

# **Regulations**

*for the Air Cargo Challenge 2019 in Stuttgart*

*(European edition)*

Version 1.05

15<sup>th</sup> of April 2019

# TABLE OF CONTENTS

1 INTRODUCTION .....	1
2 COMPETITION PURPOSE.....	2
3 PARTICIPATION .....	3
4 APPLICATIONS .....	4
5 COMPETITION PROGRAM.....	8
6 INSURANCE AND ACCIDENTS.....	9
7 NOTIFICATIONS, NEWS AND CONTACT.....	9
8 AIRCRAFT REQUIREMENTS .....	11
9 TRANSPORTATION BOX.....	14
10 AIRCRAFT IDENTIFICATION .....	14
11 RADIO REQUIREMENTS .....	15
12 EVALUATION .....	16
13 JUDGES.....	22
14 GENERAL SCORE .....	23
15 BONUS.....	26
16 IMPORTANT DEADLINES .....	27
17 NOTES.....	28
18 APPENDIX.....	30

# 1 INTRODUCTION

The competition Air Cargo Challenge was originally initiated in 2003, inspired by the North American DBF (design-build-fly) aircraft university competitions. Since then, the competition was held every two years and, from 2007, the challenge gained an European projection. In 2019, the competition is organized by the Euroavia Stuttgart and the Akamodell Stuttgart (the winner of the competition 2009, 2013 and 2017) for the third time. It is a competition for university students and postgraduates of the engineering or science area and was created to stimulate the interest in the fields of aeronautics. In this competition each team gets the chance to test and improve their skills by competing with other teams in a design-, build- and fly competition.

Euroavia Stuttgart as well as Akamodell Stuttgart are exclusively managed by students and former students of the University of Stuttgart. They work as non-political and non-profit associations to promote and spread Aeronautical Engineering. The Air Cargo Challenge offers students the unique opportunity to develop a multidisciplinary and challenging project from its beginning to the finished product. By participating at ACC the teams can test their knowledge and, at the same time, get involved with a wide range of challenges which students will find in their future professional career: technical, interpersonal and financial challenges as well as strict deadlines. To participate in the Air Cargo Challenge competition, the team should design, document, build and fly a radio-controlled aircraft with the maximum possible payload for certain flight task. The aircraft must take-off in under 60 meters, fly 10 legs with 100 metres each as fast as possible and land safely in the place previously defined by the organizing committee. The aircraft must comply with the following competition's regulations which include design restrictions such as limited motor power and aircraft dimensions.

## 2 COMPETITION PURPOSE

### 2.1 *AIM*

The Air Cargo Challenge Competition offers students and university members the opportunity to design, build and fly a radio controlled aircraft and to compete with teams from different European universities. Engineering skills are needed to accomplish the task of designing an aircraft being successful in this competition.

The team will do its best to guarantee the fulfilment of the main objectives of this competition:

- To develop a dynamic and creative spirit between the academic and scientific communities
- To encourage cultural exchange between European universities
- To promote social interaction between people who share the same interests
- To stimulate interest in the field of aeronautics
- To develop team work
- To give professors and students with the same working field an opportunity to connect
- To share knowledge and techniques between university students and modellers
- To develop and experiment with new ideas in a practical manner
- To provide hands-on experience for professors and students who in their academic life have had few opportunities to experiment with their theoretical knowledge
- To give an opportunity to represent institutions and transmit, in an ethical and professional way, their good image

## **2.2 TEAM'S OBJECTIVES**

The team should design and build a radio-controlled aircraft with limited inner dimensions which is able to take-off within 60 metres with the maximum payload possible and to fly a given distance in a minimum time.

The competition is divided into two parts - design and flight.

- In the design part the team will construct a plane considering the requirements and produce a design report to document the design and construction process as well as their financial and teamwork approach. This design report is reviewed and graded by the competition jury.
- The flight competition determines the maximum payload transported over the given distance of 1000 metre in a minimum time. The flight competition will consist

of as many runs as possible. The goal is to have at least three runs. The number of runs depends on the number of teams and on weather conditions.

Flights will be made even under rainy and windy conditions. The decision if it is possible to fly will be made by the organisation committee.

### **3 PARTICIPATION**

All engineering/science students and engineers can participate to represent their University as long as the team has the following composition:

- A pilot:

Pilots are not required to be students nor be members of the university but must be accredited model aircraft pilots. The pilot must have an insurance for model airplanes valid in Germany. The pilot may, but does not need to be a member of the university.

- Three to six members:

One of the members takes the leader's responsibilities such as communication with the organization committee. Except for the pilot, all other team members should be professors, students and/or research associates of the higher education institution that they are representing. Teams not representing higher education institutions or from universities outside Europe are accepted if the maximum number of teams is not reached by European universities teams.

#### **3.1 PROFESSOR IN CHARGE**

A professor in charge is required when the team represents a university or different higher education school. He may also be a team member. A written declaration is required in which the professor states that the team is representing the university and approves that all team members are students or employees of the university. The aircraft has to be designed and build by students and/or university employees (such as PhD students or engineers working as research assistants) supervised by the professor. In case the Organizing Committee proves some of the team members are not from the university or other irregular actions occurred the team will be disqualified immediately.

## 4 APPLICATIONS

The applications will begin on 1<sup>st</sup> of November and will close on the 31<sup>th</sup> of December 2018 and the application form can be downloaded on our website during this period on the competition website: <http://www.acc2019.de>

The application is limited to 30 teams. If the limit is exceeded, the applications will be accepted in a first come first serve manner. Each university can have a maximum of two teams if they are from different associations and different professor in charge. The Organizing Committee will consider the applications by order of arrival and by their quality in the accomplishment of the competition aims. The application will only be considered as valid after the organization receives the following items:

- Registration form correctly filled out
- Copies of documents proving that all team members are eligible (ex: Student card, etc.)
- Professor in charge statement

All this information must be sent to [info@acc2019.de](mailto:info@acc2019.de) with declaration of the team name in the subject line of the e-mail.

Applications made after midnight, 31<sup>th</sup> December 2018, will not be accepted. However, the Organizing Committee can postpone the registration deadline or accept applications if the team limit of 30 teams is not achieved by that time. The teams will be contacted after 31<sup>th</sup> December by e-mail to confirm successful registration. A provisional list of the teams will be published on the official website. Application will then become effective with the bank transfer of the teams application fee (see 4.1).

The transfer has to take place between 31<sup>th</sup> December 2018 and 20<sup>th</sup> January 2019. For the reason of payment the team number and the name of the university have to be used.

#### 4.1 APPLICATION FEE

Full Package		Basic Package		
Lodging for 6 days (5 nights)				
Transport between university, hostel and flight field				
4 Lunches		4 Lunches		
3 Dinners		3 Dinners		
Final Dinner		Final Dinner		
Participant package		Participant package		
Payment Deadlines (total sum transferred until)				
Team members		Guests		Deadline
Full Package	Basic Package	Full Package	Basic Package	earliest transfer date: 31 <sup>th</sup> of December 2018
100€	50€	100€	50€	20 <sup>th</sup> of January 2019
180€	100€	200€	100€	1 <sup>th</sup> of April 2019
230€ (total)	130€ (total)	280€ (total)	180€ (total)	7 <sup>th</sup> of August 2019

**Table 1: Fees and Payment Deadlines**

Participation requires payment of a fee that obeys the following conditions:

Euroavia Stuttgart and Akamodell Stuttgart are legal associations and will make all efforts in order to provide the teams the greatest comfort and support possible. Accommodation, meals and transportation during the competition in Stuttgart for the duration of the flight competition are provided in the full package application fee. Accommodation and transportation are not included in the basic package application fee. Each member including pilot must pay the application fee. The fee for team members does not cover all expenses

of the organizing committee. The deficit will be covered by sponsors. Guests are not covered by sponsoring, hence they will have to pay a higher fee. If a financial surplus will be achieved, the second or third payment will be reduced for team members accordingly.

The teams are responsible for fulfilling all application fee deadlines.

In case of no need of lodging, please contact the Organizing Committee via e-mail when applying to participate in the competition.

### **Participating in the Competition**

Team members and other representatives of a registered university present at the competition are considered to be “participating in the competition” from the time they arrive at the event site until they depart the site at the conclusion of the competition or earlier by withdrawing. If you wish to stay longer, you should directly contact a hotel or inform us so that we can make a reservation at a hotel. The expenses of a longer stay are not included in the registration fee. Payment of the application fee must be made before the deadlines of Table 1: Fees and Payment Deadlines by means of bank transfer.

BIC: VOBADESS

IBAN: DE86 6009 0100 0275 6770 01

The Address of the bank is as follows:

Volksbank Stuttgart eG

Vaihinger Markt 12

70563 Stuttgart

Germany

The address of the account owner is as follows:

EUROAVIA Stuttgart Studenteninitiative e.V.

Pfaffenwaldring 27

70569 Stuttgart

Germany



The transfer data should be sent by e-mail so that the registration can be completed. The application fee will not be returned in any case, unless the event does not take place.

**Checks will not be accepted! Payment may only be made via bank transfer (SEPA-transfer recommended)!**

## 5 COMPETITION PROGRAM

The program for the Air Cargo Challenge 2019 in Stuttgart is planned as shown in the following table:

<b>Monday</b> 12 <sup>th</sup> August	<b>Tuesday</b> 13 <sup>th</sup> August	<b>Wednesday</b> 14 <sup>th</sup> Aug	<b>Thursday</b> 15 <sup>th</sup> August	<b>Friday</b> 16 <sup>th</sup> August	<b>Saturday</b> 17 <sup>th</sup> August
Arrival in Stuttgart	Oral presentation, Technical Inspection	Flight competition	Flight competition	Flight competition, Final Dinner	Departure

**Table 2: Competition Days**

### 5.1 REGISTRATION OF SEVERAL AIRCRAFT FROM THE SAME UNIVERSITY

The universities may participate with a maximum of two aircraft under the following conditions:

- Each aircraft registered should correspond to one team only
- Each aircraft registered should be different in geometry
- The aircraft registered should show clear design differences between them. By different designs we mean designs that follow different philosophies in their definition.
- Each person can only be registered in one team, except the pilot that can belong to both teams
- Each team can only participate with one aircraft
- Each of them has to be from independent associations and need a separate professor in charge

## **6 INSURANCE AND ACCIDENTS**

For the competition the Organization Committee will have insurance for the duration of the event. Yet the pilots need to have an insurance for model air planes by German law. It must amount a minimum of 1.000.000 €.

We advise all participants to travel with a health insurance and with a European card of medical assistance.

## **7 NOTIFICATIONS, NEWS AND CONTACT**

The organizing committee is available to all interested people.

The contact should be directed through e-mail to

[info@acc2019.de](mailto:info@acc2019.de)

All ads, warnings, news, deadlines changes, or any other subject related to the competition will be available on the official website:

[www.acc2019.de](http://www.acc2019.de)

The competition regulations may be changed by the Organizing Committee in order to fix errors or omissions that are found in the existing regulations. The Organizing Committee may contact the team leaders by e-mail about more or less urgent subjects. All teams are considered to be notified from the moment that all the information is available at the official website of the competition.

The organization committee will provide email support to answer questions regarding the event or technical questions. If necessary or helpful, important information will also be published on the website.

Note: We suggest visiting the website regularly from the day of the team's application on.

**In case you have any questions about ACC feel free to contact us!**

Contact:

Website: [www.acc2019.de](http://www.acc2019.de)

E-mail: [info@acc2019.de](mailto:info@acc2019.de)

Address:

EUROAVIA Stuttgart  
Studenteninitiative e.V.  
Pfaffenwaldring 27  
D-70569 Stuttgart

## **8 AIRCRAFT REQUIREMENTS**

### **8.1 AIRCRAFT CONFIGURATION**

The aircraft may be of any configuration except rotary wing or lighter-than-air (for example, helicopters, autogyros, dirigibles, balloons are excluded).

- No form of externally assisted take-off is allowed. All energy for take-off must come from the on-board propulsion battery pack(s). The only means of aircraft propulsion is the prescribed electric motor (see 8.2.1).

### **8.2 MOTOR, PROPELLER AND BATTERIES**

#### **8.2.1 Motor**

- The motor must be an unmodified AXI Gold 2826/10. All official variations of this motor series are allowed. The aircraft must be driven by a single motor.
- Any ESC can be used.
- The motor current will be limited by the given propeller. (See **8.2.3**)

The motor is limited to this one to ensure each team has equal conditions. An AXI motor has been used for the last four competitions. Again an AXI has been chosen due to its reliability, high quality and availability. To avoid overheating of the motor, we recommend open mounting with good access to cooling airflow.

### **8.2.2 Batteries**

All Lithium based batteries (LiPo, LiFe, LiIon) can be used. The teams can use up to 3 cells in series. The product of max. continuous discharge rate times the capacity has to be at least 45A.

The batteries must have a minimum capacity to ensure the planes can perform at least one flight pattern. However, each team can choose to use batteries with larger capacities (in case a re-flight is necessary or for other reasons). Each team is responsible to have their batteries charged before each flight.

It is recommended to bring more than just one battery. Voltage, capacity and max. charge/discharge rate have to be clearly identified on battery. The cells/packs have to keep their factory look and may not be altered.

At the airfield electric power (230V AC and 12V DC) will be available in order to enable the teams to charge their batteries.

### **8.2.3 Propeller**

There is only one single propeller allowed. Ducted fans are allowed. A spinner or security screw must be used.

The only Propeller allowed is an unmodified Aeronaut Cam Carbon light prop 12x7 (manufactory code 721636)

The reason for the prescription of this specific propeller type is to ensure comparable thrust for all teams without overloading the motor. A limitation of the motor current has shown to be unreliable and to delay the flight competition, hence this option has been discarded.

### **8.2.4 Transmission**

Transmission gears, chains and propeller shafts are allowed as long as the rotation ratio between the motor and the propeller is 1:1.

## **8.3 AIRCRAFT RESTRICTIONS**

Restriction for the aircraft dimensions is that all parts, they are necessary for flight, fit in a box with outer dimensions 750mm \* 400mm \* 250mm.

### **Control restrictions:**

No autopilot or control assistance systems (gyroscope, any artificial stabilizing systems) may be used. Mixing abilities in the transmitter/receiver may be used, as long as they do not use any input of sensors.

However, sensors may be used for safety reasons (controlling voltage of RX battery, temperature of battery, motor etc.).

Each aircraft has to be controlled by only one single pilot.

### **8.4 CARGO BAY**

The volume of the bay will be checked during the dimensional inspection and design analysis. The cargo bay may be larger than required to allow the payload positioning and adjustment of the centre of gravity, but always keeping the exact spacing of 80mm between the two 8mm diameter supports. The cargo bay should be shown clearly in one of the drawings, including dimensions and the corresponding volume should be included in the data chart of the 3-view drawing. The cargo bay may have any shape as long as it carries the payload support with the prescribed design (see attachment). During the technical verifications, the jury will use an orthogonal volume of 160x80x80mm (see attachment) made of foam that will be introduced in the cargo bay in order to simulate the cargo plates and ensure that every team respected the minimum cargo volume as stated in the regulations.

### **8.5 PAYLOAD**

#### **8.5.1 Payload and load support**

The payload consists of an amount of steel plates which have the corresponding weight. The payload plates are mounted through two 8mm diameter supports (bolts or screws with 80mm distance) in or on the plane. The payload has to be mounted in or to the plane and should not be able to move under normal loads (taxiing, flight, landing etc.).

#### **8.5.2 Payload distribution**

The payload may not have any effect on the structural stability of the aircraft and must be fixed in the cargo bay to prevent it from moving during flight. The payload has to be

mounted in the cargo bay as one block and should not have much influence on the centre of gravity of the plane. Therefore the cargo bay should be in the centre of gravity of the plane.

## **9 TRANSPORTATION BOX**

Each team has to use a transportation box for the aircraft. The box is limited in size and must not exceed  $750 \times 400 \times 250 \text{ mm}^3$  (inside dimensions, see attachment). All parts of the aircraft (wing, tail, fuselage, landing gear, motor, propeller, batteries...) must fit into this box at one time. The transmitter is not regarded as a part of the aircraft. The box is to be used during the transfer between the hostel and the airfield and is also well suited to travel as luggage in an airplane.

It is also recommended that each transportation box has handles on both ends.

## **10 AIRCRAFT IDENTIFICATION**

Each aircraft must have unique identification symbols. This identification should be the team number and the name of the university. Other logos, for example from sponsors, are also allowed.

### **10.1 TEAM NUMBER**

The fuselage and wings of each aircraft must be identified with the team number in clear figures of at least 10 cm height. The number of each team will be decided in a draw. The team number should be shown at least at the following positions:

- On both of the wings (top and bottom);
- On both sides of the fuselage or vertical stabilizer.

### **10.2 UNIVERSITY NAME**

The University name (if applicable) should be visible on the wings or the fuselage. The University initials can be used if they are unique and recognizable.

# 11 RADIO REQUIREMENTS

## 11.1 RADIO CONTROL

The radio control is used to fly and operate the aircraft. Any gyroscope/ auto-pilot assistance is not allowed. The servos have to be capable of withstanding the aerodynamic loads the aircraft is going to be subjected to during the flight. The flight will occur independent on weather conditions, either sunny, rainy or windy. Therefore the teams should be prepared to protect their radio equipment. All radios should comply with the frequencies for aircraft models in Germany. An independent RX battery pack is mandatory, with a minimum capacity of 600 mAh.

Note: a list of allowed channels in Germany can be found at

[http://www.rc-network.de/magazin/artikel\\_05/art\\_05-027/laender/GER.pdf](http://www.rc-network.de/magazin/artikel_05/art_05-027/laender/GER.pdf)

In Germany the 35MHz band and 2.4GHz Systems are allowed.

We highly recommend the use of a 2.4GHz system, since it reduces the risk of multiple teams having the same frequency channel. It also enables the teams to keep their transmitter all the time. This is helpful to adjust the transmitter settings during the competition.

If a 35MHz system is used, the channel number has to be mounted on the transmitter in large letters.

# 12 EVALUATION

The evaluation of the designs will be made in four disciplines:

1. Preliminary Report
2. Report (Technical Report and Drawings)
3. Oral Presentation
4. Flight Competition.

The report has to be sent in as a hardback and must additionally be emailed as a PDF file. Both report and presentation must be in English. The slide show for the oral presentation should be either in \*.ppt, \*.pptx or in \*.pdf format.

## **12.1 PRELIMINARY REPORT**

A preliminary report must be delivered until the 1st April 2019, so that the organizing committee can get an overview of the ongoing competition. The preliminary report consists of a written document that should not exceed one A4 page and eight additional pictures. The text should give a summary of the status of the project, making reference to what is already developed, what is not yet developed, the difficulties encountered, etc. The pictures should be an evidence of the aircraft's building condition and can also be about the experience of the team in the development of the project. The report should be sent by e-mail as a PDF file and is not scored. There is, however, a penalty for teams who do not deliver the report.

## **12.2 REPORT**

The design report and the drawings must be delivered until 15th May 2019 without delay penalty. By the 25th June 2019 the maximum penalty will be given. The date being checked by the organization committee will be the post time stamp. The report may have 30 pages maximum (without attachments). It must be printed in A4 format and font Times New Roman with size 12. The report has to be a hardback so that there are not any separate sheets. It should be correctly identified with the name and number of the team and the University has to appear on the front page. Each team has to send four complete copies of the report and also email it as a PDF file. The report must be written in English language. The report will be evaluated in terms of its technical content, methods, creativity, clear organization, objectivity and form. A copy of the registration form signed by all the members and the professor in charge of the project should be attached to the reports.

For having a better comparability between the different reports, the report shall contain at least the following chapters:

- Introduction
- Project management (financial budget and time schedule)
- Aerodynamic Design
- Structural Design
- Payload Prediction
- Outlook



More content is requested and necessary for getting the full score for the Report.

### **12.3 DRAWINGS**

Each copy of the report must include a set of four detailed drawings of the aircraft. These drawings consist of A3 size sheets, printed on one side, properly folded, and bound with the report so that they can be analysed without separating them from the rest of the document. One of the drawings must be a 3-view drawing of the aircraft using European projection, that is:

- front view at the top left corner
- top view below
- starboard view on the right (of the front view)

The views must contain the main aircraft dimensions (wingspan, wing chords, length and height, etc.). Below the starboard view, there must be a table containing other dimensional information such as relevant areas and/or volumes. Another drawing must be an isometric perspective view of the aircraft. The remaining three must contain information that each team finds relevant with at least one drawing showing the cargo bay, its location and dimensions. A standard scale for each drawing must be properly chosen. The 3-view and isometric perspective drawings may not display hidden lines. All dimensions must be in SI units except for linear lengths which should be in millimetres and plain angles which should be in degrees. All the drawings must have a label in the right bottom corner containing the University logo, the team's name and number, a short description and other pertinent information. The team should send a separate extra copy of the 3-view drawing to be used during the dimensional inspection prior to the flight competition. This copy has to be sent with the report or a penalty of 10 points will be given. If the aircraft is changed after the report is send in, a new copy with remarks identifying the changes has to be e-mailed to the organization committee.

- 3-view drawing
- Isometric drawing
- Cargo bay
- Free choice

#### **12.4 CALCULATION OF THE PAYLOAD**

A payload prediction has to be calculated as a function of the air density.

A linear approximation should be used. The report has to include the formula and a graph showing the predicted payload over air density.

The equation must be in the following form:

$$\text{predicted payload [kg]} = a * \text{air density [kg/m}^3\text{]} + b$$

#### **12.5 CHANGES TO THE AIRCRAFT**

Changes made to the aircraft should be presented in written form to the organizing committee at the latest seven days before the beginning of the flight competition at the latest. The judges will then decide on point deductions based on the amount and relevance of the changes done to the aircraft when compared to the design presented in the report. Relevant changes during the competition will only be allowed when accepted by the judges. The judges' decision concerning the change cannot be questioned by the team.

#### **12.6 ORAL PRESENTATION**

All teams must hold an oral presentation about their project on the first day of the competition. The aim is to share the experience gained during the construction and test phases with the audience. The presentation is scored up to 30 points. There will be penalties for those who arrive late or run out of time. The following items are taken into account especially:

- Clearness of information
- Articulation
- Presentation style
- accentuation of distinctive features of the design
- Elements about difficulties during the Project, lessons learned for a future Project, description of the methods used in the construction, etc. ...

The oral presentation is limited to 15 minutes. A projector and a computer will be available to teams at the presentation day. The teams should be prepared to answer any questions asked by the judges. The presentations must include evidence (a movie) that proves that the aircraft has previously flown. The time for questions by the audience is five minutes following the presentation. The proof of flight video and a PDF version of the presentation have to be delivered to the Organizing Committee.

### **12.7 FLIGHT COMPETITION**

The flight Competition will take place in August 2019 near Stuttgart, Germany.

There will be a safety inspection of every aircraft before the flight competition starts.

The safety inspections will include the following:

Physical inspection of the aircraft to ensure structural integrity and to verify compliance with the design report:

1. Verification that all components are adequately secured to the vehicle
2. Verification that the propeller is attached safely
3. Visual inspection of all electronic wiring to ensure adequate wires and connectors are used
4. Radio range check, motor off and motor on
5. Verification that all controls move in the proper sense
6. Check general integrity of the payload system
7. Check if the structure of the aircraft can handle the payload. Therefore the wing is lifted up at the wingtips

The orientation of the flight course will be adjusted based on the prevailing winds as determined by the Flight Line Judge. The flight will be positioned to maintain the greatest possible safety to personnel, facilities and spectators. The maximum take-off distance is 60 meters. The number of points given to a team will be based on the maximum payload carried and the flight time for 10 legs each 100 metre. In order for a team to participate in the flight competition, it must accomplish all the requirements of the competition project and must have previously tested the aircraft. The team should demonstrate at the oral

presentation that the aircraft has already successfully flown in the same condition it is going to participate in the flight competition.

If the organizing committee concludes that this is not the case, the team can be disqualified based on a security argument. An aircraft that has never flown before the competition or has no proof of flight will not be allowed to fly during the competition.

#### **12.7.1 Flight pattern (fully acceptable flight)**

The aircraft should take off within the defined 60 metres long runway strip. The initial position of the aircraft is located at the departure line (main gear on the line). The aircraft has to take off (be in the air) within 60m, otherwise the flight attempt is invalid.

There is a 3 minute time window for performing a successful take off within the 60m runway. Multiple attempts are possible during this time frame.

After take-off there is a 30 second time window for gaining some altitude and flying into the speed task course.

After the 30 seconds are over or the plane enters the speed course the time for speed task starts.

Afterwards the pilot should perform a landing as fast as possible.

You should respect the safety area defined for the flight competition. Repairs are only allowed to broken parts. Changes are only allowed if the judges give their permission.

#### **12.7.2 Landing**

The landing is valid as long as it is performed completely on the flying field and without losing parts. The field is about 120m long and 40m wide, but mainly consists of short cut grass except for the runway for the take-off.

#### **12.7.3 Changes and repairs**

The aircraft can be repaired during the competition. However, the aircraft should finish the competition with elements similar to the original ones. The servos, propeller, motors

and landing gears can be replaced at any time. The Organizing Committee must be informed of all modifications. The use and addition of covering, tape, glue, small screws or rivets and structural internal components is not considered to be a change.

## **13 JUDGES**

Each team will design, document, implement and demonstrate the aircraft they determine to be capable of achieving the highest score at the contest. A group of professors, engineers and students will be designated to judge the reports, the oral presentations and the flight competitions of each team. The overall team score is a combination of the Design Report and flight scores. The team with the highest overall score will be the winner.

The Judges will also oversee the technical inspection. Their measurements, checks and decisions overrule the teams' decisions and measurements.

For the measurements the judges will be equipped with appropriate tools to make fair measurements and decisions.

The jury will be formed by members of the Euroavia Stuttgart, Akamodell Stuttgart, a professor of the University of Stuttgart and a representative of the industry.

The members of the jury will be announced on the website prior to the competition date.

## **14 GENERAL SCORE**

The general score will be calculated as follows:

Flight Competition Points + Project Competition Points – Penalties Formel

### **14.1 PROJECT SCORE**

The Design Project competition will be scored according to the following criteria:

- Detailed drawings = max. 30 points
- Report = max. 50 points
- Estimated Payload = max. 10 points
- Oral presentation = max. 30 points

## 14.2 FLIGHT COMPETITION

In order for a team to participate in the flight competition, it must fulfil all the requirements of the competition and must have previously tested the aircraft.

At the oral presentation each team has to show an evidence of flight for their aircraft (video).

In this proof of flight the plane has to be in the same condition as during the competitions. No major changes will be tolerated. This does not affect repairs that have to be made before the competition.

### 14.2.1 Maximum payload carried

The flight competition will consist of at least 3 scoring runs if weather conditions permit (and an optional previous free test run) in which the teams will try to carry the maximum possible weight and fly 10 legs a 100m (see drawing in Appendix). The number of points will be determined using the following formula.

$$\text{Flight competition points} = \left( \frac{\text{flown weight [kg]}}{\text{flown time [s]}} \cdot 2000 + a + b + c \right) \cdot d + \text{Timebonus}$$

a = 10 for no parts lost ; a=0 for parts lost

b = 10 for landing on field

c = 10 for landing in 60m area

d = 0 for crashes or invalid start (jury will decide in that case)

For c, an extra area will be marked on the landing field.

The weight and the legs have to be flown in the same round. If two or less rounds flown in the competition, the best flight will count for result. Otherwise the points for total score will be the average value of best and second best flight.

### 14.3 PENALTIES

The reports, drawings, the estimated payload chart and the envelope with the 3-view drawings should be delivered to the organizing committee no later than the established date. The organizing committee will not be liable for document loss or mistakes in the addresses. It is suggested that all the reports and drawings are sent by mail or delivered by hand. Only receipts, mail stamps or bills will be accepted as proof of the sending date.

The penalties will be:

Subject	Penalty
Preliminary Report missing	30 points
Delay in delivering reports/drawings	10 points per day
Delay or not being present at start of oral presentations	12 points
Delays during competition	2 points per minute
Chart or equation of payload vs. air density is missing	no payload prediction bonus
Replacements of parts without notifying the organisation committee	10 points
Extra version of drawings is missing	10 points
Disregard of regulations	Disqualification
Video for proof of flight is missing	Disqualification
Changes to the original project of the aircraft	Defined for each case
Wrong size of the cargo bay	40 points
Flying outside specified flying area	Disqualification for that run, run gets 0 points
Flying over spectator area	50 points penalty on final score (for all runs)

Unsuitability regarding the aims of the competition	Min. 30 points up to disqualification
Disrespect/disobedience to judges	Min. 10 points up to disqualification
Any major attitude against organizing or logistic procedures	3 points
Breaking security rules	Up to disqualification
Aircraft parts transported outside the transportation box	Up to disqualification
Unstated protests	35 points

**Table 3: Penalties**

## 15 BONUS

### 15.1 PAYLOAD PREDICTION BONUS

The payload prediction bonus will be determined according to the following formula:

$$\text{Prediction Bonus} = 10 \cdot \left( 1 - \frac{\text{predicted payload} - \text{actual payload}}{\text{predicted payload}} \right)$$

The predicted payload is a constant value obtained from the chart of payload prediction. The actual payload is the payload achieved during the flight competition. Be aware that the maximum possible payload will not necessarily result in maximum points as it might be beneficial for the distance task to fly lighter.

### 15.2 TIME BONUS

At the flight competition each team has two minutes to put the payload into the aircraft. The shorter the amount of time a team needs for loading the more points can be gained. The aircraft shall be prepared for take-off completely before the two minutes countdown starts. After the payload is mounted no more changes to the aircraft may be made (except plugging the battery in).

The relationship is the following:

$$\text{Time Bonus} = 24 \times (1 - t/120s) \text{ for } t < 120s$$





## **17.2 PROTESTS**

The teams have the right to protest against the decisions made by the organizing committee. The current regulation and the decisions of the judges cannot be the target of any protests. The protests should be presented in writing to the judges and addressed by the team's leader. The organizing committee is available to accept any suggestions or criticism aiming at improving any aspect of the competition. We remind you that unjustified protests will end in a penalty.

## **17.3 COMPETITION OFFICIALS AND TECHNICAL AND SCIENTIFIC COUNSELLORS**

The Organizing Committee includes three groups of people that will take care of the score process, organisation and management of the competition. The name of these people will be announced at the appropriate time.

## **17.4 TECHNICAL AND SCIENTIFIC COUNSELLORS**

### **Scientific Committee:**

The **Scientific Committee** is constituted of university scientists in the aeronautics field. They cooperate with the Organizing Committee concerning the regulations, so that this event becomes more interesting from engineering and science perspectives.

### **Technical Committee:**

It is responsible for the creation of the regulations and it has to assure that all these rules are followed during the Air Cargo Challenge. It has to check if the projects respect all the rules and to assure that all the flying competition occurs according to the previously established procedures and rules.

# 18 APPENDIX

## 18.1 FLIGHT PATTERN

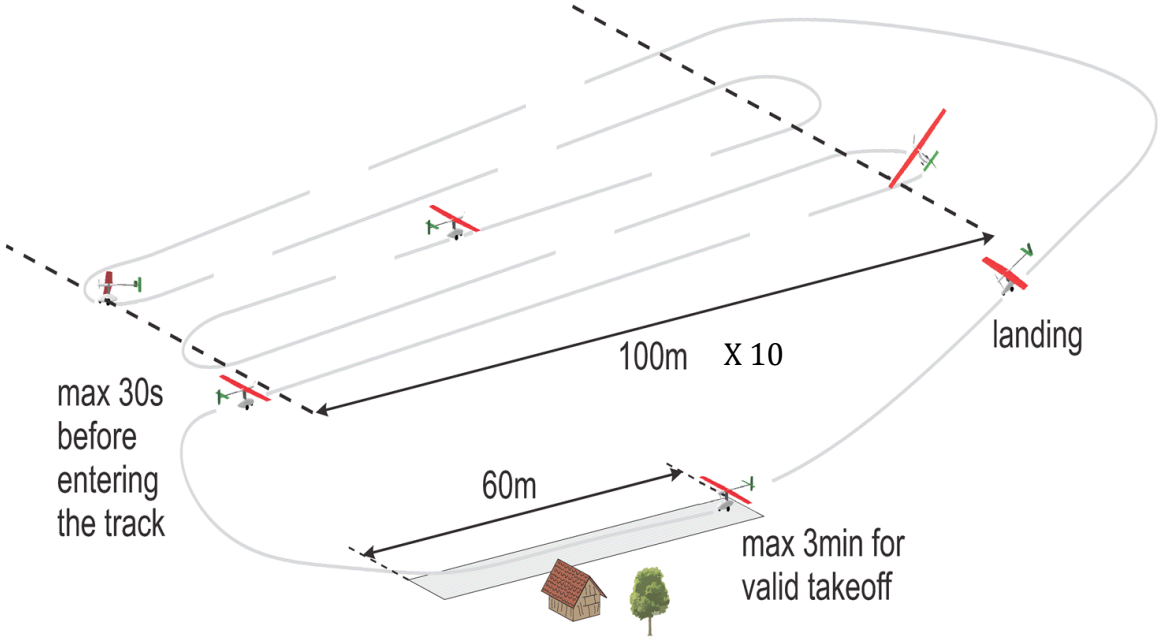
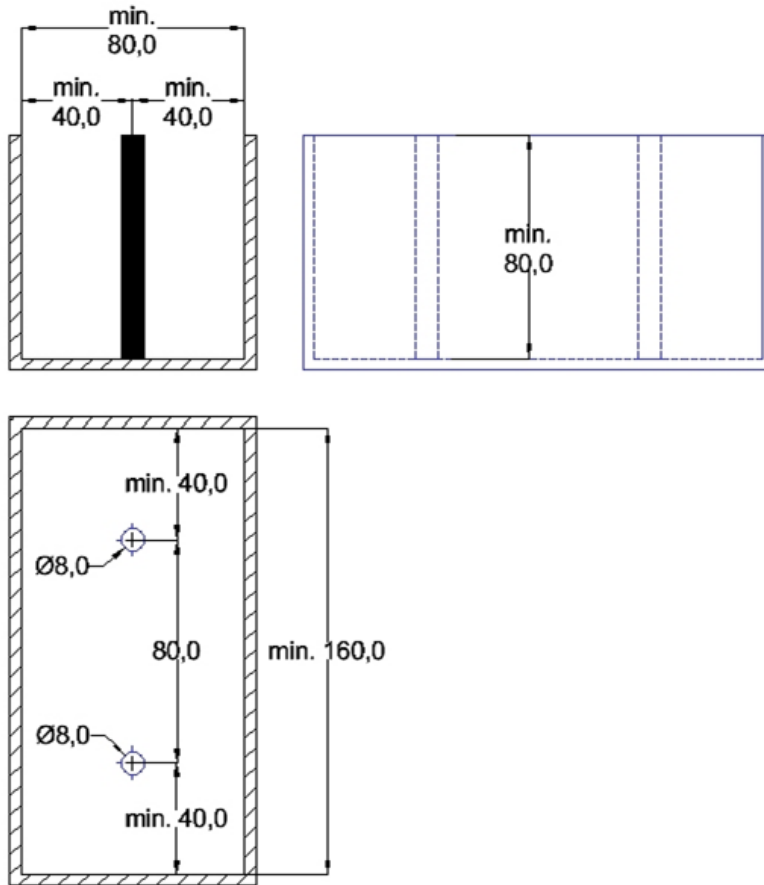


Figure 1: Graphical description of the flight pattern

## 18.2 CARGO BAY



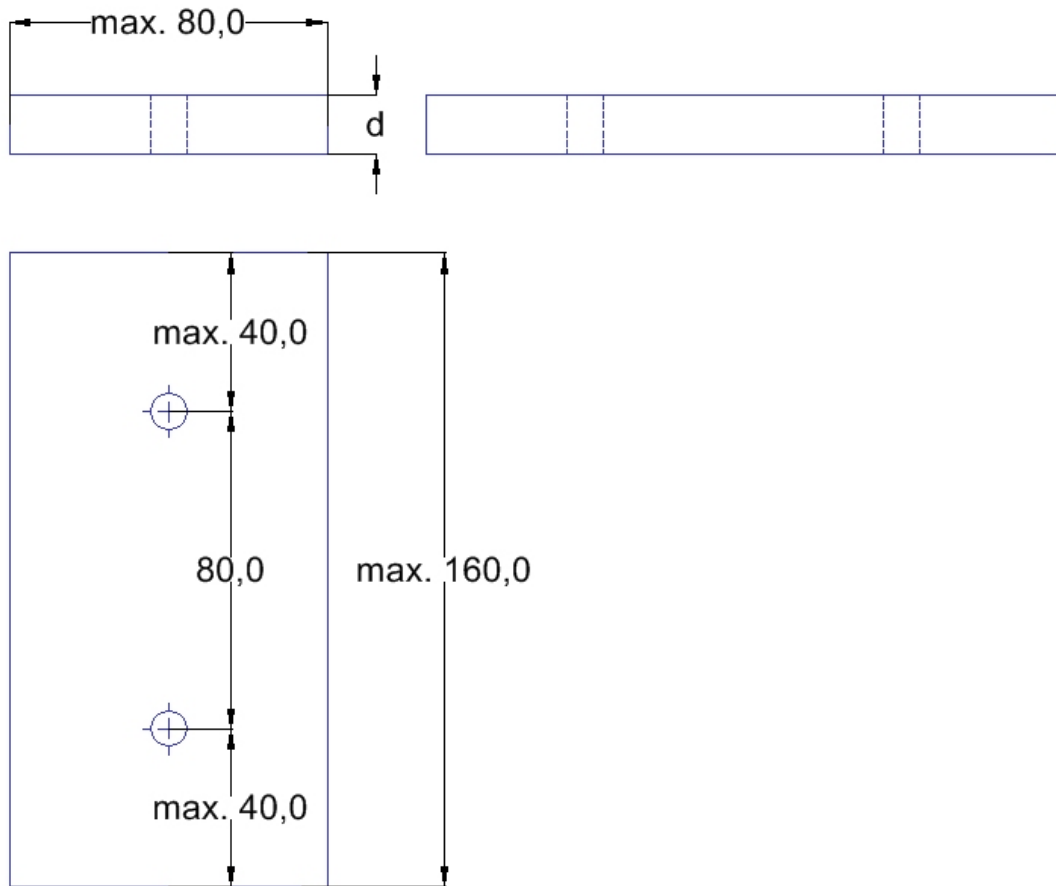
**Figure 2: Dimensions of the cargo bay**

The actual dimensions of the cargo bay may be larger than the given minimum dimensions (we recommend this).

The maximum dimensions of the metal plates are the minimal dimensions of the cargo bay.

If you decide to use the minimum dimensions for the cargo bay it might be hard to fit the plates into the cargo bay.

### 18.3 WEIGHT PLATES

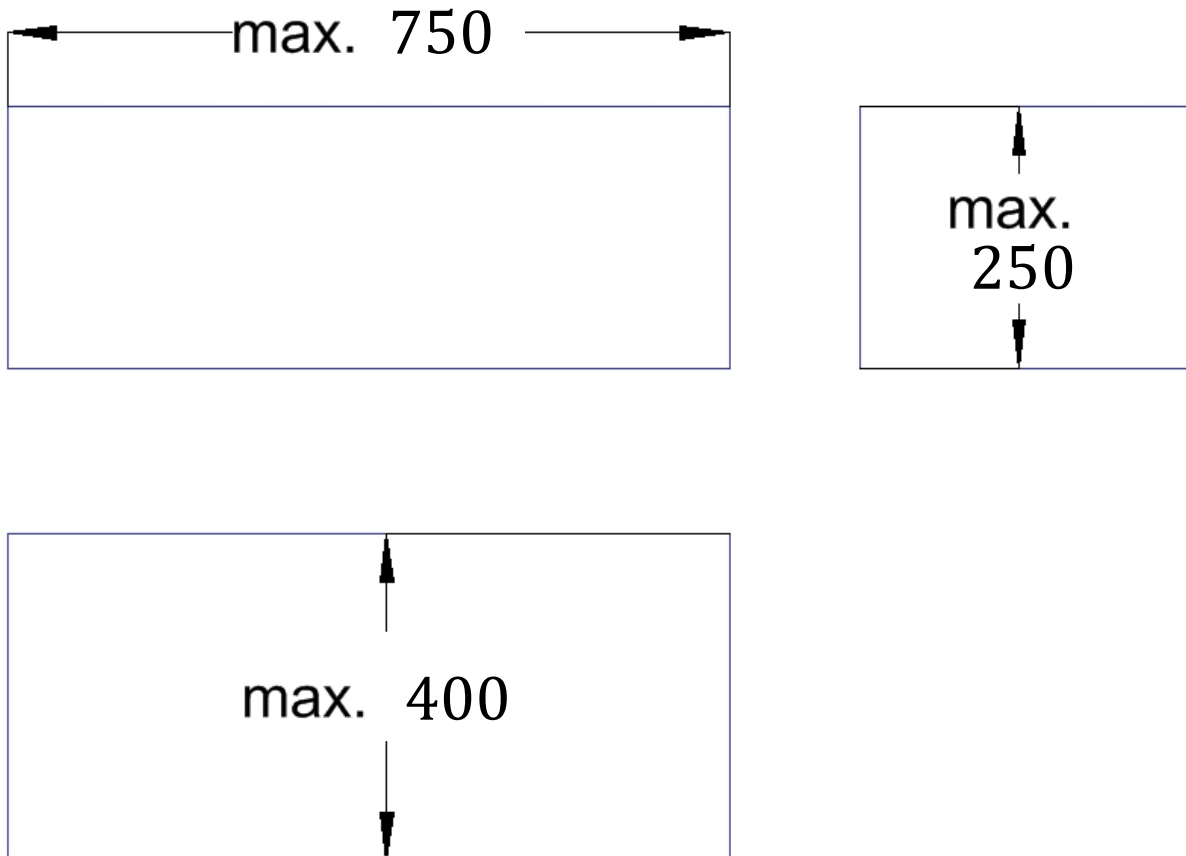


**Figure 3: Dimension of the metal plates**

The bore diameter will be slightly more than 8mm (probably 8.5 mm or 9 mm). The distance of the bores is 80 mm with less than 1mm tolerance.

The plates may be smaller and vary in thickness in order to achieve the payload requested by the teams within a tolerance of  $\pm 50$  g.

#### 18.4 TRANSPORTATION BOX



**Figure 4: Transportation Box**

The dimensions of the transportation box are maximum inner dimensions.

The weight of the transportation box should be 32 kg or less. In case it has more weight it probably is more expensive, since it will not be considered medium, but large sport baggage.

The team should notify the airline that it has oversized baggage to avoid trouble getting the transportation box on board.