



Category B Challenge Booklet 2023

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SAFMC 2023 CAT B CHALLENGE BOOKLET CHANGE LOG

Version	Release Date	Description
1.0	14 Nov 2022	Official challenge booklet release

SAFMC 2023 COMPETITION SCHEDULE

Date*	Event	Platform/Venue
20 - 29 March 2023	Presentation	Challenge day
20 – 29 March 2023	Category Challenges	Science Centre Singapore
1 April 2023	Awards Presentation Ceremony	Science Centre Singapore

** The competition schedule is subject to changes in accordance with the latest MOE guidelines for COVID-19. Any changes will be updated on the SAFMC Website and Facebook. Registered participants will be informed via their registered email address.*

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1. SINGAPORE AMAZING FLYING MACHINE COMPETITION 2023

1. INTRODUCTION

Singapore Amazing Flying Machine Competition (SAFMC) is an exciting and unique event organised by DSO National Laboratories and Science Centre Singapore, and supported by Ministry of Defence (MINDEF). Open to all schools and participants who are keen to explore the science behind flight and create their very own flying machines, this annual competition promises a fun-filled learning journey with special talks, workshops and live demonstrations.

2. CATEGORIES

CATEGORY A – PAPER PLANES (*Primary Schools*)

Each team should consist of TWO (2) to THREE (3) members.

Design and fold paper planes to achieve the longest, farthest or most unique flight.

CATEGORY B – UNPOWERED GLIDERS (*Secondary Schools / Integrated Programme*)

Each team should consist of TWO (2) to FIVE (5) members.

Category B will be open to a maximum number of 150 registered teams.

Design and build small unpowered bungee-launched gliders to achieve the farthest and most precise flight.

CATEGORY C – RADIO CONTROL FLIGHT / FIRST PERSON VIEW (FPV) FLIGHT (NOVICE, ADVANCED)

Category C1: Radio Control Flight - Fixed Wing (*Secondary Schools / Integrated Programme / Junior Colleges / Institute of Technical Education*)

Each team should consist of TWO (2) to FIVE (5) members.

Design and build a small remote-controlled fixed-wing air platform to navigate an obstacle course.

Category C2: FPV Flight – Novice (*All Schools*)

Each team should consist of ONE (1) to TWO (2) members.

Bring, or design and build, a ducted (shielded propeller) FPV drone to compete in an obstacle course.

Category C3: FPV Flight – Advanced (All Schools)

Each team should consist of ONE (1) member.

Bring, or design and build, a FPV drone to compete in an obstacle course.

CATEGORY D – SEMI-AUTONOMOUS / AUTONOMOUS (*Polytechnics / Universities*)

Category D1: Semi-Autonomous

Each team should consist of TWO (2) to FIVE (5) members.

Design and build up to three semi-autonomous small air platforms, controlled using wearables, to perform a multitude of tasks in an indoor course.

Category D2: Autonomous

Each team should consist of TWO (2) to FIVE (5) members.

Design and build three autonomous small air platforms to collaboratively perform a multitude of tasks in an indoor course.

CATEGORY E – SWARM (*Open to Public*)

Each team should consist of TWO (2) to TEN (10) members.

Bring, or design and build, a swarm of TEN (10) to TWENTY-FIVE (25) drones to compete in a search and rescue mission.

3. GENERAL SAFMC 2023 RULES

- **The deadline for registration is 24 February 2023.**
- Participants registered under a school must be a full-time student at the point of competition.
- Home-schooled participants and teams consisting of participants from different schools should be registered as “Independent teams”.
- Participants will be notified upon successful registration within two weeks of the registration deadline. The decisions made by the SAFMC organising committee are final, and are subjected to the competition schedule and availability of logistics support.
- Each person can only participate in one team within a category. However, the person can participate as a member in different categories, i.e. a person can be a member of a team

in Category B and another team in Category C but the person cannot be a member of two teams in Category B.

- Teams are allowed to take part in categories beyond the specified educational level, i.e. Primary school students are allowed to take part in Category B, C, D or E. Secondary school students are allowed to take part in Category C, D or E.
- Participants of Category C1 are also eligible to register for either Category C2 or C3 but not both.
- Participants of Category C2 are not eligible to participate in Category C3 and vice versa.
- Participants of Category D1 are also eligible to participate in Category D2 and vice versa.
- Members and family members of the organising committee are not allowed to participate in the SAFMC.
- The organisers reserve the right to amend the rules and regulations. In the event of changes, all teams will be informed at least **FOUR (4)** weeks prior to the start of the competition.
- Prizes will be issued to the Team Manager.
- A safety perimeter net will be set up at the competition field for Categories B, C, D, and E. There will be a top net approximately **EIGHT (8) meters** above the ground, which will limit the maximum flight altitude of flying machines. During the challenge attempts, teams are strongly encouraged to fly their aircraft away from the netting to avoid accidental entanglement.
- The organisers of SAFMC 2023 will not be held responsible for any damage to or the loss of any flying machine(s) throughout the entire competition.
- Participants are responsible for the safe flying of their flying machine(s) for the duration of the entire competition. The organisers reserve the right to ground the flying machine(s) of any team at any point in the competition.
- For queries regarding the competition, please send an email with the title stating the category in question (e.g.: *[CAT B] - Clarification about task locations*) to the following email address: SAFMC@science.edu.sg

4. FORMAT OF COMPETITION

Once the teams have confirmed their registration for the competition, they are expected to start work on the different aspects of the competition, which consists of the Challenge and the Presentation.

Teams are encouraged to provide equal attention to both the Challenge and the Presentation aspects of the competition.

The top team from each category will be presented with the Championship Award at the SAFMC 2023 Awards Presentation Ceremony.

4.1 PRESENTATION

The teams will be allocated a specific time slot to showcase their flying machine during the actual competition day. Teams will present their flying machine design and learning journey in this competition to a panel of judges. These teams will be assessed for a number of awards.

The presentation plays an integral part for teams who wish to compete for the SAFMC Championship Award. Teams that do not show their flying machines for the presentation may be disqualified immediately. The requirements for the Presentation segment will be detailed in Section 9.

The Chief Referee or Judge for each category reserves the right to deduct points if the flying machines used in the Challenge are drastically different from the flying machine presented at the Presentation.

4.2 CHALLENGE

The physical competition will be conducted in accordance with Safe Management Measures (SMM) guidelines, which will be announced closer to the competition.

For the Challenge, teams are to design, build and fly their flying machines to overcome various challenges for the different SAFMC categories. The Challenge consists of a presentation, and the actual in-venue flight on the competition day.

The presentation serves as a prelude to the team's aircraft capabilities and flight-worthiness. The flight allows teams to accomplish the mission tasks in a live capacity in front of an audience.

On the competition day, tables will be provided within the main competition hall for teams to work on their flying machines. Alternatively, teams may be assigned a designated area instead.

Teams should expect the following during the competition day:

- Only registered team members of the participating teams can enter the playing field and team booths/holding areas.
- Teams are expected to fully comply with safety rules. Failure to comply with safety rules after the initial warning will result in immediate disqualification and potential blacklisting from the competition. The organizer will also not be responsible for any injuries or mishaps if any participant has disregarded the safety rules.
- No trials will be allowed in the flying area unless specified by the officials.
- The participants will acknowledge that there will be variations in environmental conditions between teams, despite best efforts to control them
- Additional rules and regulations specific to Category B are detailed in Sections 8 and 9. Participants will acknowledge that they have read the rules.

5. CATEGORY B AWARDS

Award winners will be selected based on either presentation scores, performance on the competition day, or a combination of both.

There is no limit to the number of awards that a team can win, but there may not be a winner for every award. Awards may not be given out if the teams do not meet the minimum standard determined by the SAFMC organising committee, or if there are insufficient participants for each category.

All scoring decisions made by the judges are **final**. For arbitrary cases, the organising committee will have the **final** say.

5.1 CHAMPIONSHIP AWARD

This is the pinnacle award that any team can win. It is bestowed on the team that embodies the spirit of SAFMC. Teams are considered for the Championship Award based on their overall excellence and total learning experience during the course of the competition.

Scoring*	Weightage
Performance (Challenge)	50%
Creativity	20%
Theory of Flight	15%
Presentation	15%
Total	100%

*Scoring may be subjected to changes due to unforeseen circumstance that prevents the execution of the physical challenge.

5.2 BEST PERFORMANCE AWARD

This is awarded to the team that attains the highest score in the flight challenge. The total score from the two scoring rounds will be used to compete for this award. In the event there is more than one team having the same highest score after the two scoring rounds, there will be one final tie-breaker challenge. The teams will attempt to launch their glider and the team who scores the highest points in the attempt wins The Best Performance Award.

5.3 MOST CREATIVE & AESTHETIC AWARD

For the team that shows the most innovative, aesthetically decorated, and original design in their unpowered glider.

Criteria	Areas of Consideration
Creativity	Unique Design or Strategy Flair and Appearance Functionality

5.4 THEORY OF FLIGHT AWARD

For the team that best demonstrates a sound understanding and appropriate application of aerodynamic design principles, as shown by their unpowered glider.

Criteria	Areas of Consideration
Aerodynamics	Aerodynamics Control & Stability Design and Integration

5.5 BEST PRESENTATION AWARD

For the team that best exhibits creativity, fluency, confidence and flair in the presentation of their team's work, and demonstrates that "WOW" factor during the interview sessions.

Criteria	Areas of Consideration
Presentation	Fluency Confidence Flair

5.6 MERIT AWARD CERTIFICATION

For teams that exhibit high quality in design and flight performance. Overall scores are taken into consideration for this Merit Award.

6. CATEGORY B: UNPOWERED GLIDER - LAUNCHER

The unpowered glider launcher for the challenge is shown in Figure 1.

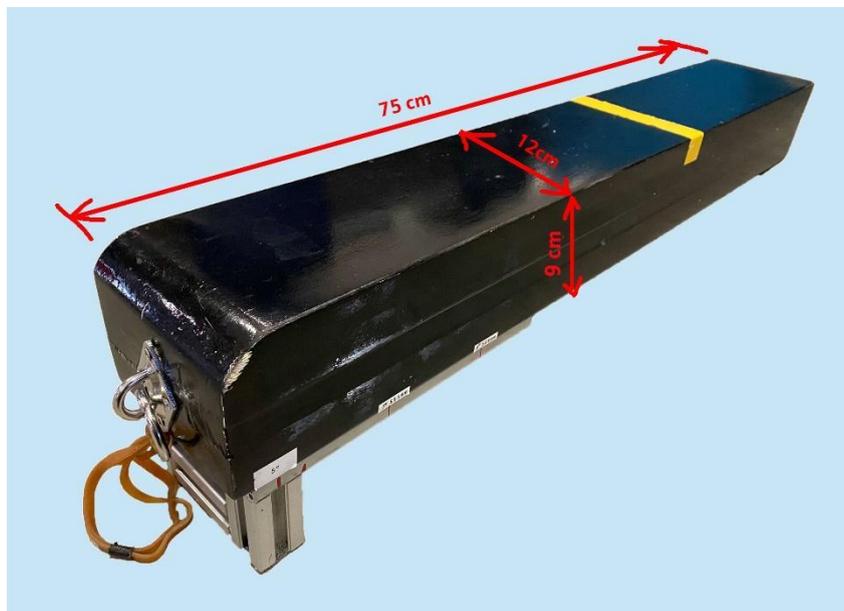


Figure 1: Unpowered Glider Launcher

Teams are strongly encouraged to fabricate and build their own launcher. The launcher consists of the structure (wooden block or other suitable material), flat rubber band and aluminium frame legs for propping up the angle of the launcher. The angle of inclination is kept at **5 +/- 1 degree** from horizontal. The dimensions and angle of inclination of the launcher are shown in Figures 1 and 2.

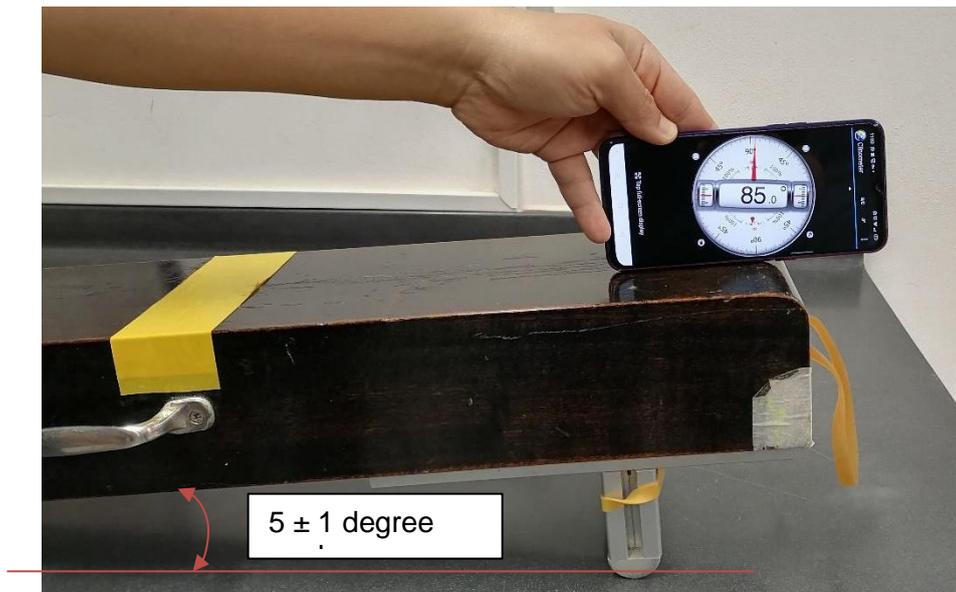


Figure 2: Unpowered Glider Launcher Platform Dimensions

Launch of the glider

The launcher will be placed on top of a table of approximately **0.75m** in height. The recommended launch force is approximately **4 ± 0.5 kgf**. The launch force is a recommendation, you can adjust the force that you need by using a force gauge or spring gauge and mark out a designated line on the platform as shown in Figure 3.



Figure 3: Unpowered Glider Launcher Launching Line

During the launch, teams will hook their glider on the rubber band and draw back the glider. The hook position from the glider will be used as a reference when the glider is being drawn back to the marked line on the platform. Upon tension to the marked line, the glider can be released.

Each team is required to incorporate a hook or slot onto the underbelly of their glider.

An illustration of examples of hook attachment and slot is shown in Figure 4.

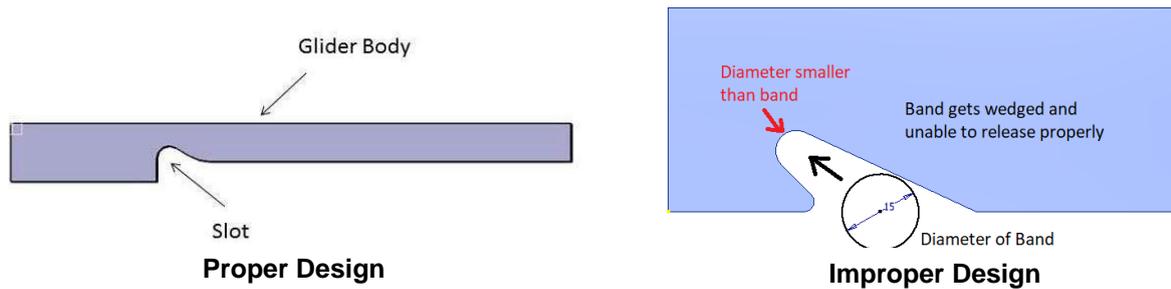


Figure 4: Examples of Hook Attachment and Slot

It is the responsibility of the team to ensure that the hook or slot design on the glider is sturdy to withstand the tension force of the rubber band without giving way when the glider is being drawn back. The team must also ensure that in the design of the glider, there are no components of the glider that come into contact with the launcher at any time during the launch.

7. CATEGORY B: UNPOWERED GLIDER - SPECIFICATIONS

The team is expected to design and build a small unpowered glider (of limited wingspan) to be rubber-band-launched from a designated launcher (as shown in Fig.1).

7.1 GENERAL RULES & REGULATIONS

Each team is to design and build **ONE (1)** unpowered glider based on the following guidelines:

1. All parts of the glider must be fabricated by the teams. Kits or off-the-shelf models or parts, i.e. servo motor, receiver, transmitter are not allowed.
2. The glider must
 - have a minimum wingspan (tip to tip) of **0.30m**
 - maximum dimension of **0.60m (wing tip to tip) x 0.60m (long or length of body)**
 - have a wing with an aspect ratio (span to mean chord) of **6.0 or more**
 - weighs no more than **0.25 kilograms**
3. The glider design must incorporate a hook or slot at the base of the glider that allows the glider to be hooked onto the rubber band of the launcher.
4. Metallic materials and fibre reinforced materials (carbon fibre, glass fibre, etc.) are not allowed for the fuselage (main body of glider). E.g. Carbon wing spars and metal

ballast are allowed.

5. Balloon or airship designs are not allowed. No gaseous substances lighter than air are allowed.
6. Propellers of any form are not allowed.
7. Teams cannot re-use past winning designs. Points will be deducted or, in the worst case, disqualified if any team is caught re-using past plane designs.

8. **CATEGORY B: UNPOWERED GLIDER - CHALLENGE**

In the challenge event, teams will launch their gliders into scoring zones to see how far their unpowered glider can reach. Figure 6 shows the competition set-up for Category B.

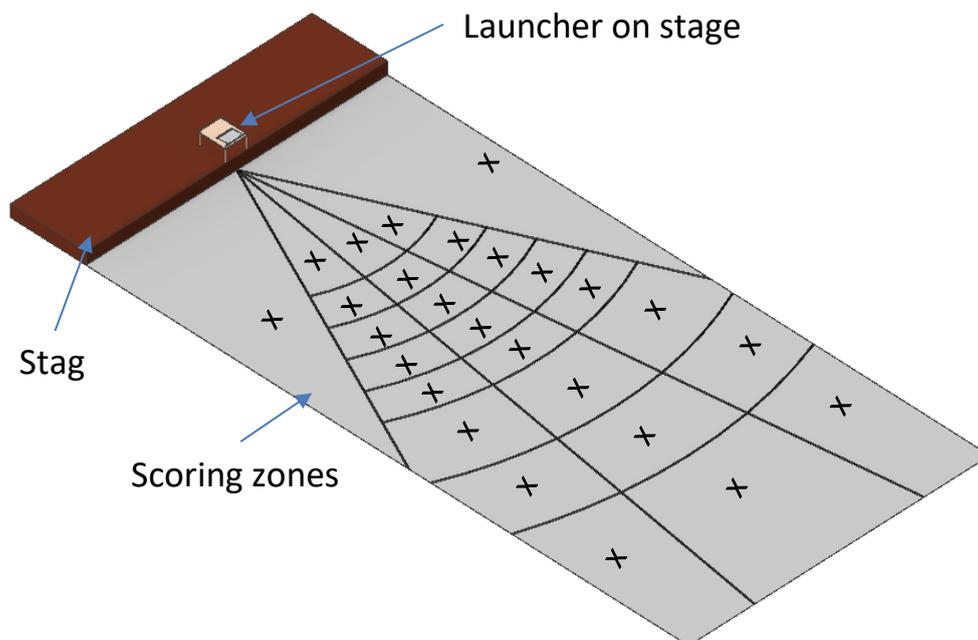


Figure 5: Competition Set-Up of Category B Challenge

8.1 CHALLENGE DATE

The challenge date is during **20 – 29 March 2023**.

8.2 CHALLENGE - SCORING FORMAT

The competition floor will be segregated into different scoring zones with respective allocated scores for each zone as shown in Figure 6. The dimension of the floor layout is shown in Figure 7.

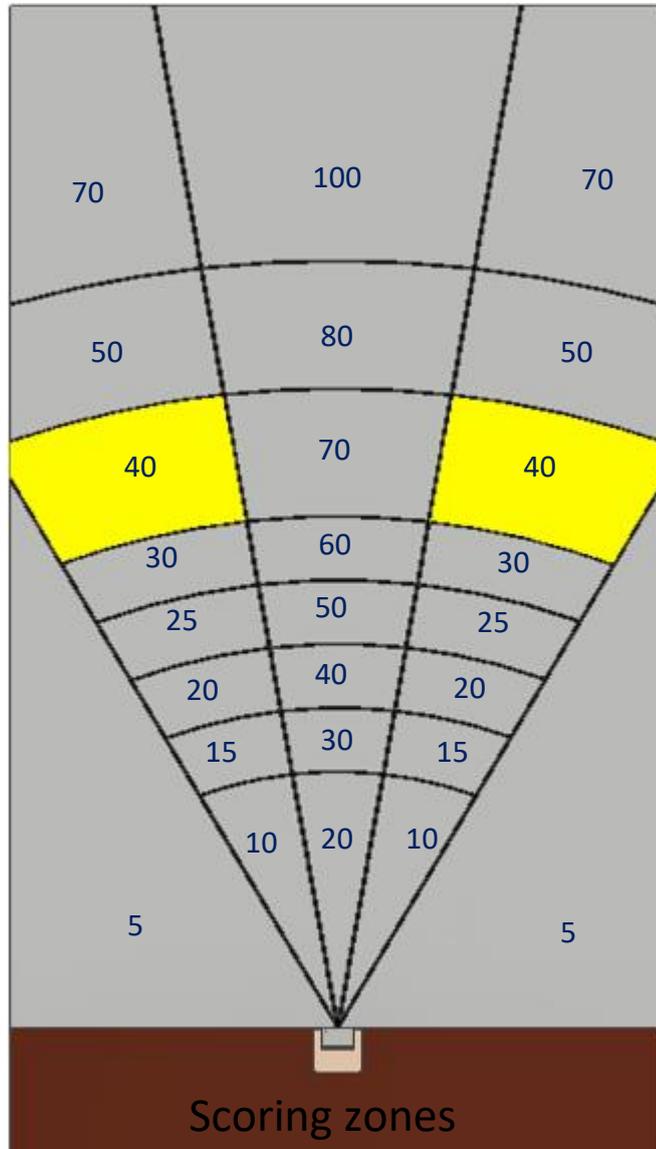


Figure 6: Floor Layout with scoring zones and respective allocated scores

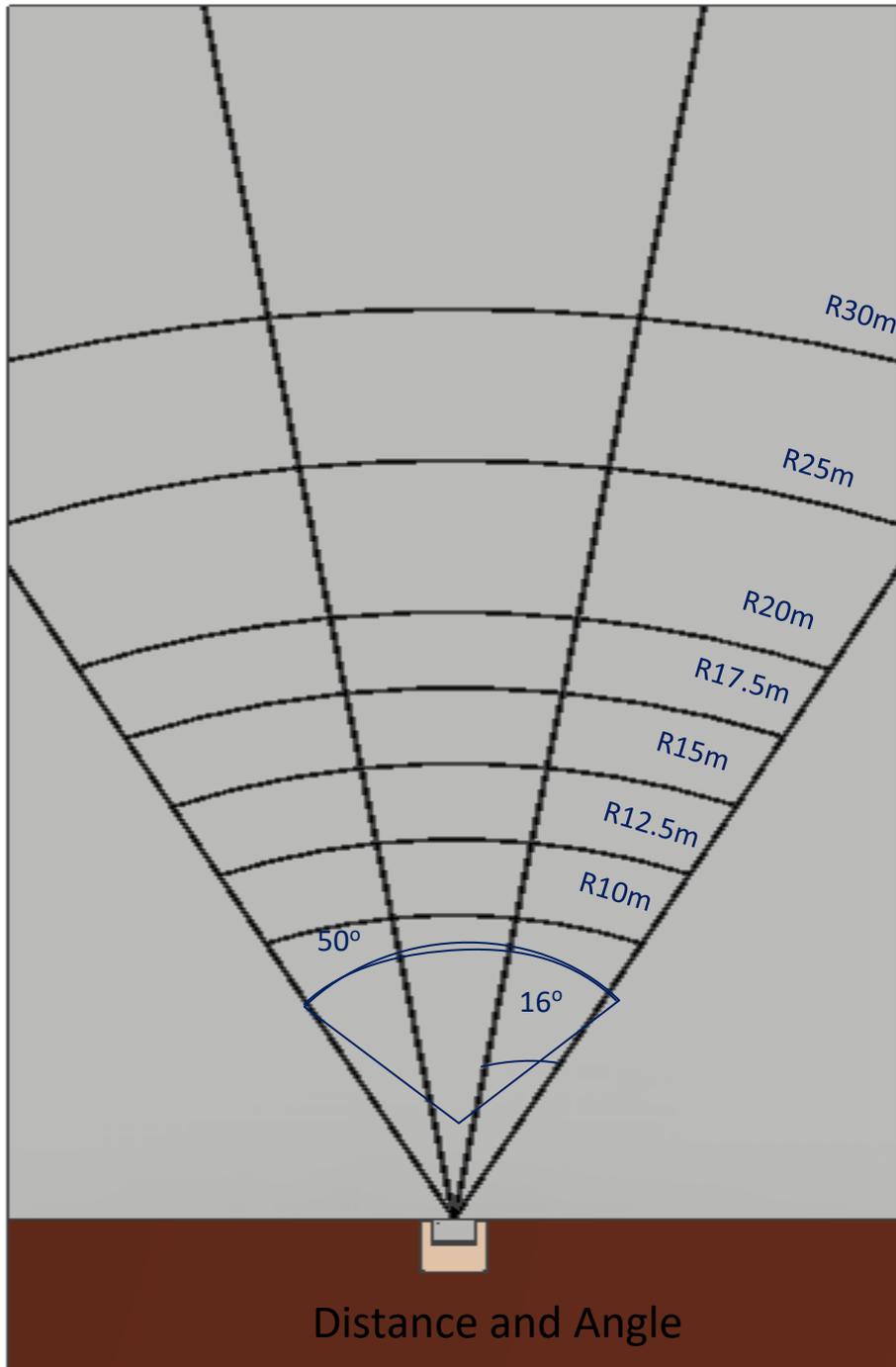


Figure 7: Dimensions of competition scoring zones

8.3 CHALLENGE - LAUNCHING PROCEDURES

1. Gliders that qualify for the challenge event will be allowed some minor modification.
2. Teams will place their glider onto the launch platform and hook on to the rubber band before drawing back the glider to the designated launching line.
3. Teams will release their glider for launch whenever they are ready. Teams will be given up to **TWO (2)** minutes to launch the glider and they are to adhere to the instructions given by the referees during launch .
4. After the unpowered glider is launched, the **first contact of the glider** with the landing zone will be the landing spot (assuming the glider remains intact).
Note: In the event that the glider breaks into pieces or drops any loose parts during the flight, the nearest landing spot will be taken to be the glider part contact point.
5. A team member will accompany the referees to determine the landing spot of the glider after the launch.
6. Teams will be awarded the score allocated to the scoring zone where the landing spot of the glider is determined to be.
7. If the glider landing spot falls on the intersection lines between various scoring zones, the highest score of the affected scoring zones will be awarded.
8. If the glider hits and stays stuck to the netting, the score allocated will be the scoring zone directly below the glider. If it is on the intersection lines between various scoring zones, the highest score will be awarded.

FOR SECOND SCORING ROUND ONLY

9. Teams will be given an opportunity to score bonus points in the second scoring round
10. **TWO (2) big objects** (e.g. orange traffic cone) will be placed within the two 40-points scoring zones (highlighted in **YELLOW** in Figure 6). Each team will have **TWO (2)** mins to decide on the location. Teams will launch their glider as per normal.
11. Teams with gliders that hit the object will be awarded **2 times** the allocated score of the scoring zone which the object is placed at. A hit is awarded when the **first contact point** of the glider is on the object.
12. Teams with gliders that do not score a hit on the object but manage to have the

landing spot of the glider within the same scoring zone will be awarded **1.5 times** the score allocated to the scoring zone where the landing spot is determined to be.

13. Teams with the landing spot of the glider falling outside the scoring zone where the object is placed will be awarded the **same** score allocated to the scoring zone where the landing spot is determined to be.
14. Summary of point #10 – #13 as reflected in the table below.

Scenario	Score
Hitting the big object	2 x scoring zone points
Land in the same scoring zone	1.5 x scoring zone points
Land in other scoring zones	Points of that scoring zone

15. **It will be at the teams' own discretion and decision to go for the bonus point's opportunity.** Teams will need to inform the referees of their decision of opting for the bonus point opportunity before launching their glider in the second scoring round.
16. Teams that do not opt for the bonus point opportunity will be awarded scores as per normal for the second scoring round, i.e. score allocated to the scoring zone where the landing spot is determined to be.
17. The total score from the two scoring rounds will be taken to vie for "**The Performance Award**".

*The referees make all scoring decisions and their decision is **FINAL**. For arbitrary cases, the Chief Referee will have the **FINAL** say.*

9. CATEGORY B PRESENTATION

During the presentation, teams will be allocated a specific time slot to present their flying machine at Science Centre Singapore. They will be assessed by a panel of judges on the work they have done for this competition for the following awards:

1. Most Creative & Aesthetic Award
2. Theory of Flight Award
3. Best Presentation Award

Each team is given only a total of **TEN (10) minutes** - [FIVE (5) minutes for presentation, FIVE (5) minutes for Questions & Answers] for the presentation.

Each team from Category B will be allowed a maximum of **8 slides** as visual aid for their presentation. A video of their craft in flight must be included in the presentation slides as well.

The presentation plays an integral part for those teams who wish to vie for the Championship award. Category B teams are required to bring their flying machines that they are using in the competition for their presentation. Teams that do not bring their flying machines for the presentation will be disqualified immediately.

The Committee reserves the right to deduct points in each of the award categories if the flying machine used in the video submission is drastically different from the flying machine presented at the Presentation.

9.1 PANDEMIC RESTRICTIONS

In the event that the physical challenge could not be conducted due to tighter pandemic restrictions, the online video submission will be used to determine the awards.

The organisers reserved the right to make amendments to CAT B competition.