2018 Collegiate Design Series
SAE Aero Design Rules

Version 2018.1

FOREWORD

Welcome to SAE Aero Design 2018. Our goal each year is to create and refine a set of competition events with relevant real-world challenges that students of all engineering disciplines and levels of experience can enjoy as you apply your engineering knowledge in a design team environment to create an original aircraft design. After designing your aircraft, your team then must build what you have designed and then compete head to head with other teams to see which team is the best in several different areas: a design report, an oral presentation and the flight performance of your aircraft. SAE Aero Design consists of three competition classes: Regular Class, Micro Class and Advanced Class. Regular Class traces its lineage back to the very beginning of SAE Aero Design, when the event was created as a heavy lift competition for model aircraft. Regular Class continues as our entry level class. In 2017, SAE Aero Design introduced a new "passengers and their luggage" theme to Regular Class and that theme continues this year. We have introduced one notable change: Regular Class aircraft now have a wingspan limit of 144". Advanced Class is the most challenging class, due to its complexity. Not only does your team have to design and build an aircraft, but you must also design and create a number of reliable systems for your aircraft including downlinked FPV video, downlinked telemetry, a reliable ground station and a payload delivery system. Each system must work in concert with all others in your aircraft for your team to have a reliable and competitive aircraft. The rules also require team members to work in concert during flight operations in order to accomplish the complete Advanced Class mission.

For the 2018 SAE Aero Design competition, we are proud to present a new set of rules for Micro Class that we hope you will find interesting and challenging. The aircraft container has a new form factor. The physical payload now required for Micro Class is a common low density industrial material that should challenge teams when they are integrating this new payload to their aircraft and when teams are designing the aircraft to fit the new aircraft storage requirement. All of this new low density payload that the team ever plans to carry must fit in their aircraft storage container with their aircraft. One final change is the Assembly Demo for Micro Class. It is no longer an optional demo; it is now required for all teams in Micro Class. Teams can gain points for a fast assembly and lose points if their assembly takes too long.

Everyone on the SAE Aero Design Rules Committee is excited as we prepare for the 2018 competition season and we hope you will enjoy the challenge of the new Micro Class rules. We have made a number of small changes and refinements in all sections of the rules. As always, please do read the rules closely. Based on past history, we expect both East and West events to sell out quickly, so be sure to sign up early. As Rules Chair Brian Czapor explained in last year's forward: If you are unfortunate enough to be a waitlisted team, we encourage you to move forward with your design and plan to attend. In 2016 and 2017, all waitlisted teams were contacted and invited to attend after other teams dropped out.

We at SAE Aero Design wish all teams the best of luck as they prepare for the 2018 events!

Tom Blakeney, SAE Aero Design Rules Committee

TABLE OF CONTENTS

1 COMPETITION REQUIREMENTS

1.1 INTRODUCTION

Official Announcements and Competition Information

The SAE Aero Design competition is intended to provide undergraduate and graduate engineering students with a real-world design challenge. These rules were developed and designed by industry professionals with the focus on educational value and hands-on experience through exposure to today's technical and technology advancement. These rules were designed to compress a typical aircraft development program into one calendar year, taking participants through the system engineering process of breaking down requirements. It will expose participants to the nuances of conceptual design, manufacturing, system integration/test, and sell-off through demonstration.

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

- **The Regular Class** is an all-electric class intended to develop a fundamental understanding of aircraft design.
- **The Advanced Class** continues to use internal combustion engines. It exposes students to system integration with the focus on data acquisition and aircraft performance of complex and multi-faceted missions.
- **The Micro Class** is an all-electric class designed to help students engage in trades between two potentially conflicting requirements, carrying the highest payload fraction possible, while simultaneously pursuing the lowest empty weight possible.

Other SAE Aero Design Competitions: SAE Aero Design Brazil:

SAE BRASIL http://www.saebrasil.org.br

1.2 SAE AERO DESIGN RULES AND ORGANIZER AUTHORITY

General Authority

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

1. **Penalties**
   SAE International and the competition organizing bodies reserve rights to modify the points and/or penalties listed in the various event descriptions; to accurately reflect the operations execution of the events, or any special conditions unique to the site.
2. **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 International University Programs Committee. 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.

3. Rules Validity

The SAE Aero Design Rules posted at www.saeaerodesign.com/go/downloads and dated for the calendar year of the competition are the rules in effect for the competition. Rule sets dated for other years are invalid.

4. Rules Compliance

By entering an SAE Aero Design competition, the team members, faculty advisors and other personnel of the entering 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.

5. Understanding the Rules

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

6. Loopholes

It is virtually impossible for a set of rules to be so comprehensive that it covers all possible questions about the aircraft's design parameters or the conduct of the competition. Please keep in mind that safety remains paramount during any SAE International competition, so any perceived loopholes should be resolved in the direction of increased safety/concept of the competition.

7. Participating in the Competition

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

8. 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 seem to go through without an unreasonable delay, occasionally teams have had difficulties and in several instances visas were not issued before the competition.

AFFILIATED CDS STUDENT TEAM MEMBERS WILL HAVE THE ABILITY TO PRINT OUT A REGISTRATION CONFIRMATION LETTER FOR THE INDIVIDUAL EVENT(S) THAT 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 OUT THEIR PERSONALIZED LETTER WITH THE FOLLOWING INFORMATION: STUDENT'S NAME, SCHOOL'S NAME, THE CDS EVENT NAME, OFFICIAL DATES AND LOCATION(S).

9. **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.

10. **Certificates of Participation**
    SAE International and competition organizers do not create any Participation Certificates outside of the auto-generated certificate obtained using the directions available at http://students.sae.org/cds/aerodesign/faq/.

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

11. **Violations of Intent**
    The 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 the SAE International Officials, Competition Organizers or SAE International Staff.

12. **Right to Impound**
    SAE International and the other competition organizing bodies reserve the right to impound any on-site vehicle/aircraft at any time during a competition for inspection and examination by the organizers, officials and technical inspectors.

1.3 Society Membership and Eligibility

1. **Society Membership**
   Individual team members must be members of one of the following societies: (1) SAE International or an SAE International affiliate society, (2) ATA, or (3) IMechE or (4) VDI. Proof of membership, such as a membership card, is required at the event. Students who are members of one of the societies listed above are not required to join any of the other societies in order to participate in any SAE competition. Students may join online at: http://www.sae.org/students.

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

2. **Team Pilots**
   Team pilots are not required to be students or SAE International members, but all pilots must 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 the flying field prior to flying any team's aircraft. Non-US pilots can obtain a discounted AMA Affiliate membership that covers 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. Individual medical and accident insurance coverage is the sole responsibility of the participant.

1.5 RINGERS PROHIBITED

In order to maintain the integrity of a fair competition, the faculty advisor must prohibit ringers. A ringer is someone that has 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 must 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 discussion of alternatives with their 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 must sign the Statement of Compliance given in the Appendix.

1.7 ORIGINAL DESIGN

Any aircraft presented for competition must be an original design whose configuration is conceived by the student team members. Photographic scaling of an existing model aircraft design is not allowed. 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 engine mounts, control horns, and landing gear is allowed.

1.8 OFFICIAL LANGUAGES

The official language of the SAE Aero Design series is English. Document submissions, presentations and discussions in English are acceptable at all 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 the parties involved agree to the use of that language.

SAE Aero Design East	English
SAE Aero Design West	English
SAE Aero Design Brazil	Portuguese and English

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 empennage would likely 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

1. **One Aircraft per class**
   A university or college can only have one aircraft registered for one class. A university cannot register more than one team per class.

2. **Backup Aircraft**
   When a team has an identical aircraft as a back-up, the back-up aircraft must go through inspection with the primary aircraft.

3. **Scoring with Backup Aircraft**
   Team will forfeit all flight points earned with the original aircraft if the team decides to fly with an entirely new aircraft.

   If a team decides to replace more than 50% of the original aircraft with spare parts, the team will forfeit all flight points earned with the original aircraft.

   If a team decides to replace less than 50% of the original aircraft with spare parts, the team will retain all flight points earned with the original aircraft.

   Once the spare parts have successfully flown with original parts of the aircraft, the spare part will no longer be classified as spare.

1.11 AIRCRAFT ELIGIBILITY

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

1.12 Registration Information, Deadlines and Waitlist (NEW)

Teams intending to participate in the 2018 SAE Aero Design competitions must register their teams online per the open registration schedule.

Table 1.1 Open Registration Schedule

Event	Team Limit	Start (Open)	End (Closed)
SAE Aero Design East	75 Teams	October 2nd, 2017 10:00 am EST	November 13th, 2017 11:59 PM
SAE Aero Design West	75 Teams	October 2nd, 2017 10:00 am EST	November 13th, 2017 11:59 PM

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 East and West events.

1. **Team/Class/University Policy**
   A university or college can only have one aircraft registered for one class. A university cannot register more than one team per class. The registration fees indicated on the website ($1000) must be paid within 48 hours of registration.

2. **Individual Registration Requirements – ACTION REQUIRED**
   All participating team members and faculty advisors must be sure that they are individually affiliated to their respective school / 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 need to select the "Student Membership" link and then follow the series of questions that are asked Please note all student participants must be SAE International members to participate in the events.

   Faculty members who wish to become SAE International members should choose the "Professional Membership" link. Please note: this is not mandatory for faculty advisors.

   All student participants and faculty advisors must affiliate themselves to the appropriate team(s) online. To affiliate, refer to the SAE Aero Design FAQ page (http://students.sae.org/cds/aerodesign/faq/).

   The "Add New Member" button will allow 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. Please be sure this is done separately for each of the events your team has entered.

   All students, both domestic and international, must affiliate themselves online prior to the competition.

****NOTE: When your team is registering for a competition, only the student or faculty advisor completing the registration needs to be linked to the school. All other students and faculty can affiliate themselves after registration has been completed; however this must be done prior to two weeks before the competition start date.**

1.13 WAITLIST

Once an event reaches the 75 team capacity, all remaining registered team will be asked to be placed on a waitlist. The waitlist is capped at 40 available spaces per event and will close on the same day as 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 spot on the registered teams list has opened. You will have 24 hours to accept or reject the position and an additional 24 hours to have the registration payment completed or process for payment begun. Waitlisted teams are required to submit all documents by the deadlines in order to be considered serious participants and any team that does not submit all documents will be removed from the waitlist.

1.14 POLICY DEADLINE

1. **Failure to meet deadlines**

   Teams registering for SAE Aero Design competitions are required to submit a number of documents prior to the competition including a Design Report and Technical Data Sheet that the event judges use to evaluate the team during the competition. When these documents are not submitted our judges cannot properly assess the team. Additionally, teams that do not submit required documents typically do not come to the competition. Teams that do not notify us that they are withdrawing create the following problems:

   1. They are included in the static event schedules and judging time is wasted.
   2. Their unused registration slot cannot be offered to a team on the waitlist. Additionally, failure to submit the required documents is a clear violation of the rules.

2. **Late Submission Penalty**

   Late submission or failure to submit the Design Report will be penalized five (5) points per day. If your required documents are received more than five (5) days late it will be classified as "Not Submitted" and your team will not participate and the automatic withdrawal policy will be in effect (see section 0).

3. **Automatic Withdrawal Policy**

   Failure to submit the required Design Report, Technical Data Sheet, and Drawings within 5 days of the deadline will constitute 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 5 days your team's registration will be cancelled and no refund will be given.

1.15 Faculty Advisor

Each team is expected to have a Faculty Advisor appointed by the university. The Faculty Advisor is expected to accompany the team to the 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 theory, 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 that are not eligible student team members may not participate in flight operations during competition weekend except as noted.

1.16 Questions, Complaints and Appeals

1. **Questions**

   Any questions or comments about the rules should be brought to the attention of the Rules Committee by submitting a rules 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 according to the competition in which you are competing: students.sae.org/cds/aerodesign/

2. **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 rulebook at the field.

3. **Appeal / Preliminary Review**

   A team can only appeal issues related to own-team scoring, judging, venue policies, and/or any official actions. Team Captain(s) and/or 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.

4. **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 them any substantive damage.

5. Appeal Format

If a faculty advisor or team captain(s) feel that their issue regarding an official action or rules interpretation was not properly addressed by the event officials, the team may file a formal appeal to the action or rules interpretation with the Appeals Committee.

All appeals must be filed in writing (see Appendix F) to the Organizer by the faculty advisor or team captain only.

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.

All rulings issued by the Appeals Committee are final.

6. Appeals Period

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

7. Appeals Committee

When a timely appeal is received, the committee will review in detail 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 must consist of a minimum of three members: the Organizer or delegate, SAE International representative, and either the Chief Steward, the Chief Judge, the Air Boss and/or rule committee member.

1.17 PROFESSIONAL CONDUCT

1. Unsportsmanlike Conduct

In the event of unsportsmanlike conduct by team members or that team's faculty advisor, the team will receive a warning from a Competition Official. A second violation will result in expulsion of the team from the competition and loss of any points earned in all aspects of the competition.

2. Arguments with Officials

Arguments with or disobedience toward any competition official may result in the team being eliminated from the competition. All members of the team may be immediately escorted from the grounds.

3. 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 the competition. Any violations of this rule will result in the immediate expulsion of all members of the offending school, not just the individual team member in violation. This rule applies to team members and faculty advisors. Any use of illegal drugs or any use of alcohol by an underage person must be reported to the local law enforcement authorities for prosecution.

4. 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 which is required for efficient operation or safety of the competition.

5. Ground Safety and Flight Line Safety Equipment

1. No open toe shoes allowed. All team participants, including faculty advisors and pilots, will be required to wear CLOSED toe shoes during flight testing and during flight competition.
2. Smoking is prohibited. Smoking is prohibited in all competition areas.
3. All students in all classes involved at the flight line must wear safety glasses.
4. Micro Class must wear hard hats in addition to safety glasses at the flight line.

1.18 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.

To access, teams can follow these procedures. Once registered, a link to SAE MOBILUS will appear to access the technical standards under "Design Standards" on your team's profile page on sae.org, where all the required onsite team information is added. On SAE MOBILUS, you will have the ability to search standards either by J-number assigned or topic of interest such as brake light.

A list of accessible SAE International Technical Standards can be found in Appendix G.

2 GENERAL AIRCRAFT REQUIREMENTS

2.1 AIRCRAFT IDENTIFICATION

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.

1. Aircraft must be identified with the school name and address either on the outside or the inside of the aircraft.
2. Team numbers on Regular and Advanced Class aircraft shall be a minimum of 3 inches in height. Micro Class team numbers shall be a minimum of 1 inch in height.
3. The University name must be clearly displayed on the wings or fuselage.
4. The University initials may be substituted in lieu of the University name provided the initials are unique and recognizable.

The assigned aircraft 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: http://students.sae.org/cds/aerodesign/east/

SAE Aero West: http://students.sae.org/cds/aerodesign/west/

2.2 NO LIGHTER-THAN-AIR OR ROTARY WING AIRCRAFT

Competing designs are limited to fixed wing aircraft only. No lighter-than-air or rotary wing aircraft such as helicopters or auto-gyros will be allowed to compete.

2.3 EMPTY CG DESIGN REQUIREMENT AND EMPTY CG MARKINGS ON AIRCRAFT

All aircraft must 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 classic CG symbol (Figure 2.1) that is a minimum of 0.5 inches in diameter centered at the Empty CG position, per the submitted 2D drawings. (Wing type aircraft may place the two CG markings on the bottom of the wing.)
3. The Empty CG location will be verified during Technical and Safety Inspection.
4. No empty weight flight is required.

Figure 2.1 - Center Of Gravity Symbol

2.4 GROSS WEIGHT LIMIT

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

2.5 CONTROLLABILITY

1. All aircraft must be controllable in flight.
2. If an aircraft is equipped with a wheeled landing gear, the aircraft must have some form of ground steering mechanism for positive directional control during takeoffs and landings. Aircraft may not rely solely on aerodynamic control surfaces for ground steering.

2.6 RADIO CONTROL SYSTEM

The use of a 2.4 GHz radio control system is required for all aircraft. The 2.4 GHz radio control system must have a functional fail safe system that will reduce the throttle to zero if the radio signal is lost.

2.7 SPINNERS OR SAFETY NUTS REQUIRED

All aircraft must utilize either a spinner or a rounded model aircraft type safety nut.

2.8 METAL PROPELLERS

Metal propellers are not allowed.

2.9 LEAD IS PROHIBITED

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

2.10 PAYLOAD DISTRIBUTION

The payload cannot contribute to the structural integrity of the airframe.

2.11 AIRCRAFT BALLAST

Aircraft ballast is allowed with the following conditions:

1. Ballast cannot be used in the closed payload bay or passenger cabin.
2. Ballast stations must be clearly indicated on the 2D drawings.
3. Ballast must be secured so as to avoid shifting or falling off the aircraft and causing a CG problem.
4. Ballast will not be counted as payload.

2.12 STORED ENERGY RESTRICTION

Aircraft must be powered by the engine(s)/motor on board the aircraft. No other internal and/or external forms of stored potential energy allowed.

2.13 CONTROL SURFACE SLOP

Aircraft control surfaces and linkage must not feature excessive slop. Sloppy control surfaces lead to reduced controllability in mild cases, or control surface flutter in severe cases.

2.14 SERVO SIZING

Analysis and/or testing must be described in the Design Report that demonstrates the servos are adequately sized to handle the expected aerodynamic loads during flight.

2.15 Clevis Keepers

All control clevises must have additional mechanical keepers to prevent accidental opening of the control clevis in flight.

2.16 Red Arming Plug

All electric powered aircraft MUST use a discrete and removable red arming plug to arm and disarm the aircraft propulsion system. This red arming plug must be integrated into the electrical circuit between the battery and the electronic speed controller (ESC).

1. The red arming plug must physically be located at 40% to 60% of the aircraft length from the aircraft propeller. This is to allow arming and disarming the aircraft at a safe distance from the propeller.
2. The red arming plug must be located on top of the fuselage or wing and external of the aircraft surface.
3. The location of the red arming plug must be clearly visible.
4. The non-removable portion of the arming plug interface may not have more than one male lead.
5. Disconnecting wiring harnesses to arm and disarm a system will NOT be allowed.

2.17 Repairs, Alterations, and Spares

1. The original design of the aircraft as presented in the written and oral reports must be maintained as the baseline aircraft during the course of the competition.
2. In the event of damage to the aircraft, the aircraft may be repaired provided such repairs do not drastically deviate from the original baseline design. All major repairs must inspected before the aircraft is cleared for flight.

2.18 Alteration after First Flight

Minor alterations are allowed after the first and subsequent flight attempts.

1. A penalty will be assessed ONLY if 2/3 of the ruling committee (Event Director, Head scoring judge and/or SAE staff judge) agree that there was significant modifications made from the baseline configuration.
2. If the ruling committee determines that the changes are a result of safety-of-flight, the changes will not incur penalty points. Alteration must be reported utilizing Engineering Change Request (ECR) Appendix E.

2.19 Competition Supplied Fuel

Classes that use internal combustion engine may use the competition-supplied fuel.

1. Advanced Class teams may provide their own fuel.
2. Fuel used for the Advanced Class must be acceptable for use by the AMA and the competition organizer.
3. No fuel systems with gaseous boosts in which gases other than air enter the internal combustion engine will be allowed; pressurized air is also not allowed.
4. Engines utilizing extremely hazardous fuels such as those containing tetra nitromethane or hydrazine are prohibited.

3 MISSION REQUIREMENTS AND SCORING

3.1 ROUND ATTEMPT

Teams are allowed one (1) flight attempt per round.

- **Regular and Advanced Classes:** Without violating other take-off restrictions, a team can have multiple attempts to become airborne within the team's prescribed time limit for each respective class identified in section 3.5.
- **Micro Class:** only one launch attempt is allowed per round.

3.2 ENGINE OR MOTOR RUN-UP BEFORE TAKEOFF

Aircraft may be throttled up/run up for takeoff, subject to the following conditions:

- **Advanced Class:** Use of a helper to hold the aircraft for takeoff is allowed. Helper may not push the aircraft on release.
- **Regular Class:** Use of a helper to hold the aircraft is allowed. Main wheels must be placed on the takeoff line for Regular Class. The helper may not push the aircraft upon release.
- **Micro Class:** aircraft must be run up and hand launched within the launch circle for Micro .

3.3 AIRCRAFT CONFIGURATION AT LIFTOFF AND DURING THE FLIGHT ATTEMPT

The aircraft must remain intact during takeoff, the circuit of the field and landing.

1. No parts of any kind may leave the aircraft during the flight attempt.
2. Exception: a broken prop during landing is allowed and does not invalidate the flight attempt.

3.4 COMPETITION CIRCUIT REQUIREMENTS

1. During departure and approach to landing, the pilot must not fly the aircraft in a pattern that will allow the aircraft to enter any of the no-fly zones.
2. No aerobatic maneuvers will be allowed at any time during the flight competition in any competition class. This includes but not limited to: loops, figure 8's, Immelmann, all types of rolling maneuvers and inverted flight.
3. Regular and Micro Class aircraft must successfully complete a minimum of one 360° circuit.
4. Advanced Class has no specific flight pattern. (See Advanced Class rules for details concerning the releasable payload drop mission element.)

3.5 TIME LIMITS AND MULTIPLE FLIGHTS ATTEMPTS

1. Multiple takeoff attempts are allowed within the class specific time allotment as long as the aircraft has NOT become airborne during an aborted attempt.
2. If an airborne aircraft returns to the ground after being airborne and is beyond the take-off limits, the flight attempt will be disqualified for that round.

Table 3.1: Flight Attempt Information

Class	Time Limit (sec)	Can make multiple takeoff attempts if:			Definition of Takeoff 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 wheels leave the starting line
Advanced	180	Yes	Yes	No	The wheels leave the starting line
Micro	60	No	No	No	The launcher is no longer in contact with the aircraft

3.6 TAKE-OFF

Takeoff direction will be determined by the Air Boss, and will selected to face into the wind if possible.

1. Regular and Advanced Class aircraft must remain on the runway during the takeoff roll.
2. Micro Class must be hand launched from the designated launch area that is a half circle with a radius of 7.5 ft.
3. Distance requirements are defined in Table 3.2.
4. Making the initial turn before passing the "distance from start before initial turn" requirement will disqualify that flight attempt. (Table 3.2)

Table 3.2: Take-Off information

Class	Take-Off Distance Limits (ft.)	Distance from start before initial turn (ft.)	Description
Regular	200 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	N/A	400 ft.	Team may use the entire launch half-circle per attempt to get the aircraft airborne. Only one (1) launch attempt per round is allowed.

3.7 LANDING

A successful landing is defined as a controlled return to the ground inside the landing zone for that class and remaining on the ground through rollout. A failed landing attempt will result in no score for the round.

3.8 LANDING ZONE

The landing zone is a predetermined fixed area for each class for the purpose of returning a flying aircraft back to the ground. See Table 3.3 for class requirements.

1. The landing zones will be visibly marked at each event site prior to the start of the competition.
2. It is the team and team pilot's responsibility to be aware of the class specific landing zone dimensions at the event site.

1. Allowed during Landing

1. Controlled rollout beyond the landing zone is allowed provided the aircraft touches the ground inside the landing zone.
2. Controlled run-off to the side of the runway within the landing zone is allowed provided the aircraft touches the ground inside the landing zone.
3. Controlled run-off to the side of the runway beyond the landing zone is allowed provided the aircraft touches the ground inside the landing zone.

2. Not Allowed during Landing

1. Touchdown outside the landing zone for that class.
2. Uncontrolled runoff or bouncing across the boundary at the end of the landing zone is not allowed and will be judged as a failed landing attempt.
3. Touch-and-goes are not allowed and will be judged as a failed landing attempt.
4. Uncontrolled runoff or a bouncing run-off to the side of the runway is not allowed and will be judged as a failed landing attempt.

Table 3.3: Landing Distance Limit

Class	Landing Distance Limits (ft.)	Description
Regular	400 ft.	Aircraft must land in the same direction as takeoff within a designated landing zone.
Advanced	None	Aircraft must land in the same direction as takeoff within a designated landing zone.
Micro	200 ft.	Aircraft must land in the same direction as takeoff within a designated landing zone.

3.9 GROUNDING AN AIRCRAFT

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

3.10 NO-FLY ZONE

Each competition will have venue-specific **no-fly zones**. The no-fly zones will be defined during the all hands briefing at the event and during the pilot's briefings.

1. At no time will an aircraft enter the no-fly zones, whether under controlled flight or uncontrolled.
2. First infraction for crossing into the no-fly zone will result in an invalidated flight attempt and zero points will be awarded for that flight.
3. Second infraction will result in disqualification from the entire event and loss of all points.
4. It is the team and team pilot's responsibility to be aware of the venue-specific 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 Flight 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 so ordered by the officials.

3.11 FLIGHT RULES ANNOUNCEMENT

Flight rules will be explained to all teams before the flight competition begins, either during the pilots' meeting or during activities surrounding the technical inspections and oral presentations.

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 will be obeyed during the flight competition.
2. In the event that club rules conflict with competition rules, it is the responsibility of the team captain and/or faculty advisor to bring attention to the conflict and follow the appeals process to resolve the conflict.

3.14 COMPETITION SCORING

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

1. Technical Design Report (Design, Written and Drawing)
2. Presentation
3. Flight Score
4. Penalties

Any Penalty Points assessed during the competition will be deducted from a team's overall score.

4 DESIGN REPORT

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

Some topics that are important 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 as appropriate may be included, see 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 www.saeaerodesign.com/go/downloads.

4.1 SUBMISSION DEADLINES

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

http://students.sae.org/cds/aerodesign

Neither the Organizer nor the SAE International is responsible for any lost or misdirected reports, drawings, or server routing delays. The SAE International will not receive any paper copies of the reports through regular mail or email outside of the emergency submissions email.

4.2 ORIGINAL WORK

The Technical Design Report shall be the team's original work for this competition year. Resubmissions of previous year's design reports will not be accepted. Recitation of previous year's work is acceptable if appropriately cited and credited to the original author. 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.

4.3 TECHNICAL DESIGN REPORT REQUIREMENTS

Technical Design Report will be 50 points (pts) of the competition score as broken down in Table 4.3.1.

1. The Technical Design Report shall not exceed thirty (30) pages, including the certificate of compliance, 2D Drawing, and the Supplemental Datasheet for each class. If the design report exceeds thirty (30) pages, the judges will only score the first thirty (30) pages.
2. The Technical Design Report shall include a Cover Page with Team Name, Team Number, and School Name and Team Member Names.
3. The Technical Design Report shall include a Certificate of Compliance signed by hand by the team's faculty advisor.
4. The Technical Design Report shall be typewritten and double-spaced. Tables, charts and graphs are exempt from this
5. The report font shall be 12 pt. proportional; or 10 char/in. non-proportional font.
6. The report margins shall be: 1" Left, 0.5" right, 0.5" top, and 0.5" bottom.
7. Each page, except the Cover Page, Certificate of Compliance, 2D Drawing and Technical Data Sheet (TDS) shall include a page number.
8. All report pages shall be ANSI A (81/2 x 11 inches) portrait-format.
9. The Technical Design Report shall include a Table of Contents, Table of Figures, Table of Tables, Table of References and Table of Acronyms.
10. The Technical Design Report shall be single-column text layout.
11. The Technical Design Report shall include one Technical Data Sheet (TDS) appropriate for the team's competition entrant class.

Table 4.3.1 Technical Design Report

	Page Count	Regular Class	Advanced Class	Micro Class
Cover Page	1	40 pts	40 pts	40 pts
Certificate of Compliance	1			
Design Report	26			
2D Drawing	1	5 pts	5 pts	5 pts
TDS: Payload Prediction	1	5 pts	-	-
TDS: Radio Link Budget (Appendix B)	1	-	5 pts	-
TDS: Aircraft Weight Build-Up Schedule (Appendix C)	1	-	-	5 pts
Total	**30**	**50 pts**	**50 pts**	**50 pts**

4.4 2D Drawing Requirements

1. 2D Format and Size

The 2D drawing must be ANSI B sized page (PDF) format (11 x 17 inches).

1. For teams outside North America that cannot submit an ANSI B size drawings, page format size must be the closest size available to ANSI B.
2. Drawing shall consist of one (1) page.

2. Markings Required

The 2D drawing must be clearly marked with:

1. Team number
2. Team name
3. School name

3. 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).
4. (Regular Class Only) Regular Class shall include an additional view, separate from the basic aircraft, illustrating the passenger cabin layout with appropriate dimensions identifying the passenger seating arrangement. Total passenger capacity shall be labeled.

4. 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

5. Summary Data Required

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

1. Wingspan
2. Empty weight
3. Battery(s) capacity
4. Motor or engine make and model
5. Motor KV (micro and Regular Class only)
6. Propeller manufacturer, diameter, and pitch
7. Servo manufacturer, model number and torque specification in ounce-inches for each servo used on the aircraft. Identify servo being used at each position on the aircraft.

6. 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 listed must 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 list of pertinent equipment includes:
   a. Motor or engine
   b. Battery(s)
   c. Fuel (Advanced Class)
   d. Payload
   e. Ballast (if used)
   f. Electronics
3. Aircraft mean aerodynamic cord, stability margin and Center of Gravity (CG) information listed below must be clearly shown on drawing.
   a. Aircraft mean aerodynamic cord
   b. Stability margin for loaded CG and empty CG
   c. Empty CG location (flightworthy)
   d. Fully loaded CG (flightworthy, with payload and fuel, if applicable)

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

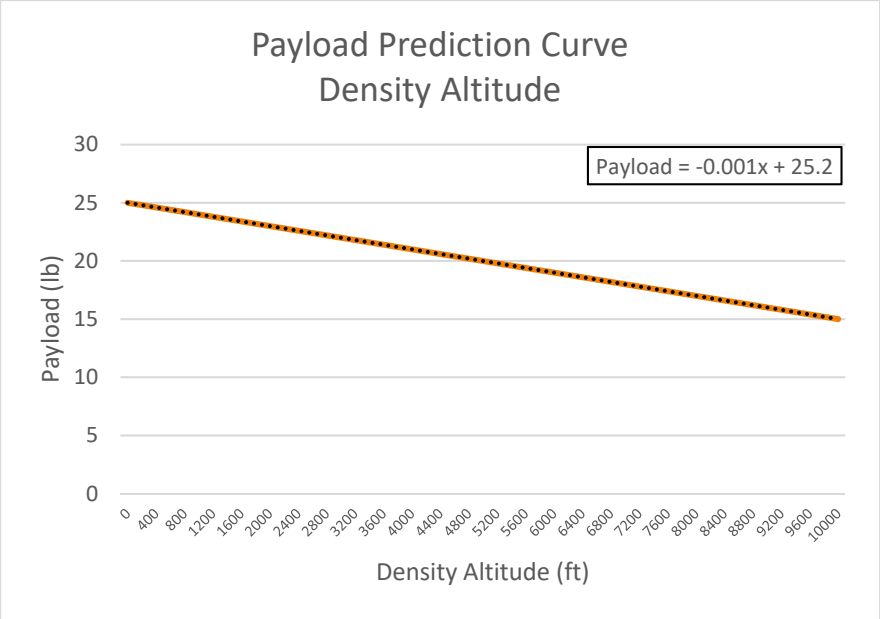
Regular Class teams must include a total payload prediction curve as part of the technical report. The graph represents an engineering estimate of the aircraft's lift performance based on density altitude.

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



4.6 TECH DATA SHEET: RADIO LINK BUDGET (ADVANCED CLASS ONLY)

A **link budget** is an accounting of all of the gains and losses from the transmitter, through the medium (free space, cable, waveguide, fiber, etc.) to the receiver in a telecommunication system. It accounts for the attenuation of the transmitted signal due to propagation, as well as the antenna gains, feed-line and miscellaneous losses. Randomly varying channel gains and propagation fading are taken into account by adding signal margin, depending on the anticipated severity of these effects. The amount of margin required can be reduced by the use of mitigating techniques such as antenna diversity or frequency hopping.

A template for the link budget can be found in Appendix B.

4.7 TECH DATA SHEET: WEIGHT BUILDUP (MICRO CLASS ONLY)

The Micro Class Weight & Balance Build-up schedule will help teams understand the importance of managing aircraft weight to achieve safety of flight at the desired payload fraction. Each team shall supply a one (1) sheet summary list of pertinent aircraft parts and weight (lb.).

A template for the weight buildup can be found in Appendix C.

5 TECHNICAL PRESENTATION

Like all professionals, engineers must possess a well-developed ability to synthesize issues and communicate effectively to diverse audiences. The technical portion of the aero-design competition is designed to emphasize the value of an ability to deliver clear, concise and effective oral presentations. Teams can obtain a maximum technical presentation score of fifty (50) points. Presentation score shall be comprised of scores from the presenter's delivery technique and the judges' evaluation of technical content, empirical analysis, and quality visual aide.

5.1 TECHNICAL PRESENTATION REQUIREMENTS

1. Technical presentation shall last ten (10) minutes and be followed by a five (5) minute "Question and Answer" (Q&A) period.
2. Technical presentation shall be delivered in English.
3. Technical presentation shall address, but are not limited to, trade studies performed, design challenges, and manufacturing techniques.
4. Technical presentation is limited to student team members only. Non-team member pilot, faculty advisors, and/or parents can attend the technical presentation but are prohibited from participating in the setup, delivery, and/or the Q&A.
5. Assistance in the use of visual aids is advisable; Film clips, if used, may not exceed one-minute total duration; Film clips may not be accompanied by recorded narration.
6. Regular and Micro Class shall display their entry aircraft during technical presentation. Advanced Class team are exempted from the requirement to have a static display if and only if the size of the aircraft prevents entry into the room.
7. Advanced Class teams shall make every effort to bring all or a portion of their aircraft to the presentation; however, if the size of the aircraft prevents its display, adequate photographs are acceptable substitutes.
8. During the presentation and static display setup, the teams shall provide a single sheet (8.5" x 11") marketing/promotion piece to further detail aircraft's feature, capabilities, and unique design attributes.

5.2 TECHNICAL PRESENTATION PROCESS AND PROCEDURES

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

1. With agreement from the speaker, the timekeeper will give the speaker a one (1) minute warning prior to the ten (10) minute limit.
2. If the team exceeds the ten (10) minute limit, the team will be assessed a five (5) point penalty for going over the time limit.
3. The presentation shall be stopped at the eleven (11) minute mark.
4. A team shall have five (5) minutes for Q&A immediately following the presentation. Questions may be asked by any judge on the panel.
5. Any time remaining or exceeding the ten (10) minutes shall be added to or subtracted from the five (5) minute Q&A.
6. Presentation Time Breakdown:

Time (Minutes)	Description
2	Setup presentation, visual aide, and/or static display
10	Perform Technical Presentation
5	Questions & Answers
3	Pack-up presentation and static display

6 TECHNICAL INSPECTION AND AIRCRAFT DEMONSTRATIONS

Technical and Safety inspection of all aircraft will be conducted using the published Technical and Safety Inspection checklists for each class for the current year. The checklists can be found at www.saeaerodesign.com/go/downloads.

Technical and Safety Inspection is the process of checking all aircraft for:

- Compliance with all General aircraft requirements.
- Compliance with all aircraft configuration requirements for their class.
- Overall safety and airworthiness.

All aircraft must pass the Technical and Safety Inspection in order to compete. It is strongly suggested that each team pre-inspect their aircraft and correct any problems using the official inspection checklist before arriving at the competition.

All required Aircraft Demonstrations will be performed at designated locations in the Technical Inspection area.

- **Regular Class** will demonstrate the ability to load and unload their aircraft per the requirements of rule 7.6.
- **Advanced Class** will demonstrate that their aircraft has proven operational ability by providing a video showing the aircraft successfully taking off, dropping a payload and landing per the requirements of rule 8.1.
- **Micro Class** will demonstrate the timed assembly of their aircraft per the requirements of rule 9.6.

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. All teams must have a hard copy of their design report with them during technical inspection.
3. Aircraft will have their actual empty CG compared to the empty CG presented in the design report 2D drawing.

6.2 FAILURE TO REPORT DESIGN CHANGES

Failure to report any design changes incorporated after Design Report submission and prior to Technical Check-in will incur a one (1) point penalty for each unreported design change discovered during technical inspection.

6.3 DEVIATIONS FROM 2D DRAWING

Any deviation in construction of the aircraft from the submitted 2D drawing, after submission of the Design Report, must be reported in writing.

1. Each design change must be documented separately using the Engineering Change Request (ECR) – a physical copy of which must be brought to the Technical and safety Inspection
2. Only one design change may be submitted per ECR form.
3. Penalty points for design changes will be assessed in accordance with the penalty guidelines in Appendix E, subject to the judges' final determination.

6.4 SAFETY AND AIRWORTHINESS OF AIRCRAFT

Technical and Safety Inspection will be also be used to assess the general safety and airworthiness aspects 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. Structural and mechanical soundness

6.5 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 complete aircraft at Technical Inspection on Friday.
3. Additional spare aircraft and parts beyond two sets may be submitted for inspection during the event on Saturday and Sunday.

6.6 AIRCRAFT MUST MEET ALL INSPECTION REQUIREMENTS THROUGHOUT THE COMPETITION.

1. All aircraft must meet all Technical and Safety Inspection requirements throughout the competition.
2. Any official may request that an aircraft be re-inspected if a general, class configuration or safety requirement problem is seen on an aircraft at any time during the event.
3. This includes any errors or omissions made by officials during inspection.

6.7 TECHNICAL AND SAFETY INSPECTION PENALTIES

No points are available to be scored as a result of the Technical and Safety Inspection: teams may only lose points as a result of errors and problems encountered during the inspection process. Any penalties assessed during Technical Inspection will be applied to the overall competition score.

7 REGULAR CLASS DESIGN REQUIREMENTS

The objective of Regular Class is to design an aircraft that can generate revenue by carrying as much payload as possible while observing the power available requirement. Payload will consist of passengers, represented by tennis balls, and Luggage, represented by payload weights, which must be carried on each flight. Accurately predicting the lifting capacity of the aircraft and selecting the appropriate number of passenger seats is an important part of the airplane design.

7.1 AIRCRAFT DIMENSION REQUIREMENT

Regular Class aircraft are limited to a wingspan of 144 inches.

7.2 MATERIAL AND EQUIPMENT RESTRICTIONS FOR REGULAR CLASS

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

2. **Rubber bands**
   Elastic material such as rubber bands shall not be used to retain the wing or payloads to the fuselage.

3. **Stability Assistance**
   All types of gyroscopic or other stability assistance are prohibited.

7.3 AIRCRAFT SYSTEM REQUIREMENTS

1. **Electric Motor Requirements**
   The aircraft shall be propelled by a single electric motor (no multiple motors). There are no restrictions on the make or model of the electric motor.

2. **Gear boxes, Drives, and Shafts**
   Gearboxes, belt drive systems, and propeller shaft extensions are allowed as long as a one-to-one propeller to motor RPM is maintained. The prop(s) must rotate at motor RPM.

3. **Aircraft Propulsion System Battery**
   Regular Class aircraft must be powered by a commercially available Lithium-Polymer battery pack.

   1. Required: 6 cell (22.2 volt) Lithium Polymer (Li-Poly/Li-Po) battery pack. Minimum requirements for Li-Po battery: 3000 mAh, 25c
   2. Homemade batteries are NOT allowed.

4. **Power Limiter**
   All Regular Class aircraft must use a 2015 V2 or newer version 1000 watt power limiter from the official supplier, Neumotors.com.

   1. Repair and/or modifications to the limiter are prohibited.
   2. The limiter must be fully visible and easy to inspect.

3. Only battery, receiver, speed control, and limiter are allowed within the power circuit.
4. The limiter is only available at the follow link:

http://neumotors.cartloom.com/shop/item/24377

This supplier has agreed to ship worldwide to any team.

5. Radio System Battery and Switch

If a separate battery is used for the radio system, the battery pack must have enough capacity to safely drive all the servos in the aircraft, taking into consideration the number of servos and potential current draw from those servos.

1. A battery pack with a minimum capacity of 1000 mAh must be used for the radio system.
2. The battery pack must be a LiPo or LiFE type battery.
3. Battery voltage regulators are allowed.
4. The battery pack must be controlled by a clearly visible and properly mounted on/off switch on the external surface of the aircraft, located at least 12" from the prop.

7.4 Payload Requirements

1. Types of Payload

Regular Class payload shall consist of two types; (1) Passengers and (2) Luggage, which must be carried in proportion to one another in the Passenger Cabin and Payload Bay respectively. Both the Passenger Cabin and Payload Bay must be designed for ease of access to both Passengers and Luggage. This will be demonstrated during the oral presentation (Reference Section 7.6 for demonstration details).

2. Payload Bay Requirements

Regular Class aircraft shall have a single fully enclosed Payload Bay for carrying Luggage (see section 7.4.2) with the following additional requirements:

1. The Payload Bay shall only contain Luggage.
2. The Payload Bay shall fully enclose the Luggage.
3. The Payload Bay has no restriction on size or shape.
4. Only one Payload Bay is allowed in a Regular Class aircraft.

3. Luggage and Luggage Support Requirements

Luggage shall consist of a support assembly and payload plates with the following additional requirements:

1. For weight measurement and scoring, Luggage shall consist of the payload plates and support structure used to retain the weight(s) in the Payload Bay.
2. An average Luggage weight of ½ lb. or more must be carried for each Passenger carried.
3. If the Luggage weight carried does not meet the ½ lb. per passenger requirement, the excess Passengers will be counted as empty seats and the flight scored accordingly.
4. Luggage weight in excess of ¾ lbs. per passenger will not count in Luggage weight scoring.
5. There is no required configuration for the payload plates.
6. Teams must provide their own payload plates.
7. The support assembly must securely bolt together all payload plates, creating a single mass of payload. The support assembly must also securely bolt all payload plates to the structure of the aircraft to ensure that the payload luggage will not shift or come loose in flight.
8. Tape, Velcro, rubber bands, container systems and friction systems alone may not be used to retain the support assembly and/or payload plates.

4. Passenger Payload Definition

The Passenger* payload must consist only of unmodified tennis balls which meet or exceed the minimum size and weight specifications for Type 1 and Type 2 tennis balls as specified by the International Tennis Federation (ITF). Accordingly, the minimum tennis ball weight is 1.975 ounces and minimum ball diameter allowed is 2.57 inches. A list of accepted brands of tennis balls is given at:

http://www.itftennis.com/technical/balls/.

* Teams must provide their own Passengers.

5. Passenger Cabin Requirements

Regular Class aircraft must position all Passengers in a single Passenger Cabin.

1. The Passenger Cabin must position all Passengers to be tangent to the same side of a single geometric plane.
2. All Passengers must be constrained to the geometric plane within the Passenger Cabin so that they will not shift or come loose during any portion of a flight.
3. A position designed to hold a Passenger is a Seat. Passenger Seats must be in contiguous positions. Contiguous is defined as being less than 0.25 inches from the adjacent Passenger.
4. Any Passenger not in a seat after a flight will not count as revenue generated by Passengers.
5. Passengers must be in a countable configuration to be scored as a revenue generating Passenger. A countable configuration is defined as when Passengers are clearly visible and can be easily touch-counted.

6. Each Passenger carried in excess of the maximum number (as determined by Luggage weight), will not count as a revenue generating Passenger and will be scored as an empty Seat.

7.5 PASSENGER SEATING REQUIREMENTS

1. Regular Class aircraft must accommodate a minimum of 10 passengers and the required luggage.
2. Regular Class teams must document the number of passenger seats in their design per rule 4.4.3.4 at the time the design report is submitted. This seat number is used to determine passenger count and empty seats for the scoring equation.
3. Teams are allowed to reduce the number of seats in their design one time. This reduction can only be made after design report submission and before technical inspection. An Engineering Change Request defining the new seating number must be submitted on the normal ECR form. There is a one point penalty for each seat removed from the original design submission. After this ECR is submitted, the revised number of seats is then used in the scoring equation.
4. The number of passenger seats may never be increased after Design Report submission.

7.6 REGULAR CLASS PAYLOAD LOADING AND UNLOADING DEMONSTRATION

Technical Presentation for Regular Class shall demonstrate the requirement to quickly load/secure and unload both Passengers and Luggage. This is a timed activity and shall be performed by no more than two (2) members of the team within the following time constraints:

1. One (1) minute to load/secure both Luggage (5 – 7.5lbs.) and 10 passengers for flight.
    - The demonstration will start with the passengers and cargo separate from the aircraft and the aircraft in a flight-ready configuration.
    - The demonstration is considered complete when all required passengers and Luggage are loaded, secured, and the aircraft is put back in a flight-ready configuration.
2. One (1) minute to unload both Luggage (5 – 7.5lbs.) and 10 Passengers.
    - The demonstration will start with all required Passengers and Luggage loaded, secured, and the aircraft in a flight-ready configuration.
    - The demonstration will be considered complete when both the Passengers and Luggage are separate from the aircraft and the aircraft is put back in a flight-ready configuration.

This demonstration will be performed at a designated location in the Technical Inspection area on Friday.

7.7 REGULAR CLASS SCORING

In order 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.

The Final Regular Class Flight Score shall be based upon the Total Revenue earned and Total Penalty deductions received.

Scoring Equation:

$$FFS = \ Final\ Flight\ Score = \frac{1}{40\ N}\left[\sum_{1}^{N} FS\right]$$

Where:

$$FS = Flight\ Score = \$100P + \$50C - \$100E\ for\ each\ flight$$

$$P = Number\ of\ seated\ Passengers\ carried\ on\ a\ flight$$

$$C = Luggage\ weight\ (lbs)$$

$$E = Number\ of\ empty\ Seats$$

$$N = Total\ Number\ of\ Flight\ Rounds\ During\ Competition$$

All Flight Score's with a value less than zero (0) will default to zero (0).

Penalty Points

Any penalty points assessed during the competition are now deducted from a team's overall score per rule 3.14.

8 ADVANCED CLASS DESIGN REQUIREMENTS

The objective of the Advanced Class is to design the most efficient aircraft capable of accurately dropping multiple two pound (2 lb.) humanitarian aid packages from a minimum of 100ft above ground level. Though the class is mostly focused on mission success, students will need to perform trade studies to optimize empty weight and anticipate repair build-up weight while meeting several aircraft design requirements.

8.1 VIDEO DOCUMENTATION OF PROVEN OPERATIONAL ABILITY FOR ADVANCED CLASS

All Advanced Class teams are required to bring a video documenting the proven operational ability of their Advanced Class aircraft to Technical and Safety Inspection. The hard deadline for video submission is 8AM Saturday Morning.

1. The video must show the following three activities accomplished successfully with their competition aircraft: A takeoff, a payload release, and a landing without damage.
2. The video will be reviewed by SAE officials in the Technical Inspection area.
3. Advanced Class aircraft will not be inspected or allowed to compete without the video documentation of proven operational ability.
4. 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 accomplish each required activity.
5. Videos should be no more than 1 minute in length. Edited video will be accepted if the video is of the same flight.

8.2 AIRCRAFT DIMENSION REQUIREMENT

There are no dimensional limits on an Advanced Class Aircraft.

8.3 ENGINE REQUIREMENTS

Advanced Class aircraft must be solely powered by internal combustion, reciprocating engines. The common-use displacement will be used to determine displacement, i.e. the advertised displacement.

1. The total displacement may not exceed .46 cubic inches.
2. Advanced Class aircraft are not limited to the number of engines.
3. No changes to the internal displacement of the engine(s) will be allowed.
4. No restriction to the make and model of the engine(s).

8.4 RADIO SYSTEM BATTERY

The radio system battery pack must have enough capacity to safely drive all the servos in the aircraft, taking into consideration the number of servos and potential current draw from those servos. If the radio system battery also supplies DAS and FPV power needs, the radio system battery must be large enough for these power requirements as well.

1. A battery pack with a minimum capacity of 1000 mAh must be used for the radio system.
2. The battery pack must be a LiPo or LiFE type battery.
3. Battery voltage regulators are allowed.

4. The battery pack must be controlled by a clearly visible and properly mounted on/off switch on the external surface of the aircraft, located at least 12" from the prop.

8.5 Rubber Bands

Rubber bands shall not be used to retain the wing to the fuselage.

8.6 Payload Requirements

Advanced Class payload requirements shall consist of two types of payload.

- Releasable payload
- Static payload

1. Releasable Payload Requirements

There is no limit to the number of Releasable Payloads that can be carried by each aircraft. The following requirements apply to releasable payload:

1. Releasable Payloads may be mounted internally and/or externally to the airframe.
2. The CG of each mounted Releasable Payload shall not exceed a distance of 6 inches laterally or longitudinally from the CG of the EW aircraft. This shall be measured during technical inspection.
3. Each Releasable Payload shall be sand enclosed within a sewn woven fabric material container. Placing the sand inside a thin plastic bag inside the woven fabric is allowed. No metal hardware is allowed on the releasable payload.
4. Each Releasable Payload shall have a minimum weight of 2.0 lbs. and a maximum weight of 2.25 lbs.
5. Each Releasable Payload shall have one (1) flexible streamer attached to facilitate payload location and recovery
6. Each streamer shall be at least 48 inches long and 2 inches wide.
7. Releasable payload shall be marked with the team number in two places, on the container, and one end of the streamer with numbers 2-inches in height.
8. Streamers will remain attached to each Releasable Payload at all times. Attached is defined as being able to support the weight of the Releasable Payload.
9. If a team elects to make two separate payload drops during a flight attempt, the Releasable Payloads for each separate drop shall have streamers of a different color.
10. Streamers shall be in a stored configuration prior to the drop and deploy before each Releasable Payload strikes the ground.
11. All Releasable Payloads that are connected (e.g. become tangled during drop) in any way shall not be counted for score.
12. All Releasable Payloads that achieve a scoring drop on the target, or a successful drop from above 100 feet that misses the target, will be inspected and measured at the weigh station after that drop. This is the only time Releasable Payloads will be inspected. If any Releasable Payload is not in compliance with all related rules, score for that Releasable Payload will be zero (0) for that flight attempt.

2. Static Payload Requirements

1. Static payload shall be in its own payload bay(s).
2. Static payload bay(s) shall be fully enclosed and be completely closed off and physically separated from all releasable payload.
3. Static payload bay(s) shall have no restriction on size or shape.
4. Advanced Class may have multiple Static Payload bays.
5. Teams must be able to unload their Static Payload at the weigh station after their flight in 5 minutes or less.

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 prohibited.

8.9 DATA ACQUISITION SYSTEM (DAS)

Advanced Class aircraft must have a Data Acquisition System (DAS) that shall record altitude.

1. Using a ground receiver station, the team must display the real-time altitude of the aircraft to the Payload Specialist and the flight judge.
2. Team must automatically record the altitude of the aircraft at the moment they initiate the release of any Releasable Payload.
3. The DAS recording must be performed on the ground station and must support play back for review on demand.
4. Altitude must be measured in feet with display precision of at least one (1) ft. and an accuracy error of less than ten (10) ft.
5. DAS system must use a discrete and removable Red arming plug to apply power to the DAS system. The DAS arming plug must be located on top of the aircraft at least 12 inches from the propeller. One Red arming plug can be used for both DAS and FPV.
6. DAS equipment may also have a reset switch, if desired. If a manual reset switch is used, it must be located externally at least 12 inches away from the propeller. A wireless DAS reset system is allowed.
7. DAS systems shall not use the same 2.4 GHz channel as the flight control system, unless the telemetry being used is part of the radio control system being used. A DAS built into the radio control system must meet all DAS rules requirements.

8.10 FIRST PERSON VIEW SYSTEM (FPV)

Some type of First Person View (FPV) system is required to be used as a drop sighting device. FPV video and the required telemetry data for altitude must be transmitted to the ground station and be visible to the Payload Specialist and the flight judge.

1. The ground station FPV video screen or window provided for the judges viewing must be 7 inches or larger in the diagonal dimension. DAS altitude readout must be .5 inches or larger on the screen to be considered viewable.

2. Payload Specialist must be a team member and must use the FPV video stream to verbally direct the pilot to the drop zone.
3. The primary pilot must fly visually only (no FPV goggles or ground station reference).
4. The FPV system must transmit a live real time video signal from the aircraft to the ground station. FPV and DAS data may be combined on the ground station display.
5. FPV systems CANNOT use the same frequency as the flight control system. Use of 2.4 GHz for FPV video is prohibited.
6. The FPV system must use a discrete and removable Red arming plug to apply power to the FPV system. The Red arming plug must be located on top of the aircraft at least 12" from the propeller. One Red arming plug can be used for both DAS and FPV.

8.11 DAS AND FPV FAILURES

Any DAS or FPV failure during the flight attempt is considered a missed flight attempt and receives no points.

> *Example: A team has flown four (4) rounds successfully and on the 5th round the aircraft takes-off successfully, makes a successful drop, but the DAS altitude reading malfunctions. The flight attempt will NOT be considered a qualified flight and the team will receive zero (0) flight score for round 5.*

Advanced Class aircraft must have accurate DAS altitude readout in accordance with 8.9 and a functioning FPV in accordance with 8.10 to be allowed to take off for an official flight.

8.12 PAYLOAD SPECIALIST

Advanced Class aircraft must be able to drop the Releasable payload using a system commanded by the Payload Specialist.

1. The primary pilot cannot have access to or activate the Releasable Payload.
2. The Payload release must be manually activated by the Payload Specialist or by an automatic release system that is part of the aircraft electronics.
3. If an automatic Payload release system is used, it must have a manual override controlled by the payload specialist.
4. The Releasable Payload release cannot be controlled from or connected to the primary pilot's R/C transmitter in any way.
5. Teams may activate the payload release system using a second 2.4 GHz radio system or some other method based on their DAS or telemetry system.

8.13 LINK BUDGET FORMAT FOR SAE AERO DESIGN COMPETITION

Radio Link Budget should be used to establish the requirements for the Advanced Class FPV and DAS systems. Each system component needs to be described with enough detail to evaluate its effect on system performance. The link budget form provided in the rules appendix is required to summarize the system parameters in the design report. Calculations for the 2.4GHz radio control systems are optional. Calculations for the FPV and DAS systems are required. An example link budget form can be found in Appendix B.

8.14 FLIGHT & DROP PROCEDURES

1. Teams are allowed two drop attempts on the target. Teams may drop as many or as few releasable payloads as they wish during each drop attempt.
2. Advanced Class teams are allowed to drop their releasable cargo in the upwind or downwind directions or both.
3. Dropping direction shall be declared to the Air Boss prior to takeoff and adhered to during flight operations. Stated direction will be recorded on the flight log.
4. To receive a flight score, the team shall release at least one successful payload.

A successful payload release is defined as the intentional targeted drop of at least one releasable payload, at 100ft above the target, in the dropping direction indicated to the flight boss prior to takeoff. The payload does not have to land in the target zone but must meet all requirements after the drop. Altitude at release must be successfully recorded on the DAS and displayed on the ground station.

Example 1:

A team states they will drop in one direction (upwind or downwind). They will get two attempts to position their aircraft in the proper direction. Each approach to the drop zone in the declared direction will be counted as a drop attempt.

Example 2:

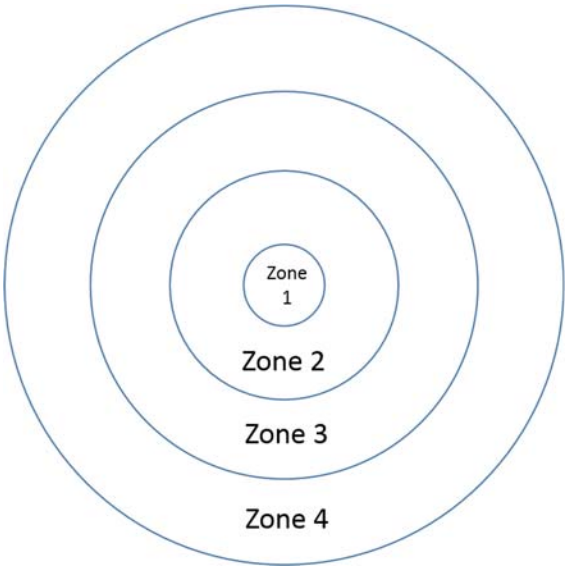
A team states they will drop in both directions; upwind and downwind. Any approach to the drop zone is considered an attempt.

8.15 ADVANCE CLASS SCORING

In order 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. In addition, each team must have provided video demonstration of aircraft operational ability to SAE officials by the deadline established for the event.

Zone Multiplier:

The Zone Multiplier (Z_m) is the multiplier earned for each releasable payload successfully dropped in the respective drop zone.



Zone	Range	Multiplier
1	0 ft. → 15 ft.	1.00
2	15 ft. → 30 ft.	0.75
3	30 ft. → 45 ft.	0.50
4	45 ft. → 60 ft.	0.25
OUTSIDE	60 ft. +	0.00

Scoring Equation:

$$FFS = Final\ Flight\ Score = 4 \times \left(\frac{1}{N}\sum_{1}^{N} FS\right)$$

Where:

$$FS = Flight\ Score = S_p + \left(S_p \times \sum Z_m\right)$$

$Z_m = Zone\ Multiplier$

$S_p = Static\ Payload\ (lbs)$

$N = Total\ Number\ of\ Flight\ Rounds\ During\ Competition$

Penalty Points

Any penalty points assessed during the competition are now deducted from a team's overall score per rule 3.14.

9 MICRO CLASS DESIGN REQUIREMENTS

The objective of Micro Class is to design light-weight micro UAV style aircraft that can be quickly deployed from a small package and able to carry a large, unwieldy low density payload. For this year, we are basing scores on both the maximum performance of the aircraft and on overall performance throughout the event. The Micro Class assembly demo is now a mandatory timed event. Payload fraction is still a core element of the class.

9.1 AIRCRAFT SYSTEMS REQUIREMENTS

1. **Propulsion Requirements**
   Micro Class aircraft are restricted to electric motor propulsion only.

2. **Propeller and Gearbox**
   Gearboxes on a Micro Class aircraft where the propeller RPM differs from the motor RPM are allowed. Multiple motors, multiple propellers, propeller shrouds, and ducted fans are allowed in Micro Class.

3. **Aircraft Propulsion System Battery**
   Micro Class aircraft must use Lithium Polymer batteries. The maximum size propulsion system battery allowed for Micro Class is a 3 cell 2200mAh lithium polymer battery. Batteries having fewer cells and lower capacity are permitted.

4. **Gyroscopic Assist Allowed**
   Gyroscopic assist and other forms of stability augmentation are allowed in Micro Class.

5. **Aircraft Empty Weight Definition**
   An empty aircraft has completed a successful flight and has the payload removed for weigh-in. All aircraft parts that are not payload, as defined in 9.2, contribute to the empty aircraft weight, including, but not limited to: airframe, receiver, electronics, batteries, hardware, brackets, straps and other associated features.

9.2 PAYLOAD REQUIREMENTS

1. Micro Class aircraft shall use 2 inch diameter, Schedule 40, White Polyvinyl Chloride (PVC) pipe in accordance with ASTM D1785 as payload weights:
    1. Outer diameter: 2.375 inches
    2. Nominal Inner diameter: 2.000 inches
    3. Minimum Wall Thickness: .154 inches
    4. Inner diameter (Ref): 2.067 inches MAX
    5. Weight (Ref): .680 lbm. /ft.
    6. Color: White
2. When free from the aircraft the inner diameter of the payload pipes shall be free from obstruction.
3. Except being cut to length or having holes drilled in the sidewall of the pipe, the PVC pipes shall be unmodified.
4. Payload support structure for the PVC pipes is NOT included in the payload weight for scoring purposes.

Notes:

- There is no requirement for internal carriage of payload within the aircraft.
- There is no required carriage configuration for the payload.

9.3 Micro Class Aircraft Launch

1. Hand launched (tossed)

The Micro Class aircraft must be hand launched (tossed) by throwing the aircraft using one (1) hand grasping the aircraft.

1. Only one (1) member of the team can enter pre-marked launch zone.
2. The pilot must be outside the pre-marked launch zone during the tossing action.
3. The aircraft can only be tossed by one (1) team member.
4. The aircraft cannot be tossed by the pilot.
5. There is no limit on number of steps taken during the launching action, but the person must remain inside the launch zone before and after releasing the aircraft.

2. Hand launched (tossed) violations

The following actions are not permitted and will invalidate the flight attempt and score for the round.

1. Using more than one hand to toss the aircraft
2. Tossing the aircraft from any other part of the aircraft other than the fuselage
3. Running with the aircraft during launch
4. Pilot launching (tossing) the aircraft

9.4 Micro Class Aircraft Hand-Launch Safety Requirements

Safety gear must be used by the designated team member performing the aircraft toss and any team member assisting with preparing the aircraft inside the launch zone.

Safety gear will consist of:

- Safety glasses
- Hard hat

9.5 Aircraft System Container

1. Aircraft System Container Requirements

Micro Class aircraft will fit in an aircraft system container with size limitations. Compliance with the following requirements will be confirmed during technical inspection.

1. The aircraft system container shall be a cardboard box with absolute maximum outside dimensions of 12.125 inches X 3.625 inches X 13.875 inches maximum. Minimum wall thickness of container is .125 inches.
2. The fully packed aircraft system container must weigh no more than 10 pounds (lbs.).
3. The aircraft system container must have school name, school address, team name, and team number on a mailing label.

2. Aircraft System Packaging General Requirements

The aircraft container must contain the following:

1. The following items must be packaged within the constraints of the aircraft system container:
   - The airframe
   - Propulsion system battery
   - All (maximum) payload to be carried. Teams may not carry any payload that was not stored in the aircraft container.
   - All tools needed for the Assembly Demonstration, except a box-cutter or knife to cut packing tape
2. Any additional components not listed herein required for flight. The propulsion system battery must not be pre-installed in the aircraft.
3. The red arming plug must not be pre-installed in the aircraft.
4. The propulsion system battery must be contained in its own partitioned space in the aircraft system container.
5. The transmitter and any spare parts are not required to be in the aircraft system container.
6. The payload shall not be preinstalled to the aircraft.
7. If the aircraft uses a separate radio system battery, it may be pre-installed in its flight location. If the aircraft uses a radio system battery and a team elects not to pre-install it, then the radio system battery must be contained within its own partitioned space within the aircraft system container.

9.6 TIMED AIRCRAFT ASSEMBLY DEMONSTRATION

1. Performance

The Assembly Demonstration will be performed on Friday in the demonstration and inspection area. Timed assembly demonstrations will not be done at the flying site.

The assembly demonstration shall be accomplished under the following constraints:

1. The assembly of the aircraft shall be accomplished within 3 minutes. If 3 minutes is exceeded, then the demonstration will be halted.
2. The assembly demonstration score (AD) will be calculated per section 9.8.
3. The aircraft shall be completely packaged in the aircraft system container. The box will be taped closed with packing tape that will be provided at the assembly demonstration.
4. The assembly demonstration will consist of aircraft removal from the box and installation of the propulsion system battery at a minimum.
5. The use of any type of time-dependent curing adhesives such as glue, super-glue or epoxies are prohibited in the assembly demonstration.
6. Only the tools contained within the aircraft system container at the beginning of the assembly demonstration are permitted for use during the assembly process.

7. All payload carried in the aircraft system container will be installed on the aircraft before the assembly demonstration is considered complete.

2. Process for Assembly Demonstration:

1. Two team members tasked with assembling the aircraft will be located at a table in the Technical Inspection and Demonstration area. At this time the fully packaged, non-energized aircraft, with flight battery uninstalled will be in the container with the aircraft system container taped closed with the tape provided. Failure to have the Red Arming Plug removed or the battery uninstalled at this time will result in an assembly demonstration time of three minutes.
2. An official will give the "GO" command to begin the assembly demonstration. Assembly will start with the team opening the aircraft system container. Two officials will record the elapsed assembly time. Teams may use a knife to cut open the aircraft system container as described in rule 9.5.2.1.
3. The prop will be installed for the demo, but shall not be fully tightened to the motor for safety reasons.
4. When the aircraft is fully assembled, with all (maximum) payload from the container installed, with the flight battery installed, the team will give the "DONE" command to signal the officials to stop timing.
5. After the "DONE" command is given by the assembling team, no further assembly may occur.
6. The assembly demonstration is considered complete when all tasks required for flight have been performed with the exception of:
   - Installing the Red Arming Plug.
   - Performing preflight controls check.
7. The officials will inspect the aircraft to confirm aircraft flight ready status and record elapsed time.
8. The aircraft will then be powered up for a flight control and motor function check. If the aircraft checks out as fully ready for flight, the assembly demonstration time is awarded.
9. Disassembling the aircraft during the pre-flight and motor checks will invalidate any assembly time of less than 3 minutes.

9.7 Mission Requirements

1. Time Limit for Aircraft Launch

Micro Class aircraft should be assembled prior to entering the launch zone.

1. Each team will have 60 seconds to complete preflight checks, energize the propulsion system, and check the controls and hand-launch the aircraft.
2. Only one takeoff launch attempt is permitted per round.

2. Aircraft Takeoff and Circuit

Takeoff for Micro Class is defined as the point at which the aircraft departs the hand of the person throwing the aircraft. Once takeoff occurs, Micro Class aircraft are required to:

1. Remain airborne and fly past the designated turn point before turning approximately 180 degrees in heading.
2. Flying past a second designated turn point, turning 180 degrees in heading.
3. Land in the designated landing zone for Micro Class. Micro Class aircraft should be prepared to land on either a paved landing zone or an unpaved landing zone.
4. Takeoff direction will be determined by the Air Boss, and normally selected to face into the wind.

9.8 MICRO CLASS FLIGHT SCORING

Final Flight Score will be calculated in two parts: the average of all flight round scores and the maximum scored for any one flight round. This running calculation will be posted on the score board to determine team standings.

Scoring Equation:

$$Final\ Flight\ Score = FSS = \ 20 * \left[0.5 * \left(\frac{1}{N}\sum_{1}^{N} FS_n\right) + 0.5 * MAX(FS_n)\right]$$

Where:

$$FS_n = Flight\ Score_n = \frac{W_{payload}}{\sqrt{W_{empty}}}$$

The Micro Class Assembly Demo score, either positive or negative, will be added to or deducted from the team's overall score, per rule 3.14.

Assembly Demonstration

$$AD = Assembly\ Demonstration = 5 * \left(2 - \frac{t}{60}\right)^3$$

$$MAX = Team's\ maximum\ single\ flight\ round\ score$$

$$t = time\ recorded\ in\ seconds$$

$$N = total\ number\ of\ flight\ rounds\ during\ the\ competition$$

Penalty Points:

Any penalty points assessed during the competition will be deducted from the team's overall score, per rule 3.14.

SAE AERO DESIGN

STATEMENT OF COMPLIANCE

Certification of Qualification

Team Name		Team Number	
School			
Faculty Advisor			
Faculty Advisor's Email			

Statement of Compliance

As Faculty Advisor, I certify that the registered team members are enrolled in collegiate courses. This team has designed, constructed and/or modified the radio controlled aircraft they will use for the SAE Aero Design 2018 competition, without direct assistance from professional engineers, R/C model experts or pilots, or related professionals.

Signature of Faculty Advisor

Team Captain Information:

Team Captain:
Captain's E-mail:
Captain's Phone:

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

APPENDIX B

Advanced Class Tech-Data Sheet: Radio Link Budget

Supply data for each transmitter used onboard aircraft. Expand number of columns as needed. Calculations for Radio control systems using 2.4GHz are optional.

Radio System Function (FPV, DAS, RC, Payload)	Units	FPV	DAS	RC	Payload Release
Operating Frequency (F)	MHz				
Wavelength (WL) = 300 / F Hz)	meters				
Maximum Operating Range (Rng)	meters				
Free Space Path Loss (Lfs) = 20Log(4Pi (Rng / WL))	dB				
Transmitter Brand & Model ID					
Transmitter FCC ID	FCC ID				
Transmitter Power (Pt)	dBm				
Number of Transmitter Channels Available	---				
Transmit Antenna Gain (Gt)	dB				
Transmit Antenna Polarization	H, V RHC, LHC				
Transmit Line or Misc. Losses (Lt)	dB				
Receive Line or Misc. Losses (Lr)	dB				
Receive Antenna Gain (Gr)	dB				
Receive Antenna Polarization	H, V RHC, LHC				
Polarization Mismatch Loss (Lpol)	dB				
Power Rcvd (Pr) = Pt + Gt + Gr – Lfs – Lt – Lr – Lpol	dBm				
Receiver Signal Power Required (Pmin)	dBm				
Signal Margin = Pr – Pmin	dB				

FPV Transmitter Operating Frequencies Available (MHz).

If your video transmitter or data-link operates on a frequency which can be changed, list all the available frequencies below and highlight the one you intend to use. If your system is spread spectrum, list the range of frequencies you intend to use.

The FCC ID is marked on the transmitter board if certified for use in USA.

Reference: https://en.Wikipedia.org/wiki/Link_budget

APPENDIX C

Micro Class Tech–Data Sheet: Weight Buildup

	Component	Weight (lb.)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
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15		
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23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
	Total	

APPENDIX D

Engineering Change Request (ECR)

Team Number:				
School Name:				
Team Name:				
Discovery Method	☐Tech Inspection ☐Safety Inspection ☐Test Flight ☐Design Analysis	System Affected	☐Wing (area +/-) ☐Fuselage (area +/-) ☐Horiz. Stabilizer (area +/-) ☐Vertical Tail (area +/-) ☐Engine Mount assembly	☐Mechanical ☐Landing System ☐Structural ☐Electronics (avionics) ☐Payload bay Assembly
Surface Area	AREA ADDED:_____ AREA REDUCED:_____ *If surface area was impacted by the modification, specify total area added or reduced. Show calculations:*			
Describe the Modification				
Reason for Modification				
Other Considerations				
*** OFFICIAL USE ONLY ***				
ECR #				

APPENDIX E

Penalty Chart Guidelines

These charts provide guidelines to possible assessment of penalty points for different design changes. Final assessment of penalty points is subject to the judges' determination.

Table D1: Penalties guidelies for for wing surface changes

Dimension	Add	Remove
Span	2pts per inch	1pt per inch
Chord	10pts per inch	5 pts per inch

Table D2: Penalty guidelines by category and size of change

Type	Small	Medium	Large
Structural	2pts	4pts	6pts
Mechanical	2pts	4pts	6pts
Electronics	1pts	2pts	3pts
Miscellaneous	1pts	3pts	5pts

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	

SAE Technical Standards

The SAE Technical Standards Board (TSB) has made the following SAE Technical Standards available on line, **at no cost**, for use by Collegiate Design teams. Standards are important in all areas of engineering and we urge you to review these documents and to become familiar will their contents and use.

The technical documents listed below include both (1) standards that are identified in the rules and (2) standards that the TSB and the various rules committees believe are valuable references or which may be mentioned in future rule sets.

All Collegiate Design Series teams registered for competitions in North America have access to all the standards listed below - including standards not specific to your competition.

SAE Technical Standards included in the CDS Rules

Baja SAE
J586 - Stop Lamps for Use on Motor Vehicles Less Than 2032 mm in Overall Width
J759 - Lighting Identification Code
J994 - Alarm - Backup – Electric Laboratory Tests
J1741 - Discriminating Back-Up Alarm Standard
Clean Snowmobile Challenge
J192 - Maximum Exterior Sound Level for Snowmobiles
J1161 - Sound Measurement – Off-Road Self-Propelled Work Machines Operator-Work Cycle
Formula Hybrid
J1318 - Gaseous Discharge Warning Lamp for Authorized Emergency, Maintenance and Service Vehicles
J1673 - High Voltage Automotive Wiring Assembly Design
Formula SAE
SAE 4130 steel is referenced but no specific standard is identified
SAE Grade 5 bolts are required but no specific standard is identified
Supermileage
J586 - Stop Lamps for Use on Motor Vehicles Less Than 2032 mm in Overall Width

SAE Technical Standards for Supplemental Use

Standards Relevant to Baja SAE

J98 – Personal Protection for General Purpose Industrial Machines – Standard
J183 – Engine Oil Performance and Engine Service Classification - Standard
J306 – Automotive Gear Lubricant Viscosity Classification - Standard
J429 – Mechanical and Material Requirements for Externally Threaded Fasteners – Standard

J512 – Automotive Tube Fittings - Standard
J517 – Hydraulic Hose - Standard
J1166 – Sound Measurement – Off-Road Self-Propelled Work Machines Operator-Work Cycle
J1194 – Rollover Protective Structures (ROPS) for Wheeled Agricultural Tractors
J1362 – Graphical Symbols for Operator Controls and Displays on Off-Road Self-Propelled Work Machines - Standard
J1614 – Wiring Distribution Systems for Construction, Agricultural and Off-Road Work Machines
J1703 - Motor Vehicle Brake Fluid - Standard
J2030 – Heavy Duty Electrical Connector Performance Standard
J2402 – Road Vehicles – Symbols for Controls, Indicators and Tell-Tales – Standard

Standards Relevant to Clean Snowmobile Challenge

J44 – Service Brake System Performance Requirements – Snowmobiles - Recommended Practice
J45 – Brake System Test Procedure – Snowmobiles – Recommended Practice
J68 – Tests for Snowmobile Switching Devices and Components - Recommended Practice
J89 – Dynamic Cushioning Performance Criteria for Snowmobile Seats - Recommended Practice
J92 – Snowmobile Throttle Control Systems – Recommended Practice
J192 – Maximum Exterior Sound Level for Snowmobiles - Recommended Practice
J288 – Snowmobile Fuel Tanks - Recommended Practice
J1161 – Operational Sound Level Measurement Procedure for Snowmobiles - Recommended Practice
J1222 – Speed Control Assurance for Snowmobiles - Recommended Practice
J1279 – Snowmobile Drive Mechanisms - Recommended Practice
J1282 – Snowmobile Brake Control Systems - Recommended Practice
J2567 – Measurement of Exhaust Sound Levels of Stationary Snowmobiles - Recommended Practice

Standards Relevant to Formula SAE

J183 – Engine Oil Performance and Engine Service Classification - Standard
J306 – Automotive Gear Lubricant Viscosity Classification - Standard
J429 – Mechanical and Material Requirements for Externally Threaded Fasteners – Standard
J452 - General Information – Chemical Compositions, Mechanical and Physical Properties of SAE Aluminum Casting Alloys – Information Report
J512 – Automotive Tube Fittings - Standard
J517 – Hydraulic Hose - Standard
J637 – Automotive V-Belt Drives – Recommended Practice
J829 – Fuel Tank Filler Cap and Cap Retainer
J1153 - Hydraulic Cylinders for Motor Vehicle Brakes – Test Procedure
J1154 – Hydraulic Master Cylinders for Motor Vehicle Brakes - Performance Requirements - Standard
J1703 - Motor Vehicle Brake Fluid - Standard

J2045 – Performance Requirements for Fuel System Tubing Assemblies - Standard

J2053 – Brake Master Cylinder Plastic Reservoir Assembly for Road Vehicles – Standard

Standard Relevant to Formula Hybrid

J1772 – SAE Electric Vehicle and Plug in Hybrid Conductive Charge Coupler

Standard Relevant to all CDS Competitions

J1739 – Potential Failure Mode and Effects Analysis in Design (Design FMEA) Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA) and Potential Failure Mode and Effects Analysis for Machinery (Machinery FMEA)