2025 Collegiate Design Series
SAE Aero Design Rules

Version 2025.0

Forward

Welcome to SAE Aero Design 2025! This competition has challenged students with relevant aircraft design and real-world engineering experiences since 1986. Technical competition and project management is a hallmark of the aerospace industry. Students are introduced to the concepts of design, manufacture, and mission performance through an industry-like series of competition events which require technical documentation, test readiness presentation, and flight competition.

The 2025 competition introduces a new mission challenge for the Advanced Class. In the context of airborne delivery of packages, the competition's structure where teams are awarded points based on mission segments completed parallels the multi-step processes involved in real-world delivery scenarios. Each segment, from takeoff to navigation, payload delivery, and retrieval, represents a crucial component of the delivery chain. The focus on autonomy underscores the industry's shift towards reducing human intervention, thereby increasing reliability and scalability. This approach not only enhances operational efficiency but also addresses challenges such as traffic congestion and environmental impact. By fostering advancements in these areas, the competition contributes to the broader goal of developing sustainable and resilient logistics solutions.

The SAE Aero Design Rules Committee continues to be impressed with the ingenuity, teamwork, and dedication of the student teams. The experience the competition provides is tailored to be representative of real-world process with a focus on hardware and flight demonstration in addition to requirements deconstruction, preliminary design, and analysis. Working on a team to accomplish a difficult engineering challenge and learn by doing is a key element. Good luck to all teams undertaking this journey.

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1 COMPETITION REQUIREMENTS

1.1 INTRODUCTION

Official Announcements and Competition Information

The SAE Aero Design competition provides undergraduate and graduate engineering students with a real-world design challenge. These rules are developed by industry professionals with a focus on educational value and hands-on experience. These rules compress a typical aircraft development program into one academic year. This competition exposes participants to conceptual design, manufacturing, system integration/test, and verification through demonstration.

SAE Aero Design features three competition classes—Regular, Advanced, and Micro.

1. **Regular Class** is an all-electric class designed to develop a fundamental understanding of aircraft design.
2. **Advanced Class** is an all-electric class aimed at inspiring students to design and execute precision payload delivery and recovery leveraging flight mode transition and autonomous flight.
3. **Micro Class** is an all-electric class designed to encourage students to explore multiple design paths through trade-studies to uncover the most effective and efficient approach to solving real industry challenges.

Other SAE Aero Design Competitions:

SAE BRASIL https://saebrasil.org.br/programas-estudantis/aero-design-sae-brasil/

1.2 SAE AERO DESIGN RULES AND ORGANIZER AUTHORITY

General Authority

SAE International and the competition organizing bodies reserve the right to revise the competition schedule and/or interpret or modify the rules at any time and in any manner, that is, in their sole judgment, required for efficient and safe operation of the event or the SAE Aero Design series.

Penalties

SAE International and the competition organizing bodies reserve the right to modify the points and/or penalties listed in various event descriptions; to accurately reflect the operational execution of events, or any special conditions unique to the site.

Rules Authority

The SAE Aero Design Rules are the responsibility of the SAE Aero Design Rules Committee and are issued under the authority of the SAE Collegiate Design Series. Official announcements from the SAE Aero Design Rules Committee, SAE International, or the other SAE International Organizers shall be considered part of and have the same validity as these rules. Ambiguities or questions concerning the meaning or intent of these rules will be resolved by the officials, SAE International Rules Committee, or SAE International Staff.

Rules Validity

The SAE Aero Design Rules (www.saeaerodesign.com/go/downloads) dated for the academic year of the competition are the rules in effect. Rule-sets dated for prior competition years are invalid.

Rules Compliance

By entering an SAE Aero Design competition, the team members, Faculty Advisors and other personnel of the registered university agree to comply with, and be bound by, the rules and all rules interpretations or procedures issued or announced by SAE International, the SAE Aero Design Rules Committee and other organizing bodies. All team members, Faculty Advisors and other university representatives are required to cooperate with and follow all instructions from Competition Organizers, officials, and judges.

Understanding the Rules

Teams are responsible for reading and understanding the rules in their entirety. The section and paragraph headings in these rules are provided to facilitate reading and do not affect the paragraph contents.

Loopholes

Anticipating a comprehensive design space covering all possibilities and potential questions about the aircraft's design parameters or the conduct of the competition is virtually impossible. Please keep in mind that safety remains paramount during any SAE International competition. Any perceived loopholes will be resolved in the direction of increased safety. When in doubt, please contact the SAE Aero Design Rules Committee using the FAQ forum early to avoid design impacts at competition.

Participating in the Competition

Teams, team members as individuals, Faculty Advisors and other representatives of a registered university who are present on-site for competition are considered to be "participating in the competition" from the time they arrive until they depart the site at the conclusion of the competition or earlier by withdrawing.

Visa--United States Visas

Teams requiring visas to enter to the United States are advised to apply at least sixty (60) days prior to the competition. Although most visa applications go through without an unreasonable delay, occasionally teams have difficulties and may not be issued visas before the competition.

AFFILIATED STUDENT TEAM MEMBERS WILL HAVE THE ABILITY TO PRINT A REGISTRATION CONFIRMATION LETTER FOR THE INDIVIDUAL EVENT(S) THEY ARE ATTENDING. ONCE A STUDENT TEAM MEMBER AFFILIATES THEMSELVES TO THEIR TEAM PROFILE PAGE UNDER THEIR INDIVIDUAL EDIT SECTION, THEY WILL HAVE THE OPPORTUNITY TO PRINT THEIR PERSONALIZED LETTER WITH THE FOLLOWING INFORMATION: STUDENT'S NAME, SCHOOL'S NAME, THE CDS EVENT NAME, OFFICIAL DATES AND LOCATION(S).

Letters of Invitation

Neither SAE International staff nor any Competition Organizers are permitted to give advice on visas, customs regulations or vehicle shipping regulations concerning the United States or any other country.

Certificates of Participation

SAE International and Competition Organizers do not create Participation Certificates outside of the auto-generated certificate on your team profile page at sae.org.

Certificates are available once students are affiliated to the current competition's team. Certificates will not be available once that competition year closes.

Violations of Intent

A violation of the intent of a rule will be considered a violation of the rule itself. Questions about the intent or meaning of a rule may be addressed to SAE International Officials, Competition Organizers, or SAE International Staff.

Right to Impound

SAE International and Competition Organizers reserve the right to impound any on-site vehicle/aircraft at any time during competition for inspection by Competition Organizers, officials, and/or technical inspectors.

1.3 Society Membership and Eligibility

Society Membership

Individual team members must be members of SAE International or an SAE International affiliate society. Proof of membership, such as a membership card, is required at the event. Students may join online at: https://www.sae.org/participate/membership/join

Teams shall read the articles posted on the SAE Aero Design News Feed (www.saeaerodesign.com/go/news) by SAE International and the other organizing bodies. Teams shall also be familiar with all official announcements concerning the competition and rule interpretations released by the SAE Aero Design Rules Committee.

Team Pilots

Team pilots are not required to be students or SAE International members; however, all pilots shall be current members of the Academy of Model Aeronautics or the Model Aircraft Association of Canada (AMA has an agreement with MAAC). Valid AMA membership cards must be presented at competition prior to flying any team's aircraft. Non-US pilots can obtain a discounted AMA Affiliate membership covering flying activities while in the US by going to the AMA web site and submitting the following form: https://www.modelaircraft.org/files/902.pdf.

1.4 Liability Waiver and Insurance Requirements

All on-site participants and Faculty Advisors are required to sign a liability waiver, which is part of their Fast-Track Registration Form that can be printed off their team registration page. Individual medical and accident insurance coverage is the sole responsibility of the participant.

1.5 Ringers Prohibited

To maintain the integrity of the competition, the Faculty Advisor(s) must prohibit ringers. A ringer is someone with exceptional skills related to the competition (e.g., a professional model builder) that cannot be a legal member of the team but helps the team win points.

1.6 Design and Fabrication

The aircraft shall be designed and built by the SAE International student members without direct involvement from professional engineers, radio control model experts, pilots, machinists, or related professionals. The students may use any literature or knowledge related to R/C aircraft design and construction and information from professionals or from professors, as long as the information is given as a discussion of alternatives with pros and cons and is acknowledged in the references in the design report. Professionals may not make design decisions, nor contribute to the drawings, the report, or the construction of the aircraft. The Faculty Advisor shall sign the Statement of Compliance given in the Appendix.

1.7 Original Design

Any aircraft presented for competition shall be an original design conceived by student team members. Photographic scaling of an existing model aircraft design is prohibited. Use of major components such as wings, fuselage, or empennage of existing model aircraft kits is prohibited. Use of standard model aircraft hardware such as motor mounts, control horns, and landing gear is allowed.

1.8 Official Languages

The official language of SAE Aero Design series is English. Document submissions, presentations and discussions in English are required at all US competitions in the series.

Team members, judges and officials at Non-U.S. competition events may use their respective national languages for document submissions, presentations and discussions if all parties involved agree to the use of that language.

1.9 Unique Designs

Universities may enter more than one team in each SAE Aero Design competition, but each entry must be a unique design, significantly different from each other. If the aircraft are not significantly different in the opinion of the Rules Committee and Organizer, then the university will be considered to have only a single entry and only one of the teams and its aircraft will be allowed to participate in the competition. For example, two aircraft with identical wings and fuselages but different empennages would not be considered significantly different. For guidance regarding this topic, please submit a rules question at www.saeaerodesign.com.

1.10 Aircraft Classification/Duplicate Aircraft

One Team Entry per Class

A university is limited to registering one team per class (Regular, Advanced, Micro).

Backup Aircraft

Any back-up aircraft must complete inspection before flying.

1.11 AIRFRAME ELIGIBILITY

Airframes will only be allowed to compete during a ***single academic year***. An airframe may be entered in both SAE Aero Design East and SAE Aero Design West during the same ***academic year***, but that same airframe may not be used in either competition during the following year. Entering the same airframe in SAE Aero Design West one year and SAE Aero Design East the next year is not allowed.

An airframe is considered "entered to competition" during an academic year once design documentation is submitted. If the airframe does not fly at competition during that same academic year, the airframe is not eligible for competition during future academic years.

The airframe shall be designed within eleven (11) months of competition and constructed within nine (9) months of competition. The airframe includes the fuselage, wings, and tail.

1.12 REGISTRATION INFORMATION, DEADLINES, WITHDRAWAL, AND WAITLIST

Teams intending to participate in the SAE Aero Design competitions must register online per the registration schedule in Table 1.1. By registering for any university program, the registered University assumes liability of the student project.

Table 1.1 Open Registration Schedule

Event	***Start (Open)***	***End (Closed)***
Registration Window	October 1, 2024 10:00 AM EDT	November 15, 2024 11:59 PM EST

The registration fee is non-refundable and failure to meet these deadlines will be considered a failure to qualify for the competition. Separate entry fees are required for the events.

Team/Class/University Policy

A university or college can only have one team registered per class. The registration fees must be paid within 48 hours of registration to be eligible.

Individual Registration Requirements – ACTION REQUIRED

A team member must be enrolled as degree seeking undergraduate or graduate student at the college or university of the team with which they are participating. Team members who have graduated during the seven (7) months prior to the competition remain eligible to participate.

All participating team members and Faculty Advisors must ensure they are individually affiliated to their respective college or university on the SAE International website (www.sae.org) Team Profile page.

If you are not an SAE International member, go to www.sae.org and select the "Membership" link. Students will select "Student Membership" and answer the series of questions. All student participants must be members of one of the organizations listed in Section 1.3 to participate.

Faculty members who wish to become SAE International members will select "Professional Membership". This is not mandatory for Faculty Advisors.

All student participants, both domestic and international, and Faculty Advisors must affiliate themselves to the appropriate team(s) online prior to competition.

The “Add New Member” button allows individuals to access this page and include the necessary credentials. If the individual is already affiliated to the team, simply select the Edit button next to the name. This must be done separately for each event your team has entered.

Each team member may participate for only one team. If the university or college is entering multiple classes, team members must choose only one team to affiliate and participate with in the competition. For example, students cannot compete as part of a Micro class team and an Advanced class team.

Pre-Registration Information

SAE will utilize a pre-registration process. Teams who placed top 3 overall in their class during the previous competition will be awarded the opportunity to register up to one week prior to general registration. Pre-registration is restricted to the relative class and event (East or West) of the previous year. For example, if you were in the top 3 in your class at SAE Aero Design East in 2024, you can pre-register for that same class at the SAE Aero Design East 2025 event. Starting on September 24th 10:00 AM ET, top placing teams from the 2024 season will have early access to register.

Any team that placed top 3 overall at both events will have to choose one event for pre-registration. The team can then register for a second competition once the regular registration window opens.
Here is the list of 2025 pre-registration eligible teams.

****NOTE: When your team is registering, only the student or Faculty Advisor completing the registration needs to be linked to the college or university. All other students and faculty can affiliate after registration has been completed; however, this must be completed no later than two (2) weeks before the competition start date.**

1.13 VOLUNTARY WITHDRAWAL

Teams must notify the SAE competition coordinator if they voluntarily withdraw from the competition. This notification will allow organizers to move teams from the waitlist into the competition participation list.

1.14 WAITLIST

Once an event reaches the venue’s capacity, all remaining registered team(s) will be placed on a waitlist. The waitlist is capped at sixty (60) spaces per event and closes on the same day registration closes. Once a team withdraws from an event, an SAE International staff member will inform your team by email (the individual who registered the team to the waitlist) that a competition spot has opened. You will have 24 hours to accept or reject the position and an additional 24 hours to complete registration payment. Waitlisted teams shall submit all documents by the deadlines to be considered serious participants and any team that does not submit all documents will be removed from the waitlist.

1.15 Deadline Policy

Teams registering for SAE Aero Design are required to submit several documents prior to the competition including a Design Report and Technical Data Sheet.

Late Submission Penalty

Late submission or failure to submit the Design Report, Technical Data Sheet(s), and Drawings by the deadline will be penalized five (5) points per day. If your required documents are received more than five (5) days late, the documents will be classified as "Not Submitted" and your team will not be allowed to participate.

Automatic Withdrawal Policy

Failure to submit the required Design Report, Technical Data Sheet(s), and Drawings within five (5) days of the deadline constitutes an automatic withdrawal of your team. Your team will be notified before or on the 4th day of no submission that we have not received your documents and after the 5th day your team's registration will be canceled. No refunds will be given.

Activity/Action	*Class*	*East Event Deadline*	*West Event Deadline*
Event Registration	All	11/15/2024 11:59 PM EST	11/15/2024 11:59 PM EST
Design Report Submission	All	3/16/2025 11:59:59 EST	2/16/2025 11:59:59 EST
Withdrawal Request	All	Reference www.saeaerodesign.com	

1.16 Faculty Advisor

Each team is expected to have a Faculty Advisor appointed by the college or university. The Faculty Advisor is expected to accompany the team to competition and will be considered by competition officials to be the official university representative. Faculty Advisors may advise their teams on general engineering and engineering project management but may not design any part of the vehicle nor directly participate in the development of any documentation or presentation. Additionally, Faculty Advisors may neither fabricate nor assemble any components nor assist in the preparation, maintenance, or testing of the vehicle. In brief, Faculty Advisors may not design, build, or repair any part of the aircraft. Faculty Advisors may not participate in flight operations during competition weekend except as noted.

1.17 Questions, Complaints and Appeals

Questions

Any questions or comments about the rules should be brought to the attention of the Rules Committee by submitting a question at https://www.saeaerodesign.com.

General information about hotels and other attractions in the area, as well as a schedule of events, will be posted on the SAE International website: https://www.sae.org/attend/student-events/

Complaints

Competition officials will be available to listen to complaints regarding errors in scoring, interpretation, or application of the rules during the competition. Competition officials will not be available to listen to complaints regarding the nature, validity, or efficacy of the rules themselves at the competition. In other words, the

Organizer will not change the rules-set at the field, unless competition safety requires updates.

Appeal / Preliminary Review

A team can only appeal issues related to scoring, judging, venue policies, and/or any official actions *regarding their own team*. Team Captain(s) and/or the Faculty Advisor must bring the issue to the Organizer's or SAE International staff's attention for an informal preliminary review before filing an official appeal.

A team cannot file an appeal to cause harm to another team's standing and/or score.

Cause for Appeal

A team may appeal any rule interpretation, own-team scoring or official actions which the team feel has caused some actual, non-trivial, harm to own-team, or has had a substantive effect on their score.

Teams may not appeal rule interpretations or actions that have not caused the team any substantive damage.

Appeal Format

If a Faculty Advisor or Team Captain(s) feel their issue regarding an official action or rules interpretation was not properly addressed by the event officials, the team may file a formal appeal with the Appeals Committee.

All appeals must be filed in writing (see Appendix B) to the Organizer by the Faculty Advisor or Team Captain(s) only.

All appeals require the team to offer twenty-five (25) points as collateral. If the appeal is successful, the team ***will not*** forfeit the twenty-five (25) points. If the appeal is overruled, the team will forfeit the twenty-five (25) points.

Appeals Period

All appeals must be submitted within thirty (30) minutes of the end of the flight or other competition event to which the appeal relates.

Appeals Committee

When a timely appeal is received, the committee will review the claims. All contentions or issues raised in the formal appeal will be addressed in a timely manner. The consideration in each review is whether the actions in dispute were just and in-line with the intent of the rules. Once the review is completed, a new order will be issued affirming, reversing, or modifying the original determination.

All rulings issued by the Appeals Committee are final.

The Appeals Committee shall consist of a minimum of three members: the Organizer or delegate, SAE International representative, and a Rules Committee member.

1.18 PROFESSIONAL CONDUCT

Unsportsmanlike Conduct

Unsportsmanlike conduct is not acceptable at SAE Aero Design events. If SAE staff and/or Rules Committee members observe unsportsmanlike conduct, SAE Aero

Design reserves the right to assess penalty points or remove the team from competition.

Arguments with Officials

Arguments with or disobedience toward any competition official may result in the team's elimination from competition. All team members may be immediately escorted from the competition grounds.

Alcohol and Illegal Material

Alcoholic beverages, illegal drugs, firearms, weapons, or illegal material of any type are not permitted on the event sites at any time during competition. Any violations will result in the immediate expulsion of all team members and Faculty Advisor(s) of the offending school, not just the team member(s) in violation. This rule applies to team members and Faculty Advisors. Any use of illegal drugs or alcohol by an underage person will be reported to local law enforcement authorities for prosecution.

Organizer's Authority

The Organizer reserves the exclusive right to revise the schedule of the competition and/or to interpret the competition rules at any time and in any manner required for efficient operation or safety of the competition.

Ground Safety and Flight Line Safety Equipment

- No open toe shoes allowed. All team members, including Faculty Advisors(s) and pilots, are required to wear CLOSED toe shoes during flight testing and flight competition.
- Smoking is prohibited. Smoking is prohibited in all competition areas.
- Personal Protective Equipment required. All students involved in flight-line launch and recovery operations for all aircraft classes must wear safety glasses.
- Only non-visible Class 1 eye-safe (EN/IEC 60825-1 2014) lasers are allowed. Laser pointers are prohibited.

Line Etiquette

To make a flight attempt, teams must form a line and have their aircraft and competition flightlog with them. Flightlog and Aircraft must be present at all times to maintain line position. Holding a space in line without a valid aircraft or flightlog is not permitted and considered unsportsmanlike conduct. If the aircraft and flightlog are not present, the team will be removed from the line. Once a team uses all available flight attempts, they are no longer permitted to stand in line.

1.19 SAE Technical Standards Access

A cooperative program of SAE International's Education Board and Technical Standards Board is making some of SAE International's Technical Standards available to teams registered for any North American CDS competition at no cost. The Technical Standards referenced in the Collegiate Design Series rules, along with other standards with reference value, will be accessible online to registered teams, team members, and Faculty Advisors.

2 GENERAL AIRCRAFT REQUIREMENTS

2.1 TECHNICAL DEFINITIONS

- The word “shall” within these requirements denotes legal, inspectable or operational requirements. Satisfaction of shall statements determines valid scoring.
- The word “will” within these requirements describes or clarifies a system or device’s intent or purpose.

2.2 AIRCRAFT IDENTIFICATION

The Team Number as assigned by SAE International must be visible on both the top and bottom of the wing, and on both sides of the vertical stabilizer or other vertical surface if they exist.

1. Aircraft shall be identified with the school name, mailing address, and email address either on the outside or the inside of the aircraft.
2. Team Numbers on Regular and Advanced aircraft shall be a minimum of four (**4**) inches in height.
3. Team Numbers on Micro Class shall be a minimum of two (**2**) inch in height.
4. The University name shall be clearly displayed on the wings or fuselage.
5. The University initials may be substituted in lieu of the University name, provided the initials are unique and recognizable.

The assigned Team Numbers appear next to the school name on the “Registered Teams” page of the SAE Aero Design section of the Collegiate Design Series website at:

SAE Aero East: https://www.sae.org/attend/student-events/sae-aero-design-east

SAE Aero West: https://www.sae.org/attend/student-events/sae-aero-design-west

2.3 PROHIBITED AIRCRAFT CONFIGURATION

Unless otherwise specified, competition entrants shall be fixed wing configuration only. Advanced class aircraft may have variable geometry wings. Lighter-than-air aircraft, rotary wing aircraft, or auto-gyros and steerable parafoil aircraft are prohibited.

2.4 Empty CG Design Requirement and Empty CG Markings on Aircraft

The Empty CG location will be verified during Safety and Airworthiness Inspection. Empty weight flight demonstration is not required. All aircraft shall meet the following Center of Gravity (CG) related requirements:

1. All aircraft must be flyable at their designated Empty CG position (no payload, ready to fly) on the submitted 2D aircraft drawing.
2. All aircraft must have the fuselage clearly marked on both sides with a CG symbol (Figure 2.1)
3. CG markings shall be a minimum of 0.5 inches in diameter centered at the Empty CG position +/-0.25 inches, per the submitted 2D drawings. Wing type aircraft may place the CG markings on the bottom of the wing.

Figure 2-1 – Center of Gravity Symbol

2.5 Gross Weight Limit

Aircraft gross take-off weight may not exceed fifty-five (55) pounds.

2.6 Controllability

All aircraft must be controllable in flight.

If an aircraft is equipped with a wheeled landing gear, the aircraft must have a ground steering mechanism for positive directional control during takeoffs and landings.

Aircraft cannot rely solely on aerodynamic control surfaces for ground steering.

2.7 Radio Control System

All aircraft shall employ a 2.4 GHz radio control system with a functional fail-safe system.

The control system's fail-safe system shall reduce the throttle to zero **immediately** upon the loss of the radio signal. Teams may have to reset the default on the fail-safe to meet this requirement.

2.8 Managing Radio Frequency

Teams will be responsible for managing radio frequency (RF) and addressing potential interference or conflicts. Competition organizers encourage teams to implement mitigation measures to minimize risk. Any intentional attempts by teams to gain an unfair advantage will be subject to the Unsportsmanlike Conduct rule outlined in Section 1.17 of the Professional Conduct guidelines.

2.9 Spinners or Safety Nuts Required

All powered aircraft shall utilize either a spinner or a rounded model aircraft type safety nut. Nylon-insert Lock-Nuts are prohibited. Figure 2-2 shows examples of acceptable hardware.

Figure 2-2 - Spinners and Safety Nut

2.10 Metal Propellers

Metal propellers are not allowed.

2.11 Lead is Prohibited

The use of lead in any portion of aircraft (payload included) is prohibited.

2.12 Payload Distribution

The payload design shall not contribute to the structural integrity of the airframe. The airframe will be flight worthy without the payload installed.

2.13 Static Payload Plate Attachment

All static payload plates shall be secured with metal hardware that penetrates all payload plates.

Payload plates shall be secured to the aircraft structure with metal hardware as a single mass inside the designated payload bay, as defined for each competition class.

2.14 Aircraft Ballast

Aircraft ballast is allowed. Ballast, if employed, shall be properly secured.

Ballast shall not be in the payload bay.

2.15 Control Surface Looseness or Backlash

Aircraft control surfaces and linkages shall not feature excessive slop. Control surfaces with excessive backlash contribute to reduced control effectiveness in mild cases and contribute to aeroelastic flutter in severe cases.

2.16 Servo Sizing

Analysis and/or testing will be described in the Design Report demonstrating the servos are sufficiently sized to handle the expected aerodynamic loads during flight.

2.17 Clevis Keepers

All control clevises shall employ additional mechanical retention devices (keepers) to prevent accidental opening of the control clevis in flight.

2.18 Stored Energy Restriction

Aircraft shall be powered by the on-board motor. No other internal and/or external forms of stored potential energy are allowed, for example rubber bands or pressure vessels like CO2 cartridges.

2.19 Battery Pack Restrictions

- All Batteries shall be commercially available. Homemade batteries are prohibited.
- All batteries shall be positively secured so they cannot move under all flight loads.
- The battery bay or location in the aircraft shall be free of any hardware or other protrusions that could penetrate the battery in the event of a crash.

2.20 Use of Lasers

The use of lasers for marking/highlighting landing zones or directing an aircraft to a landing zone is prohibited.

2.21 Power Limiter

Some classes shall use a third-party electronic device (power limiter) to limit the power the propulsion system can use. The official power limiter supplier is Neumotors.com. The supplier will ship worldwide. The limiters are only available at the following link:

https://neuracing.us/product-category/saelimiters/

- Repairs and/or modifications to the limiter are prohibited.
- The limiter shall be fully visible and easy to inspect.
- Only battery, receiver, Battery Eliminator Circuit (BEC), speed control, arming plug, and limiter shall be allowed within the power circuit.

2.22 Red Arming Plug

All electric powered aircraft shall use a discrete and removable red arming plug to arm and disarm the aircraft propulsion system.

The red arming plug shall be integrated into the electrical circuit between the battery and the electronic speed controller (ESC).

The red arming plug shall be located on the positive (RED) wire between the battery and the power limiter.

The red arming plug shall be located as follows:

- The arming plug must be past the opposite edge of the wing from the propeller.
- On a tractor flying wing or delta, the arming plug must be within 2 inches of the wing control surface hinge line or on the trailing edge of the main body/fuselage.

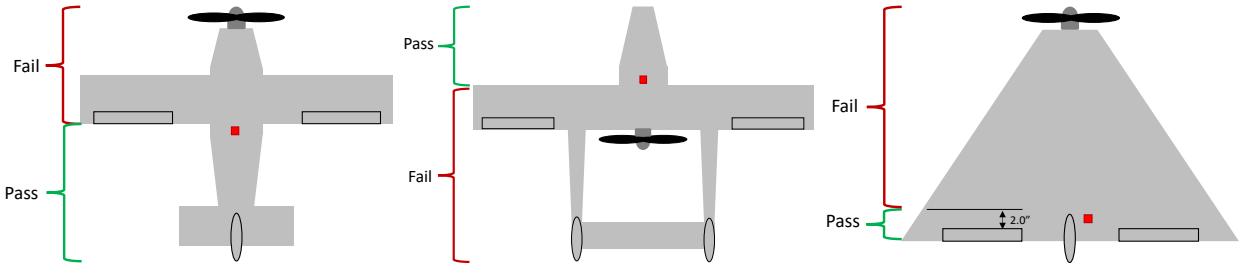

Figure 2-3: Layout diagram of red arming plug on several example aircraft configurations.

The red arming plug shall be located on the top, near the centerline of the fuselage or wing, and external to the aircraft surface.

The red arming plug location shall be clearly visible.

The non-removable portion of the arming plug interface shall not have more than one male lead.

Disconnecting wiring harnesses to arm and disarm a system shall be prohibited.

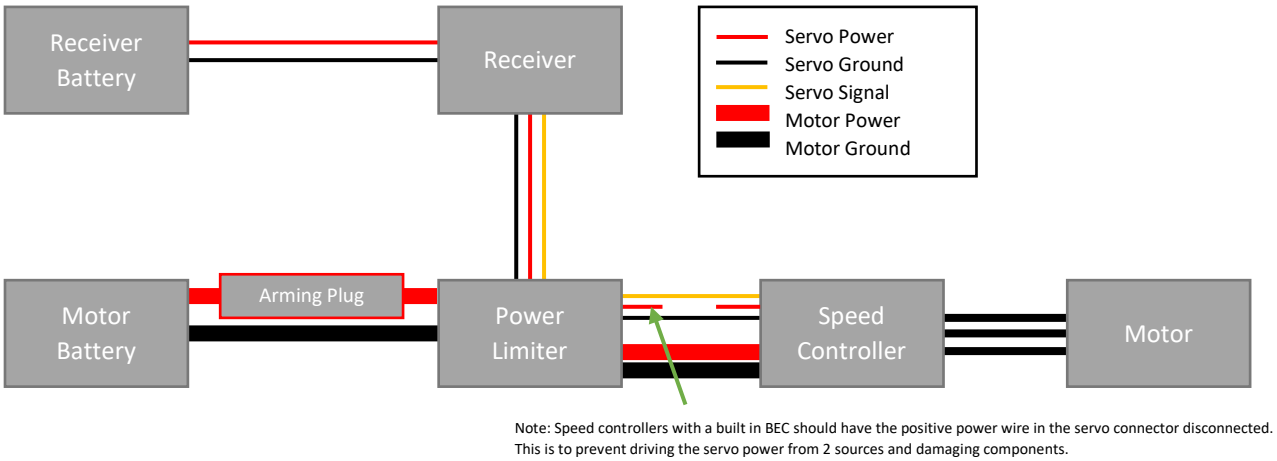

Figure 2-4: Example diagram of propulsion system with Arming Plug and Power Limiter. Note, different classes may have additional requirements, or allow for alternative configurations.

2.23 Receiver System Battery Pack

A separate battery or separate BEC shall be required for the receiver system.

Batteries shall have enough capacity to safely drive all aircraft servos, taking into consideration the number of servos and maximum current draw.

The aircraft receiver system shall be able to operate without the arming plug installed.

The receiver system must have an independent battery pack with a minimum capacity of 1000 mAh.

The battery pack shall be a LiPo or LiFE type battery.

Battery voltage regulators are allowed.

2.24 On/Off Switch

The receiver system shall be controlled by a clearly visible, properly mounted on/off switch mounted to the aircraft exterior, located at least 12” from the propeller.

2.25 Repairs

The original design of the aircraft as presented in the Design Report and presentation shall be maintained as the baseline aircraft during the competition.

In the event of aircraft damage, the aircraft may be repaired provided such repairs do not drastically deviate from the baseline design. All major repairs shall undergo safety inspection before the aircraft is cleared for flight.

2.26 Alteration after Flight

Minor alterations are allowed after the first and subsequent flight attempts. Consult with Rules Committee members to determine if desired changes may be subject to penalty points. Any change made solely for safety of flight will not be subject to penalty points.

3 MISSION REQUIREMENTS AND SCORING

3.1 AIR BOSS

The Air Boss is a qualified SAE event official or appointed volunteer that manages the flight line process. Their responsibilities include:

1. Ensuring safety of the flight line by maintaining an orderly and controlled runway.
2. Being the official of record for the success or failure of the flight, including takeoff and landing.
3. Declaration of flight termination at any time during the flight attempt.

Air Boss, or event organizers, may continue flight operations at their discretion in continuous winds up to 45 knots with gusts no greater than 65 knots.

3.2 PILOT AREA

A pilot area will be defined at pilot briefing. All pilots shall fly from the designated area.

3.3 FLIGHT ATTEMPT

Teams are allowed one (1) flight per attempt. There is no fixed or guaranteed number of flights.

A **Flight Attempt** is defined as each time the team brings their aircraft for mission demonstration, starting when the team enters the 'On-Deck' area. Each team will have a limited number of flight attempts for the competition, depending on local conditions.

A **Take-off Try** is defined as trying to get airborne within the time limit.

Airborne is defined as all parts of the aircraft are no longer touching the ground.

A **Bounce** is defined as any part of the aircraft touching the runway after becoming airborne.

For all competition classes the aircraft may be throttled-up/run-up for take-off, subject to the following conditions:

- **Regular Class**: Two (2) team members are allowed to hold the aircraft in place prior to take-off roll.
- **Micro and Advanced Classes**: One (1) team member is allowed to hold the aircraft in place prior to take-off roll.
- The aircraft holder may not push the aircraft on release.
- **Regular and Micro Classes:** the main gear shall remain on the take-off line prior to release.

3.4 AIRCRAFT CONFIGURATION AT LIFTOFF AND DURING THE FLIGHT ATTEMPT

The aircraft shall remain intact during a flight attempt to receive full flight score.

A twenty-five percent (25%) deduction from the flight score will be assessed if any of the following items are observed to completely detach from the aircraft during a flight attempt.

- Stickers
- Tape
- Coverings

If any components, other than a broken propellor during landing, fall off during a flight attempt, the flight shall be disqualified.

3.5 Competition Circuit Requirements

1. During departure and approach to landing, the pilot shall not fly the aircraft in a pattern that will allow the aircraft to enter any of the no-fly zones.
2. Aerobatic maneuvers shall be prohibited during the flight competition for all competition classes. This includes but is not limited to: loops, figure 8's, Immelmann, all types of rolling maneuvers, and inverted flight.
3. Regular and Micro Class aircraft shall successfully complete a minimum of one (1) complete 360° circuit around the field. See Table 3.2 for additional information.
4. Advanced Class has no specific flight pattern (See Advanced Class rules for clarification).

3.6 Time Limits and Multiple Takeoff Tries

1. Multiple takeoff tries per flight attempt may be allowed for some classes within the class-specific time allotment. Refer to Table 3.1 for specific information.
2. If an airborne aircraft bounces or returns to the ground after being airborne and is beyond the take-off distance limits, the flight attempt shall be disqualified.
3. (Regular Class) Wing panels will be installed once the aircraft is on the flight line and the take-off timing has started.

Table 3.1: Flight Attempt Information

Class	**Time Limit (sec)**	**Can make multiple take-off tries if:**			**Take-off Try is defined as the point at which:**
		Still within the Time Limit	Bounce within required take-off distance	Bounce outside the required take-off distance	
Regular	120	Yes	Yes	No	The aircraft leaves the starting line and moves forward under its own power
Advanced	60	Yes	Yes	No	
Micro	60	No	No	No	

3.7 On-Deck Area

The 'On-Deck Area' is an area near the flight line where teams will prepare for their flight attempt.

1. Teams shall surrender one (1) flight attempt when directed to the On-Deck Area as they wait for their turn to take the flight line.
2. Teams may mount propellers, perform control surface checks, and range checks.
3. Teams may decide, or be directed by the Airboss or Pitboss, to leave the On-Deck Area for maintenance and/or technical issues but shall forfeit the flight attempt.
4. Teams should have enough reserve power for any expected delays.
5. Teams shall not be allowed to install their propulsion arming plugs.
6. Motor runup and testing shall not be allowed.
7. Wing panels shall not be installed in the On-Deck area

3.8 Take-off

Take-off direction will be determined at the discretion of the Air Boss. If possible, the take-off direction will face into the wind. Changes in wind direction, in light and variable winds, may affect the take-off direction throughout the day. SAE Aero Design reserves the right to change the take-off direction at any time for weather or safety reasons.

1. All aircraft shall remain on the runway during the take-off roll.
2. Table 3.2 defines distance requirements.
3. Making the initial turn before passing the "distance from initial start before turn" requirement shall disqualify the flight attempt.

Table 3.2: Take-off Information

Class	Take-off Distance Limits	Distance from initial start before turn	Description
Regular	100 ft.	400 ft.	Aircraft must be airborne within the prescribed take-off distance.
Advanced	None	None	Aircraft will have the full use of the runway.
Micro	See Section 9.5	400 ft.	Team may use the entire launch area per attempt to get the aircraft airborne. Only one (1) launch release per flight attempt is allowed.

3.9 Landing Requirements

A successful landing is defined as a controlled return to the ground. Aircraft shall remain inside the specified landing zone for each class. The aircraft may leave the landing zone only if given permission by the Air Boss.

The landing zone is a pre-determined, fixed area for each class for the purpose of returning aircraft to the ground. See Table 3.3 for class requirements.

1. The landing zones will be visibly marked prior to the start of competition.
2. It is the team and pilot's responsibility to be aware of the class-specific landing zone dimensions.
3. Any aircraft that leaves the designated landing zone or the paved runway for any reason during landing shall be disqualified.
4. Any flight where the aircraft does not make initial touch down for landing inside the designated landing zone shall be disqualified.
5. Touch-and-go landings are not allowed and shall be judged as a failed landing.
6. The criterion for being within the landing zone is that all supporting parts of the aircraft touching the ground shall be within the landing zone. For example, a wing tip or fuselage can overhang the edge of the landing zone, provided no supporting part of the aircraft is physically touching outside the landing zone.

Table 3.3: Landing Distance Limit

Class	Landing Distance Limits (ft.)	Description
Regular	400 ft.	Aircraft must land in the same direction as take-off. Aircraft must stop within the designated landing zone to avoid a penalty (ref 3.9.3).
Advanced	Available Runway	
Micro	200 ft.	

3.10 Grounding an Aircraft

1. An aircraft will be grounded if it is deemed non-flightworthy or not in compliance with the rules by any SAE official, event official or a designated technical/safety inspector.
2. Until the non-flightworthy or out-of-compliance condition has been addressed and cleared by re-inspection, the aircraft will not be allowed to fly.

3.11 Flight Rules Announcement

Flight rules, updates, and changes will be reviewed in a pre-competition pilot meeting before the flight competition begins.

3.12 Flight Rules Violations

1. Violation of any flight rule may result in the team being eliminated from the competition.
2. All members of an eliminated team may be escorted from the grounds.

3.13 Local Field Rules

In addition to competition rules, the local flying club may have additional rules in place at the event flying field.

1. Club rules shall be obeyed during the competition.
2. If club rules conflict with competition rules, it is the responsibility of the Team Captain(s) and/or Faculty Advisor to bring attention to the conflict and follow the appeals process to resolve the conflict.

3.14 No-Fly Zone

Each competition will have venue-specific **no-fly zones**. The no-fly zones will be defined during the pilot meeting.

1. At no time shall an aircraft enter the no-fly zones, whether under controlled flight or uncontrolled.
2. The first infraction for crossing into the no-fly zone shall result in a disqualified flight attempt and zero points will be awarded for that flight.
3. A second infraction shall result in disqualification from the entire event and a loss of all points.
4. It is the team and pilot's responsibility to be aware of the no-fly zones and to comply with all venue-specific rules.
5. If a team is unable to directionally control their aircraft and it is headed towards or is in a no-fly zone, the Judges and/or Air Boss may order the pilot to intentionally crash the aircraft to prevent it from endangering people or property. This safety directive must be followed immediately, if ordered by the officials.

3.15 Competition Scoring

A team's final, overall score is composed of scores in the following categories:

1. Technical Design Report (Design Report and Drawing)
2. Flight Demonstration Readiness Review (FDRR) Presentation
3. Flight Event
4. Penalties

To participate in the flight portion of the competition, each team is required to have submitted AND received a score for their Design Report and Oral Presentation.

Teams must participate in the design report, presentation, and flight event categories to be included in the competition for overall score. Passing Requirements Check & Safety and Airworthiness inspection counts as participating in the Flight Event.

3.16 Aircraft Empty Weight Definition

All aircraft parts that are not payload, as defined in the relevant class's section, contribute to the empty aircraft weight, including, but not limited to: airframe, receiver, electronics, batteries, hardware, brackets, straps, and other associated features.

4 DESIGN REPORT

The Design Report is the primary means for a team to convey the story of how their aircraft is the most suited design to accomplish the mission. The Design Report should explain the team's thought processes and engineering philosophy that drove their conclusions.

Some important topics to cover are: selection of the overall vehicle configuration, wing planform design including airfoil selection, drag analysis including three-dimensional drag effects, aircraft stability and control, power plant performance including both static and dynamic thrust, and performance prediction. Other topics should be included as appropriate. See the SAE Aero Design Report Guidelines available at www.saeaerodesign.com/go/downloads for additional comments, suggested topics, and a suggested outline. For more information regarding performance prediction, a white paper by Leland Nicolai is also available at http://www.saeaerodesign.com/go/downloads

4.1 SUBMISSION DEADLINES

The Technical Design Report, 2D drawing, and supplemental Tech Data Sheet (TDS) shall be electronically submitted to www.saeaerodesign.com no later than the date indicated on the Action Deadlines given on the SAE International Website:

https://saeaerodesign.com/Deadlines.aspx?seriesCode=AERO

Neither the Organizer nor the SAE International is responsible for any lost or misdirected reports, drawings, or server routing delays. SAE International shall not accept any paper copies of reports received through regular mail or email.

4.2 ORIGINAL WORK

The Technical Design Report shall be the team's original work for the current competition. Resubmissions of **previous and current** year's design reports will not be accepted. Recitation of previous year's work is acceptable **if and only if** appropriately cited and credited to the original author(s). Plagiarism is a forbidden industry and academic practice. All references, quoted text, and reused images from any source shall have appropriate citation within the text and within the Technical Design Report's Table of References, providing credit to the original author and editor.

Reports may be checked against **previous and current** submissions to determine if re-use, copying, or other elements of plagiarism are indicated.

For the SAE Aero Design Competition, plagiarism is defined as any of the following:

1. Use of information from textbooks, reports, or other published material without proper citation
2. Use of sections or work from previous SAE Aero Design competitions without proper citation

If plagiarism is detected in the written report, a team will be given 24 hours to make a case to SAE and the Rules Committee. If the report and/or case is found to be insufficient, the team will receive zero score for the report. The team will be allowed to compete in all remaining categories of the competition but will not be eligible for awards. SAE reserves the right to notify the University.

If plagiarism is detected in the oral presentation, the team will receive zero score for the presentation. The team will be allowed to compete in all remaining categories of the competition but will not be eligible for awards. SAE reserves the right to notify the University.

The SAE Aero Design Rules Committee & SAE International has the sole discretion to determine whether plagiarism is indicated, and the above rules are enacted. The above rules may be implemented at any time before, during, or for up to six (6) months after the competition event.

4.3 Technical Design Report Requirements

The Technical Design Report shall be valued at 50 points (pts) of the competition score as detailed in Table 4.3.1.

- The Technical Design Report shall not exceed thirty (30) pages, complying to all formatting requirements herein. If the design report exceeds thirty (30) pages, the judges will only score the first thirty (30) pages.
- The Technical Design Report shall include a Cover Page with Team Name, Team Number, and School Name and Team Member Names.
- The Technical Design Report shall include a current Certificate of Compliance signed by hand by the team's Faculty Advisor.
- The Technical Design Report shall be typewritten and double-spaced. Tables, charts, and graphs are exempt from this. For single-spaced reports, only the first fifteen (15) pages will be scored. All other content sections will receive zero (0) points.
- The font shall be 12 pt. proportional; or 10 char/in. non-proportional font.
- The margins shall be: 1" Left, 0.5" right, 0.5" top, and 0.5" bottom.
- Each page, except the Cover Page, Certificate of Compliance, 2D Drawing and Technical Data Sheet shall include a page number.
- All report pages shall be ANSI A (8 1/2 x 11 inches) portrait-format.
- The Technical Design Report shall include a Table of Contents, Table of Figures, Table of Tables, Table of References and Table of Acronyms.
- The Technical Design Report shall be single-column text layout.
- The Technical Design Report shall include the Technical Data Sheet(s) (TDS) appropriate for the team's competition class. The TDS must include the Team Name, School Name, and Team Number.
- Non-original technical content and graphics shall cite the originating author's credit.

Table 4.3.1 Technical Design Report

Section	Page Count	Points		
		Regular	Advanced	Micro
Cover Page	1	40	40	40
Certificate of Compliance	1			
Design Report	27			
2D Drawing	1	5	5	5
Total Document	**30**	**45**	**45**	**45**
TDS: Payload Prediction	1	5	-	-
TDS: Sequence Diagram for Payload Delivery/Capture	1		5.0	
TDS: Vehicle Performance	1	-	-	5
Total		**50 pts**	**50 pts**	**50 pts**

4.4 2D Drawing Requirements

2D Format and Size

The 2D drawing shall be one (1) ANSI B sized page (PDF) format (11 x 17 inches). For teams outside North America that cannot submit an ANSI B size drawing, page format size must be the closest size available to ANSI B.

Markings Required

The 2D drawing must be clearly marked with:

1. Team Number
2. Team Name
3. School Name

Views Required

Drawings shall include at a minimum, a standard aeronautical 3-view orthographic projection arranged as described:

1. Left side view, in lower left, with nose pointed left.
2. Top view, above and aligned with the left side view, also with nose pointed left (wing-span break-view permitted).
3. Front view aligned to side view, located in the lower right (projection view non-standard movement as noted by projection view arrows in accordance with ANSI-Y14.5M 1994 or more recent).

Dimensions Required

Drawing dimensions and tolerance shall be in English units, decimal notation accordance with ANSI-Y14.5M 1994 to an appropriate level of precision to account for construction tolerances (allowable variation from analyzed prediction to account for fabrication) (i.e. X.X = ± .1 in; X.XX = ± .03 in; X.XXX = ± .010 in).

The minimum required dimensions/tolerances are: aircraft length, width, and height.

Summary Data Required

The drawing shall contain a summary table of pertinent data to include but not limited to:

1. Wingspan
2. Wing Area
3. Aspect Ratio
4. Empty weight
5. Battery(s) capacity
6. Motor make and model
7. Motor KV
8. Propeller manufacturer, diameter, and pitch
9. Servo manufacturer, model number, and torque specification in ounce-inches for each aircraft servo. Identify the servo being used at each position on the aircraft.

Weight and Balance Information

The 2D drawing shall contain the following weight, balance, and stability information:

1. A clearly marked and labeled aircraft datum
2. A weight and balance table containing pertinent aircraft equipment. Each item shall show its location from the aircraft datum in inches (the moment arm), the force, and resultant moment. See www.saeaerodesign.com/go/downloads for additional information. The minimum pertinent equipment list includes:
    a. Motor
    b. Battery(s)
    c. Payload(s)
    d. Electronics
3. Aircraft mean aerodynamic cord, stability margin and Center of Gravity (CG) information listed below shall be clearly shown on drawing.
    a. Aircraft mean aerodynamic chord
    b. Stability margin for loaded CG and empty CG
    c. Empty CG location (flightworthy)
    d. Fully loaded CG (flightworthy, with payload, if applicable)

4.5 TECH DATA SHEET: PAYLOAD PREDICTION (REGULAR CLASS ONLY)

Regular Class shall include a total payload prediction curve as part of the technical report. The graph represents an engineering estimate of the aircraft's lift performance based on density altitude.

1. Graph of payload weight shall be linearized over the relevant range.
2. The linear equation shall be in the form of:

$$y = mX + b$$

Y = Payload weight (lbs.)
X = Density Altitude (feet)
m = Slope of the linear line
b = y-intercept.

3. Only one line and one equation shall be presented on the graph. This curve may account for predicted headwind for local conditions, rolling drag, inertia, motor and propeller performance, or any other factors that may affect take-off performance. All these factors are allowed components of the prediction curve, but only one curve will be allowed; multiple curves for varying headwind conditions will not be allowed.
4. The team shall provide a brief explanation of how the line was generated in the report. The report section containing this information shall be noted on the payload prediction curve.
5. Graph axes shall be in English units, decimal notation.

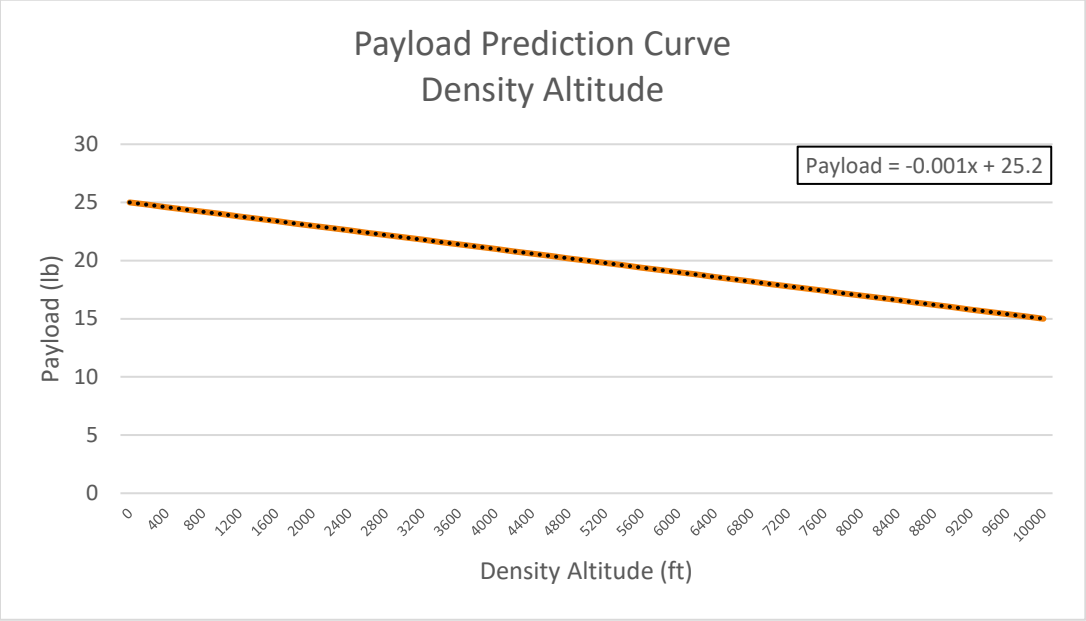

Figure 4-1: Example Regular Class Payload Prediction Curve

4.6 TECH DATA SHEET: SEQUENCE DIAGRAM FOR PAYLOAD DELIVERY/CAPTURE (ADVANCED CLASS ONLY)

Advanced class team shall provide a single-page Technical Data Sheet (TDS) that identifies critical contributors to sequence of operations using a sequence diagram, or a type of interaction diagram using the Unified Modeling Language (UML) to show how objects interact in a particular sequence of events.

The team's sequence diagram TDS shall illustrate the autonomous flow of operations and interactions between various contributors involved in the take-off, release/delivery, capture, and Return to Base (RTB) process. (See Figure 4.2 for an example of a sequence diagram for ordering food from a restaurant)

Autonomous Sequence Diagram should include:

1. Contributors: Players and external entities that interact with the system, such as, but not limited to the Pilot, Vehicle, Payload, Command & Control, Release Mechanism, Delivery Mechanism, and Capture Mechanism
2. 2-4 Sentences describing the overall system, contributors role, and the desired outcome from the system

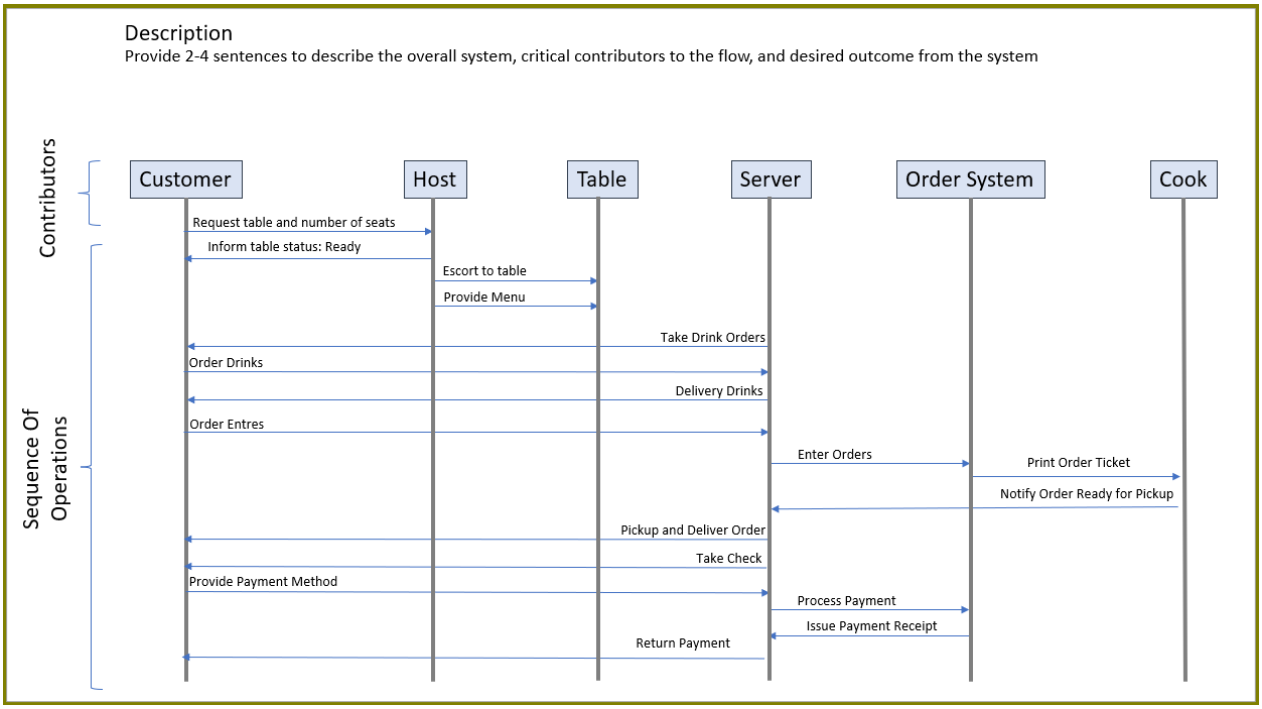

Figure 4-2: Example of Advanced Class Sequence Diagram

4.7 TECH DATA SHEET: AIRCRAFT PERFORMANCE PREDICTION (MICRO CLASS ONLY)

Micro class must provide a plot of the aircraft's neutral point and a plot of static margin on a single page, each from -10 degrees to +15 degrees angle-of-attack with the water container half-full. Teams should include a paragraph discussing stability accounting for water movement.

5 FLIGHT DEMONSTRATION READINESS REVIEW

Prior to conducting expensive test campaigns, professional engineers are required to complete technical readiness reviews with senior technical leadership and independent reviewers. These reviews require engineers to accurately assess program maturity, develop a planned path forward, and communicate effectively with technical leaders who may not be familiar with the detailed design. The intent of a Flight Demonstration Readiness Review (FDRR) is to communicate the path forward for the team through the completion of competition including work remaining, outstanding issues or risks, and plan for mission execution. FDRRs are forward looking reviews to anticipate potential hurdles to completing the mission successfully.

The competition technical presentation will be focused on a FDRR allowing teams the opportunity to demonstrate they are ready to perform safely in the competition's flight operations. Teams can obtain a maximum FDRR score of fifty (50) points. The score shall be comprised of scores from each judge based on the judges' evaluation of the technical content and the team's readiness to compete.

5.1 PRESENTATION REQUIREMENTS

1. The FDRR shall be timed with a follow-on, timed "Question and Answer" (Q&A) period. The time limits are detailed in Table 5.1 (Regular and Micro Class) and Table 5.2 (Advanced Class).
2. The FDRR shall be delivered in English.
3. The FDRR shall address, but is not limited to: mission overview, preflight predictions, mission hardware & software pedigree and readiness, competition first time events & mission risks, outstanding major milestones prior to competition, team roles and responsibilities, and post flight risk planning.
    - A **First Time Event** (FTE) is defined as any subsystem tests, assembly & integration, flight testing, new conditions, new pilot, or any other occurrence that may be encountered during competition weekend for the first time.
4. The FDRR is limited to student team members only. Non-team member pilot or Faculty Advisors can attend but are prohibited from participating in the setup, delivery, and/or the Q&A.
5. Use of visual aids are advised. Film clips, if used, shall not exceed one-minute total duration. Film clips may not be accompanied by recorded narration.

5.2 PRESENTATION PROCESS AND PROCEDURES

Each presentation room shall have a lead judge with the responsibility to ensure compliance with competition rules and schedule. The lead judge will also identify a timekeeper.

1. With agreement from the speaker, the timekeeper will give the speaker a one (1) minute warning prior to the presentation time limit.
2. If the team exceeds the presentation time limit, the team shall be assessed a five (5) point penalty.
3. The presentation shall be stopped after one (1) additional minute.

4. A team shall have time for Q&A immediately following the presentation according to Table 5.1 (Regular and Micro Class) and Table 5.2 (Advanced Class). Questions may be asked by any judge.
5. Any time remaining or exceeding the presentation time limit shall be added to or subtracted from the Q&A time limit.

Table 5.1: Micro and Regular Class Presentation Time Breakdown

Time (Minutes)	Description
2	Setup presentation
12	Present Flight Demo Readiness Review
7	Questions & Answers
1	Close down presentation

Table 5.2: Advanced Class Presentation Time Breakdown

Time (Minutes)	Description
2	Setup presentation
15	Present Flight Demo Readiness Review
7	Questions & Answers
1	Close down presentation

6 REQUIREMENTS CHECK & SAFETY AND AIRWORTHINESS INSPECTION

Requirements Check & Safety and Airworthiness Inspection of all aircraft will be conducted using checklists for each class for the current year. The checklists will be posted on SAE STARS. All teams will receive a unique code to access their interactive checklist and conduct self-certification.

Safety and Airworthiness Inspection is the process of checking each aircraft for any issues or problems that could cause a safety problem in flight or on the ground.

Requirements Check is the process of checking all aircraft for:

- Compliance with all General aircraft requirements.
- Compliance with all Class-specific requirements.
- The aircraft presented matches the design submitted by the team.

All aircraft must pass the Requirements Check & Safety and Airworthiness to compete. **Per the Statement of Compliance, teams shall not begin the inspection process prior to presenting a fully completed Requirements Check & Safety and Airworthiness Inspection for their aircraft submitted on SAE STARS by the Faculty Advisor or Team Captain.**

Inspectors will be given a list of five (5) to seven (7) requirements to spot check, instead of checking all items. These will be randomly chosen before the event. Even though items are being spot checked, teams must comply with all items at all times.

6.1 AIRCRAFT CONFORMANCE TO 2D DRAWING

During Technical Inspection, the aircraft will be inspected and measured for conformance to the 2D drawing presented in the Design Report.

1. At a minimum, aircraft length, wingspan and height dimensions will be measured and compared to the 2D drawing.
2. Aircraft will have the actual empty CG compared to the empty CG presented in the 2D drawing.

6.2 DEVIATIONS FROM 2D DRAWING

Any deviation in construction of the aircraft from the submitted 2D drawing, shall be reported in writing. **For Advanced and Regular Class aircraft, there is no need to report deviations in the length (L), width (W), and height (H) of the aircraft, if the following is satisfied, where dimensions are in inches:**

$$\left|L_{actual} - L_{drawing}\right| + \left|W_{actual} - W_{drawing}\right| + \left|H_{actual} - H_{drawing}\right| \leq X \; inches$$

$$Where \; X = 1 \; for \; Micro \; Class, 3 \; for \; Regular \; and \; Advanced \; Class$$

6.3 SAFETY AND AIRWORTHINESS OF AIRCRAFT

Safety and Airworthiness Inspection will also assess the general safety and airworthiness of each aircraft by seeking any problems that could cause an aircraft to depart controlled flight. This assessment includes, but is not limited to:

1. Unintentional wing warps
2. Control surface alignment
3. Correct control surface response to radio transmitter inputs
4. Linkage problems
5. Structural and mechanical soundness of aircraft

6.4 Inspection of Spare Aircraft and Spare Aircraft Components

1. All spare aircraft and spare aircraft components (wings, fuselages and tail surfaces) must be presented for inspection.
2. Teams may submit up to two (2) complete aircraft at inspection on Friday.
3. Additional spare aircraft and parts beyond two (2) sets may be submitted for inspection on Saturday and Sunday.

6.5 Aircraft Must Maintain Compliance Throughout the Competition.

All aircraft shall meet all Requirements Checks & Safety and Airworthiness requirements throughout the competition.

Compliance with any rules requirement herein may be verified or require reinspection by any SAE official, event official or a designated technical/safety inspector at any time, including any errors of omissions made by officials during inspection.

6.6 Requirements Check & Safety and Airworthiness Inspection Penalties

1. If a team fails the spot check process for any of the General Aircraft requirements or Class requirements, there shall be a point penalty for each item failed. The aircraft shall be brought into compliance to compete.
2. SAE Aero Design reserves the right to assess the point penalty on any requirement item found during inspection, even if the item is not on the spot check list.
3. Any Requirements Check failure involving penalty points shall be confirmed by a Rules Committee member.
4. No additional penalty points shall be assessed for a team's second aircraft that has the same requirements failure as the first aircraft.
5. If a Requirements Check item failure is found on an aircraft after inspection or during flight rounds, the point penalty shall be applied and any flight score earned while the aircraft was non-compliant will be zeroed. The aircraft shall be brought into compliance before flying again.
6. Penalty points shall not be applied for failing any Safety or Airworthiness item. However, the team shall correct any failures before the aircraft is allowed to fly. Flight points earned while the aircraft was not in compliance with Safety and Airworthiness requirements may be subject to being zeroed.

7 REGULAR CLASS DESIGN REQUIREMENTS

The Regular Class objective is to design an aircraft that can maximize both payload weight carried and wingspan. Payload will consist of Regular Boxed Cargo, represented by payload weights, which must be carried on each flight. Accurately predicting the aircraft lifting capacity is an important part of aircraft design.

7.1 AIRCRAFT DIMENSION REQUIREMENT

Regular Class aircraft must have a minimum planform wingspan of **120** inches.

Regular Class aircraft are limited to a maximum planform wingspan of **180** inches. When not on the flight line, teams will be required to remove outer wing sections for easy transport.

Wings with small chord extensions added to gain span are not allowed. There can be no chord steps or discontinuity in the projected wing drawing. The minimum wingtip chord is 4 inches.

The aircraft must disassemble into components, each of which must measure 48 inches or less, along any primary axis in the flight configuration aircraft body frame. Components permanently attached to each other (i.e., bonded) are considered members the same component.

The aircraft's outer-most wing panels must be at least 42 inches in span as defined in the paragraph above.

7.2 MATERIAL AND EQUIPMENT RESTRICTIONS FOR REGULAR CLASS

Fiber-Reinforced Plastic (FRP)

The use of Fiber-Reinforced Plastic (FRP) is prohibited on all parts of the aircraft. Fiber-Reinforced Plastic includes duct tape. Exceptions include commercially available FRP motor mount, propeller, landing gear, and control linkage components. Exploration of alternative materials is encouraged.

Rubber Bands

Elastic material such as rubber bands, shall not retain the wing or payloads to the fuselage.

Stability Assistance

All types of gyroscopic or other stability assistance are prohibited.

Wing Section Joining

No Tape or covering material will be allowed over/on the wing joints.

7.3 AIRCRAFT SYSTEM REQUIREMENTS

Electric Motor Requirements

The aircraft shall be propelled by a single electric motor. There are no restrictions on the make or model of the electric motor.

Gearboxes, Drives, and Shafts

Gearboxes, belt drive systems, and propeller shaft extensions are allowed if a one-to-one propeller to motor RPM is maintained. The prop(s) must rotate at motor RPM.

Aircraft Propulsion System Battery

Regular Class aircraft must be powered by a commercially available 6 cell (22.2volt) Lithium-Polymer battery pack. Minimum requirements: 3000 mAh, 25c.

Power Limiter

Regular Class aircraft must use a 2018 V2 or newer, 750-watt power limiter from the official supplier as described in Section 2.19. If you have a 1000-watt limiter, you can send the limiter back to be changed to 750-watts.

7.4 Payload Requirements

Types of Cargo

Regular Class payload shall consist of Regular Boxed Cargo, which must be carried internally. Payload attachment must be designed for ease of access. Reference Section 7.5 for demonstration details.

Cargo Bay Requirements

Regular Class aircraft shall have a single fully enclosed Cargo Bay for carrying Regular Boxed Cargo with the following additional requirements:

1. The Cargo Bay shall fully enclose the Regular Boxed Cargo. Regular Boxed Cargo may not be exposed to airstream at any point in flight.
2. The Cargo Bay has no restriction on size or shape.
3. Only one Cargo Bay is allowed in a Regular Class aircraft.

Regular Boxed Cargo Support Requirements

Regular Boxed Cargo shall consist of a support assembly and payload plates with the following additional requirements:

1. There is no required configuration for the payload plates, other than as defined by Section 2.10 and 2.11.
2. Teams must provide their own payload plates.
3. Tape, Velcro, rubber bands, container systems and friction systems alone may not be used to retain the support assembly and/or payload plates.

7.5 Regular Class Payload Unloading

To complete a successful flight for score, the post-flight unloading Regular Boxed Cargo must be accomplished within one (1) minute. This demonstration will occur at the weigh station after the completion of each successful flight.

This activity is timed and shall be performed by no more than two (2) team members.

The demonstration will start with all Regular Boxed Cargo loaded and secured, and the aircraft configuration unchanged from the most recent successful flight.

Only Regular Boxed Cargo successfully unloaded within the time limit will be weighed and recorded for scoring that flight.

7.6 REGULAR CLASS SCORING

The team's Final Flight Score (FFS) is the sum of the team's top three (3) flight scores achieved during the competition (FS_1, FS_2, and FS_3) and the Wingspan Score.

Scoring Equation:

$$FFS = \ Final\ Flight\ Score = \ FS_1 + FS_2 + FS_3 + WS$$

Where:

$$FS = Flight\ Score = \frac{W_{Payload}}{2} + PBB$$

$$PPB = Payload\ Prediction\ Bonus = MAX\left(5 - \left(W_{payload} - P\right)^2, 0\right)$$

$$WS = Wingspan\ Score = 2^{\left(1+\frac{b}{5}\right)}$$

$W_{Payload} = Regular\ Boxed\ Cargo\ Weight\ (lbs)$

$b = Aircraft\ Wingspan\ (ft)$

$P = Predicted\ Payload$

The predicted payload, P, is determined from the payload prediction curve provided in the Technical Data Sheet (Section 4.5) and the density altitude measured at the event.

The Payload Prediction Bonus will be calculated for each flight. All Payload Prediction Bonus (PPB) scores less than zero (0) will default to zero (0).

Wingspan Score will only be calculated after a team has a successful flight.

Penalty Points

Penalty points assessed during competition are deducted from a team's overall score.

8 ADVANCED CLASS DESIGN REQUIREMENTS

The intent of the Advanced Class is to autonomously deliver and retrieve payloads to a predefined area. Teams earn points for completing various mission segments leading up to delivery and retrieval of their payload, with a strong focus on autonomous performance.

8.1 AIRCRAFT DIMENSION REQUIREMENT

Advanced Class aircraft are limited to a maximum planform wingspan of **120** inches.

Advanced Class aircraft are limited to a maximum weight of **3.50** lbs.

8.2 AIRCRAFT SYSTEM REQUIREMENTS

Propulsion Requirements

Advanced class aircraft are limited to electric motors only.

Advanced class aircraft are limited to a maximum of 3 motors and 3 propellers.

Gearboxes, Drives, and Shafts

Gearboxes, belt drive systems, and propeller shaft extensions are allowed.

Aircraft Propulsion System Battery

Advanced Class aircraft must be powered by a commercially available 4 cell (14.8volt) Lithium-Polymer battery pack with a maximum capacity of 3000mAh.

Power Limiter

Advanced class aircraft are not required to fly with a power limiter.

Rubber Bands

Elastic material, such as rubber bands, shall not retain the wing to the fuselage.

8.3 VIDEO DOCUMENTATION OF PROVEN OPERATIONAL ABILITY FOR ADVANCED CLASS

All Advanced Class teams must provide video documentation demonstrating the proven operational capability of their Advanced Class aircraft during the Inspection component of the event. Failure to do so will result in prohibition from entering the flight portion of the event.

1. Teams must provide a device to play the video for the officials at a screen size that allows the officials to clearly see the aircraft and runway.
2. The video must show the following activities accomplished successfully with their competition aircraft:
    a. Conventional Takeoff mission segment with sustained stable flight for 10 seconds
    b. Return to Base (RTB) mission segment with controlled landing on runway without damage
3. Videos should be no more than 1.5 minutes in length. Edited video will be accepted if the video is of the same flight.
4. Video shall be provided to and approved by officials before teams will be allowed to enter flight competition.

5. Proof of Flight Video (PoFV) can be obtained on the day of the Requirements Check & Safety and Airworthiness Inspection if the field is open. Once the flying portion of the competition has begun, the event will not pause for teams to record PoFV. Teams may record PoFV from another nearby open field and have the sole responsibility to coordinate with the external field.

8.4 Mission Description

Advanced Class mission is based around payload delivery and retrieval from a Designated Landing Zone (DLZ). Mission success is measured by maximizing mission segment score with higher scoring corresponding to more complex and connected mission segment execution.

The advanced class mission is broken down into several consecutive segments. Conventional Takeoff, Payload Release or Delivery, Payload Capture, and Return to Base (RTB). Each segment may be attempted autonomously or manually.

Maximum Mission time is four **(4) minutes**. Teams are incentivized to minimize mission time with a time bonus.

Conventional Takeoff is defined as transitioning from zero velocity on the runway to stable, horizontal flight consistent with Section 3.8.

Payload Release is defined as retaining onboard payload from conventional takeoff until intentional payload separation from the vehicle while the vehicle is airborne OR in motion.

Payload Delivery is defined as retaining onboard payload from conventional takeoff until intentional payload separation while the vehicle is stopped and resting on the DLZ.

Payload Capture is defined as picking up and retaining a previously Released or Delivered payload, as well as the aircraft and payload successfully returning to horizontal flight.

Return To Base is defined as a conventional landing back on the runway according to Section 3.9. Payload will only be weighed for this segment if Capture segment was successfully completed.

Only one payload may be carried at a time. To receive a Payload Capture Mission Segment Score, teams must pick up a valid payload that was Released or Delivered during a previous flight attempt. It is possible to score up to two Payload Segment Scores during one flight attempt if a team can score a Delivery or Release with one payload and then score a Capture with a different payload.

To earn points for the mission segment, the payload that is released or delivered shall remain entirely within the DLZ for the mission. The payload shall be fully supported by the DLZ. If the payload falls off or touches the ground outside the DLZ during the mission, or between missions, it will be disqualified from any mission scoring. Released payloads which do not remain on the correct DLZ will be recovered by officials and returned to teams at least once per day.

Although mission segment scoring is additive in nature, at a minimum, teams shall complete both Conventional Takeoff mission segment and Return to Base mission segment in order to receive a Flight Score in a given flight attempt.

8.5 Aircraft Payload Requirements

Each team shall build and provide deliverable payloads. Payloads will be weighed regularly for scoring calculations. Weighing will occur prior to flight attempt if payload is present during takeoff. Weighing will occur after flight attempt if payload is present during landing.

1. Aircraft may carry up to one (1) payload during a given mission segment.
2. Payloads must be clearly marked with team number in minimum one inch font.
3. Payloads must be uniquely numbered in minimum one inch font.
4. Payloads shall be capable of unloading in under one (1) minute for weighing purposes. If payload unloading is not performed in the required time, the affected mission segments will receive zero payload weight for scoring purposes.
5. Largest linear dimension of payload is twelve (12) inches.

8.6 Designated Landing Zone (DLZ)

The advanced class aircraft is required to deliver and recover payload from a Designated Landing Zone (DLZ). Teams are responsible for sourcing all DLZ materials and installing their landing zone. Teams may select and setup their DLZ after successfully completing Requirements Check & Safety and Airworthiness Inspection. Landing zone location selection and setup shall be supervised by officials to ensure fairness. There will be a designated area on the far side of the runway where DLZs are allowed to be located.

Designated Landing Zone Requirements

1. One (1) Zone with a size of 8 ft x 8 ft..
2. Surface made from two (2) sheets of 4 ft x 8 ft coroplast (corrugated plastic) with a 4 mm thickness.
3. Surface staked into the ground with a minimum of nine (9) stakes (see Figure 8.1). Stakes are 8 inch or longer, metal, and fully embedded into the ground.
4. No nets or modified surfaces that can adhere to or catch the payload (Velcro, magnets, tape, or other positive retention methods).
5. No electronics or batteries located at DLZ.
6. Moving the zone will only be allowed with official approval and oversight on a non-interference basis with competition flying.
7. Teams may only successfully land on their DLZ.

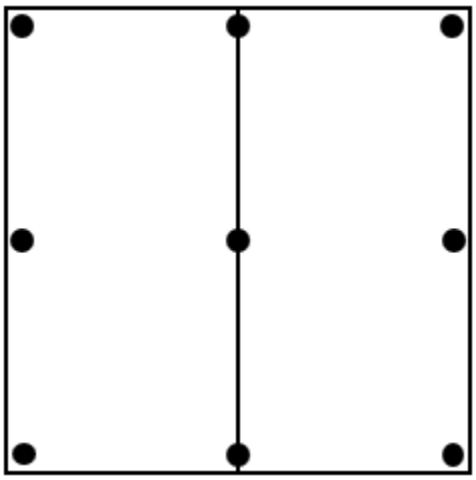

Figure 8.1 Designated Landing Zone Configuration with Stakes

8.7 Gyroscopic and Other Stability Augmentation

Gyroscopic assist or other forms of stability augmentation are allowed in Advanced Class.

8.8 Autonomous Flight

Autonomous flight systems that cause the aircraft to navigate without direct pilot control input are allowed. Autonomous flight is subject to the following rules:

1. In addition to the motor, the aircraft shall have an active navigation system controlling at least two (2) degrees of freedom.
2. Teams must have a manual override for control through a dedicated transmitter. There shall be a red-colored switch on that transmitter to switch between autonomous and manual flight modes.
3. Manual override may be used at the team's discretion. Any use of manual override shall be considered manual for the scoring of that flight segment.
4. Any time the team switches between automatic and manual flight modes, the pilot must clearly announce the change.
5. If the aircraft is flying in an unsafe manner, the Air Boss may order grounding as per Section 3.11.5. The flight shall be considered unsuccessful.

8.9 Autopilot

1. The autopilot system must use a discrete and removable Red arming plug to apply power. This arming plug is subject to the Section 2.20 requirements. One Red arming plug can be used for both autopilot and FPV.
2. Autopilot equipment may also have a reset switch, if desired. If a manual reset switch is used, it must be located externally at least twelve (12) inches behind the propeller in the longitudinal direction. A wireless reset system is allowed.
3. Autopilot data link shall not use the same 2.4 GHz band as the pilot transmitter.

8.10 First Person View System (FPV)

FPV is not required for Advanced Class. For teams wishing to use an FPV system for operational reasons, the following conditions apply:

1. The pilot must fly visually only (no FPV goggles or ground station reference).
2. FPV systems CANNOT use the same frequency as the flight control system. Use of 2.4 GHz for FPV video is prohibited.
3. The FPV system must use a discrete and removable Red arming plug to apply power. This arming plug is subject to the Section 2.20 requirements.

8.11 Payload Operator (PO)

Autonomous flight is encouraged. If teams elect to perform payload operations manually, a Payload Operator (PO) must be utilized. All communication between the PO and pilot must be in English.

1. One (1) team member may act as PO. The PO should not rely on having a line-of-sight view to the aircraft or DLZ.
2. PO may activate the payload release or capture system using a second 2.4 GHz radio system or some other method based on their telemetry system, however this will count as manually executing that mission segment.
3. Manual safety arming of an autonomous release system will not be considered manual execution of the mission segment.

8.12 ADVANCE CLASS SCORING

The team's Final Flight Score (FFS) is the sum of the team's top three (3) flight scores achieved during competition. Teams receive points within a given flight attempt based on accomplishing mission segments, with more points awarded for autonomous flight than manual control. Segment scores are based on mission complexity, the payload weight carried for that mission segment, and a potential bonus for the total time required for mission completion. Flight Score (FS) is comprised of additive and multiplicative factors based on segments completed and a time bonus.

Scoring Equation:

$$Final\ Flight\ Score = FS_1 + FS_2 + FS_3$$

Where:

Mission Segment Multiplier (MSM)

X Mission Segment	Autonomous Multiplier	Manual Multiplier
Conventional Take off	**2**	**1**
Payload Release	**3**	**1**
Payload Delivery	**8**	**1**
Payload Capture	**12**	**2**
Return To Base	**3**	**1**

$$FS = Flight\ Score = \left(S_{Takeoff} + \left[S_{Release}\ or\ S_{Delivery}\right] + S_{Pickup} + S_{RTB}\right) + TB$$

$$S_x = S_{Mission\ Segment} = 1 + \left(MSM * W_{Payload}\right)$$

$$TB = Time\ Bonus = \begin{cases} \mathbf{0} & if\ 180 \le T_m < 240\ sec \\ \mathbf{1} & if\ 120 \le T_m < 180\ sec \\ \mathbf{2} & if\ \ 0 \le T_m < 120\ sec \end{cases}$$

$$W_{Payload} = Payload\ Weight\ (lbs)$$

$$T_m = Total\ Mission\ Time\ (sec)$$

Penalty Points

Penalty points assessed during competition are deducted from a team's overall score.

9 MICRO CLASS DESIGN REQUIREMENTS

The Micro Class objective is to challenge students to design a small, all electric aircraft to overcome conflicting design and performance requirements. Teams must maximize scoring for short takeoff and liquid payload, while minimizing penalties for wingspan and empty weight.

9.1 AIRCRAFT DIMENSION REQUIREMENTS

Micro Class aircraft are not limited to a maximum planform wingspan.

9.2 AIRCRAFT SYSTEMS REQUIREMENTS

Propulsion Requirements

Micro Class aircraft are restricted to electric motor propulsion only.

Propeller and Gearbox

Gearboxes where the propeller RPM differs from the motor RPM are allowed. Multiple motors, multiple propellers, propeller shrouds, and ducted fans are allowed.

Aircraft Propulsion System Battery

Micro Class aircraft must use Lithium Polymer batteries. Micro class batteries are allowed to be a maximum of four (4) cells.

Gyroscopic Assist

Gyroscopic assist and other forms of stability augmentation are allowed in Micro Class.

Power Limiter

Micro Class aircraft must use a 2021 or newer, 450-watt power limiter from the official supplier as described in Section 2.19.

9.3 PAYLOAD REQUIREMENTS

Types of Cargo

Micro Class payload shall consist of liquid water. Frozen water is prohibited.

Payload Container Requirements

Micro Class aircraft shall have a single Payload Container for carrying liquid water with the following additional requirements:

1. Payload container shall be fully enclosed with a minimum of two (2) sealable holes.
2. The first hole shall be on top of the payload container for filling.
3. The second hole shall be on the bottom of the container and used for unloading liquid water from the payload container.
4. Payload container must have a minimum volume of 67 fluid ounces. Teams must consider the ability to quickly drain all liquid water as a timed activity.
5. Event organization reserves the right to inspect team's Payload Container.

9.4 MICRO CLASS PAYLOAD UNLOADING

To achieve a successful flight score, teams must demonstrate the ability to drain liquid water from an external port located at the bottom of the airplane on the vehicle without

opening the internal payload bay. This timed demonstration for score will occur at the weigh station with the aircraft configuration unchanged from the most recent successful flight. Only the liquid water successfully drained from the aircraft will be weighed and recorded for scoring.

1. The demonstration must be performed by no more than two (2) team members.
2. The draining process should occur within a one (1) minute window.
3. External forces (such as squeezing or applying air pressure) must not be used during the draining process.

9.5 Micro Class Aircraft Take-off

A Micro Class team will have one (1) take-off try per flight attempt.

The Micro Class take-off performance scoring equation determines the team's flight score. The take-off performance is determined using four (4) distance limits of 10 ft, 25 ft, 50 ft, and 100 ft. Each take-off distance limit will earn a multiplier for the team's flight score.

Any take-off beyond 100 ft will disqualify the flight attempt.

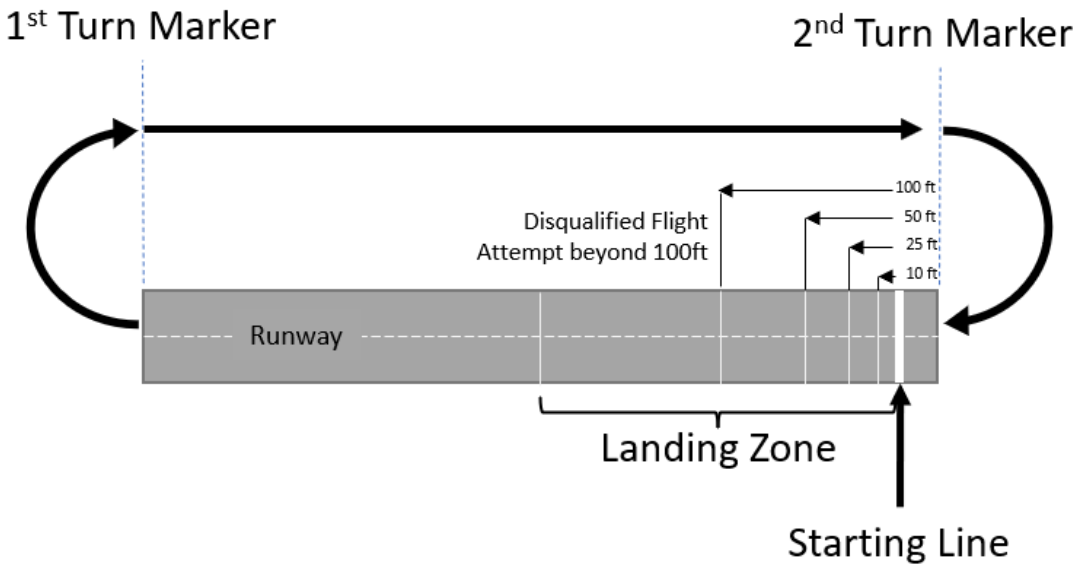

Figure 9-1 – Notional Micro-Class Flight Circuit

9.6 MICRO CLASS FLIGHT SCORING

To participate in the flight portion of the competition, each team is required to have submitted AND received a score for both Design Report and Oral Presentation.

The team's Final Flight Score (FFS) is the sum of the team's top three (3) flight scores achieved during the competition (FS_1, FS_2, and FS_3).

Scoring Equation:

$$Final\ Flight\ Score = FSS = FS_1 + FS_2 + FS_3$$

Where:

$$Flight\ Score = FS = 3 * W_{Payload} * M + Z$$

$$M = \frac{11}{\left(W_{Empty} - 1\right)^4 + 8.9}$$

$$Z = B_{Takeoff} - S^{1.5}$$

$W_{Payload} = Payload\ Weight\ (lbs)$

$W_{Empty} = Empty\ Weight\ (lbs)$

$S = Wingspan\ (ft)$

$$B_{Takeoff} = \begin{cases} 20 & 0 \le x \le 10\ ft \\ 15 & 10 < x \le 25\ ft \\ 9 & 25 < x \le 50\ ft \\ 0 & 50 < x \le 100\ ft \end{cases}$$

Penalty Points:

Penalty points assessed during competition are deducted from the team's overall score.

APPENDIX A - STATEMENT OF COMPLIANCE

Certification of Qualification

Team Name _____ Team Number _____

School _____

Faculty Advisor _____

Faculty Advisor's Email _____

Statement of Compliance

As faculty Adviser:

_____ (Initial) I certify that the registered team members are enrolled in collegiate courses.

_____ (Initial) I certify that this team has designed and constructed the radio-controlled aircraft in the past nine (9) months with the intention to use this aircraft in the 2025 SAE Aero Design competition, without direct assistance from professional engineers, R/C model experts, and/or related professionals.

_____ (Initial) I certify that this year's Design Report has original content written by members of this year's team.

_____ (Initial) I certify that all reused content has been properly referenced and is in compliance with the University's plagiarism and reuse policies.

____ (Initial) I certify that the team shall use the Requirements Check & Safety and Airworthiness Inspection checklists to inspect their aircraft before arrival at Technical Inspection and that the team shall submit the completed checklists, signed by the Faculty Advisor or Team Captain, to the inspectors before Technical Inspection begins.

_____ _____

Signature of Faculty Advisor Date

_____ _____

Signature of Team Captain Date

Note: A copy of this statement needs to be included in your Design Report as page 2 (Reference Section 4.3)

APPENDIX B - APPEALS

Team Name	
Team Captain	
Collateral Points	*All appeals will require the team to post twenty-five (25) points as collateral. If the appeal is successful and the action is reversed, the team will not forfeit the twenty-five (25) collateral points. If the appeal is overruled, the team will forfeit the twenty-five (25) collateral points* Collateral Points: 25 Sign if Agree: _____
Reason for this Appeal	
Rule Reference	*List the section(s) in the official rule that is (are) in conflict with the action(s) taken by competition official* Section:_____ Section:_____ Section:_____ Section:_____
Desire outcome	