Swarm
Challenge Booklet 2026

Organised by:

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SAFMC 2026 CATEGORY SWARM CHALLENGE BOOKLET CHANGE LOG

Version	Release Date	Description
1.0	03 Nov 2025	Official challenge booklet release

CONTENTS

1.   INTRODUCTION

Competition Schedule, General Rules and Regulations can be found in the "General Rules and Regulations" Booklet.

For Category Swarm[1], teams made up of **TWO (2)** to **TEN (10)** members are expected to bring, or design and build, a swarm of **TEN (10)** to **TWENTY-FIVE (25)** drones to compete in a search-and-rescue mission.

2.   CATEGORY SWARM AWARDS

Award winners will be selected based on either presentation scores, performance on the competition's challenge 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.

All scoring decisions made by the judges are **final**. For cases that require arbitration, the Singapore Amazing Flying Machine Competition (SAFMC) organising committee will have the **final** say.

The list of awards for Category Swarm is listed in the subsequent sections.

2.1. CHAMPIONSHIP AWARD

This is the pinnacle award any team can win and is bestowed on the team that achieves the highest total score across all areas. For Category Swarm, there will be **THREE (3)** Championship Awards: **ONE (1)** winner and **TWO (2)** runners-up. The scoring and weightage can be found in Section 4.

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[1] Each team must include at least one Singapore citizen to be eligible to participate.

2.2. JUDGES' COMMENDATION

This award is given out to Category Swarm teams exhibiting a high quality in design and/or performance but did not win the Championship Award or the runners-up prizes. Teams that have won any of the top three prizes will not be considered for the Judge's Commendation Prizes. Overall scores may be taken into consideration for this award. Up to **TWO (2)** Judges' Commendation awards may be given for the whole Category Swarm.

2.3. PRIZES

CATEGORY SWARM				
Awards	**Medals**	**Trophy**	**Cash Prize**	**Remarks**
Championship Award	✓	✓	$20,000	
1st Runner Up	✓		$15,000	
2nd Runner Up	✓		$10,000	
3rd and 4th Runner Up	✓			
Judge's Commendation	✓		$1,000	Up to two teams can win this award

3. CATEGORY SWARM MISSION

Teams are required to design a system of **TEN (10)** to **TWENTY-FIVE (25)** drones to navigate through an indoor environment and search for victims and fires, using either a centralised or de-centralised fully autonomous

control system. The system must possess localisation, obstacle sensing and obstacle avoidance capabilities. The drones and localisation system may be customised or commercial off-the-shelf (COTS) products and need not be homogenous.

The description of the mission tasks and scoring criteria will be detailed in Section 3.1 and Section 3.4 respectively. Teams are advised to read through these sections in detail to develop a strategy and identify key design requirements, before designing the drones to execute the mission. The technical rules for the drones are found in Section 6.

3.1. MISSION TASKS

The mission requires the system of drones to collaboratively explore an indoor environment and search for victims and fires.

The key phases of the mission are:

- **Take off** simultaneously within the Start Area.
- **Search** for all victims and fires as fast as possible.
- **Extinguish** fires by landing next to them until the end of the mission.
- **Rescue** victims by landing next to them until the end of the mission.
- **Form** a relay from a bonus victim back to the Start Area.

3.2. PLAY FIELD
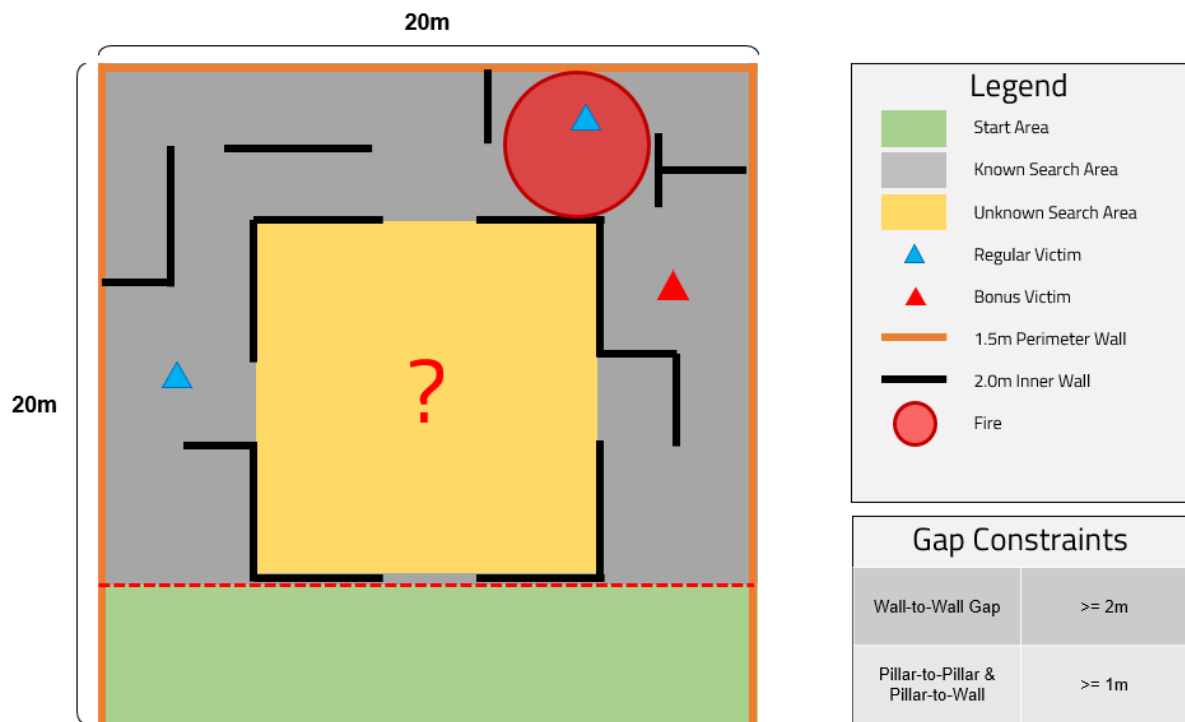
The layout of the play field is shown above. The play field is approximately 20m x 20m. It is surrounded by a perimeter wall on three sides, and netting on all sides.

When referring to the above diagram, note that:

- The layout is **not drawn to scale**.

- The placement and number of victims and fires shown are for **illustration purposes only**.

- The placements of the inner walls will follow the diagram, but the **exact positions and dimensions will NOT be given**.

- The layout within the Unknown Search Area is **intentionally NOT shown**.

The approximate dimensions of the play field elements are shown below.

Play Field Element	Approximate Dimensions
Start Area	20m x 6m
Unknown Search Area	10m x 10m
Perimeter Wall	1.5m tall
Inner Wall	2m tall
Pillar Obstacle	0.3m diameter, 2m height (Includes a weighted circular base of 0.5m diameter and 0.15m height)
Gaps Between Walls	At least 2m
Gaps Between Pillar Obstacles and Walls / Other Pillar Obstacles	At least 1m

3.3. MISSION RULES

3.3.1 GENERAL

1. Teams will be given setup time prior to each run. The time is allocated as follows:

Setup (25 min)	Run 1 (10 min)	Setup (15 min)	Run 2 (10 min)

2. Every team will be given **TWO (2)** runs.
3. A minimum of **TEN (10)** and maximum of **TWENTY-FIVE (25)** drones are required to participate in each run.

4. A run starts when any part of any drone has exited the Start Area. It ends when all drones have landed, or the mission time has exceeded, whichever occurs first.

5. During the setup time, teams are allowed to take off the drones for testing, but the drones must stay within the Start Area. (Note safety rules Section 5.4)

6. If teams complete their setup earlier, the remaining setup time will not be carried over to the mission time. In such cases, teams must inform the officials that they are ready to start the mission.

7. During mission time, teams may reset and re-attempt take-off as long as no part of any drone has exited the Start Area.

8. Teams are not allowed to repair/troubleshoot the drones during a run. Any drones that malfunction during a run will be out for that run. The run may continue if the remaining drones are deemed to be safe by the referee.

9. Teams are allowed to repair their drones outside of runs. There is no restriction on the number of spare drones the team can prepare as long as they have passed the inspection. (See Section 5.3)

10. The system must be fully autonomous. Teams are not allowed to input commands during the run, unless informed / permitted by the referees.

11. Drones are not allowed to be physically connected to each other (e.g. tied together).

12. Ground robots are not allowed to be used during the run.

13. Drones are not allowed to fly over walls. The maximum flight height is 1.4m.

14. Any navigation aids (e.g. ultra-wideband systems, fiducials) must be:
   a. Placed during setup time.
   b. Placed within the perimeter walls.

    c. Easily removable without leaving a mark.

    d. Properly secured, e.g. will not topple over.

    e. Cannot be secured to overhead structures.

    f. Within 1m x 1m (no height limit).

15. A maximum of **TEN (10)** navigation aids is allowed in the Known Search Area. Teams are allowed to enter the Known Search Area only during setup time.

16. There is no limit on the number of navigation aids within the Start Area.

17. Navigation aids are **NOT** allowed in the Unknown Search Area. Teams are **NOT** allowed to enter the Unknown Search Area at all times.

3.3.2 TAKE-OFF

1. Drones are to take off only within the Start Area.

2. Each run has a maximum of **TWO (2)** simultaneous take-offs. A simultaneous take-off is defined as a group of drones taking off, with the last drone of the group taking off within **TEN (10)** seconds after the first drone of the group had taken off.

3. There are no restrictions to the number of drones participating in a simultaneous take-off.

4. After the **TWO (2)** simultaneous take-offs, no other drones are allowed to take off.

    a. An exception is made if no drone has left the Start Area (See Section 3.3.1 Rule 7)

3.3.3 VICTIMS

1. The number of victims and their positions will be unknown to the teams.

2. There are 2 types of victims: Regular Victims and Bonus Victims. Bonus Victims are likely to be placed in regions that are harder to rescue but are worth more points than Regular Victims.

3. Teams shall provide **FOUR (4)** markers to be used as Regular Victims, and **FOUR (4)** markers to be used as Bonus Victims. The markers must be non-electronic, be within 30cm x 30cm x 100cm (L x B x H), and weigh less than 1kg.

4. Officials will simply place the markers on the floor. Special instructions (e.g. taping markers down) must be made known to the officials before the run. Officials may reject the special instructions if they are deemed unsafe, time-consuming, or damage the play field.

5. There is a possibility that the placement of victims may overlap with any navigation aids placed by the teams.

3.3.4 RESCUE

1. The rescue of a victim is done by having at least **ONE (1)** drone land within 1m of the victim, within Line-of-Sight (LOS), i.e. when drawing a straight line from the drone to the victim, there must be no walls or pillars on the line.

2. When measuring the distance between a drone and a victim, the start point of the measurement will be the position of the victim, as set by the SAFMC organising committee.

3. The start point will remain the same even if the victim markers are dislodged (e.g. by drones flying over). Teams must indicate on each drone where the end point of the measurement will be, e.g. with a sticker or marking.

4. If a victim is within 2.5m of a fire (See Section 3.3.5), the fire must be extinguished (See Section 3.3.6) for the rescue to be considered successful. Otherwise, the rescue is worth no points.

3.3.5 FIRES

1. The number of fires and their positions will be unknown to the teams.
2. Teams shall provide **FOUR (4)** markers to be used as the fires. The markers must be non-electronic, be within 30cm x 30cm x 100cm (L x B x H), and weigh less than 1kg.
3. Officials will simply place the markers on the floor. Special instructions (e.g. taping markers down) must be made known to the officials before the run. Officials may reject the special instructions if they are deemed unsafe, time-consuming, or damage the play field.
4. There is a possibility that the placement of fires may overlap with any navigation aids placed by the teams.

3.3.6 EXTINGUISHMENT

1. The extinguishing of a fire is done by having at least **ONE (1)** drone land within 1m of the fire, within Line-of-Sight (LOS), i.e. when drawing a straight line from the drone to the fire, there must be no walls or pillars on the line.
2. When measuring the distance between a drone and a fire, the start point of the measurement will be the position of the fire, as set by the SAFMC organising committee.
3. The start point will remain the same even if the fire markers are dislodged (e.g. by drones flying over). Teams must indicate on each

drone where the end point of the measurement will be, e.g. with a sticker or marking.

3.3.7 VICTIM RELAY

1.   A victim relay is considered successful if there is a path consisting of landed drones from a bonus victim to the start area, where:
     a. Adjacent landed drones are not more than 1m apart.
     b. Adjacent landed drones have LOS to each other (i.e. not blocked by a wall / pillar).
     c. One drone must have rescued the bonus victim (i.e. one drone will rescue and be the start of the relay).
     d. One drone must be in the start area.
2.   One relay is sufficient to score full points for this task (i.e. two relays will score the same points as one relay).

3.3.8 LANDING

1.   The swarm must decide when it has sufficiently completed the tasks and end the mission by landing. Teams are also allowed to send a command to land the remaining drones with permission from the referees.

3.3.9 UNKNOWN SEARCH AREA

1.   The swarm may enter the Unknown Search Area via the open doorways shown in the diagram in Section 3.2. The doorways will be closed during setup time to prevent teams from entering the Unknown Search Area.

2.   The Unknown Search Area will contain Bonus Victim(s), wall(s), pillar obstacle(s) and fire(s).

3.4. MISSION SCORING

The possible points and penalties that a team may receive are listed in the table below. The referees will make all scoring decisions, and their decisions are **final**. For arbitrary cases, the **Chief Referee** will have the **final** say.

Scoring Criteria	Points Awarded / Penalties Incurred
Regular Victim rescued (At least 1 drone lands within 1m of the victim within LOS)	+5 for each victim
Bonus Victim rescued (At least 1 drone lands within 1m of the victim within LOS)	+15 for each victim
Fire extinguished (At least 1 drone lands within 1m of the fire within LOS)	+10 for each fire
Fire not extinguished	0 points awarded for any victims within 2.5m of the fire
At least 1 relay formed between a bonus victim and the start area	2x multiplier for total mission score
The **highest score** attained across the runs will be taken as the mission score. If teams have the same total score, the **run time will be used to break ties**. Each victim/fire can only be rescued/extinguished **once**, e.g. if multiple drones rescue the same victim, only one rescue is acknowledged.	

3.5. PENALTIES

The referees will make all penalty decisions, and their decisions are **final**.

For arbitrary cases, the **Chief Referee** will have the **final** say. Further correspondences will not be entertained. The list of mission penalties is shown below.

S/N	Description	Penalty
1	Exceeding the setup time.	Mission time will start regardless. No additional mission time will be provided.
2	Less than 10 drones in the Start Area.	The mission run will be forfeited.
3	Drones taking off and leaving the Start Area during Setup Time.	Referee's discretion or **disqualification**.
4	Additional take-offs after two simultaneous take-offs have occurred.	Referee's discretion or **disqualification**.
5	Use of external markers outside of the play field.	Referee's discretion or **disqualification**.
6	Internal markers within the play field that are unable to be removed or leave a mark after being removed, e.g. damage to structures.	Referee's discretion or **disqualification**.
7	Internal markers within the play field that cause harm to persons, e.g. tripod stands toppling due to improper securing.	Referee's discretion or **disqualification**.
8	Interrupting the competition by potentially interfering with other competitors, e.g. switching on your platform's VTX, transmitters, etc.	Referee's discretion or **disqualification**.
9	Attempting to subvert competition rules or gain an unfair advantage over other teams, e.g. receiving assistance from spectators, etc.	Referee's discretion or **disqualification**.

4.   SCORING

The scoring components for the competition are:

1.   Team Challenge **V**ideo (V)

2.   Team Live **P**resentation (P)

3.   **M**ission (M)

The first 2 components (V and P) will be assessed by our Category Swarm Judges, while the Mission (M) component will be computed from the highest attained score from the challenge attempts. Scores will be awarded relative to the performance of other teams. Further details on the scoring components can be found below.

The weightage of the scoring components is listed as follows:

Component	Weightage
Team Challenge **V**ideo	10%

Team Live **P**resentation
    • Strategy – 30%
    • Presentation Quality – 10%
	40%

Mission	50%
Total	**100%**

For Category Swarm the total score **T** is computed as T = V + P + M.

4.1. TEAM CHALLENGE VIDEO (V)

The Team Challenge Video provides a proof-of-flight insight into how the swarm performs before the challenge day. The video should include:

1.   Flightworthiness

   a. Drones must be shown to perform stable, sustained flight.

      b. At least **FIVE (5)** drones must be shown to take off simultaneously.

2. Mission-readiness

      a. Explain the on-board sensor suite for each unique drone used in the challenge segment.

      b. At least **TWO (2)** drones must be shown avoiding static obstacles.

      c. At least **TWO (2)** drones must be shown to search a room containing at least **TWO (2)** victims, and land next to them when detected.

3. Creativity

      a. Resourcefulness in re-creating competition layout to showcase similar mission requirements.

4.2. TEAM LIVE PRESENTATION (P)

Teams should present their proposed strategy and learning outcomes.

Proposed Strategy

Teams are to explain how their drones, sub-systems, and swarm algorithms help in their mission strategy. These include:

1. Choice of sensor suite used to tackle the mission.
2. Obstacle and collision avoidance method.
3. Positioning method.
4. Search strategy.
5. Method of communication between drones and ground control station (GCS).
6. Any other algorithms used in completion of the mission.

Teams are also encouraged to utilise and present unique concepts, which may include:

1. Robust and intelligent methods of swarm control.
2. Effective utilisation of different kinds of drones in the swarm.

3. Unconventional ideas and methods to complete the mission.

4. Methods to reduce time taken to complete the mission.

Learning Outcomes and Insights

Teams are to share about their experience preparing for the competition. These include:

1. Challenges faced and lessons learnt.

2. Key decisions made during the design process and their rationale.

4.3. MISSION (M)

The challenge segment scores on the challenge day will form the **Mission (M)** score. Please refer to Section 3.4 and Section 3.5 for the mission scoring and penalties.

5.   FLOW OF EVENTS

Similar to real-world scenarios, teams may face unexpected issues during the competition. They should not expect the conditions or layout of the challenges to be fully defined beforehand or to remain identical for each attempt between competitors. Factors such as luck, venue conditions, and other uncontrollable elements can also influence competition results.

5.1. PRESENTATION SEGMENT

Teams will deliver their presentation to a panel of judges in person during the challenge day.

Teams will be given a maximum of **FIFTEEN (15)** minutes for this segment. **TEN (10)** minutes are allocated for the team presentation, and **FIVE (5)** minutes for Questions & Answers.

Please refer to Section 4.2 for scoring factors for the presentation segment.

During the presentation segment, teams are required to:

1. Bring each unique drone used for the challenge segment.

2. Prepare **ONE (1)** presentation in slides format.

5.2. TEAM CHALLENGE VIDEO

Teams are to submit **ONE (1)** Team Challenge Video to the SAFMC organising committee. The video length should be no longer than **TEN (10)** minutes and should include the key components as stated in Section 4.1.

Videos should be uploaded to YouTube and set as "Unlisted". The link to the video should be sent to SAFMC@science.edu.sg with title subject: "[CATEGORY SWARM] - [Team Name] – Challenge Video" before the deadline. The deadline for submission is **28 February 2026, 2359hrs**. Video should be uploaded before the deadline, and any re-upload of the video detected past the deadline may result in **penalisation** or **disqualification**. You may write in to the SAFMC 2026 organising committee to request for a re-upload of the Team Video if necessary.

The submitted video should adhere to the following guidelines:

1. Animations are **NOT** allowed.

2. Computer-aided simulations may **NOT** be used to prove flight worthiness and mission-readiness.

3. Video must **NOT** be produced by a professional, or with professional assistance.

4. No offensive images or audio.

5. Narration and/or subtitles are allowed.

6. All videos must be original work conceived and created by the participants. No copyright materials (images, music, etc.) may be used in the video unless the participants own the copyright or have a license to use the material in the video.

7. If the participants have gained formal permission to use any copyright materials (images, music, etc.) under terms and conditions stipulated by the copyright owners, acknowledgements/credits must be included at the end of the video.

8. The use of logos including known commercial brands, institutional crests or trademarks, unless integral to the project, is not allowed.

9. Ownership of the underlying intellectual property of the video remains with the participant(s) of the individual/team project, with the following exception:

    a. Participant(s) grant the SAFMC organising committee the right to use, distribute and display their videos without further compensation or notification to the participant(s).

    b. Participant(s) grant the SAFMC organising committee the right to use their images and videos for publicity and advertising without further compensation or notification to the participant(s).

5.3. CHALLENGE SEGMENT

Teams are expected to comply with the following during the challenge segment:

1. Teams are to arrive at their designated reporting time.

2. At the allocated competition schedule, the team shall report to the safety inspection point. An SAFMC official will check the drones for any violation of the category rules and regulations. Teams who do not pass the inspection will **not** be allowed to fly their drones for the mission and may face **immediate disqualification** from the competition. The inspection will include, but is not limited to, the following checks:

a. The maximum take-off weight (MTOW) and size of the drones.

b. RC / datalink / video link transmitter and receiver are operating on allowed frequencies.

c. Electrical harnessing should be appropriately insulated and should not be chafed or broken. No exposed wires and connectors are permitted.

d. All major assemblies and critical components must be securely fastened to the drones; loose items should be tied down and kept away from the propellers.

e. For drones operating on semi-autonomous / autonomous modes, it should allow complete manual pilot override on-demand via RC or GCS.

f. The drones must demonstrate **failsafe capability** in the **event of a loss of link** between the RC/GCS and the drones. The failsafe check procedure is as follows:

   i. All propellers and releasable payloads are to be removed from the drones.

   ii. Flight motors will be armed and throttled up.

   iii. While the motors are still spinning in the same flight mode, the Wi-Fi router(s) will be <u>switched off</u> to simulate a link loss.

iv. All motors should come to a **<u>complete stop immediately</u>**. The drones should **<u>not</u>** attempt a hover / controlled descent / to return home.

g. An SAFMC official will be with the operator during the mission attempt. The official may give instructions to the operator depending on the behaviour of the swarm (e.g. to land immediately if the drones appear to be uncontrollable). The operator is to comply immediately with all such instructions, which may include the activation of the failsafe to ground the drones.

h. The drones must demonstrate **<u>failsafe capability</u>** upon **<u>operator command</u>**. The failsafe check procedure is as follows:

i. All propellers and releasable payloads are to be removed from the platform.

ii. Flight motors will be armed and throttled up.

iii. While the motors are still spinning in the same flight mode, the operator must be able to activate a kill-switch.

iv. All motors should come to a **<u>complete stop immediately</u>**. The drones should **<u>not</u>** attempt a hover / controlled descent / to return home.

i. Failsafe capability for the DJI Tello and Hula drones will be the OEM default failsafe logic. Any tampering or modifying of the OEM failsafe logic (unless to meet Point 2(e), Point 2(f) and Point 2(h)), will result in a disqualification. These drones are exempt from Point 2(e), Point 2(f) and Point 2(h), because:

i. The SDK does not allow for the expected failsafe behaviour to be configured.

ii. The drones do not allow motors to function when propellers are removed.

j. At the end of each mission attempt, the radio control transmitter, datalink transceiver, video receiver and any other wireless device for the drones must be switched off.

5.4. KEY RULES TO NOTE

Rules for personnel movement and communication during the setup time and the mission attempt are dictated in the following points:

1. Only members of the participating team are allowed to be inside the play field during their allocated time.

2. No outside communication or assistance from the audience / spectators is allowed at any point. No headphones or earpieces are allowed to be worn by the operator / pilot. Teams who violate this rule may be **disqualified**. Communication amongst teammates is allowed.

3. The netted play field **must** be clear of persons whenever any drone(s) are armed or in flight.

4. If any drone(s) are **connected to batteries**, persons entering the netted play field **must** don the appropriate Personal Protective Equipment (PPE), which will be provided.

5. Team members may enter the field to collect their drones, or to bring them out of the play field to modify or repair (including changing batteries) **after** they have landed and have been disarmed. Entry into the play field is only allowed upon confirmation with SAFMC officials.

6. Multiple video **receivers** are allowed. Only **ONE (1)** video transmitter is allowed for each drone.

7. No radio control transmitters, datalink transmitters and video transmitters and receivers are to be switched on within the

competition venue, unless permitted to do so in the holding area or play field. All repairs / maintenance / troubleshooting should be done in Raceband channel 8 with VTX set to either 25mW or pit-stop mode. Non-compliance may lead to **disqualification**.

8. There will be a charging space allocated for teams to charge their batteries. Teams will have to bring their own charger / charging equipment should they plan to charge their batteries. At any point, there **MUST** be at least **ONE (1)** team member overseeing the charging. Failure to do so will result in **disqualification**.

9. Teams shall make sure that their designated representatives are contactable and should arrive at least **TEN (10)** minutes before any allocated timing. Latecomers may have their mission times shortened or may be **disqualified**.

6.   TECHNICAL RULES & REGULATIONS

Each team is to design and build a swarm based on the following guidelines:

1. Off-the-shelf products and components are allowed in the competition.

2. For safety considerations, the total weight of each drone **must not exceed 1.0kg**.

3. Each drone, including propellers, must fit within a **30cm x 30cm x 30cm box.**

4. Participants are only allowed to use up to **TWENTY-FIVE (25)** drones for each mission attempt. Teams can bring similar backup drones to

replace any drones that has become incapable of flight. Teams can only change drones between runs.

5. Only electric-based flight propulsion is allowed. Both brushed and brushless motors are allowed. No modification to the motors is allowed.

6. No internal combustion or gasoline engines are allowed.

7. No tethering or umbilical wires to the drones are allowed during flight.

8. External aids such as markers, indicators, etc. will be allowed **only** in the play field, and can only be placed when there are no drones armed or in flight.

9. For safety considerations, the swarm must be able to stop the mission and power down.

6.1. AVIONICS SYSTEM

There is no limit on the number of inertial measurement units (IMUs), flight controllers (FCs), and other electronics used in the drones.

6.2. BATTERY

There is no limit on the number of batteries used, in series or parallel. Participants should size their batteries and drones appropriately for the mission. Lithium-Polymer (LiPo) batteries are preferred.

Batteries must be properly strapped or locked onto the drones before launch.