2014 Collegiate Design Series

SAE Aero Design®

East and West

Rules

Section 1 Foreword

Welcome to SAE Aero Design 2014!! In our plan of revamping one class every year, Regular Class has been majorly overhauled this year. The new changes have taken considerable effort by the rules committee and I believe these changes are positive and beneficial in giving engineering students real world experience. Let's take a look at some of the major points of change and our reason for them. One: Regular Class is now an electric propulsion class. Almost every small commercial UAV platform on the market uses an electric propulsion system. We hope students can learn the elusive art of choosing and mating the right combination of electrical components to optimize their electrical system based on the new requirements. Two: use of ballast has always been a point of contention with organizers and student teams. This year we decided that since the use of ballast is inevitable, that teams can use ballast as they see fit with one restriction. It can be used anywhere on the aircraft, at any time and in any amount except in the "enclosed" payload bay volume. What do we mean by an "enclosed" payload bay volume? Three: The payload bay volume must now be a box where the weights can be inserted from the top. Why a box? So organizers can now, without a doubt, verify that no ballast is used in the payload bay volume. Four: students are now required to submit a weight and balance form to accurately locate the C.G. for the empty weight and "fully loaded" aircraft. This is a real world requirement that every aircraft manufacturer uses. Datum planes and moment arms will be a part of your C.G. calculations. Five, the last major change is to the scoring formula. Since this is a weight lifting contest, we will now use a summation of all the weights lifted from all flight rounds to determine a winner. Of course, this is a quick overview for Regular Class so please **read the rules carefully and thoroughly for ALL the changes, for all classes**. I wish you all the best of luck this year and hope to see you soon. Be safe but have fun.

Oliver Alvarado
SAE Aero Rules Committee

Section 2 Requirements for all Classes

2.1 Introduction

Official Announcements and Competition Information

The Aero Design competition is intended to provide undergraduate and graduate engineering students with a real-life engineering exercise. The competition has been designed to provide exposure to the kinds of situations that engineers face in the real work environment. First and foremost a design competition, students will find themselves performing trade studies and making compromises to arrive at a design solution that will optimally meet the mission requirements while still conforming to the configuration limitations.

The importance of interpersonal communication skills is often overlooked by engineers, yet both written and oral communication skills are vital in the engineering workplace. To help teams develop these skills, a high percentage of a team's score is devoted to the Design Report and the oral presentation required in the competition.

Aero Design features three classes of competition—**Regular**, **Advanced**, and **Micro**. Regular Class ***(now all electric)*** is intended to be simpler than Advanced Class, and therefore more accessible to the Novice team. Advanced Class is intended to be less restrictive than Regular Class, thereby opening a larger potential solution set. Its lack of restriction allows teams to pursue more complex aircraft configurations, thereby encouraging greater creativity in satisfying the mission requirements. Micro Class (all electric) teams are required to make 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/

SAE Aero Design Rules and Organizer Authority

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 University Programs Committee. Official announcements from the SAE Aero Design Rules Committee, SAE or the other SAE 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 Rules Committee or SAE Staff.

Rules Validity

The SAE Aero Design Rules posted on the SAE Website 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.

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, the SAE Aero Design Rules Committee and other organizing bodies. All team members, faculty advisors and other university representatives are required to cooperate with, and follow all instructions from competition organizers, officials and judges.

Understanding the Rules

Teams are responsible for reading and understanding the rules in its 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.

Loopholes

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

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.

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.

Don't wait – apply early for your visa.

Registration Confirmation Letters (new)
Aero Design 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 teams 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, the School's Name, the SAE Event Name, Official Dates and Location(s).

Please be advised that SAE International cannot intervene with, or call or send personal letters to, the State Departments, Embassies or Consulates of the United States or other governments on behalf of any meeting or event participant.

Violations of Intent
The violations 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 Officials, Competition Organizers or SAE Staff

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

General Authority

SAE and the competition organizing bodies reserve the right 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 operation of the event or the SAE Aero Design series as a whole.

Penalties
Organizers have the right to modify the points and/or penalties listed in the various event descriptions; to better reflect the design of their events, or any special conditions unique to the site.

2.2 Team Member Eligibility

Teams are required to read the articles posted on the SAE Aero Design homepage (**http://students.sae.org/competitions/aerodesign/**) published by SAE and the other organizing bodies. Teams must also be familiar with all official announcements concerning the competitions and rule interpretations released by the Aero Design Rules Committee.

2.3 Society Membership

Individual team members must be members of one of the following societies: (1) SAE or an SAE 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 www.sae.org/students

2.3.1 Pilots

Pilots are not required to be students or SAE members, but they must be current members of either the **Academy of Model Aeronautics** or the **national model aircraft club** in their country of origin (such as the MAAC for Canadian teams). Valid AMA membership cards must be presented at the flying field prior to flying any team's aircraft. Copies of AMA application forms will not suffice as proof of AMA membership; the actual AMA card must be presented at the event flying field.

2.3.2 Liability Waiver and Insurance Requirements

All on-site participants and faculty advisors are required to sign a liability waiver upon registration. Individual medical and accident insurance coverage is the sole responsibility of the participant.

2.4 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.

2.5 Design and Fabrication

The airplane must be designed and built by the SAE 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 airplane. The faculty advisor must sign the Statement of Compliance given in Appendix.

2.6 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.

2.7 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.

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

2.8 Unique Designs

Universities may enter more than one team in each 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 email CollegiateCompetitions@sae.org.

2.9 Aircraft Classification/Duplicate Aircraft

Aircraft may only compete in one class. Simultaneous entry in Advanced, Regular, and Micro Class, with the same aircraft, is not allowed. When a team has an identical aircraft as a back-up, the back-up aircraft must go through inspection with the primary aircraft. If the entire back-up aircraft is used in competition, previously earned flight points are forfeited and flight point scoring starts over.

2.10 Aircraft Eligibility

Aircraft will only be allowed to compete during a single academic year. Aircraft may be entered in both Aero Design East and 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 Aero Design West one year and Aero Design East the next year is not allowed.

2.11 Registration Information and Deadlines

Teams intending to participate in the 2014 SAE Aero Design competitions must register their teams online starting

Tuesday, October 8, 2013 at 10:00 am EDT (75 team limit)

Registration (or is sold out) closes for both Aero Design and Aero Design West,

December 16, 2013 at 11:59 PM Eastern Standard Time.

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.

The registration fees indicated in the Appendix ($ 700) must be paid online by credit card at the time of online registration. Registration fees may not be paid by any other means.

Please note each Aero Design event will have limits on the number of teams…

75 for Aero Design East

75 for Aero Design West

Individual Registration Requirements – ACTION REQUIRED

All participating team members and faculty advisors must be sure that they are individually linked to their respective school / university on the SAE website, registration page.

If you are not an SAE 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 members to participate in the events.

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

All international student participants, or unaffiliated faculty advisors, who are not SAE members are required to complete the International Student Registration form per team found on the Registration page of the specific event (http://students.sae.org/competitions/aerodesign/west/registration.htm). Upon completion, email the form to CollegiateCompetitions@sae.org .

All student participants and faculty advisors must affiliate themselves to the appropriate team(s) online. To do this you will need to go to the Aero Design homepage and select the SAE Aero Design Series link to expand the menu. Select the event(s) that you are registered for, and once the menu expands, click on the Registration link. From here you will select the "Register Your Team / Update Team Information" link in which your team links should appear on the next page. Select the team link and scroll to the bottom of the page; the "Add New Member" button will allow individuals to include themselves with the rest of the team.

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 or submit the International Student Registration form by March 7st, 2014
For additional assistance, please contact CollegiateCompetitions@sae.org

****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 on or before March 7th, 2014**

2.12 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 plane.

NOTICE: In the event that the number of teams registering for the competition exceeds the number of teams/participants the facilities can handle, then registration priority will be given to colleges and universities with SAE student chapters.

2.13 Complaints, Protests and Questions

2.13.1 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.

2.13.2 Protests / Preliminary Review

If a team has a question about scoring, judging, policies, or any official action, they must bring the question to the Organizer's or SAE staff's attention for an informal preliminary review before a protest is filed.

2.13.3 Cause for Protest

A team may protest any rule interpretation, score or official action (unless specifically excluded from protest) which they feel has caused some actual, non-trivial, harm to their team, or has had a substantive effect on their score. Teams may not protest rule interpretations or actions that have not caused them any substantive damage.

2.13.4 Protest Format

If a faculty advisor or team captain feels that his complaint about an official action or rules interpretation was not properly addressed by the event officials, he or she may protest. All protests must be filed in writing to the Organizer by the faculty advisor or team captain only.

2.13.5 Protest Period

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

2.13.6 Protest Committee

Any protests must be reviewed by the Protest Committee. The Protest Committee must consist of a minimum of three members: the Organizer, SAE Collegiate Design Series representative, and either the Chief Steward, the Chief Judge, or the Air Boss. The decision of the Protest Committee must be final. If a member of the Aero Design Rules Committee is at the competition, he or she will be in the Protest Committee.

2.13.7 Protest Resolution

In order to have a protest considered, a team will be required to post twenty five (25) points as collateral. If the protest is sustained, the appropriate correction will be applied and the team will forfeit no points. If the protest is overruled, the team will forfeit the twenty five (25) collateral points.

2.13.8 Questions

Any questions or comments about the rules should be brought to the attention of the Rules Committee via the SAE Aero Design forum at

http://forums.sae.org/access/dispatch.cgi/aerodesign_pf

General information about hotels and other attractions in the area as well as a schedule of events will be posted on the SAE website according to the competition in which you are competing: http://students.sae.org/competitions/aerodesign/

2.14 Professional Conduct

2.14.1 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.

2.14.2 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.

2.14.3 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.

2.14.4 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.

SAE Technical Standards Access

A cooperative program of SAE's Education Board and Technical Standards Board is making some of SAE'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 the standards (1) your team must be registered for a competition in North America and

(2) The individual team member or faculty advisor wanting access must link to the team in SAE's system.

Access Procedure - Once your team has registered there will be a link to the technical standards titled "Design Standards" on the main registration screen where all the required onsite insurance information is added. On the technical standards webpage 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 Technical Standards can be found in Appendix S.

Section 3 Mission Requirements

3.1 Take Off

Takeoff is defined as the point at which the main wheels leave the ground.

3.1.1 Time Limit (NEW)

- **Micro Class:** Upon a signal given by the Air Boss, a team will have 1.5 minutes to setup their launch system, if applicable, and get their aircraft airborne. Only one attempt is allowed.
- **Regular Class:** Upon a signal given by the Air Boss, a team will have three (3) minutes to accomplish a successful takeoff. Multiple takeoff attempts are allowed within the three-minute window as long as the aircraft has **NOT** become airborne during an aborted attempt.
- **Advance Class:** Upon a signal given by the Air Boss, a team will have five (5) minutes to accomplish a successful takeoff. Multiple takeoff attempts are allowed within the five-minute window as long as the aircraft has **NOT** become airborne during an aborted attempt.

3.1.2 Take-off Zone

Takeoff direction will be determined by the Air Boss, and selected to face into the wind. Aircraft must remain on the runway during the takeoff roll.
Distance requirement is defined in the Table.

Take-Off Distance Requirement

Class	Take-off Requirements	Description
Regular	200 ft. (61m)	Aircraft must lift from the ground within a take-off distance requirement.
Micro	N/A	N/A
Advanced	N/A	Aircraft shall have the full use of the runway.

3.1.3 Engine Run-up

Use of a helper to hold the model while the engine is revved prior to release for takeoff is allowed, but the helper may not push the model upon release. To stay within the takeoff zone, the main wheels of the aircraft are to be placed on the takeoff line.

3.1.4 Aircraft Configuration upon Liftoff

The aircraft must remain intact during takeoff, from release through liftoff. No parts may depart the aircraft during the takeoff process.

3.2 Competition Circuit Requirements

Regular and Micro Class aircraft must successfully complete one 360° circuit of the field. 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 (See Para. 20.3.4). More than one circuit of the field is allowed. During a flight, each aircraft must fly past the departure end of the takeoff zone, turn the aircraft through approximately 180° of heading, and fly past the approach end of the takeoff zone prior to landing. 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, immelmans, barrel rolls, etc.

3.3 Initial Turn after take-off

The pilot may begin to make the initial turn of the 360^{o} circuit after the aircraft has passed the Take-Off Distance Requirement (see table). Making the initial turn before passing the Take-Off Distance Requirement will disqualify the flight attempt.

3.4 Landing

Landing is defined as occurring from initial touchdown to the point at which the aircraft stops moving. Initial touchdown is defined as the point at which any part of the aircraft touches the ground.

3.4.1 Landing Zone

Touch-and-goes are not allowed, and a crash-landing invalidates the landing attempt. A good landing is defined as touching down within the designated landing zone for the class, and remaining on the ground through rollout. Rolling-out beyond the landing zone is allowed, provided the aircraft touches down within the landing zone. Bouncing across the boundary at the end of the landing zone is not allowed, and will be judged as a failed landing attempt. A failed landing attempt will result in no score for the round.

During a landing, the aircraft must remain on the runaway between their landing limits to be considered a successful landing. Running off the side of the runway onto the grass is not allowed. If an aircraft crosses their respective landing limits, running off onto the grass is permitted.

Landing Distance Requirements

Class	Landing Requirement	Description
Regular	400 ft (122m)	Aircraft must land in the same direction as takeoff within a designated landing zone.
Micro	N/A	Aircraft must land in the same direction as takeoff within a designated landing zone.
Advanced	N/A	Aircraft must land in the same direction as takeoff within a designated landing zone.

3.4.2 Post-landing Condition

The aircraft must take off and land intact to receive points for the flight. All parts must remain attached to the aircraft during flight and landing maneuver, with the exception of the propeller. Broken propellers are allowed, and will not invalidate a flight attempt.

3.4.3 Flight Authority

The Organizer, Chief Judge, Air Boss, SAE Official, or other designated competition technical inspector may prohibit flight of any aircraft deemed non-flight-worthy until the non-flight-worthy condition has been repaired and the aircraft has been re-inspected by the judges.

3.4.4 Controllability

All aircraft must be controllable in flight.

3.4.5 No-Fly Zone

Each flying site will have site-specific no-fly zones. At no time is any aircraft to enter the no-fly zones, whether under controlled flight or uncontrolled. First infraction for crossing into the no-fly zone will result in an invalidated flight attempt and no points will be awarded for that flight. Second infraction will result

in disqualification from the entire event and loss of all points. Flying over the pit area is not allowed at any time.

3.4.6 Flight Rules Announcement

Flight 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.

3.4.7 Flight Rules Violations

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

3.4.8 Local Field Rules

In addition to competition rules, the local flying club may have additional rules in place at the event flying field. Club rules will be obeyed during the flight competition; for example, the club may have specific frequency control procedures that must be used during the event.

3.4.9 Repairs and Alterations

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.

3.4.10 Repairs

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.

3.4.11 Alteration after First Flight

Minor alterations are allowed after the first and subsequent flight attempts. Penalty will ***ONLY*** be assessed if 2/3 of the ruling committee (Event Director, Head Judge, SAE Judge) agree that there was significant modifications made from the baseline configuration. Changes due to safety will not be assessed with penalty points. Alteration must be reported as described in section 7.3.3

3.4.12 Ground Safety

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.

Smoking – Prohibited--Smoking is prohibited in all competition areas.

3.4.13 Flight Line Safety

All students involved at the flight line must wear safety glasses.

Micro Class must have hard hats in addition to safety glasses.

Section 4 (NEW) Regular Class Requirements

Design Objective:

The objective of Regular Class is to design an aircraft that can lift as much weight as possible while observing the available power and aircraft's length, width, and height requirements. Accurately predicting the lifting capacity of the aircraft is an important part of the exercise, as prediction bonus points often determine the difference in placement between competing teams.

The Regular Class will be divided into 3 phases as follows:

Phase 1: Technical report

Teams will electronically submit their proposals for competition detailing how their design has met or exceeded the design requirements.

Phase 2: Technical Presentation and Inspection

Phase 2A – Payload Loading Demonstration (timed event during Oral Presentation).

Phase 2B – Payload Unloading Demonstration (timed event during Oral Presentation)

Phase C – Oral Presentation

Phase 3: Flight Competition

4.1 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 autogyros will be allowed to compete.

4.2 Aircraft Dimension Requirement

Fully configured for takeoff, the free standing aircraft shall have a maximum combined length, width, and height of **175 inches**. Aircraft exceeding this design requirement will be disqualified from the competition.

Length is defined as the maximum distance from front to the aft of the aircraft. Width is the span or the maximum distance from wingtip to wingtip. Height is defined as the maximum distance perpendicular to the ground to the highest part of the aircraft (propeller not included).

Note: Modifications to the aircraft to meet the Length + Width + Height limitations during technical inspection are subjected to design change penalties.

4.2.1 Gross Weight Limit

Regular Class aircraft may not weigh more than sixty-five (65) pounds with payload and fuel.

4.2.2 Aircraft Identification

Team number as assigned by SAE must be visible on both the top and bottom of the wing, and on both sides of the vertical stabilizer or other vertical surface in 4-inch numbers. The University name must be clearly displayed on the wings or fuselage. 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:

Aero East:
http://www.sae.org/students/aeroeast.htm
Aero West:
http://www.sae.org/students/aerowest.htm

4.2.3 Name and Address

Regular Class aircraft must be identified with the school name and address either on the outside or the inside of the aircraft.

4.2.4 Material Restriction

The use of Fiber-Reinforced Plastic (FRP) is prohibited on all parts of the aircraft. The only exception is the use of a commercially available engine mount and propeller. Exploration of other materials and building methods are greatly encouraged.

In addition, the use of lead in any portion of the aircraft (payload included) is strictly prohibited.

4.3 Aircraft System Requirement

4.3.1 Electric Motor Requirements

There are no restrictions (make or model) on the electric motor. Only a single motor configuration is allowed (no multiple motors).

4.3.2 Gear boxes, Drives, and Shafts

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

4.3.3 Aircraft Batteries

Regular Class aircraft must be powered by a commercially available Lithium-Polymer battery. Homemade batteries are NOT allowed.
Required: 4 cell (14.8 volt) Lithium Polymer (Li-Poly/Li-Po) battery
Minimum requirements for Li-Po battery: 4000 mah, 25C

4.3.4 Power Limiter

All Regular Class aircraft must use a 1000 watt power limiter from our supplier (Neumotors.com). The limiter is only available at the follow link:

http://www.neumotors.com/store/page19/page19.html

This supplier has agreed to ship worldwide to any team.

4.3.5 Gyroscopic Assist Prohibited

No gyroscopic assist of any kind is allowed in the Regular Class.

4.3.6 Shunt Plug

All Regular Class aircraft **MUST** use a shunt plug to arm and disarm the electrical system. This shunt plug must be integrated into the electrical circuit between the battery and the electronic speed controller (ESC).
The shunt plug must physically be located at 40% to 60% of the aircraft length from the aircraft propeller. This is to avoid arming/disarming the aircraft without incursion through the prop arc. In addition, the shunt plug must be located on top of the fuselage and external of the aircraft surface. Please note: Disconnecting wires to arm/disarm a system will NOT be allowed.

4.4 Payload Requirements

4.4.1 Payload and Payload Support

The payload must consist of a support assembly and payload plates. All payload carried for score must be carried within the cargo bay. The support assembly must be constructed so as to retain the weights as a **homogeneous mass**. There is no required configuration for the payload plates. The design of the support assembly will depend upon the configuration of the payload plates. The payload must be secured to the airframe to ensure the payload will not shift or come loose in flight. The total payload consists of the plates plus the support assembly. It is the responsibility of each team to provide its own payload plates.

Again, no lead weights will be allowed as payload.

4.4.2 Payload Bay Limit(s)

Regular Class aircraft has a "Closed" payload bay dimensional requirements for the 2014 design year. A "Closed" payload bay is defined as having four sides, a bottom and a top. The top can be a hatch or the wing once installed on the aircraft. The payload bay must be fully enclosed within the fuselage and the aircraft must be structurally airworthy with and without the payload installed. No penetrations are allowed through the payload bay except for the payload support assembly, in which case the support assembly MUST be made removable. It must be removable so that the test block can be inserted into the payload bay during technical inspection. The removable payload support assembly will be considered as payload.

"Closed" Payload bay volume dimension shall be 4 x 4 x 10 inch +1/8, -0

- Each team is allowed only 1 payload bay per aircraft
- Teams must provide their own payload for all portions of the competition.
- During Technical Presentation (timed event) (see Section 7.2.2)
  - Team must demonstrate their design provides the capability to load and secure payload (**Ready for Flight**) in less than 1 minute.
  - Team must demonstrate their design provides the capability to unload the payload in less than 1 minute
  - **Ready for Flight** shall be defined by a completely assembled aircraft with all latches engaged and nuts/bolts tightened. NO power connected (i.e. shunt plug dis-engaged)

4.4.3 Payload Distribution

The payload cannot contribute to the structural integrity of the airframe, and must be secured to the airframe within the cargo bay so as to avoid shifting while in flight.

4.4.4 Aircraft Ballast

Aircraft ballast is allowed to be used as teams desire with the following exceptions:

1. Ballast can never be used in the closed payload bay.
2. Ballast stations must be indicated on the 2D drawings.
3. Cannot use lead as ballast.
4. Ballast must be secured so as to avoid shifting or falling off the aircraft and causing a CG problem.
5. Ballast will never be counted as payload.

4.5 General Requirements

4.5.1 Radios

The use of 2.4 GHz radio is required for all aircraft competing.

4.5.2 Spinners or Safety Nuts Required (NEW)

All aircraft must utilize either a spinner or a rounded safety nut. Prop savers are not allowed in Regular Class due to the high power propulsion system used.

4.5.3 Metal Propellers Prohibited

Metal propellers are not allowed.

4.5.4 Control Surface Slop

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

4.5.5 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.

4.6 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.

4.6.1 Regular Class Flight Score

The Final Regular Class Flight Score shall comprise of total weights lifted, Max Payload Prediction Bonus and Total Penalty deduction

$$FFS = \sum_{1}^{n} R_n - \sum T + B_{n(max)}$$

$B_n = Payload\ Prediction\ Bonus\ for\ n\ round$

$B_{n(max)} = Maximum\ Payload\ Prediction\ Bonus\ earned\ for\ the\ competition.$

> *Note: $B_{n(max)}$ is NOT the summation of all the Payload Prediction Bonus earned and **shall not exceed** 20 points*

$R_n = Round\ Flight\ Score = Payload_{lb}$

4.6.2 Payload Prediction Bonus

The prediction bonus will be determined according to the following formula:

$$B_n = 20 - \left(P_p - P_a\right)^2$$

$$P_p = Payload\ Prediction$$

$$P_a = Actual\ Payload\ Carried$$

If $\boldsymbol{B_n}$ is positive, the resulting number will be applied as the prediction bonus. If the above number is negative, no bonus will be applied.

4.6.3 Total Penalty Points

Any penalties assessed during Design Report Submission, Technical Inspection, and Aircraft Modifications will be applied to the overall Flight Score.

$$T = Penalty\ Points$$

4.6.4 SAMPLE SCORE CARD

Round	R_n	B_n	T	FFS
1	10.70	0.00	5.00	
2	0.00	0.00	0.00	
3	16.40	4.00	3.00	
4	17.85	8.00	0.00	
5	18.02	19.00	0.00	
6	16.41	4.00	0.00	
SUM=	**79.38**	**19.00**	**8.00**	**90.38**

$$FFS = \sum_{1}^{n} R_n - \sum T + B_{n(max)}$$

FFS = 79.38 – 8.00 + 19.00

FFS = 90.38 pts

Section 5 Advanced Class Requirements

Design Objectives:

The objective of the Advanced Class is to design the most efficient aircraft capable of accurately dropping a three pound (3 lb) humanitarian aid package from a minimum of 100ft off the ground. 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.

The Advanced Class will be divided into 3 phases as follows:

Phase 1: Technical report

Teams will electronically submit their proposals for competition detailing how their design has met or exceeded the design requirements.

Phase 2: Technical Presentation and Inspection

Teams will present a technical briefing on the proposed concept demonstrator.

Teams will be subjected to a technical inspection of aircraft to make sure concept demonstrator will match design proposal, comply with design requirements and adhere to safety practices.

Phase 3: Flight Competition

Demonstrate aircraft can perform mission

5.1 Aircraft Requirements and Restrictions

5.1.1 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 autogyros will be allowed to compete.

5.1.2 Gross Weight Limit

Advanced Class aircraft may not weigh more than sixty-five (65) pounds with payload and fuel.

5.1.3 Wing Span Limit

Advanced Class aircraft are not limited by wing span.

5.1.4 Payload Requirements

Advanced Class payload requirements shall consist of two types of cargo; static cargo, and expellable cargo.

5.1.4.1 Static Cargo-Bay(s)

Advanced Class Static Cargo-Bay shall be fully enclosed.

Advanced Class Static Cargo-Bay shall have no restriction to size or shape.

Advanced Class can have multiple Static Cargo-Bays and cannot conflict with the fully-enclosed requirement.

5.1.4.1.1 Structural Integrity

Advanced Class Static Cargo-Bay shall not contribute to the structural integrity of the airframe, and must be secured to the airframe within the cargo bay so as to avoid shifting while in flight.

5.1.4.1.2 Support Assembly

Advanced Class Static Cargo-Bay must consist of a support assembly and cargo plates. The support assembly must be constructed so as to retain the weights as a homogeneous mass. There is no required configuration for the cargo plates. It is the responsibility of each team to provide its own cargo plates.

The use of lead in the construction of the cargo plates is strictly prohibited.

5.1.4.2 Expellable Cargo-Bay

Expellable Cargo-Bay shall be used to carry the one (1) 3-lb humanitarian package.

Expellable Cargo-Bay can be either internal or external.

Expellable Cargo-bay cannot occupy the same space as the Static Cargo-Bay area.

5.1.4.2.1 Expellable Cargo Requirement

Expellable Cargo shall be sand enclosed by a sewn fabric material.

Expellable Cargo MUST weigh between 3.000 lbs and 3.250 lbs.

Fabric material shall be labeled with the team aircraft number in at least 2-inch numbers.

All Expellable Cargo packages used during competition shall be inspected and weighed during technical inspection.

5.1.5 Aircraft Identification

Team number as assigned by SAE must be visible on both the top and bottom of the wing, and on both sides of the vertical stabilizer or other vertical surface in 3-inch numbers. The University name must be clearly displayed on the wings or fuselage. 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:

Aero East:
http://students.sae.org/competitions/aerodesign/east/

Aero West:
http://students.sae.org/competitions/aerodesign/west/

5.1.6 Name and Address

Advanced Class aircraft must be identified with the school name and address either on the outside or the inside of the aircraft.

5.1.7 Engine Requirements for Advanced Class

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.

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

5.1.8 Stored Energy Restriction

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

5.1.9 Propeller and Gearbox Issues

Gearboxes are allowed in Advanced Class in which the propeller RPM differs from the engine RPM. Multiple engines, multiple propellers, propeller shrouds, and ducted fans are allowed in Advanced Class.

5.1.10 Competition Supplied Fuel

Advanced Class teams may provide their own fuel, but fuel for Advanced Class entries must be acceptable for use by the AMA and the competition organizer. 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. Engines utilizing extremely hazardous fuels such as those containing tetranitromethane or hydrazine are prohibited. Advanced Class teams are welcome to use the competition-supplied fuel.

5.1.11 Fuel Tanks

Advanced Class fuel tanks need not be accessible.

5.1.12 Gyroscopic Assist Allowed

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

5.1.13 Data Acquisition System (DAS)

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

- Team must be able to provide real-time altitude reading at a ground station.
- Team must be able to record the altitude at the moment they release the expellable cargo.

5.1.14 DAS Requirements (NEW)

- DAS shall be measured in feet with precision of at least 1 ft.
- DAS shall have a read-out and visible from a ground station.
- DAS **MUST** have an arming/reset switch. If a manual switch is used, it must be located externally at least 12 inches away from the propeller. Wireless arming/reset switch is allowed.
- DAS systems **CANNOT** use the same frequency as the flight control system. Use of 2.4 Ghz for DAS is prohibited.

5.1.15 DAS Failures

DAS failures are considered a missed flight attempt.

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

5.1.16 First Person View System (FPV) (NEW)

Some type of First Person View (FPV) system is required to be used as a drop sighting device. This is where telemetry and/or video stream can be transmitted to a local visual device (FPV goggles or laptop). Telemetry data such as airspeed and altitude shall be transmitted to the laptop computer

- The primary pilot will fly visually only (no goggles or laptop visual)
- Secondary pilot **must be a team member** and will use the telemetry video stream to verbally direct the pilot to the drop zone
- The primary pilot cannot initiate the release of the humanitarian cargo. This task is the responsibility of a design team member. If the primary pilot is a member of the design team, then the team shall select another member of the team to initiate the expellable cargo release.

- **NOTE: FPV systems CANNOT use the same frequency as the flight control system. Use of 2.4 Ghz for video is prohibited.**

5.1.17 Brakes

Advanced Class aircraft does not have a brake requirement

5.1.18 Radios (Requirement)

The use of 2.4 GHz radio is required for all aircraft.

5.1.19 In-Flight Battery Packs

Advanced Class aircraft must use a battery pack with capacity suitable to safely drive all the servos in the aircraft, taking into consideration the number of servos and potential current draw from those servos. Batteries may be charged at any time on the ground.

Advanced Class aircraft must use a battery pack with no less than 1000 mAh capacity.

5.1.20 Spinners and Safety Nuts Required

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

5.1.21 Metal Propellers Prohibited

Metal propellers are not allowed.

5.1.22 Control Surface Slop

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

5.1.23 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.

5.1.24 Qualification Flights

Qualification flights are not required.

5.2 Flight Procedures (NEW)

Advance Class teams are allowed to drop their expellable cargo in the upwind or downwind directions or both. Dropping direction must be declared to the flight boss prior to takeoff and adhered to during flight operations. Stated direction will be recorded on the flight log. If a team misses the drop in any intended direction, the flight is disqualified. Teams will get two attempts to drop their expellable cargo during a single flight.
Example 1: A team states they will drop in upwind direction only. They will get two attempts to position their aircraft in the proper direction. If a team does an upwind fly over the drop zone, it is considered an attempt.
Example 2: A team states they will drop in either upwind or downwind directions. Any approach to the drop zone (upwind or downwind) is considered an attempt.

5.3 Advanced Class Scoring (NEW)

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.

Advanced Class aircraft will receive flight scores based on accuracy, Empty Weight (EW), and Static Cargo Weight (CWs).

$$\textit{Final Flight Score} = \left(\frac{1}{n} \sum_{x=1}^{n} FS \right)$$

N = total number of flight rounds at competition (including

$$FS = (4)[S_1][S_2][S_3]$$

$$S_1 = \begin{cases} 50 - D & 0 \le D \le 50 \\ 0 & D > 50 \end{cases}$$

D = Distance from Drop Target

$$S_2 = \begin{cases} 1 & 0 \le EW < 8 \\ -\frac{1}{4}EW + 3 & 8 \le EW < 12 \\ 0 & EW \ge 12 \end{cases}$$

EW = Aircraft Empty Weight

$$S_3 = \begin{cases} 0 & \text{CWs} < 12 \\ -\frac{1}{9}(15 - \text{CWs})^2 + 1 & 12 \le \text{CWs} < 18 \\ 0 & \text{CWs} \ge 18 \end{cases}$$

CW_s = Static Cargo Weight

Section 6 Micro Class Requirements

Design Objectives:
The objective of Micro Class is to design a system containing a portable (modular based) UAV and launching system within specified packaging requirements. Aircraft will be launched either by hand, or by use of an engineered launching system without the use of a runway for takeoff. In either case, the entire system must be contained within the specified packaging requirements.

Micro Class aircraft will be tasked with carrying the highest payload fraction possible while simultaneously pursuing the lowest empty weight possible. High performance and operational availability are critical through the entirety of the competition.

Micro class will be divided into 3 phases as follows:

Phase 1: Technical report
Teams will electronically submit their proposals for competition detailing how their design has met or exceeded the design requirements.
Phase 2: Technical Presentation and Inspection
Phase 2A – Aircraft ease of assembly must be demonstrated (timed event).
Phase 2B – Oral Presentation on Concept Demonstrator
Phase 3: Flight Competition

6.1 Aircraft Requirements and Restrictions

6.1.1 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 autogiros will be allowed to compete.

6.1.2 Aircraft Identification

Team number as assigned by SAE must be visible on both the top and bottom of the wing, and on both sides of the vertical stabilizer or other vertical surface in 3-inch numbers. The University name must be clearly displayed on the wings or fuselage. 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.

Aircraft should have "HL", "EL", or ELS" marked on the top of their main wing in 3-inch letters to positively identify their launch method. "HL" designates Hand Launch,

"EL" designates Elastic Launch, and "ELS" designates Elastic Launch with Shuttle. Only one launch method may be used.

6.1.3 Assembly and Carrying Case

The aircraft must be capable of assembly from a foam padded carrying case in three (3) minutes by two (2) people. See section 6.3.8

6.1.4 Name and Address

Micro Class aircraft must be identified with the school name and address either on the outside or the inside of the aircraft and on the carrying case.

6.2 Aircraft Systems Requirements

6.2.1 Propulsion Requirements

Micro Class aircraft are restricted to electric motor propulsion only. See section 6.3.1 for battery pack requirements.

6.2.2 Propeller and Gearbox Issues

Gearboxes in Micro Class --- which the propeller RPM differs from the motor RPM are allowed. Multiple motors, multiple propellers, propeller shrouds, and ducted fans are allowed in Micro Class.

6.2.3 Gyroscopic Assist Allowed

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

6.2.4 Payload Requirements

6.2.4.1 Payload and Payload Support

The payload must consist of a support assembly and payload plates. All payloads carried for score must be carried within the cargo bay(s). The support assembly must be constructed so as to retain the weights as a homogeneous mass. There is no required configuration for the payload plates. An example of one possible payload support configuration is provided below, but this is only an example. The design of the support assembly will depend upon the configuration of the payload plates. The total payload consists of the plates plus the support assembly. It is the responsibility of each team to provide its own payload plates.

6.2.4.2 Payload Distribution

The payload cannot contribute to the structural integrity of the airframe, and must be secured to the airframe within the cargo bay so as to avoid shifting while in flight.

6.2.4.3 Payload Bay Limit(s)

Micro Class aircraft must be capable of carrying and fully enclosing a rectangular block measuring 2 inches by 2 inches by 5 inches.

During technical inspection, compliance with this rule must be tested by inserting a block with these dimensions into the aircraft. This block must be easily inserted and removed without application of excess force during insertion or extraction, and the aircraft must be structurally airworthy without the block installed. Aircraft not capable of carrying and fully enclosing the defined cargo block will be disqualified from the competition.

6.2.4.4 Payload Material

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

6.2.5 Launching Method

Teams will have 2 options for launching aircraft. The first option is to launch the aircraft by hand. The second option is to launch aircraft by use of an engineered launching system having elastic bands. With both options the entire system must be contained within the specified packaging requirements detailed in section 5.3.8, Aircraft Carrying Case Specifications. Real-world tradeoffs will need to be made when choosing a launch method.

6.2.5.1 Hand Launch (Option 1)

Aircraft may be launched by firmly grasping the fuselage and using a one-step (stride) launch. Running with the aircraft during launch is strictly prohibited. Grasping and launching the aircraft by any part of the aircraft other than the fuselage is strictly prohibited. Only one person may be used to hand launch the aircraft.

6.2.5.2 Elastic Launching System (Option 2)

As an alternative option aircraft may be launched by use of an engineered launching system. All components of the launching system must be contained within the carrying case including all necessary tools for deploying the system. A single 1" diameter stake 6 inches above the ground will be provided by the contest organizer and must be used to secure the launching system to the ground upon takeoff (see section 5.4.2 Aircraft Takeoff). Other stakes which penetrate the ground are strictly prohibited. Shuttles used for launching are allowed and may separate from the aircraft during launch. Only one person may be used to launch the aircraft. Launching systems must propel aircraft into flight at an angle no greater than 45 degrees.

All energy used by the launching system to launch the aircraft must be derived from human power and stored by potential energy in elastic (latex/rubber) tube. The maximum "un-stretched" tube outside diameter shall not exceed 0.500". Multiple tubes acting in parallel are prohibited. Solid core elastic band is prohibited. There is no restriction on the type of elastic material that may be used. Testing and analysis of the launching system shall be provided in the design report with recorded safety factors. The rules committee reserves the right to disqualify any system deemed to be

unsafe and/or ask the team to redesign the system at competition. Use of chemical propellants, rockets, or any other non-human power derived energy is strictly prohibited for use in the launching system.

6.3 General Requirements

The use of 2.4 GHz radio is required for all aircraft competing in SAE Aero Design competition.

6.3.1 In-Flight Battery Packs

Micro Class aircraft must use a battery pack with capacity suitable to safely drive all the servos in the aircraft, taking into consideration the number of servos and potential current draw from those servos. Batteries may be charged at any time on the ground. Please follow all manufacturer recommendations and instructions in the use, handling, charging, discharging and disposal of all batteries. Teams may choose one of the following available options; a two battery system, or a single battery system.

6.3.2 Two Battery System

Two battery systems must utilize separate batteries for the radio equipment and motor. The motor battery must be removed during technical inspection.

6.3.3 Single Battery System

Single battery systems with BEC (Battery Eliminator Circuits) may be used if a red shunt plug is positioned between the ESC and battery. This plug must be clearly visible and must be disconnected during technical inspection.

6.3.4 Shunt Plug (NEW)

All Micro Class aircraft MUST use a shunt plug to arm and disarm the electrical system. This shunt plug must be integrated into the electrical circuit between the battery and the electronic speed controller (ESC).
The shunt plug must physically be located at 40% to 60% of the aircraft length from the aircraft propeller. This is to avoid arming/disarming the aircraft without incursion through the prop arc. In addition, the shunt plug must be located on top of the fuselage and external of the aircraft surface.

Please note: Disconnecting wires to arm/disarm a system will NOT be allowed.

6.3.5 Spinners and Safety Nuts Required

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

6.3.6 Metal Propellers Prohibited

Metal propellers are not allowed.

6.3.7 Control Surface Slop

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

6.3.8 Servo Sizing

Servos must be adequately sized to handle the expected air loads during flight.

6.3.9 Qualification Flights

Qualification flights are not required.

6.3.10 Aircraft Packaging General Requirements

The flight ready aircraft and all accessories shall be packaged in an unassembled state in a foam padded box for easy transportation and one person portability. The carrying case will contain all aircraft parts necessary for flight, including the radio transmitter, payload assembly, weights, batteries, and aircraft launching system.

The propulsion battery will be packaged in its own space within the aircraft carrying case, i.e., it will NOT be pre-installed in the aircraft. The flight control battery may be pre-installed in the aircraft in its pre-determined flight position. If team elects not to pre-install the flight control battery, it must be included in the carry case in its own labeled location. During Phase 2A assembly demonstration, the propulsion system battery will not need to be installed for safety reasons.

6.3.11 Aircraft Carrying Case Specifications

The aircraft carrying case may be purchased or locally constructed.
Case requirements are listed below:

- Inside dimensions shall not exceed: 24 inches by 18 inches by 8 inches.
- A handle or carrying strap shall be attached to the case.
- The carrying case interior shall be foam lined.
- Foam cutouts shall be used and labeled accordingly (Ex. Transmitter, battery, etc.)
- Foam cutouts must be form fitting (in shape and size).
- The launching system must be contained in the carrying case.

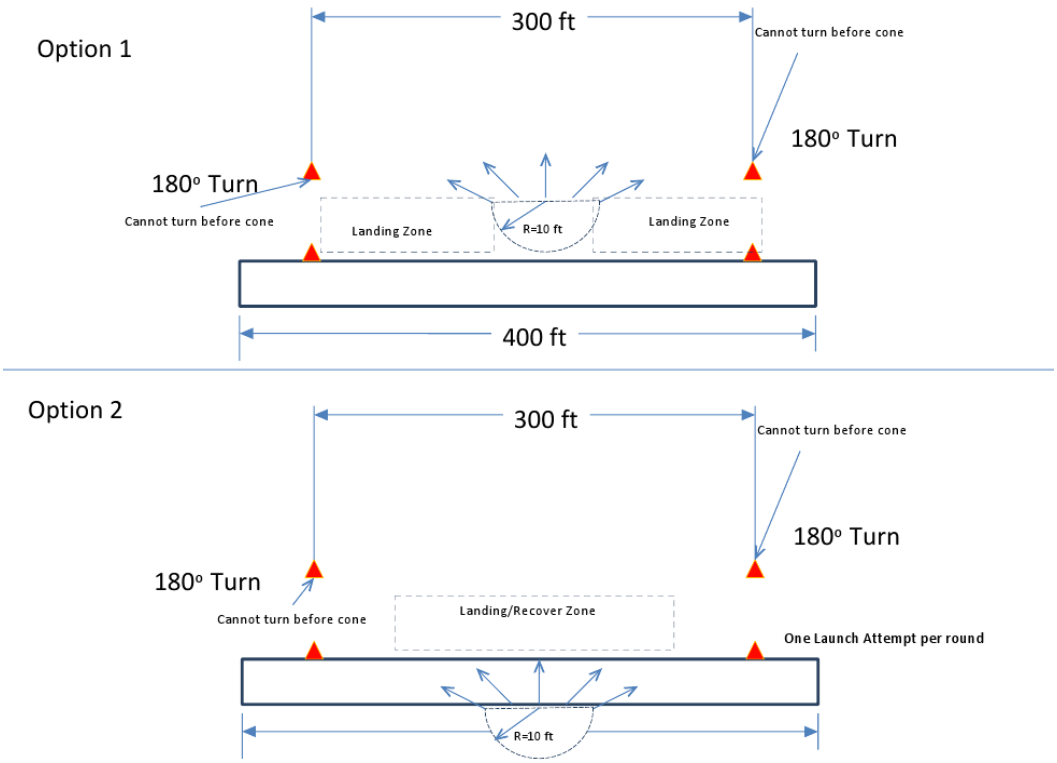
6.4 Mission Requirements

6.4.1 Time Limit

Upon a signal given by the Air Boss, each team will have one and a half (1.5) minutes to deploy their aircraft, set up their launching system, energize it, and accomplish a successful takeoff. Only one takeoff attempt is allowed within the one and a half minute window.

6.4.2 Aircraft Takeoff

Takeoff is defined as the point at which the aircraft departs the launching system or leaves the hand of the person throwing the aircraft. Once takeoff occurs, Micro Class aircraft are required to remain airborne and fly past a first cone before turning approximately 180 degrees in heading, flying past a second cone, turning 180 degrees in heading, and landing (see figure below). Takeoff direction will be determined by the Air Boss, and normally selected to face into the wind.



Takeoff will occur from a semicircular launching zone measuring 10 feet in radius. The takeoff zone will be positioned on a grass surface adjacent to the runway. A single 1 inch diameter metal rod will be provided by the contest organizer for securing launching systems to the ground. This rod will protrude from the ground approximately 6 inch and will be located 1 foot inside the center point of the launch circle. All elastic launching systems shall be secured to this rod upon launch. Event organizers reserve the right to move the takeoff and landing box if conditions of the field dictate.

IMPORTANT: Safety gear must be used by individuals launching the aircraft. Safety glasses and hard hat with full face shield are required.

6.4.3 Landing

Landing is defined as occurring from initial touchdown to the point at which the aircraft stops moving. Initial touchdown is defined as the point at which any part of the aircraft touches the ground.

Micro Class aircraft shall land in a designated grass field landing zone measuring 200 feet in length. The width of the landing zone will be approximately the width of the runway and will be determined by the competition organizers at the time of the event.

Touch-and-goes are not allowed, and a crash-landing invalidates the landing attempt. A good landing for a successful flight is defined as touching down within the designated landing zone. Rolling-out or sliding beyond the landing zone limits is allowed, provided the aircraft initial touch down occurs within the landing zone. Bouncing across the boundary at the end of the landing zone is not allowed, and will be judged as a failed attempt. A failed landing attempt will result in no score for the round.

The aircraft must take off and land intact to receive points for the flight. All parts must remain attached to the aircraft during flight and during the landing maneuver, with the exception of the propeller and takeoff shuttle. Broken propellers are allowed, and will not invalidate a flight attempt.

6.5 Micro Class Flight Scoring

Final Flight Score will be the summation of all the Round Scores. This will be the score posted on the Score board to determine team standings.

$$Final\ Flight\ Score = \sum_{1}^{n} R_n$$

$$R_n = \left(2 - \overline{EW}\right) \times PF_n + \left(P_n \times \sum_{1}^{n} P_n\right)$$

$$\overline{EW} = Average\ Empty\ Weight$$

$$P_n = Payload\ (lbs.)$$

$$PF_n = Payload\ Fraction = \frac{P_n}{P_n + \overline{EW}}$$

6.5.1 Sample Score Calculation

Round	FFS	Rn	Ewn	Avg EW	P (lbs)	Sum (P)	PF	P x Sum(P)
1	36.86	36.86	1.00	1.00	6.00	6.00	0.86	36.00
2	58.82	21.96	1.01	1.01	2.50	8.50	0.71	21.25
3	58.82	0.00		1.01	0.00	8.50	0.00	0.00
4	58.82	0.00		1.01	0.00	8.50	0.00	0.00
5	58.82	0.00		1.01	0.00	8.50	0.00	0.00
6	89.08	30.27	1.01	1.01	2.65	11.15	0.72	29.55
7	126.37	37.29	1.01	1.01	2.65	13.80	0.72	36.57
8	158.55	32.18	1.50	1.11	2.00	15.80	0.64	31.60
9	194.67	36.12	1.50	1.17	2.00	17.80	0.63	35.60
10	234.76	40.09	1.50	1.22	2.00	19.80	0.62	39.60

Section 7 Design Reports and Technical Presentation

A team must have a score for their design report AND oral presentation in order to qualify for flight competition.

7.1 Design reports

The Design Report is the primary means in which a team is to convey to the judges how they arrived at their conclusion, that the aircraft they are entering in the competition is the aircraft most suited to perform the intended mission. The Design Report should explain the team's thought processes and engineering philosophy that drove them to their conclusions. Further, it should detail the methods, procedures, and where applicable, the calculations used to arrive at the presented solution.

The SAE Technical Paper standard is a good guideline for the Design Report,

SAE Technical Paper Format.

Some topics that are important to cover are: selection of the overall vehicle configuration, wing plan form 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. For more information regarding performance prediction, a white paper by Leland Nicolai is available on the Aero Design website.

The Design Report consists of the report itself, the plans, and a payload prediction graph. The signed Statement of Compliance needs to be included as page 2 of the Design Report. The Design Report must be scored with the following maximum number of points available for each section:

Report	40 Points
Plans	5 Points
Prediction Graph	5 Points
Total Design Score	50 Points

7.1.1 Design Report Requirements

7.1.1.1 Page Limit (NEW)

The report must not exceed thirty (30) double-spaced, typewritten pages, including appendices, Cover Page, Table of Contents, and Prediction Graph. If the design report exceeds thirty (30) pages, the judges will only read and judge the first thirty pages. 2D drawings and Statement of Compliance will no longer be counted toward the 30 page limit.

7.1.1.2 Electronic Report Format

All reports will now be submitted in (.PDF) format only.

7.1.1.3 Font

The minimum size type is 12 point proportional or a 10 character per inch non-proportional font.

7.1.1.4 Margin

1" Left, ½" right, top, and bottom.

7.1.1.5 Page size

All report pages will be ANSI A (81/2 x 11 inches) page format.

7.1.1.6 Cover page

All Design Reports must feature a cover page that states the team's name, school, and team number. The cover page will count against the 30-page limit.

7.1.1.7 Submission of Reports

Teams are required to submit a PDF file emailed by the deadline date as stated in the Appendix to:

East – AeroDesign@sae.org

West – AeroDesign@sae.org

Subject line must read:

Design Report, Aero Design East (or West) 2014, also include your school name and number.

7.1.2 Electronic Plan Requirements (NEW)

7.1.2.1 Format Size

Plan sheet must be ANSI B sized page (PDF) format (11 x 17 inches). For teams outside North America, page format size must be the closest size available to ANSI B. Plans must only consist of one (1) page, and must have the US-standard third-order projection.

7.1.2.2 Required Views

The plans shall consist of a standard aeronautical three-view, using a US-standard third-order projection; i.e., right side view in the lower left with the nose pointing right, top view above the right side view also with the nose pointing right, and front view in the lower right.

7.1.2.3 Dimensions

At a minimum, all aircraft must have the length, width, height, and CG location clearly marked and dimensioned on the submitted engineering drawings. All dimensions must be in inches and decimal inches, to an appropriate level of precision. **(Hint: four decimal places are too many!)**

Regular Class Aircraft: In addition to the minimum aircraft dimensions requirements, Regular Class aircraft must call out the main wheel diameter. Failure to call out the main wheel diameter will result in a 5 point technical inspection penalty to be applied to the overall design score.

7.1.2.4 Summary Data (NEW)

The plans must also contain a table with a summary of pertinent aircraft data such as wingspan, empty weight, motor/engine make and model.

7.1.2.5 Weight and Balance Data (NEW)

The plans must now also contain a weight and balance table with a summary of pertinent aircraft equipment (motor/engine, battery, payload, ballast, etc), location from datum in inches, moment arms and resultant moment of CG. See "Rules and Important Documents" section of the Aero Design website for additional information.

- All aircraft must have a designated aircraft datum indicated on the 2D drawings.
- All aircraft drawings must indicate the following static CG margins: forward CG limit, aft CG limit and empty weight CG. Hint: Weight and Balance worksheet should correspond with static margins on 2D drawings.

7.1.2.6 Other Required Markings

The plans must be marked with the team name, school name, and team number.

7.1.3 Electronic Payload Prediction Curve Requirements

7.1.3.1 Number of Copies (NEW)

One copy of the payload prediction curve will be included with your Design Report and will count against the 30-page limit. One electronic copy of the payload prediction **"EQUATION ONLY"** will be provided on the face of the 2D drawing.

7.1.3.2 Page Size

Prediction curves must be on ANSI A sized page format (PDF) (8 ½ x 11 inches) in landscape format. For teams outside North America, page size must be the closest size available to ANSI A.

7.1.3.3 Graph Markings

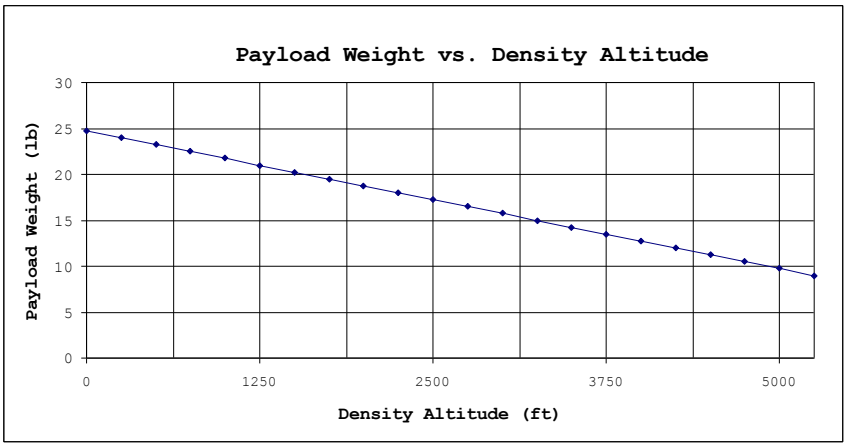
The payload prediction curve (graph) must be marked with the team name and school name across the top of the graph, and with the team number marked in the bottom-right corner. The graph must include the formula used to calculate the curve.

7.1.3.4 Nature of the Curve

For Regular and Advanced Classes, the curve must present the payload capacity of the aircraft in pounds as a function of density altitude in feet. For Micro Class, the curve must present the payload *fraction* of the aircraft as a function of density altitude in feet. The graph must be linearized over the relevant range, and the linear equation used to predict the payload capacity or payload fraction must be clearly shown on the graph.

Only one curve, and hence 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. Teams presenting multiple curves will receive no bonus points for payload prediction.

Payload Prediction Chart – Example



$W_{max} = 24.7 - (4.6 \times 10^{-4})h$ Density

7.1.3.5 Scoring Precedence

In scoring the payload prediction, the equation as printed on the prediction graph will be used to calculate the prediction bonus. In the event the line as printed on the graph contradicts the equation, the equation must be used to determine the prediction bonus. Teams omitting the prediction curve equation from the prediction graph will receive no bonus points for payload prediction.

7.1.3.6 Micro Class Not Exempt

Although no payload prediction bonus is available for Micro Class, Micro Class teams are still required to provide a payload prediction curve according to the guidelines described above.

7.1.4 Submission Deadlines (NEW)

The Design Report and 2D drawing plans must be electronically submitted no later than the date indicated on the Action Deadlines given in the Appendix. Neither the Organizer nor the SAE is responsible for any lost or misdirected reports or plans. The SAE will not receive any paper copies of the reports through regular mail.

7.2 Technical Presentations

Each team is to give a ten (10) minute technical presentation of their design. Judging criteria for the presentation include both the quality of the technical content AND the manner in which that content is presented. During this presentation, the team should present in oral form the same information they provided in their Design Report.

As a guideline, teams should prepare for the Oral Presentation as if they were trying to convince the industry customer to purchase their aircraft design instead of any competitor's design. That means a team should give a detailed explanation of how they arrived at the conclusion that their design is the best. Teams should explain why they chose their design configuration, and then present the results of any analysis or testing that was done to justify their design choices. Any aspects of the design relevant to aircraft performance should be explained.

Regular and Micro Class aircraft must be present at the Oral Presentation. Advanced Class participants should 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.

The Oral Presentation must be given in English, and it is worth a maximum of 50 points. Teams that exceed the 15 minute presentation time will be penalized five points against their Oral Presentation score.

Presentation Breakdown:

- 3 minutes setup
- 3 minute aircraft assembly (timed event for Micro Class only)
- **1 minute Payload Loading Demonstration (Regular Class Only)**
- **1 Minute Payload Unloading Demonstration (Regular Class Only)**
- 10 minute technical presentation
- 5 minute question and answers
- 2 minute teardown

7.2.1 Proof of Concept Demonstrating (Micro Class)

Micro Class aircraft have an additional requirement. Micro Class entries have to validate their ease of assembly requirement during the Oral Presentation. The aircraft must be assembled to flight ready status (minus fuel or propulsion battery) by two (2) people and actuate the flight control surfaces using the radio transmitter in three (3) minutes or less. Failure to comply will result in a 3 point deduction. For safety reasons, connection and/or installation of the propulsion battery will NOT be required or performed. It is required that the configuration presented during the assembly demonstration be the same flight configuration for flight competition. Any deviation in configuration from the assembly demonstration to the flight competition will be addressed with a design change form along with any applicable point deductions.

7.2.2 Regular Class Payload Loading and Unloading Demonstration (NEW)

The regular class has an additional requirement to demonstrate the capabilities to quickly load/secure and unload payloads. This is a timed activity and shall be performed by one (1) member of the team for the following time constraints.

- One minute to load/secure the payload for flight
- One minute to unload the payload
- A minimum of ten (10) pounds (LBS) must be used during the demonstration.

7.2.3 Marketing Material All Classes

During Oral Presentations, teams are required to provide a single sheet (8.5” x 11”) marketing/promotion piece to further detail aircraft’s feature, capabilities, and unique design attributes. It is up to the teams when and how to distribute the marketing material to the judges.

7.3 Technical Inspection

7.3.1 Conformance to Configuration Requirements

Technical Inspection is the event during which the aircraft are checked for compliance to the aircraft configuration requirements. Regular Class aircraft will be measured for wing span fit of the cargo block into the payload bay, and compliance of the engine to configuration requirements. Advanced Class aircraft will be checked for engine displacement and gross weight requirements. Any spare aircraft or spare components (major assemblies such as wings, fuselages, and empennage) must be inspected with the primary competition aircraft. Micro Class has an additional item for technical inspection. All Micro Class entries must have their carrying case inspected for compliance.

Technical Inspection will be used to assess airworthiness of entered aircraft. Items mentioned in the respective rules for each class will be verified, as well as any other items that could cause an aircraft to depart controlled flight. Wing warp, control surface alignment, center of gravity, and many other items will be inspected during this event.

7.3.2 Aircraft Conformance to Plans

During Technical Inspection the aircraft will be inspected for conformance to the plans presented in the Design Report. All teams must have a hard copy of their design report with them during technical inspection.

7.3.3 Deviation from Design

Any deviation in construction of the aircraft since submission of the Design Report must be reported in writing. Each design change must be documented separately using FORM MOD-C. Technical Inspectors will assess penalty points obtained using the penalty chart (FORM MOD-P)

7.3.4 Failure to Report Design Changes

In the case where a team fails to report a design change, an additional 10 points will be assessed on top of each design change as discovered during tech inspection.

7.3.5 Scoring the Technical Inspection

No points are available to be scored as a result of the Technical 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 Design Report score.

7.4 Total Competition Scoring

The overall competition score will be the sum of the individual components:

Overall Score = Design Report Score + Oral Presentation Score + Flight Score

7.5 Projection Equipment

Teams planning to use data projection are responsible for bringing, or otherwise arranging for, their own data projectors. Some data projectors may be provided by the organizers; however teams should not rely on either the availability or functionality of such equipment.

7.6 Tie Breakers

Tie Breakers for specific events within the competition will be decided by averaging the top three (3) flight scores.

Action deadlines: Deadlines for both competitions can be found at:

SAE Aero West
http://students.sae.org/competitions/aerodesign/west/dates.htm

SAE Aero East
http://students.sae.org/competitions/aerodesign/east/dates.htm

Section 8 Future *Possible* Rule Changes

This section is intended to give teams advance notice of possible future changes to the Aero Design rules. These changes might have a significant effect on the design of the aircraft. This is an informational notice only and does not imply that the proposed change will in fact be adopted.

- Regular Class plan form parameters will change.
- One of the new metrics the rules committee is considering for the Micro class is to measure endurance. This may be incorporated in future Micro-Class Competition.
- The use of lock washers and nylon locking nuts are already popular and in use in the RC hobby may be included in future competitions.
- A standardized noise test may be incorporated into future competitions.

Appendix
2014 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 airplane they will use for the SAE Aero Design 2013 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 (see 6.1).

FORM MOD-C

Team Number _____

Team Name _____

School: _____

Desired Results
(Describe the reason for modification and the desired results)

Action Taken
(Describe the actions or changes made to achieve the desired result)

Systems Affected
(Circle all that applies)

Aero-Dynamics **Structural Change** **Mechanical** **Electronic** **Misc**

Discovery Method
(Describe how the problem was discovered)

Submitted By: _____

FORM MOD-P

Aero-Dynamic Changes							
Plan Form Area		Points		Structural Change (Pts Deducted)	Mechanical (Pts Deducted)	Electronic (Pts Deducted)	Misc (Pts Deducted)
Add (in^2)	Removed (in^2)	Add	Removed				
1		1	.5	4	3	3	2
2		1	.5	4	3	3	2
3		1	.5	4	3	3	2
4		1	.5	4	3	3	2
5		1	.5	4	3	3	2
6		2	1	4	3	3	2
7		2	1	4	3	3	2
8		2	1	4	3	3	2
9		2	1	4	3	3	2
10		4	2	4	3	3	2
11		4	2	4	3	3	2
12		4	2	4	3	3	2
13		4	2	4	3	3	2
14		4	2	4	3	3	2
15		6	3	4	3	3	2
16		6	3	4	3	3	2
17		6	3	4	3	3	2
18		6	3	4	3	3	2
19		6	3	4	3	3	2
20		8	4	4	3	3	2
21		8	4	4	3	3	2
22		8	4	4	3	3	2
23		8	4	4	3	3	2
24		8	4	4	3	3	2
25		10	5	4	3	3	2
26		10	5	4	3	3	2
27		10	5	4	3	3	2
28		10	5	4	3	3	2
29		10	5	4	3	3	2
30		12	6	4	3	3	2
31		12	6	4	3	3	2
32		12	6	4	3	3	2
33		12	6	4	3	3	2
34		12	6	4	3	3	2
35		14	7	4	3	3	2
36		14	7	4	3	3	2
37		14	7	4	3	3	2
38		14	7	4	3	3	2

Appendix S

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)