Category D2

Organised by:

DSO NATIONAL LABORATORIES

SCIENCE CENTRE singapore

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SAFMC 2025 CAT D2 CHALLENGE BOOKLET CHANGE LOG

Version	Release Date	Description
1.0	27 Sept 2024	Official challenge booklet release
2.0	08 Nov 2024	Revisions made to • Section 3.2.1 on the bonus zone width • Section 3.2.2.2 on large pillar obstacle • Section 3.3.2 on payload and carrier
3.0	06 Jan 2025	Revisions made to • Section 3.2.4 on Drop Zone • Section 3.3.1 on general mission rules • Section 3.3.2 on payload and carrier • Section 3.3.3 on navigational aids • Section 3.4.1 on score eligibility • Section 6 on technical rules & regulations
4.0	19 Feb 2025	Revisions made to • Section 2.2 on the Best International Team Award • Section 3.3.1 on cameras • Section 4 on scoring components • Section 5.2 on computer-aided simulations
5.0	21 Feb 2025	Revisions made to • Section 3.3.1 to prohibit any drone from touching the ground outside of the Launch Zone and Supply Zones
6.0	10 Mar 2025	Revisions made to • Section 3.3.4 to include new safety pilot rules

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1. INTRODUCTION

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

For Category D2, the teams are expected to design and build **TWO (2) to FOUR (4)** drones capable of executing autonomous payload pickup and simultaneous drops in a pseudo fire-fighting mission.

2. CATEGORY D2 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 Cat D2 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 D2, 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.

2.2. BEST INTERNATIONAL TEAM AWARD

This award is given to the best international team in CAT D2. The SAFMC organising committee recognises that international teams can bring a wide

spectrum of unique designs and innovations and would like to award the best international team in this category if the minimum standard is met.

2.3. JUDGES' COMMENDATION

This award is given out to Category D2 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 3 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)** awards may be given for the whole Category D2.

2.4. PRIZES

CATEGORY D2				
Awards	**Medals**	**Trophy**	**Cash Prize**	**Remarks**
Cat D2 Championship Award	✓	✓	$10,000	
Cat D2 1st Runner Up	✓		$7,500	
Cat D2 2nd Runner Up	✓		$5,000	
Cat D2 3rd and 4th runners up	✓			
Best International Team Award	✓	✓	$10,000	
Cat D2 Judge's Commendation	✓		$500	Up to two teams can win this award

3. CATEGORY D2 MISSION

Teams are required to design and build a system of **TWO (2) to FOUR (4)** drones to navigate through an indoor course, working dynamically and collaboratively using either a centralised or de-centralised fully autonomous control system. The system must possess localisation, obstacle sensing and obstacle avoidance capabilities.

The detailed descriptions of the play field, available tasks, as well as the scoring criteria are found in Section 3.4. Teams are advised to read through these sections in detail to develop a strategy and identify key design requirements, before designing the drone to execute the mission. The technical rules for the drone are found in Section 6.

3.1. MISSION TASKS

Taking reference from real life fire-fighting application, the mission requires the system of drones to collaboratively navigate through the indoor course, simulating at least two drones working together to extinguish a fire autonomously.

The key phases of the mission are:

Task 1: Take-off and Pick Up Payloads

Drone(s) must take off from the Launch Zone, either carrying pre-loaded payloads or flying to the Supply Zone to retrieve payloads. Additionally, the drones must be capable of identifying the colour(s) of the payload(s).

Teams are not allowed to input any commands after sending the initial take-off command.

Task 2: Navigate to the Drop Zone(s)

Drone(s) must navigate to the Drop Zones autonomously.

Task 3: Simultaneous Payload Drop

At least two drones must drop payloads simultaneously (within 3 seconds) in the same Drop Zone to simulate the collaboration of assisting a pseudo fire-fighting operation.

Task 4: Reloading of Payload

Upon release of the Payload(s), the drone(s) must be able to navigate back to the Supply Zone and reload the Payload autonomously.

After picking up a new payload, the drone(s) can repeat the tasks until the battery is depleted.

3.2. PLAY FIELD

3.2.1 LAYOUT

The layout of the play field is shown in Figure 1. The play field is approximately 20m x 20m with safety nets surrounding the perimeter. These are subject to change without prior notice and may vary on challenge day.

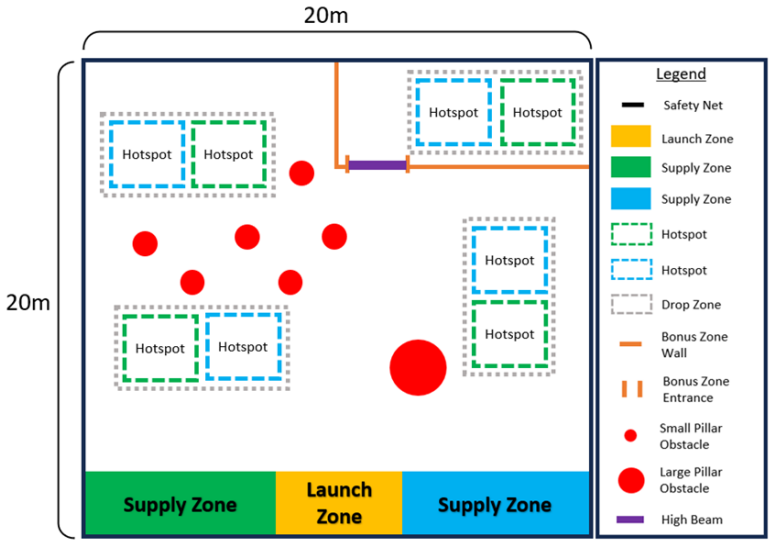

Figure 1 - Overall Play Field Layout

When referring to the above diagram, note that:

- The layout is **not drawn to scale**.
- The placement and number of pillar obstacles shown are for **illustration purposes only**.
- The exact placement position of the bonus zone entrance and high beam **will not be given**.

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

Play Field Element	Approximate Dimensions
Launch Zone	4m x 2m

Supply Zone	8m x 2m
Drop Zone	2m x 1.1m
Hotspot	0.7m x 0.7m
Bonus Zone	10m length, at least 3m width
Bonus Zone Entrance	At least 2m wide; 1.5m tall
Small Pillar Obstacle	0.3m diameter, 2m height (Includes a weighted circular base of 0.5m diameter and 0.15m height)
Gaps Between Small Pillar Obstacles	At least 1m
Large Pillar Obstacle	Diameter of at least 1.5m, approximately 2m height

3.2.2 OBSTACLES

There will be three types of obstacles distributed across the play field.

3.2.2.1 Small Pillar Obstacle

Figure 2 – Small Pillar Obstacle

The first type, illustrated in Figure 2, consists of numerous pillars positioned throughout an area. The pillars will be spaced apart at a minimum distance of 100 cm.

3.2.2.2 Large Pillar Obstacle

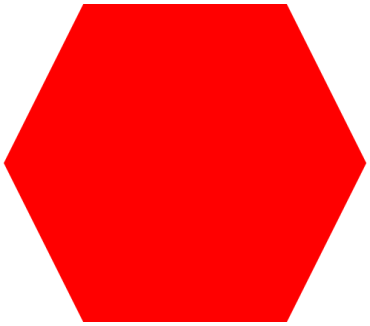

Figure 3 - Large Pillar Obstacle

The large pillar obstacle will have approximately a diameter of at least 1.5m, the exact dimensions will remain undisclosed. Please note that Figure 3 is provided for illustrative purposes only and does not represent the actual obstacle that will be present on challenge day.

3.2.2.3 Bonus Zone Entrance Obstacle

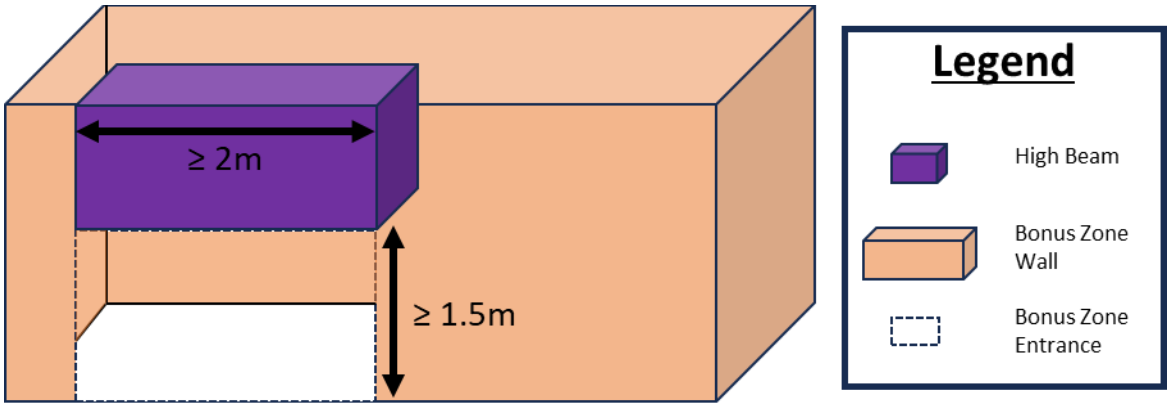

Figure 4 - Bonus Zone Entrance

The entrance to the bonus zone will feature the third type of obstacle: the high beam (Depicted in purple). The entrance will have a minimum height and width of 1.5m X 2m as depicted in Figure 4. The exact dimension of the entrance will remain undisclosed.

3.2.3 LAUNCH AND SUPPLY ZONE

Drones are required to begin their run within the Launch Zone. Payloads that are not preloaded must be placed within the Supply Zones. Ground support structures may be used to assist in the pickup of payloads in the Supply Zones.

3.2.4 DROP ZONE

Each Drop Zone contains two Hotspots, each measuring 70cm by 70cm and will be demarcated with their corresponding colours. A 20cm border will be marked around the Hotspots, as per Figure 5.

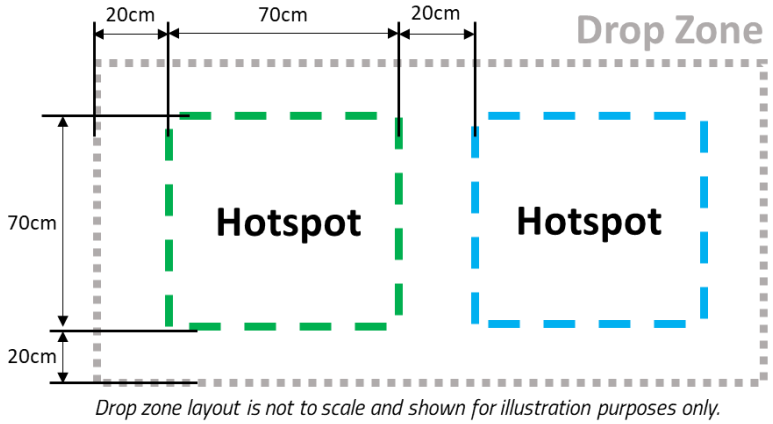

Figure 5 - Drop Zone Layout

Scoring of the Payloads in the Drop Zone will be outlined in section 3.4.2 below.

3.2.5 BONUS ZONE

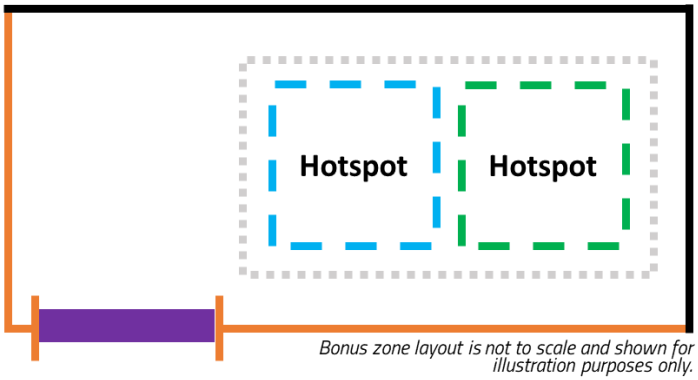

Figure 6 - Bonus Zone Layout

An area within the play field will be designated as the Bonus Zone, where completing a specific task can award bonus points. To achieve this, a simultaneous payload drop must be performed within the confined space of the Bonus Zone. However, the exact location of the Bonus Zone entrance will not be disclosed.

3.3. MISSION RULES

3.3.1 GENERAL

1. Teams must consist of **TWO (2) to TEN (10**) members.
2. The duration of the entire challenge is 60 minutes, consisting of **15 minutes setup time** and **45 minutes mission time**.
3. Teams may conduct functional checks of their drone(s) through manual flight during the 15 minutes setup time, provided they obtain permission from the referee. Rules in 3.3.4 and 5.4 would still apply.
4. Mission time segment will start immediately after the setup time segment. No time extension will be given **even if setup is incomplete**.
5. **Unlimited runs** are permitted within the mission time, with each run receiving an independent score. The final score will be the highest score achieved in a single run, and not a cumulative total of all runs.
6. A **minimum of TWO (2)** drones are required per run.
7. At the start of each run, all drones must begin at the Launch Zone, and a run begins when the first drone takes off and leaves the Launch Zone.
8. A run concludes under any of the following conditions, whichever is earlier:
    a. The team issues a command for all drones to land, after **obtaining permission** to do so from the referee.
    b. All drones land outside the Supply and Launch Zones.
    c. When there is a manual takeover of any drone, after **obtaining permission** to do so from the referee.
    d. Only in case of emergency, manual takeover before obtaining permission is allowed. Pilot must inform referee of the takeover immediately after takeover is executed.

    e. When all batteries on all drones run out.
    f. When any drone is disarmed.
9. Each drone is only allowed to be manually preloaded once before a run starts. Remaining payloads must be placed in Supply Zones of the corresponding colour and picked up autonomously during the run.
10. Each drone is not allowed to carry multiple payloads at one time.
11. Drones are not allowed to fly above any obstacle or walls.
12. Payloads dropped outside of Launch and Supply Zones cannot be retrieved during the run.
13. Drones, carrier, and ground support structures are prohibited from touching the ground outside of the Launch Zone and Supply Zones. Any drone that violates this rule will be grounded immediately for that specific run.
14. Teams are not allowed to repair/troubleshoot the drones during the run. Any drones that malfunction during the run will be out for that run. The run may continue if the remaining drones are deemed safe.
15. Ground robots are not allowed to be used.
16. Ground support structures are allowed to assist in the pickup of payloads. They must be:
    a. Designed so that the lowest point of a payload does not exceed 30cm above the ground.
    b. Placed within the boundaries of the Supply Zones.
17. Teams are only allowed to repair their drones or change batteries outside of runs.
18. Any rules requiring permission are not guaranteed and must be approved by the referees.
19. There are cameras placed near the Drop Zone(s) to capture the simultaneous payload release. There is a possibility that the

placement of the cameras may overlap with any navigation aids placed by the teams or in the path of the drones.

3.3.2 PAYLOAD AND CARRIER

1. Teams are allowed to use a maximum number of **6 blue and 6 green** beanbags as the payloads.
2. The beanbags will be approximately **12cm (H) X 12cm (W)** and weigh approximately **85g each**.
3. The beanbags can be found from the following link - https://www.javysports.com/tossing-aiming/452-834-bean-bags.html#/413-bean_bag-soft_pu_with_reinforced_stitching/414-quantity-set_of_4
4. Each payload **can be adjusted** (E.g., Folding, attachment of clips etc) but must be **returned undamaged** after the mission.
5. Payload(s) can be placed within or directly outside the carrier.
6. Carriers should not measure more than **30cm in any direction**, this includes any ropes or sticks. These measurements only apply to the carrier. For instance, if the payload carrier is exactly 30cm and the payload is intended to be mounted on top of it (Figure 7), it will be considered compliant.

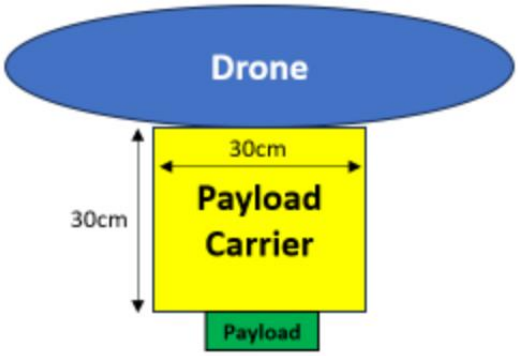

Figure 7 - Payload carrier

3.3.3 NAVIGATIONAL AIDS

1. A maximum of 30 navigational aids (e.g. UWB, fiducials) will be allowed per run.
2. Navigational aids can only be rearranged between runs. Teams are not allowed to change the positions of the navigation aids during the run. Any navigation aids that are displaced or malfunction during the run cannot be adjusted until the run ends and all drones are disarmed.
3. **Any** visual aid must not exceed **30cm X 30cm X 30cm (L X B X H).**
4. **Any** UWB must not exceed a **base area of 1m X 1m (L X B)**.
5. All navigational aids must be:
    a. Placed within play field.
    b. Easily removable without leaving a mark.
    c. Properly secured.

3.3.4 SAFETY

1. Drones must be disarmed with batteries disconnected before resetting the runs.

2. Each team must have at least one safety pilot to manually disarm or take over control of the drone(s). Teams are to conform to either one of two possible setups:
    a. Each drone must have an assigned safety pilot who is capable of manually taking over control of the drone in case of emergency or when instructed by SAFMC officials.
    b. If a team does not maintain a one-to-one ratio of safety pilots to drones (e.g., 4 drones with only 2 safety pilots), each safety pilot must be **ONLY** capable of disarming and **KILL ALL** drones immediately under the following conditions:
        i. When instructed by the SAFMC official to do so.
        ii. When any one drone requires an emergency landing.

    Failure to comply to the safety rules will result in penalties at the referee's discretion or **disqualification.**
3. Safety pilots are only allowed to follow the drones (line-of-sight) outside the safety net. The safety pilots need to demonstrate to the referees that the drones are in computer-in-control (CIC) before any drones take off.
4. Safety pilots must be on standby for manual takeover, disarming via a switch during the runs.
5. Teams are to declare if the team are following the one-to-one ratio of safety pilot or otherwise before the challenge starts.

3.4. MISSION SCORING

The possible points that can be awarded are listed in the table below. The referees will make all scoring decisions and their decision is **final**. For arbitrary cases, the Chief Referee will have the **final** say.

3.4.1 PICKUP SCORE ELIGIBILITY

1. Up to 8 payloads are eligible to obtain scores from preload and successful autonomous pickup of payloads per run.
    - Points will not be awarded for pickup of subsequent payloads.

3.4.2 DROP SCORE ELIGIBILITY AND SCORING

1. To be considered **simultaneous** payload drop:
    a. The time difference between the first and second payload landing on the ground **must not exceed 3 seconds**.
    b. Points will be awarded only if both payloads are within or touching the boundary of either the Hotspots or Drop Zone.
        i. Partial points if both payloads are within the Drop Zone.
        ii. Full points if both payloads are correctly dropped in their corresponding-coloured Hotspots.
2. Points will be awarded based on the **final position** of the payloads.
3. Non-simultaneous payload drops will result in 0 points.
4. No points are awarded for any 2 payloads dropped simultaneously at **different** Drop Zones.

Scoring Criteria

General and Pickup	Points
Start Mission before setup time expires	2
Points per unique exit of Launch Zone with preloaded payload (Only **ONE (1)** preload per drone in a run)	2
Points per unique exit of Supply Zone with successful autonomous pick up of payload	5
Points for **non-simultaneous** payload drop	0

Simultaneous drop - outside Bonus Zone	Points
Full Points for 2 **correct** payload drops & contact with Hotspots	10
Partial Points for 2 payloads within Drop Zone	5
Points for any payload outside of Drop Zone	0

Simultaneous drop - within Bonus Zone	No. of Outside Drop Zones with Points Scored			
	0	1	2	3
Full Points for 2 **correct** payload drops & contact with Hotspots	24	26	30	36
Partial Points for 2 payloads within Drop Zone	12	13	15	18
Points for any payload outside of Drop Zone	0			

NOTE: 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.

3.4.3 PENALTIES

The referees will make all penalty decisions and their decision is **final**. For arbitrary cases, the Chief Referee will have the **final** say. Further correspondence will not be entertained.

S/N	DESCRIPTION	PENALTY
1	Exceeding the 15 minutes setup time for D2.	Mission time will start regardless.
2	Use of external markers outside of the play field.	Referee's discretion or **disqualification**
3	Internal markers within the play field unable to be removed or leave a mark after being removed.	Referee's discretion or **disqualification**
4	Interrupting the competition by potentially interfering with other competitors, e.g. switching on your platform's VTX, transmitters, etc.	Referee's discretion or **disqualification**
5	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**
6	Violation of any Safety Rules during the competition.	Referee's discretion or **disqualification**
7	Violation of any Mission Rules in Section 3.3.	Referee's discretion or **disqualification**

4. SCORING

There are a total of **FIVE (5)** scoring components for the competition, namely: Aerial Platform **(A)**, Strategy, Learning Journey **(L)**, Team Challenge Video **(V),** and Mission **(M)**. The first four components (A, S, L, and V) will be assessed by our Category D2 Judges, while the Mission (M) factor 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:

Segment	**Factor**	**Weightage**
Presentation	**A**erial Platform	22.5%
	Strategy	22.5%
	Learning Journey and Insight	5%
	Team Challenge **V**ideo	10%
Competition	**M**ission	40%
	Total	***100%***

For **CAT D2** the total score **T** is computed as:

$$T=A+S+L+V+M$$

4.1. AERIAL PLATFORM FACTOR (A)

The **Aerial Platform Factor (A)** will be awarded based on the ability of the teams to demonstrate a comprehensive understanding of the following areas and apply them when designing and constructing their flying machine. It carries a 22.5% weightage to the overall score.

1. Mechanical design
    - Quality of fabrication, workmanship, materials used.
    - Platform weight optimisation.
    - Lower points for usage of commercial off the shelf products.
    - Design factors affecting platform's flight stability, and carrier stability.

2. Electronics design
    - Power / Battery sizing to meet mission objectives.
    - Explanation of choice of sensor suite for the given environment.
    - Explanation of choice of embedded computer / microprocessor.
    - Neatness of harnessing and aesthetics.

3. Software design, in particular describing how their proposed autonomous concept will work.
    - Explanation of flight control strategy.
    - Explanation of autonomy strategy.

4.2. STRATEGY FACTOR (S)

The **Strategy Factor (S)** is a measure of the team's creativity in the design of their system setup workflow, drones and control interfaces, or any sub-system which aids in their mission strategy. It is not mandatory to adopt unique concepts, but teams that do so will score higher for this factor. It carries a 22.5% weightage to the overall score.

Examples of innovative approaches may include:

- Non-conventional ideas and methods to achieve mission task(s).
- Innovative mechanisms for package delivery.
- Innovative choice of sensors.
- Innovative algorithms.

4.3. LEARNING JOURNEY AND INSIGHT FACTOR (L)

The **Learning Journey and Insight Factor (L)** is related to quality and content of the presentation. It carries a 5% weightage to the overall score.

1. Learning Journey
    - Challenges faced and overcame.
    - Solutions explored and iterations to get to the final product.
    - Team is able to explain the rationale behind design choices and major decision.
    - Key takeaways from the experience.
2. Delivery
    - Speakers are clear and concise.
    - Speakers are able to answer questions smoothly.
3. Teamwork
    - Presentation should highlight the work of all the team members, and how they have contributed and cooperated with the team.

4. Fun
    - Should be able to capture the attention of the judges.
    - The judges should enjoy your presentation.

4.4. TEAM CHALLENGE VIDEO FACTOR (V)

The **Team Challenge Video (V)** scores provide a proof-of-flight insight into how the drone system performs. It carries a 10% weightage to the overall score.

1. Flightworthiness
    - Drones must display their ability to perform stable, sustained flight while carrying a package together.
2. Mission-readiness
    - Drones must display their ability to avoid static obstacles.
    - Drones must display their ability to manipulate the carrier to unload packages.

4.5. MISSION FACTOR (M)

The points obtained during the mission will determine the team's **Mission Factor (M)** score. Please refer to Section 3.4 for the mission scoring and penalties. This carries a 40% weightage to the overall score.

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 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 **TWENTY (20)** minutes for this segment. **FIFTEEN (15)** minutes are allocated for the team presentation, and **FIVE (5)** minutes for Questions & Answers.

Please refer to Section 4 for scoring factors for the presentation component.

During the presentation segment, teams are required to:

1. Bring each unique drone to be used for the challenge.
2. Teams are to prepare ONE (1) presentation in the form of TWO (2) A0 posters OR up to 20 slides. The time limit for the presentation is 15 minutes.

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 4.4.

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: “[CAT D2] - [Team Name] – Challenge Video” before the deadline. The deadline for submission is **28 February 2025, 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 2025 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. A 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 in the challenge 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:

   (1) All propellers and releasable payloads are to be removed from the drones.

   (2) Flight motors will be armed.

   (3) Throttle will be applied to spin the motors. While the motors are still spinning in the same flight mode, the Wi-Fi router(s) will be switched off to simulate a link loss.

   (4) All motors should come to a **complete stop immediately**. The drones should not attempt a hover / controlled descent / to return home.

g. A 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 drones (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 failsafe capability upon operator command. The failsafe check procedure is as follows:
    (1) All propellers and releasable payloads are to be removed from the platform.
    (2) Flight motors will be armed and throttled up.
    (3) While the motors are still spinning in the same flight mode, the operator must be able to activate a kill-switch.
    (4) All motors should come to a **complete stop immediately**. The drones should not attempt a hover / controlled descent / to return home.

i. At the end of each mission attempt, the radio control transmitter, datalink transceiver, video receiver and any other wireless device for the flying machine 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 flout 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 it out of the play field to modify or repair (including changing batteries) **after** it has landed, and all drones 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 solution based on the following guidelines:

1. Off-the-shelf products and components are allowed in the competition.
2. For safety considerations, the MTOW of an aerial drone **must not exceed 2.5kg.** This MTOW includes the weight of carrier and payload. The platform **cannot not exceed 75cm** in any direction (this measurement includes the maximum diameter of the propeller circles and propeller guards).
3. Participants are only allowed to use between to **TWO (2) TO FOUR (4)** aerial drones for mission attempt. Teams can bring similar backup drones to replace any drones that has become incapable of flight. No additional time will be given to replace the drones.
4. Only electric-based flight propulsion is allowed. Both brushed and brushless motors are allowed. No modification to the motors is allowed.
5. No internal combustion or gasoline engines are allowed.
6. No tethering or umbilical wires to the drones are allowed during flight.
7. 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.
8. For safety considerations, the drones must be able to perform full RC manual pilot override and RC failsafe on demand.

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 respective mission. Lithium-Polymer (LiPo) batteries are preferred.

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