



## 2004 FORMULA SAE® RULES

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## 2004 Formula SAE®

### 1. CONCEPT OF THE COMPETITION

#### 1.1 COMPETITION OBJECTIVE

The Formula SAE® competition is for SAE student members to conceive, design, fabricate, and compete with small formula-style racing cars. The restrictions on the car frame and engine are limited so that the knowledge, creativity, and imagination of the students are challenged. The cars are built with a team effort over a period of about one year and are taken to the annual competition for judging and comparison with approximately 120 other vehicles from colleges and universities throughout the world. The end result is a great experience for young engineers in a meaningful engineering project as well as the opportunity of working in a dedicated team effort.

#### 1.2 VEHICLE DESIGN OBJECTIVES

For the purpose of this competition, the students are to assume that a manufacturing firm has engaged them to produce a prototype car for evaluation as a production item. The intended sales market is the nonprofessional weekend autocross racer. Therefore, the car must have very high performance in terms of its acceleration, braking, and handling qualities. The car must be low in cost, easy to maintain, and reliable. In addition, the car's marketability is enhanced by other factors such as aesthetics, comfort and use of common parts. The manufacturing firm is planning to produce four (4) cars per day for a limited production run and the prototype vehicle should actually cost below \$25,000. The challenge to the design team is to design and fabricate a prototype car that best meets these goals and intents. Each design will be compared and judged with other competing designs to determine the best overall car.

#### 1.3 JUDGING CATEGORIES

The cars are judged in a series of static and dynamic events including: technical inspection, cost, presentation, and engineering design, solo performance trials, and high performance track endurance. These events are scored to determine how well the car performs. In each event, the manufacturing firm has specified minimum acceptable performance levels that are reflected in the scoring equations. The following points are possible:



<b>Static Events</b>	
Presentation	75
Engineering Design	150
Cost Analysis	100
<b>Dynamic Events</b>	
Acceleration	75
Skid-Pad	50
Autocross	150
Fuel Economy	50
Endurance	<u>350</u>
<b>Total Points</b>	<b>1,000</b>

#### **1.4 THE 2004 FORMULA SAE SERIES**

The 2004 Formula SAE Series consists of three (3) competitions:

1. Formula SAE held in the United States
2. Formula Student held in the United Kingdom
3. Formula SAE Australasia held in Australia.

All Formula SAE competitions have open registration policies and accept student teams representing universities from any country.

Formula Student and Formula SAE Australasia may have some minor rule variations specific to those competitions. Such variations are published on the individual competition websites.

#### **1.5 THE FORMULA SAE COMPETITION YEAR**

For the purpose of defining first, second and third year cars a competition “year” is any consecutive run of the Series, i.e. Formula SAE, Formula Student and Formula SAE – Australasia, held within a roughly 12 month period counting from the event in which a vehicle first competes. For example, a car that competes first in Formula SAE Australasia is classified as a “first year car” until the following year’s Formula SAE Australasia competition.

**Note:** Teams are reminded that their vehicles must comply with the rules in effect for each competition they enter.





## 2. ELIGIBILITY

### 2.1 INDIVIDUAL PARTICIPANT REQUIREMENTS

Eligibility is limited to undergraduate and graduate students to insure that this is an engineering competition rather than a race. Individual members of teams participating in this competition must satisfy the following requirements:

**Student Status:** Team members must be enrolled as degree seeking undergraduate or graduate students in a college or university. Team members who have graduated during the seven (7) month period prior to the competition remain eligible to participate. Team members must be paid SAE members to compete.

**Note:** Students can join SAE online at: [www.sae.org/students](http://www.sae.org/students)

**Online Registration Requirements:** Once the team has officially been registered online, each team member and faculty advisor is required to add his/her identifying information online. All participants must provide their name, SAE membership number, and emergency contact individual. Drivers must provide their government issued highway driver's license number and insurance information. For more information on how to register for a competition, please go to the following link: [http://www.sae.org/students/registration\\_instructions.pdf](http://www.sae.org/students/registration_instructions.pdf)

**Liability Waiver and Insurance:** All on-site participants and faculty are required to sign a liability waiver upon registering on-site. Individual medical and accident insurance coverage is the sole responsibility of the participant.

#### 2.1.1 Driver Requirements and Limitations

All drivers must be at least 18 years of age and present proof of:

- A valid, government issued, highway driver's license
- Medical and accident insurance coverage

No individual may drive in more than six (6) Formula SAE competitions.

#### 2.1.2 Ringers Prohibited

In order to maintain the credibility of fair competition at Formula SAE, the Faculty Advisor must prohibit "ringers." A ringer is someone that has exceptional skills related to the competition (e.g., driver) who cannot be a legal member of the team but helps the team win points.



### 2.1.3 Faculty Advisor

The Faculty Advisor must accompany the team to the competition but is not allowed to provide hands-on help to the team or serve as a team member during the actual competition. The Faculty Advisor will serve as a liaison between the team and the officials.

## 2.2 PARTICIPATING IN THE COMPETITION

By registering for the Formula SAE, the team and students who individually register onsite are considered to be “participating in the competition.” Participants must agree to abide by the Formula SAE rules and procedures in effect at the competition from the time the team/individuals arrive until the time the team leave the site or the conclusion of the event.

## 2.3 VEHICLE ELIGIBILITY

The car must be conceived, designed, and fabricated by the students without direct involvement from professional engineers, automotive engineers, racers, machinists or related professionals.

The student team may use any literature or knowledge related to car design and information from professionals or from academics as long as the information is given as a discussion of alternatives with their pros and cons. Professionals may not make design decisions or drawings and the Faculty Advisor must sign a statement of compliance with this restriction.

It is the intent of the SAE Collegiate Design Series Competitions to provide direct hands-on experience to the students. Therefore, students should perform all fabrication tasks whenever possible.

## 2.4 ORGANIZER AUTHORITY

The organizer(s) of the competition reserve the exclusive right to revise the schedule of the competition and/or to interpret or modify the competition rules at any time and in any manner that is in their sole judgment, required for efficient operation or safety of the competition.



## 2.5 VEHICLE ELIGIBILITY REQUIREMENTS

### 2.5.1 Formula SAE

#### 2.5.1.1 First Year Vehicles – FSAE

Only first year vehicles may enter Formula SAE

Cars with completely new frames are classified as first year cars. Photographic or other evidence will be used to determine if the frame is new. If there is any question about whether or not the car is in fact a first year vehicle, it will be the sole responsibility of the team to produce such evidence as the organizers or judges may require.

#### 2.5.1.2 Second Year Vehicles - FSAE

Vehicles that have competed during any previous Formula SAE year are **prohibited** from Formula SAE.

#### 2.5.1.3 Entries Per University - FSAE—One

Registration into Formula SAE is limited to one vehicle per university.

#### 2.5.1.4 Registration Limit - FSAE—140 Vehicles

Registration into Formula SAE 2004 is limited to 140 vehicles.

#### 2.5.1.5 Registration Deadline—January 31, 2004

Registrations will be accepted in the order in which they are received starting October 1, 2003 and ending at midnight, Eastern Standard Time, January 31, 2004 **or** when 140 teams have registered, whichever occurs first.

The registration fee must be paid on-line by credit card at the time of registration. Registration fees may not be paid by any other means.

Registration fees are not refundable.

There is **no** late registration and there are **no exceptions** to this registration policy.



## 2.5.2 Formula Student and Formula SAE-Australasia

**Note:** Check the Formula Student and FSAE-Australasia websites for exact registration requirements, applicable to those events.

### 2.5.2.1 First Year Vehicles – Formula Student & FSAE-A

Cars with completely new frames are classified as first year cars. Photographic or other evidence may be used to determine if the frame is new. If there is any question about whether or not the car is in fact a first year vehicle, it will be the sole responsibility of the team to produce such evidence as the organizers or judges may require.

### 2.5.2.2 Second Year Vehicles – Formula Student & FSAE-A

Vehicles that have competed during any one (1) previous Formula SAE year may compete provided that they have been substantially modified from their first appearance. Photographic and design documentation detailing the modifications are required along with a statement from the team's Faculty Advisor.

Penalties for insufficient redesign or insufficient knowledge by the team will be applied during the Design Event. Refer to the section entitled "Penalties for Insufficient Redesign".

### 2.5.2.3 Third Year Vehicles – Formula Student & FSAE-A- Prohibited

Vehicles that have competed in any two (2) previous Formula SAE years are **prohibited** from participating in Formula Student and Formula SAE Australasia.

Any team found to have entered a vehicle that has already competed twice will be disqualified. Additionally, the team will be required to submit such documentation as the organizers may require in advance of the acceptance of any future registration.

Registration fees are not refundable.

## 3. VEHICLE REQUIREMENTS & RESTRICTIONS

The following requirements and restrictions will be enforced through inspection. Noncompliance must be corrected and the car re-inspected before the car is allowed to compete in the performance events.



## **3.1 GENERAL DESIGN REQUIREMENTS**

### **3.1.1 Body and Styling**

The vehicle must be open-wheeled and open-cockpit (a formula style body). To protect the driver, there shall be no openings through the bodywork into the driver compartment from the front of the vehicle back to the roll bar main hoop or firewall other than that required for the cockpit opening. Minimal openings around the front suspension components are allowed.

### **3.1.2 Wheelbase and Vehicle Configuration**

The car must have a wheelbase of at least 1525 mm (60 inches). The wheelbase is measured from the center of ground contact of the front and rear tires with the wheels pointed straight ahead. The vehicle must have four wheels that are not in a straight line.

### **3.1.3 Vehicle Track**

The smaller track of the vehicle (front or rear) must be no less than 75% of the larger track.

## **3.2 CHASSIS RULES**

### **3.2.1 Ground Clearance**

Ground Clearance must be sufficient to prevent any portion of the car (other than tires) from touching the ground during track events.

### **3.2.2 Wheels and Tires**

The wheels of the car must be 203.2 mm (8.0 inches) or more in diameter. Vehicles may have two types of tires as follows:

(a) Dry Tires – The tires on the vehicle when it is presented for technical inspection are defined as its “Dry Tires”. The dry tires may be any size or type. They may be slicks or treaded.

(b) Rain Tires – Rain tires may be any size or type of treaded or grooved tire provided:

(i) The tread pattern or grooves were molded in by the tire manufacturer, or were cut by the tire manufacturer or his appointed agent. Any grooves that have been cut must have documentary proof that it was done in accordance with these rules.

(ii) There is a minimum tread depth of 2.4 mms (3/32 inch).

**Note:** Hand cutting, grooving or modification of the tires by the teams is specifically prohibited.

Within each tire set, the tire compound or size, or wheel type or size shall not be changed after the static judging has begun. Tire warmers are not allowed. No traction enhancers may be applied to the tires after the static judging has begun.

### 3.2.3 Suspension

The car must be equipped with a fully operational suspension system with shock absorbers, front and rear, with usable wheel travel of at least 50.8 mm (2 inches), 25.4 mm (1 inch) jounce and 25.4 mm (1 inch) rebound, with driver seated. The judges reserve the right to disqualify cars which do not represent a serious attempt at an operational suspension system or which demonstrate unsafe handling.

### 3.2.4 Steering

The steering system must affect at least two wheels. The steering system must have positive steering stops that prevent the steering linkages from locking up (the inversion of a four-bar linkage at one of the pivots). The stops may be placed on the uprights or on the rack and must prevent the tires from contacting suspension, body, or frame members during the track events. Allowable steering free play will be limited to 7 degrees total measured at the steering wheel.

The steering wheel must be mechanically connected to the front wheels, i.e. “steer-by-wire” is prohibited.

### 3.2.5 Brake Systems

The car must be equipped with a braking system that acts on all four wheels and is operated by a single control. It shall have two independent hydraulic circuits such that in the case of a leak or failure at any point in the system, effective braking power shall be maintained on at least two

wheels. Each hydraulic circuit shall have its own fluid reserve, either by the use of separate reservoirs or by the use of a dammed, OEM-style reservoir. “Brake-by-wire” systems are prohibited. A single brake acting on a limited-slip differential is acceptable. The braking system must be protected with scatter shields from failure of the drive train or from minor collisions. Unarmored plastic brake lines are prohibited.

#### 3.2.5.1 Brake Over Travel Switch

A brake pedal over-travel switch must be installed on all cars. This switch shall be installed so that in the event of brake system failure such that the brake pedal over travels, a switch must be activated which will stop the engine from running. This switch must kill the ignition and cut the power to any electrical fuel pumps. Repeated actuation of the switch must not restore power to these components. The switch must be implemented with analog components, and not through recourse to programmable logic controllers, engine control units, or similar functioning digital controllers.

#### 3.2.5.2 Brake Light

The car must be equipped with a red brake light of at least 15 watts or equivalent, clearly visible from the rear. If an LED brake light is used, it must be clearly visible in very bright sunlight. This light shall be mounted between wheel centerline and driver’s shoulder level vertically and approximately on vehicle centerline laterally.

#### 3.2.6 Jacking Points

A jacking point, which is capable of supporting the car’s weight and of engaging the organizers’ “quick jacks”, must be provided at the rear of the car.

The jacking point is required to be:

- (A) Oriented horizontally and perpendicular to the centerline of the car
- (B) Made from round, 25.4 mm (1.0 inch) O.D. aluminum or steel tube
- (C) A minimum of 300 mm (11.8 inches) long
- (D) Exposed around the lower 180 degrees of its circumference over a minimum length of 280 mm (11 in)

The height of the tube is required to be such that:

- (A) There is a minimum of 75 mm (3 in) clearance from the bottom of the tube to the ground measured at tech inspection,
- (B) With the bottom of the tube 200 mm (7.9 in) above ground, the wheels do not touch the ground when they are in full rebound.

### 3.3 CRASH PROTECTION

The driver must be protected from car rollover and collisions. This requires two roll hoops that are braced, a front bulkhead with crush zone, and side protection.

#### 3.3.1 Definitions

These definitions apply throughout Section 3.3.

**A. Main Hoop**--The main rollover protection (roll bar) alongside or just behind the driver.

**B. Front Hoop**--Rollover protection (roll bar) in front of the driver above his/her legs near the steering wheel.

**C. Frame Member**--A minimum representative piece of tubing as defined by Section 3.3.3, Minimum Material Requirements.

**D. Major Structure of Chassis**--That portion of the chassis that is within the envelope of frame members or structure that meet the requirements of 3.3.3. The upper portion of the main hoop and its bracing are not included in defining this envelope.

**E. Crush Zone**--A deformable area forward of the major structure/bulkhead of the chassis designed to absorb energy.

#### 3.3.2 Safety Structure Equivalency

Designs that use alternative materials or tubing sizes to those specified in Section 3.3.3.1 - Baseline Steel Material, and which protect the driver to an equal or greater extent than required by Section 3.3.3.1, will be allowed, provided they have been judged as such by a technical review. Approval will be based upon the engineering judgment and experience of the technical judge.





The technical review is initiated by completing the Safety Structure Equivalency Form using the format given in Appendix A-1. The form must be submitted no later than the date given in the “Action Deadlines” located in the Appendix.

### 3.3.3 Minimum Material Requirements

#### 3.3.3.1 Baseline Steel Material

The safety structure of the car, which comprises of the main roll hoop, the front roll hoop, the side impact structure, the roll hoop bracing and the front bulkhead, shall be constructed of:

Either:

Round, mild or alloy, steel tubing (minimum 0.1% carbon) of the minimum dimensions specified in the following table,

Or:

Approved alternatives per Section 3.3.3.2

ITEM or APPLICATION	OUTSIDE DIAMETER x WALL THICKNESS
Main & Front Hoops	25.4 mm (1.0 inch) x 2.4 mm (0.095 inch)
Side Impact Protection, Front Bulkhead, Roll Hoop Bracing & Safety Harness Attachment	25.4 mm (1.0 inch) x 1.65 mm (0.065 inch)

**Note:** The use of alloy steel does not allow the wall thickness to be thinner than that used for mild steel.

#### 3.3.3.2 Alternative Tubing and Material

##### 3.3.3.2.1 General

Alternative tubing geometry and/or materials may be used. However, if a team chooses to use alternative tubing and/or materials:

(A) The material must have equivalent (or greater) Buckling Modulus EI (where, E = modulus of Elasticity, and I = area moment of inertia about the weakest axis)

(B) Tubing cannot be of thinner wall thickness than listed in 3.3.3.2.2 or 3.3.3.2.3.

**Note:** To maintain EI with a thinner wall thickness than specified in 3.3.3.1, the outside diameter **MUST** be increased.

(C) A Safety Structure Equivalency Form must be submitted per Section 3.3.2. The teams must submit calculations for the material they have chosen, demonstrating equivalence to the minimum requirements found in Section 3.3.3.1 for yield and ultimate strengths in bending, buckling and tension, for buckling modulus and for energy dissipation.

The main roll hoop and main roll hoop bracing must be made from steel, i.e. the use of aluminum or titanium tubing or composites are prohibited for these components.

### 3.3.3.2.2 Steel Tubing Requirements

#### **Minimum Wall Thickness Allowed:**

<b>MATERIAL &amp; APPLICATION</b>	<b>MINIMUM WALL THICKNESS</b>
Steel Tubing for Front and Main Roll Hoops	2.1 mm (0.083 inch)
Steel Tubing for Roll Hoop Bracing, Front Bulkhead & Safety Harness Attachment	1.65mm (0.065 inch)
Steel Tubing for Side Impact Protection	1.25 mm (0.049 inch)

**Note:** All steel is treated equally - there is no allowance for alloy steel tubing, e.g. SAE 4130, to have a thinner wall thickness than that used with mild steel.

### 3.3.3.2.3 Aluminum Tubing Requirements

#### **Minimum Wall Thickness:**

<b>MATERIAL &amp; APPLICATION</b>	<b>MINIMUM WALL THICKNESS</b>
Aluminum Tubing	3.175 mm (0.125 inch)

The equivalent yield strength shall be considered in the “as-welded” condition, (Reference: WELDING ALUMINUM (latest Edition) by the Aluminum

Association, or THE WELDING HANDBOOK, Vol . 4, 7th Ed., by The American Welding Society), unless the team demonstrates and shows proof that the frame has been properly solution heat treated and artificially aged.

Should aluminum tubing be solution heat-treated and age hardened to increase its strength after welding, the team must supply sufficient documentation as to how the process was performed. This includes, but is not limited to, the heat-treating facility used, the process applied, and the fixturing used.

#### 3.3.3.2.4 Composite Materials

If any composite or other material is used, the team must present documentation of material type, e.g. purchase receipt, shipping document or letter of donation, and of the material properties. Details of the composite lay-up technique as well as the structural material used (cloth type, weight, resin type, number of layers, core material, and skin material if metal) shall also be submitted. The team must submit calculations demonstrating equivalence of their composite structure to one of similar geometry made to the minimum requirements found in Section 3.3.3.1. Equivalency calculations shall be submitted for energy dissipation, yield and ultimate strengths in bending, buckling, and tension. Submit the completed Safety Structure Equivalency Form per Section 3.3.2.

No composite materials are allowed for the main hoop or the front hoop.

#### 3.3.4 Roll Hoops

The driver's head and hands must be protected from contact with the ground in any rollover attitude.

This requires a main hoop (roll bar) near the driver and a front hoop. Refer to Figure 1 on the next page.

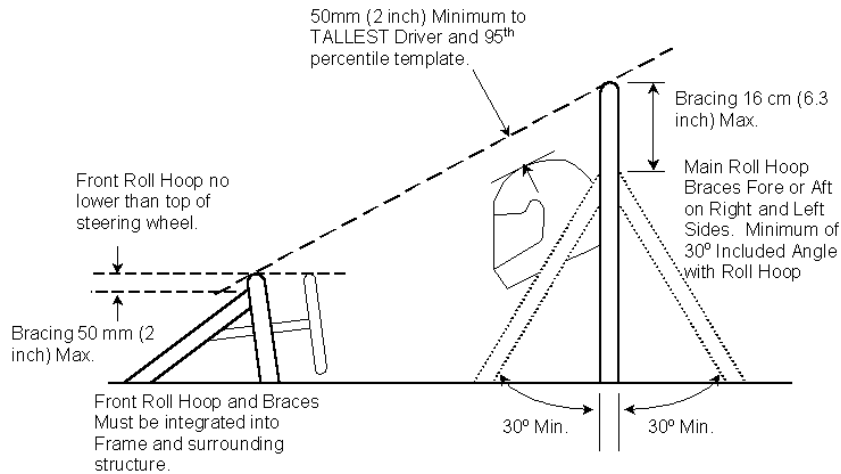


FIGURE 1

### 3.3.4.1 Main and Front Hoops – General Requirements

(A) When seated normally and restrained by the seat belt/shoulder harness, a straight line drawn from the top of the main hoop to the top of the front hoop must clear by 50.8 mm (2 inches) both the tallest driver's helmet and the helmet of a 95th percentile male (anthropometrical data).

A two dimensional template will be used to represent the 95th percentile male and ensure compliance.

-A circle of diameter 200 mm (7.87 inch) shall represent the hips and buttocks.

-A circle of diameter 200 mm (7.87 inch) shall represent the shoulder/cervical region.

-A circle of diameter 300 mm (11.81 inch) shall represent the head (with helmet).

-A straight line measuring 600 mm (23.62 inch) shall connect the centers of the two 200 mm circles.

-A straight line measuring 150 mm (5.9 inch) shall connect centers of the upper 200 mm circle and the 300 mm head circle.

With the seat adjusted to the rearmost position, the bottom 200mm circle will be placed in the seat, and the middle 200mm circle, representing the shoulders, will be positioned on the seat back. The upper 300 mm circle will be positioned up to 25.4 mm

(1 inch) away from the head restraint (i.e. where the driver's helmet would normally be located while driving).

**(B)** Both the main hoop and front hoop must each be formed from closed section metal tubing. No composite materials are allowed for the main hoop or the front hoop.

**(C)** Both the main hoop and front hoop must extend to the bottom of the chassis. Each hoop shall extend from the lowest frame member on one side of the car, up and over and down to the lowest frame member on the other side.

**(D)** The minimum radius of any bend, measured at the tube centerline, must not be less than three times the tube diameter. The bends shall be smooth and continuous with no evidence of crimping or wall failure.

**(E)** Proper gussets and tube triangulation must be used to ensure that the main and front hoops are securely attached to the primary structure.

**(F)** A 4.5 mm (0.18 inch) inspection hole must be drilled in a non-critical location of both the main hoop and the front hoop to allow verification of wall thickness.

#### 3.3.4.2 Main Hoop

**(A)** The main hoop must be constructed of steel per Section 3.3.3.1 or 3.3.3.2.

**(B)** The use of aluminum alloys, titanium alloys or composite materials is prohibited for the main hoop.

**(C)** The main hoop must be formed from a single piece of uncut, continuous, closed section metal tubing that extends from the lowest frame member on one side of the car, up and over and down to the lowest frame member on the other side.

**(D)** In the side view of the vehicle, the portion of the Main Roll Hoop that lies above its attachment point to the Major Structure of the Chassis shall be within 10 degrees of the vertical.

**(E)** In the front view, the vertical members of the main hoop must not be less than 380 mm (15 inches) apart (inside dimension) at their attachment to the chassis.

(F) On all monocoque chassis, the main hoop must be continuous and extend down to the bottom of the chassis. Mechanical fasteners must be used to ensure positive attachment of the Roll Hoop to the monocoque. All bolts (or solid rivets) used must be 8 mm (5/16 inch) minimum diameter. The number of bolts used and their placement is for the team to determine, but proof must be submitted to show equivalency to a welded tubular chassis that meets Section 3.3.3. Mounting plates welded to the roll hoop shall not be less than 2.0 mm (0.080 inch) thick steel (or the equivalent in aluminum). Backup plates of equal thickness must be used on the opposing side of the composite structure to prevent crushing the core. All teams are required to submit a Safety Structure Equivalency report per Section 3.3.2, showing the integrity of their proposed design.

#### 3.3.4.3 Front Hoop

-The front hoop must be constructed of material per Section 3.3.3.1 or 3.3.3.2.

-The front hoop must be formed from closed section metal tubing. No composite materials are allowed for the front hoop.

-The front hoop must be no lower than the top of the steering wheel in any angular position.

-The front hoop must extend to the bottom of the chassis. It must extend from the lowest frame member on one side of the car, up and over and down to the lowest frame member on the other side. With proper gusseting, it is permissible to make it from more than one piece of tubing.

#### 3.3.5 Roll Hoop Bracing

##### 3.3.5.1 Main Hoop Bracing

-The main hoop bracing must be constructed of steel, with dimensions per Section 3.3.3.1 or 3.3.3.2.

-The main hoop must be braced in the fore or aft direction on the left and right sides.

-In side view, the main hoop and the main hoop bracing cannot be on the same side of the vertical line through the top of the hoop, i.e. if the main hoop leans forward, the bracing must be forward of

the main hoop, and if the main hoop leans rearward, the bracing must be rearward of the main hoop.

-Braces must be attached as near as possible to the top of the hoop but must not be more than 160 mm (6.3 inches) below the top and at an included angle of at least 30 degrees.

-The braces must be straight, i.e. without any bends.

### 3.3.5.2 Front Hoop Bracing

-The front hoop bracing must be constructed of material per Section 3.3.3.1 or 3.3.3.2.

-The front hoop must have two braces extending forward to protect the driver's legs.

-These braces shall be attached as near as possible to the top of the hoop, but must not be more than 50.8 mm (2 in.) below the top of the hoop.

-The front hoop bracing should extend to the structure in front of the driver's feet; but in any case it must be integrated into the chassis to provide substantial support for the front hoop. When monocoque construction is used as bracing for the front hoop, it must be approved on an individual basis. Submit the "Safety Structure Equivalency Form".

### 3.3.5.3 Other Bracing Requirements

-Braces attached to monocoque chassis must be welded to plates not less than 2.0 mm (0.080 inch) thick and backed up on the inner side by plates of equal thickness using solid rivets or bolts 8 mm (5/16 inch) minimum bolt diameter through the nonferrous material.

-Roll hoop bracing may be removable. Any non-permanent joint shall be of the double-lug design as shown in figures 2 and 3. Each lug shall be at least 4.5 mm (0.177 in) thick steel, measure 25 mm (1.0 in) minimum perpendicular to the axis of the bracing, and be as short as practical along the axis of the bracing. All joints must include a capping arrangement (figure 2) and/or a doubler (figure 3), fabricated of at least 1.65 mm (.065 inch) steel. If a doubler is used, it must extend at least 120 degrees around the frame member. The pin or bolt shall be 10 mm Grade 9.8 or 3/8in Grade 8 minimum. The attachment holes in the lugs and in the

attached bracing shall be a close fit with the pin or bolt. NO SPHERICAL ROD ENDS are allowed.

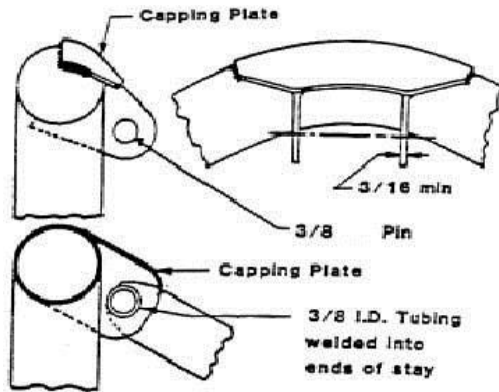


Figure 2

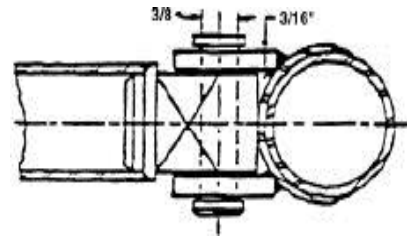


Figure 3

**REMOVABLE ROLL BAR BRACES ATTACHMENT DETAILS (FIGURES 2 & 3)**

3.3.6 Frontal Impact Protection – Drivers

In order to provide protection from a frontal impact, the driver’s feet shall be contained within the major structure of the chassis. While they are touching the pedals no part of the driver's feet shall extend outside of the major structure of the chassis as defined in 3.3.1.d. The major structure of the chassis shall extend forward to a bulkhead. Forward of this bulkhead shall be a crush zone.

3.3.6.1 Bulkhead

The bulkhead is required to:

- (A) Be constructed of material per Section 3.3.3.1 or 3.3.3.2.
- (B) Be formed of closed section tubing attached securely to the major structure of the chassis.
- (C) Be in front of all non-crushable objects (e.g. batteries, master cylinders)
- (D) Be located such that the soles of the drivers feet, when touching but not applying the pedals, shall not be forward of the



bulkhead plane. (This plane is defined as the forward most surface of the tubing.) Adjustable pedals must be in the forward most position.

(E) Be supported by the major structure of the chassis within 50.8 mm (2 ins.) of the top.

(F) All monocoque chassis (composite monocoque or metal monocoque) must provide the same protection as tube frames built per Section 3.3.3. The team must submit calculations demonstrating equivalence for energy dissipation, yield and ultimate strengths in bending, buckling, and tension. Submit the completed Safety Structure Equivalency Form per Section 3.3.2.

### 3.3.6.2 Crush Zone

The crush zone is defined by two separated planes forward of the main chassis structure. The planes defined are normal to the fore/aft axis of the car.

**Front Plane**--The forward vertical plane of the crush zone shall, as a minimum, be able to contain a rectangle of 100 mm (3.9inch) height and 200 mm (7.8 inch) width.

**Rear Plane**--The rearward vertical plane of the crush zone shall be the front plane of the Bulkhead.

**Distance Between Planes**--There shall be a minimum distance of 150 mm (5.9 inch) between the front and rear planes of the crush zone.

### 3.3.6.3 Crush Zone Construction

The material providing the crush zone:

(A) Must be capable of decelerating the car within an acceptable limit.

(B) Shall be attached securely and directly to the bulkhead (no adhesive tape or Dzus type fasteners are allowed). It shall not be attached to the vehicle by being part of non-structural bodywork.

#### 3.3.6.4 Non-Crushable Objects

All non-crushable objects (e.g. batteries, master cylinders) must be rearward of the bulkhead. No non-crushable objects are allowed in the crush zone.

#### 3.3.7 Frontal Impact Protection – Others

People shall not be endangered by contact with sharp edges on the forward facing bodywork or other protruding components. All forward facing edges on the bodywork that could impact people, e.g. the nose shall have forward facing radii of at least 38 mm (1.5 inches). This minimum radius shall extend to at least 45 degrees relative to the forward direction, along the top, sides and bottom of all affected edges.

#### 3.3.8 Side Impact Protection

The driver must be protected from a side collision while seated in the normal driving position. Side impact must meet the requirements listed below. The material requirements are given in 3.3.3.

##### 3.3.8.1 Tube Frames

A minimum of three (3) tubular members must be used for Side Impact Protection. These side impact members must be located on each side of the driver while seated in the normal driving position. See Figure 4. The three (3) frame members defined below must meet the requirements given in 3.3.3.

##### Upper Member

A member must connect the main roll hoop and the front roll hoop at a height between 200 and 350 mm (7.87 and 13.78 inches) above the ground with a 77kg (170 pound) driver seated in the normal driving position. The upper frame rail can be used as the upper side impact member **if** it meets the height, diameter and thickness requirements of the latter.

##### Diagonal Member

At least one (1) diagonal member per side must connect the upper and lower side impact members forward of the main roll hoop and rearward of the front roll hoop.

## Lower Member

A member must connect the bottom of the main roll hoop and the bottom of the front roll hoop. This lower side impact member is normally the lower frame rail/frame member.

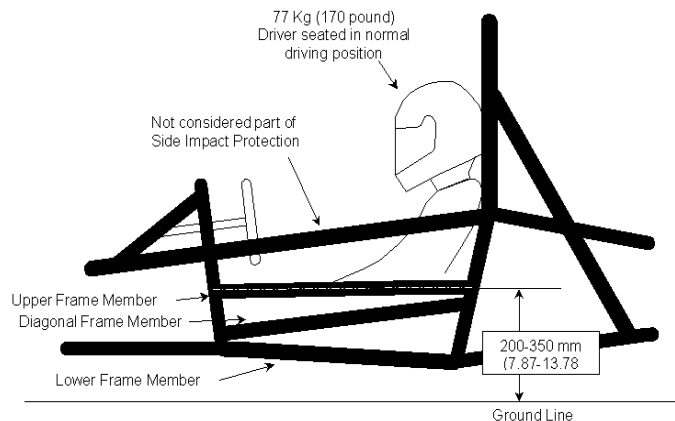
Alternative geometry to the minimum requirements given above must be approved prior to competition. Teams must submit a Safety Structure Equivalency Form per Section 3.3.2.

### 3.3.8.2 Composite Monocoque

The section properties of the sides of the vehicle must reflect impact considerations. Non-structural bodies or skins alone are not adequate to meet the side impact rule. Teams building composite monocoque bodies must submit the Safety Structure Equivalency Form per Section 3.3.2. Submitted information should include: material type(s), cloth weights, resin type, fiber orientation, number of layers, core material, and lay-up technique.

### 3.3.8.3 Metal Monocoque

These structures must meet the same requirements as tube frames and composite monocoque. Teams building metal monocoque bodies must submit the Safety Structure Equivalency Form per Section 3.3.2



**Figure 4**



## 3.4 SAFETY - DRIVER RULES

### 3.4.1 Driver's Restraint System

All drivers must use either a five or six-point restraint harness meeting the following specifications. Arm restraints are also required. The restraint system installation is subject to approval of the SCCA Chief Technical and Safety Inspector. The restraint system must be worn as tightly as possible at all times.

#### (A) 5 Point System

A five-point system consists of a 76 mm (3 inch) wide lap belt, approximately 76 mm (3 inch) wide shoulder harness straps and a single, approximately 51 mm (2 inch) wide anti-submarine strap.

The single anti-submarine strap of the five-point system must be attached to the primary structure and have a metal-to-metal connection with the single release common to the lap belt and shoulder harness.

#### (B) 6 Point System

A six point system consists of a 76 mm (3 inch) wide lap belt, approximately 76 mm (3 inch) wide shoulder harness straps and two, approximately 51 mm (2 inch) wide leg or anti-submarine strap.

The double leg straps of the six-point system may be attached to the primary structure or be attached to the lap belt so that the driver sits on them, passing them up between his or her legs and attaching to the single release common to the lap belt and shoulder harness. The leg straps may also be secured at a point common with the lap belt attachment to the structure, passing them under the driver and up between his or her legs to the harness release.

#### (C) Material Requirements

The material of all straps must be Nylon or Dacron polyester and in new or perfect condition. There must be a single release common to the lap belt and shoulder harness using a metal-to-metal quick-release type latch. All driver restraint systems must meet either SFI Specification 16.1, or FIA specification 8853/98. The belts must bear the appropriate dated labels, and be no more than five years old. It is recommended that driver restraint systems be replaced every three years.

#### **(D) Belt and Strap Mounting**

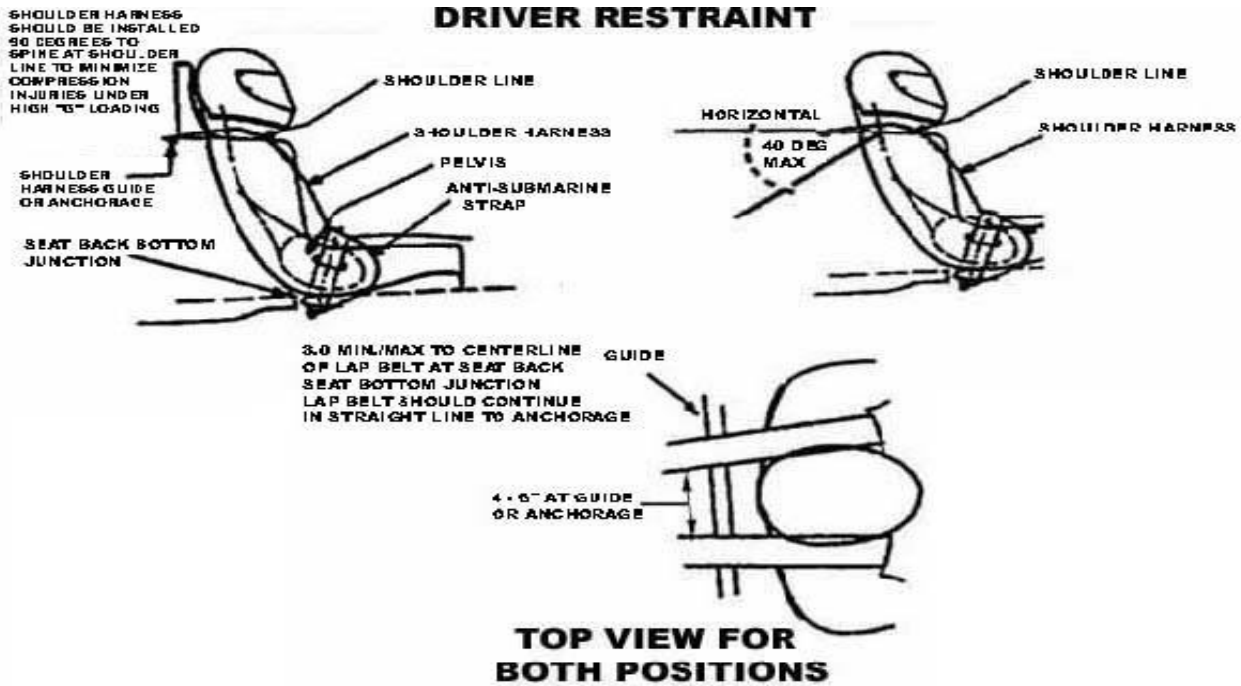
The lap belt, shoulder harness and anti-submarine strap(s) must be securely mounted to the primary structure of the car (i.e. frame tubes, roll structure). Such structure and any guide or support for the belts shall meet the minimum requirements of 3.3.3. Bolting through aluminum floor closeout panels, etc. is not acceptable. An SSE form must be completed for all monocoque structures (see 3.3.2).

#### **(E) Belt Position Requirements**

The lap belt must pass around the pelvic area below the Anterior Superior Iliac Spines (the hip bones) (Figure 5a). Under no condition may the lap belt be worn over the area of the intestines or abdomen. The lap belts should come through the seat at the bottom of the sides of the seat to maximize the wrap of the pelvic surface and continue in a straight line to the anchorage point. The centerline of the lap belt at the seat bottom should be approximately 76 mm (3 inch) forward of the seat back to seat bottom junction (see Recommended Location in Figure 5). The lap belts should not be routed over the sides of the seat. The seat must be rolled or grommeted to prevent chafing of the belts.

#### **(F) Shoulder Harness**

The shoulder harness must be the over-the shoulder type. The shoulder harness must be mounted behind the driver and above a line drawn downward from the shoulder point at an angle of 40 degrees with the horizontal to minimize spine compression injuries under high “g” deceleration. Only separate shoulder straps are permitted (i.e. “Y”-type shoulder straps are not allowed). “H”-type configuration is allowed. It is mandatory that the shoulder harness, where it passes over the shoulders, be 76 mm (3 inch) wide. The shoulder harness straps must be threaded through the three bar adjusters in accordance with manufacturers instructions.



### 3.4.2 Driver Safety Equipment

The following equipment must be worn by the driver anytime the vehicle is moving under its own power or is running on a chassis dynamometer:

#### 3.4.2.1 Safety Helmet

A well-fitting, closed face safety helmet with a Snell M-95, SA-95, M-2000, SA-2000, or British Standards Institution BS 6658-85 types A or A/FR rating. Open faced helmets are not approved. All helmets to be used in the competition must be presented during Safety and Technical Inspection where approved helmets will be stickered. The organizer reserves the right to impound all non-approved helmets until the end of the competition.

#### 3.4.2.2 Suit

A fire resistant suit that covers the body from the neck down to the ankles and the wrists. The suit shall be manufactured from one or more of the following accepted materials: Nomex, Kynol, FPT, IWS (wool), Fiberglass, Durette, Fypro, PBI, Proban and Kevlar. All suits must meet the SFI 3.2A/1 (or higher) or 1986 FIA standards and be labeled as such.

#### 3.4.2.3 Gloves

Fire resistant gloves which are free of any holes. Leather gloves are not acceptable.

#### 3.4.2.4 Eye Protection

Goggles or face shields, made of impact resistant materials.

#### 3.4.2.5 Shoes

Shoes of durable fire resistant material, and which are free from any holes.

#### 3.4.2.6 Arm Restraints

Arm restraints must also be installed on the car in a manner such that the driver can release them and exit the vehicle unassisted regardless of the vehicle's position.

#### 3.4.2.7 Hair Covering

Hair protruding from beneath a driver's helmet shall be completely covered by fire resistant material, i.e. a Nomex balaclava or a full helmet skirt of accepted fire resistant material.

### 3.4.3 Driver Visibility

#### 3.4.3.1 General Requirement

The driver shall have adequate visibility to the front and sides of the car. With the driver seated in a normal driving position he/she shall have a minimum field of vision of 200 degrees (a minimum 100 degrees to either side of the driver). The required visibility may be obtained by the driver turning his/her head and/or the use of mirrors.

#### 3.4.3.2 Mirrors

If mirrors are required to meet Rule 3.4.3.1, they shall remain in place and adjusted to enable the required visibility throughout all dynamic events.

### 3.4.4 Head Protection

#### 3.4.4.1 Head Restraint

A head restraint must be provided on the car to limit rearward motion of the head in case of an accident. The restraint shall have a minimum area of 232 sq. cm (36 sq. inches), be padded, with a non-resilient, energy absorbing material such as Ethafoam® or Ensolite® with a minimum thickness of 38 mm (1.5 inches), and be located no more than 25 mm (1 inch) away from the helmet in the uncompressed state. The head restraint must meet the above requirements for all drivers. The restraint, its attachment and mounting shall be strong enough to withstand a force of 890 Newtons (200 lbs. force) applied in a rearward direction.

#### 3.4.4.2 Roll Bar Padding

Any portion of the roll bar, roll bar bracing or frame which might be contacted by the driver's helmet shall be covered by a non-resilient, energy-absorbing material such as Ethafoam® or Ensolite® or other similar material, to a minimum thickness of 12 mm (0.5 inch). Pipe insulation material is unacceptable for this application.

### 3.4.5 Floor Closeout

All vehicles must have a floor closeout made of one or more panels, which separate the driver from the pavement. If multiple panels are used, gaps between panels are not to exceed 3 mm (1/8 inch). The closeout must extend from the foot area to the firewall and must protect the legs and torso from track debris.

### 3.4.6 Steering Wheel

#### 3.4.6.1 Circular Shape - Required

The steering wheel must have a near circular perimeter. "H", "Figure-8", or cutout wheels are not allowed.

#### 3.4.6.2 Quick Disconnect - Required

The steering wheel must be attached to the column with a quick disconnect. The driver must be able to operate the quick disconnect while in the normal driving position with gloves on.



### 3.4.7 Driver Egress

All drivers must be able to exit to the side of the vehicle in no more than 5 seconds.

Egress time begins with the driver in the fully seated position, hands in driving position on the connected steering wheel, wearing the required driver safety equipment. Egress time will stop when the driver has both feet on the pavement.

### 3.4.8 Roll Over Stability

The track and center of gravity of the car must combine to provide adequate rollover stability.

#### 3.4.8.1 Tilt Table Test

Rollover stability will be evaluated using a pass/fail test. The vehicle must not roll when tilted at an angle of 60 degrees to the horizontal in either direction corresponding to 1.7 G's. The tilt test will be conducted with the tallest driver in the normal driving position.

### 3.4.9 Master Switches

The car must be equipped with two positive master switches. Each switch shall disable all electrical circuits, including the battery, alternator, lights, fuel pump, ignition and electrical controls and **must** stop the engine.

#### 3.4.9.1 Switch Locations

One master switch must be located on the (driver's) right side of the vehicle, in the proximity of the roll bar at shoulder height, within easy reach from outside the car. The other switch must be located for easy operation by the driver.

#### 3.4.9.2 Switch Types

The switch at the main hoop must be of the rotary type, and must be direct acting, i.e. it cannot act through a relay. The other switch may be of any type and may act through a relay.

### 3.4.9.3 Master Switch Identification

The international electrical symbol of a red spark on a white-edged, blue triangle must be attached near both switches with the “off” position clearly labeled.

## 3.4.10 Fire Protection

### 3.4.10.1 Firewall

A firewall must separate the driver compartment from all components of the fuel supply, the engine oil and the liquid cooling systems. It must protect the neck of the tallest driver. It shall extend sufficiently far upwards and/or rearwards such that any point less than 100 mm (4 ins.) above the bottom of the helmet of the tallest driver shall not be in direct line of sight with any part of the fuel system, the cooling system or the engine oil system. The firewall must be a non-permeable surface made from a fire resistant material. Pass-throughs for wiring, cables, etc. are allowable if grommets are used to seal the pass-throughs. Also, multiple panels may be used to form the firewall but must be sealed at the joints to meet the intent of driver protection.

### 3.4.10.2 Fire Extinguishers

Hand held fire extinguishers are no longer permitted to be mounted on or in the car.

Each team shall have at least one 0.9 kg (2 lb.) dry chemical 10BC or 1A10BC, 2 lb. Halon 1301 or 1211, AFFF, or CEA-614 fire extinguisher readily available in their paddock area. In addition, each team shall have a second extinguisher that will accompany the vehicle wherever the vehicle is moved. All extinguishers must be equipped with a manufacturer installed pressure/charge gauge, must meet the above specifications and must be presented with the vehicle at Tech Inspection.

Extinguishers of larger capacity are acceptable.

As a team option, commercially available on-board fire systems are encouraged as an alternative to the extinguisher that accompanies the vehicle.



### 3.4.11 Batteries

All batteries (on-board power supplies) must be attached securely to the frame or chassis structure. If located in the cockpit, wet cell batteries must be in a nonconductive, marine type container or equivalent. The hot terminal must be insulated on all cars.

### 3.4.12 Accessibility of Controls

All vehicle controls, including the shifter must be accessible from inside the cockpit without any part of the driver being outside any of the major structural members of the vehicle. An example of this is that arms may not reach around the roll bar supports to operate the shifter of the vehicle.

## 3.5 POWERTRAIN

### 3.5.1 Engine and Drivetrain

#### 3.5.1.1 Engine Limitations

The engine used to power the car must be a four-stroke piston engine with a displacement not exceeding 610 cc per cycle. The engine can be modified within the restrictions of the rules. If more than one engine is used, the total displacement can not exceed 610 cc and the air for all engines must pass through a single air intake restrictor (see 3.5.4.3, “Intake System Restrictor.”)

#### 3.5.1.2 Engine Inspection

The organizer will measure or tear down a substantial number of engines to confirm conformance to the rules. The initial measurement will be made externally with a measurement accuracy of one (1) percent. When installed to and coaxially with spark plug hole, the measurement tool has dimensions of 381 mm (15 inches) long and 30 mm (1.2 inches) diameter. Teams may choose to design in access space for this tool above each spark plug hole to reduce time should their vehicle be inspected.

#### 3.5.1.3 Transmission and Drive

Any transmission and drivetrain may be used.

#### 3.5.1.4 Drive Train Shields and Guards

Exposed high-speed equipment, such as torque converters, clutches, belt drives and clutch drive, must be fitted with scatter shields to protect drivers, bystanders, fuel lines and safety equipment (such as brake lines) from flying debris in case of failure. Scatter shields protecting chains or belts must not be made of perforated material.

**(A) Chain drive** - Scatter shields protecting chains must be made of at least 2.66 mm (0.105 inch) mild steel (no alternatives are allowed), and have a minimum width equal to three (3) times the width of the chain.

**(B) Belt drive** - Scatter shields protecting belts must be made from at least 3.0 mm (0.120 inch) Aluminum Alloy 6061-T6, and have a minimum width that is equal to the belt width plus 35% on each side of the belt (1.7 times the width of the belt).

**(C) Attachment Fasteners** - All fasteners attaching scatter shields and guards must be a minimum 6mm grade M8.8 (1/4 inch SAE grade 5). Attached shields and guards must be mounted so that they remain laterally aligned with the chain or belt under all conditions.

**(D) Finger Protection** – Guards for finger protection may be made of lighter material.

#### 3.5.1.5 System Sealing

The engine and transmission must be sealed to prevent leakage. In addition, separate catch cans must be employed to retain fluids from any vents for the coolant system or the crankcase or engine lubrication system. Each can must have a volume of ten (10) percent of the fluid being contained or 0.9 liter (one U.S. quart), whichever is greater. Any crankcase or engine lubrication system vent lines routed to the intake system must be connected upstream of the intake system restrictor.

#### 3.5.1.6 Coolant Fluid Limitations

Water-cooled engines must only use plain water, or water with cooling system rust and corrosion inhibitor at no more than .015 liters per liter of plain water. Glycol-based antifreeze or water pump lubricants of any kind are strictly prohibited.



### 3.5.1.7 Starter

Each car must be equipped with an on-board starter, and be able to start without any outside assistance at any time during the competition.

## 3.5.2 Fuel Allowed

During all performance events, the cars must be operated with fuel provided by the organizer at the event. Nothing may be added to the provided fuels. This prohibition includes nitrous oxide or any other oxidizing agents.

For Formula SAE (the event held in the USA), these fuels will include 94 and 100 octane unleaded gasoline, and E85. Fuel specifications will be released to the SAE website in mid-January. For Formula Student and Formula SAE-Australasia, consult the supplementary regulations for the specific event.

### 3.5.2.1 Fuel Temperature Changes - Prohibited

The temperature of fuel introduced into the fuel system may not be changed with the intent to improve calculated fuel economy.

### 3.5.2.2 Fuel Additives - Prohibited

No agents other than fuel (gasoline or E85), and air may be induced into the combustion chamber. Non-adherence to this rule will be reason for disqualification. Officials have the right to inspect the oil.

## 3.5.3 Fuel System

### 3.5.3.1 Fuel Tank Size Limit

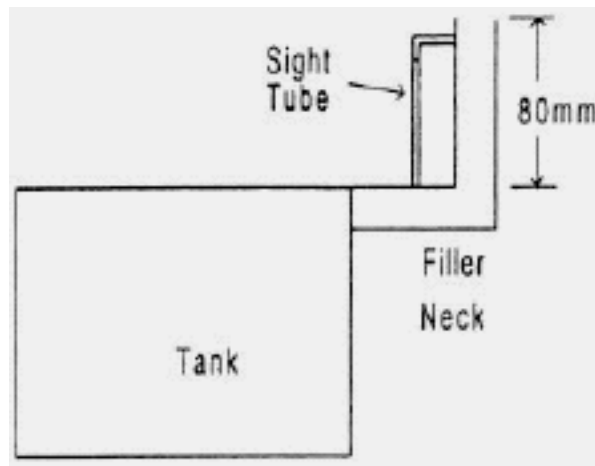
All gasoline-fueled cars must be equipped with a fuel tank having a volume of no more than 7.57 liters (2 U.S. gallons). E-85 fueled cars must be equipped with a fuel tank having a volume no greater than 10.6 liters (2.8 U.S. gallons). Any size tank may be used up to the maximum allowable size. The fuel system must have a provision for emptying the fuel tank for the purpose of measuring the tank volume.

### 3.5.3.2 Filler Neck Size & Sight Tube

All fuel tanks must have a filler neck of at least 30 mm (1.2 inches) diameter and at least 80 mm (3.2 inches) vertical height. This 80 mm of vertical height must be above the top level of the tank, and must be accompanied by a clear fuel resistant sight tube for reading fuel level (figure 6). The sight tube may not be run from the bottom of the fuel tank. A clear filler tube may be used, subject to approval by the rules committee or technical inspectors at the event.

### 3.5.3.3 Fuel Level Line

A permanent, non-moveable fuel level line must be located between 12.7 mm and 25.4 mm (0.5 inch and 1 inch) below the top of the sight tube. When filled to this level, the fuel system including fuel lines, filters, etc., must not hold any more than the maximum allowable fuel volume.



**Figure 6**

### 3.5.3.4 Tank Filling Requirement

The tank must be capable of being filled to capacity without manipulating the tank or vehicle in any way (shaking vehicle, etc.). The sight tube must be clearly visible to an individual filling the tank.

### 3.5.3.5 Spillage Prevention

The fuel system must be designed such that the spillage during refueling cannot contact the driver position, exhaust system, hot engine parts, or the ignition system. Belly pans must be vented to prevent accumulation of fuel.

### 3.5.3.6 Venting Systems

The fuel tank and carburetor venting systems must be design such that fuel cannot spill during hard cornering or acceleration. This is a concern since motorcycle carburetors normally are not designed for lateral accelerations. During the inspection, the car must be capable of being tilted to a 45-degree angle without fuel spilling from the carburetor or full gas tank. All fuel vent lines must be equipped with a check valve to prevent fuel leakage when the tank is inverted. All fuel vent lines must exit outside the bodywork.

### 3.5.3.7 Fuel Lines, Line Attachment and Protection

Plastic fuel lines between the fuel tank and the engine (supply and return) are prohibited.

Fuel lines must be securely attached to the vehicle and/or engine. All fuel lines must be protected from possible rotating equipment failure or collision damage.

### 3.5.3.8 High Pressure System Requirements

**(A) Fuel Lines** – High pressure over 103.4 kPa (15 psi) fuel systems must utilize protected hose (metal braided or some other abrasion resistant shielding) with either threaded fittings or modern OEM type fittings used without modifications to either the hose or the fitting. A hose clamp(s) over a removable line of any type is not permitted on a high pressure fuel line(s).

**(B) Fuel Rail** – The fuel rail on a fuel injection system must be securely attached to the engine cylinder block, cylinder head, or intake manifold with mechanical fasteners. This precludes the use of hose clamps, plastic ties, or safety wire.

**(C) Intake Manifold** – On engines with fuel injection, the intake manifold must be securely attached to the engine block or cylinder head.

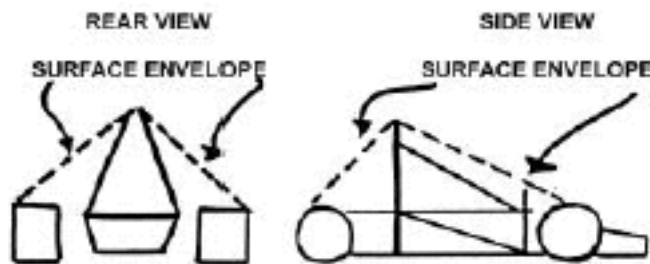
### 3.5.3.9 Fuel System Location Requirements

In order to prevent hazards in the case of a roll-over or collision, all parts of the fuel storage and supply system, and all parts of the engine air and fuel control systems (including the throttle or carburetor, and the complete air intake system, including the air cleaner and any air boxes) must lie within the surface defined by the top of the roll bar and the outside edge of the four tires (see figure 7).

All fuel tanks must lie within the major structure of the chassis as defined in 3.3.1.

All fuel tanks must be protected from side impact collisions.

Any fuel tank which is located outside the Side Impact Protection required by 3.3.8, must be protected by the same rules outlined for Side Impact Protection 3.3.8. A firewall shall also be incorporated to protect the driver, per section 3.4.10.1.



**Figure 7**

### 3.5.4 Throttle, Throttle Actuation and Intake Restrictor

#### 3.5.4.1 Carburetor/Throttle Body - Required

The car must be equipped with a carburetor or throttle body. The carburetor or throttle body may be of any size or design.

#### 3.5.4.2 Throttle Actuation

The throttle must be actuated mechanically, i.e. via a cable or a rod system. The use of electronic throttle control (ETC) or “drive-by-wire” is not permitted.



The throttle cable or rod must have smooth operation, and must not have the possibility of binding or sticking. The throttle actuation system must use at least two (2) return springs, so that the failure of any component of the throttle system will not prevent the throttle returning to the closed position. Throttle cables must be at least 50.8 mm (2 inches) from any exhaust system component and out of the exhaust stream. The use of a push-pull type throttle cable with a throttle pedal that is capable of forcing the throttle closed (e.g. toe strap) is recommended.

A positive pedal stop must be incorporated on the throttle pedal to prevent over stressing the throttle cable or actuation system.

#### 3.5.4.3 Intake System Restrictor

In order to limit the power capability from the engine, a single circular restrictor must be placed in the intake system between the throttle and the engine and all engine airflow must pass through the restrictor. Any device that has the ability to throttle the engine downstream of the restrictor is prohibited.

The maximum restrictor diameters are:

**Gasoline fueled cars** - 20.0 mm (0.7874 inch)

**E-85 Fueled cars** – 19.0 mm (0.7480 inch)

The restrictor must be located to facilitate measurement during the inspection process. The circular restricting cross section may NOT be movable or flexible in any way, e.g. the restrictor may not be part of the movable portion of a barrel throttle body.

If more than one engine is used, the intake air for all engines must pass through the one restrictor.

#### 3.5.4.4 Turbochargers & Superchargers

Turbochargers or superchargers are allowed if the competition team designs the application. Engines that have been designed for and originally come equipped with a turbocharger are not allowed to compete with the turbo installed. The restrictor must be placed upstream of the compressor but after the carburetor or throttle valve. Thus, the only sequence allowed is throttle, restrictor, compressor, engine. Only ambient air may be used to cool an intercooler.

### 3.5.5 Muffler and Exhaust System

#### 3.5.5.1 Muffler Required

The car must be equipped with a muffler in the exhaust system to reduce the noise to an acceptable level.

#### 3.5.5.2 Exhaust Outlet

-The exhaust must be routed so that the driver is not subjected to fumes at any speed considering the draft of the car.

-The exhaust outlet(s) shall not extend more than 60 cm (23.6 inches) behind the centerline of the rear axle, and shall be no more than 60 cm (23.6 inches) above the ground.

- Any exhaust components (headers, mufflers, etc.) that protrude from the side of the body between the front and rear axles must be shielded to prevent contact by persons approaching the car or a driver exiting the car.

#### 3.5.5.3 Noise

##### (A) Sound Measuring Procedure

All cars must pass the sound test before competing in any dynamic event. The sound level will be measured during a static test. Measurements will be made at 0.5 m from the end of the exhaust outlet with the microphone at the exhaust outlet level, at an angle of 45 degrees with the outlet in the horizontal plane. Where more than one exhaust outlet is present, the test will be repeated for each exhaust and the highest reading will be used. The test shall be run with the gearbox in neutral. The test rpm for a given engine will be the engine speed that corresponds to an average piston speed of 914.4 m/ min (3,000 ft/min) for that engine, rounded to the nearest 500 rpm. The test rpm's will be published by the organizers.

##### (B) Maximum Sound Level

The maximum permitted sound level shall not exceed 110 dBA, fast weighting.



### (C) Sound Level Re-testing

At the option of the judges, noise can be measured at any time during the competition. If a car fails the noise test, it will be withheld from the competition until it has been modified and re-passes the noise test.

## 3.6 VEHICLE IDENTIFICATION

### 3.6.1 Car Number

Each car will receive a number at the time of its entry in the competition. This number must be displayed in 15.24 cm (6 inch), or larger, characters in three (3) locations; the front and both sides of the vehicle. The numbers must be composed of white numerals on a black background, black numerals on a white background, or high-contrast equivalents. The use of metallic, fluorescent or other reflective colors will not be approved.

Vehicle numbers for car's registered for Formula SAE can be found on the "Registered Teams" section of the Formula SAE website.

### 3.6.2 School Name

Each car must clearly display the school name (or initials - if unique and generally recognized) in 5.08 cm (2 inch), or larger, characters on both sides of the vehicle. The characters must be placed on a high-contrast background in an easily visible location.

### 3.6.3 SAE Logo

The SAE logo must be displayed on the front and/or both sides of the vehicle in a prominent location. SAE logo stickers will be provided to the teams on site.

## 3.7 GENERAL

### 3.7.1 Aero Dynamics and Ground Effects

The purpose of the following rules is to minimize the likelihood of injury to spectators, officials, competitors, etc., in the case of accidental contact with wings or structures.

### 3.7.1.1 Wing Locations

The wing or wings must be located in plan view within a quadrilateral defined by the outside of the tires on the sides, by a transverse line 460 mm (18 inches) in front of the fronts of the front tires, and by a transverse line between the rear of the rear tires.

### 3.7.1.2 Driver Egress Requirements

Egress from the vehicle within the time set in section 3.4.7 “Driver’s Egress,” shall not require any movement of the wing or wings or their mountings. The wing or wings must be mounted in such positions, and sturdily enough, that any accident is unlikely to deform the wings or their mountings in such a way to block the driver’s egress.

### 3.7.1.3 Wing Edges - Minimum Radii

All wings: leading edges shall have a minimum radius 12.7 mm (0.5 inch) unless a wing projects in front of the front tires, in which case it must have a minimum radius of 19 mm (0.75 inch). Wing leading edges must be as blunt or blunter than the required radii for an arc of plus or minus 45 degrees centered on a plane parallel to the ground or similar reference plane for all incidence angles which lie within the range of adjustment of the wing or wing element. If leading edge slats or slots are used, both the fronts of the slats or slots and of the main body of the wings must meet the minimum radius rules.

### 3.7.1.4 Other Edge Radii Limitations

All wing edges, end plates and wing accessories must have minimum edge radii of at least 3 mm (1/8 inch) i.e., this would mean at least a 6 mm (1/4 inch) thick edge.

### 3.7.1.5 Wing Edge Safety

No small radius edges may be included anywhere on the wings in such a way that would violate the safety intent of these rules (i.e. vortex generators with thin edges, sharp square corners on end plates, etc.).



### 3.7.1.6 Ground Effect Devices - Prohibited

No power device may be used to move or remove air from under the vehicle except fans designed exclusively for cooling. No power ground effects are allowed.

## 3.7.2 Fasteners

### 3.7.2.1 Grade Requirements

All bolts utilized in the steering, braking, safety harness and suspension systems must meet SAE Grade 5, Metric Grade M 8.8 and/or AN/MS specifications.

### 3.7.2.2 Securing Fasteners

All critical bolt, nuts, and other fasteners on the steering, braking, safety harness, and suspension must be secured from unintentional loosening by the use of positive locking mechanisms. Positive locking mechanisms include:

- Correctly installed safety wiring
- Cotter pins
- Nylon lock nuts
- Prevailing torque lock nuts

**Note:** Lock washers and thread locking compounds, e.g. Loctite®, DO NOT meet the positive locking requirement.

All spherical rod ends on the steering or suspension shall be in double shear or captured by having a screw/bolt head or washer with an O.D. that is larger than spherical bearing housing I.D. Adjustable tie-rod ends must be constrained with a jam nut to prevent loosening.

## 3.7.3 Modifications and Repairs

Modifications to the car are not allowed after the inspection and engineering judging except as noted below. This includes modifications that affect the available gear ratios, power transfer-system, or safety. The removal of body panels for weight reduction is not allowed. Adjustments (e.g., tire pressure, brake bias, suspension adjustments, wing angle, and



chain or belt tension) are allowed to the car after the start of the performance events. Necessary repairs are allowed under the knowledge of the Faculty Advisor and the car must pass a re-inspection by the inspection judges.

### 3.7.4 Compressed Gas Cylinders and Lines

Any system on the vehicle that uses a compressed gas as an actuating medium must meet the following requirements:

- The working gas must be nonflammable, e.g. air, nitrogen, carbon dioxide.
- The gas cylinder/tank must be of proprietary manufacture, designed and built for the pressure being used, certified by an accredited testing laboratory in the country of its origin, and labeled or stamped appropriately.
- The pressure regulator must be mounted directly onto the tank.
- The tank/cylinder and the pressure regulator must be mounted within the major structure of the chassis, i.e. it cannot be mounted in a non-structural sidepod.
- The tank must be mounted securely to the major structure of the chassis or to the engine/transmission.
- The axis of the cylinder/tank must not point at the driver.
- The cylinder/tank must be insulated from any heat sources such as the exhaust system.
- The lines and their clamps must be appropriate for the maximum possible operating pressure of the system.
- The tank and lines must be protected from possible failure of rotating equipment.

## 4. STATIC EVENTS

### 4.1 STATIC EVENTS

The maximum possible scores in the static events are:



Safety and Technical Inspection	No points
Cost and Manufacturing Analysis	100 points
Presentation	75 points
Design	<u>150 points</u>
Total 325 points	

## 4.2 SAFETY AND TECHNICAL INSPECTION

### 4.2.1 Objective

The objective of safety and technical inspection is to determine if the vehicle meets the FSAE design and safety requirements and if, considered as a whole, it satisfies the intent of the Rules. For purposes of interpretation and inspection the violation of the intent of a rule is considered a violation of the rule itself.

### 4.2.2 Inspection & Testing

Each vehicle must pass all parts of the safety and technical inspection, and bear the inspection stickers, before it is permitted to participate in any dynamic event or to run on the practice track. The exact procedures and instruments employed for inspection and testing are entirely at the discretion of the Chief Scrutineer.

Safety and technical inspection will examine all items included on the Inspection Form found in Appendix A-2 plus any other items the inspectors may wish to examine to insure conformance with the Rules.

Once a vehicle has passed inspection it must remain in the “As-approved” condition throughout the competition and may not be modified.

Decisions of the inspectors and the Chief Scrutineer concerning vehicle compliance are final and are not permitted to be appealed.

Safety and technical inspection is a non-scored activity.

### 4.2.3 Inspection Process

Vehicle inspection will consist of three separate parts as follows:

#### **Part 1 – Safety Inspection and Scrutineering**

Each vehicle will be inspected to determine if it complies with the requirements of the rules. This inspection will include examination of the



driver's safety equipment (Rule 3.4.2) and a test of the driver egress time (Rule 3.4.7).

Part 1 must be passed before a vehicle may apply for Part 2 or Part 3 inspection.

### **Part 2 – Tilt Table Tests**

Each vehicle will be tested to insure it satisfies both the 45 degree fuel spill safety requirement (Rule 3.5.3.6) and the 60 degree tilt table requirement (Rule 3.4.8.1).

Parts 1 and 2 must both be passed before a vehicle may apply for part 3 inspection.

### **Part 3 – Brake and Noise Tests**

Each vehicle must demonstrate its ability to lock all wheels after an acceleration run. Vehicle noise will be tested by the specified method. (Rule 3.5.5.3)

#### **4.2.4 Correction and Reinspection**

If any part of a vehicle does not comply with the Rules, or is otherwise deemed to be a safety concern, then the team must correct the problem and have the car re-inspected.

The judges and inspectors have the right to re-inspect any vehicle at any time during the competition and require correction of non-compliance.

#### **4.2.5 Inspection Stickers**

All inspection stickers issued following the completion of any part of the Safety and Technical Inspection must be placed on the vehicle in a location specified by the event organizers. Inspection stickers are issued contingent on the vehicle remaining in the required condition throughout the competition. Inspection stickers may be removed from vehicles that are not in compliance with the Rules.





## 4.3 COST & MANUFACTURING ANALYSIS EVENT

**100 points**

### 4.3.1 The Concept

The objective of the Cost and Manufacturing Event is twofold:

1. To teach the participants that cost and a budget are significant factors that must be taken into account in any engineering exercise.
2. For the participants to learn and understand the manufacturing techniques and processes of some of the components that they have chosen to purchase rather than fabricate themselves.

### 4.3.2 The Requirements

This event is comprised of two (2) parts:

1. The preparation and submission of a written report (the “Cost Report”), which is to be sent to the Cost Judges prior to the competition. (See Section 4.3.4)
2. A discussion at the Competition with the Cost Judges around the team’s vehicle. (See Section 4.3.5) This evaluates not only the cost of the car, but also the team’s ability to prepare accurate engineering and manufacturing cost estimates.

### 4.3.3 Scoring

In spite of the changes that have been made, the event is still worth 100 points, but these points will be broken down as follows:

$\frac{30 \times (25,000 - P_{\text{your}})}{25,000 - P_{\text{min}}}$	30 Points	Lowest cost - each of the participating schools will be ranked by total adjusted retail cost from the BOM and given 0-30 points based on the formula on the left. P <sub>your</sub> is the adjusted cost of your car (with penalties), and P <sub>min</sub> is the adjusted cost of the lowest cost car. If P <sub>your</sub> is greater than \$25,000 US, the car will be disqualified from the Cost Event
	30 Points	The Cost Report – written, professional presentation of cost data - The report score will be given based on the quality of the cost report, its accuracy and thoroughness. The range for the report score is 0 –30 points.
	20 Points	Event Day/Visual Inspection - The cars will be reviewed for part content and manufacturing feasibility. 0-20 points.
	20 Points	Event Day/Manufacturing Processes - The teams must be prepared to discuss in detail the manufacturing processes for 2 items chosen at random from the list in Section 4.3.5. 0-10 points per item.
Total	100 Points	



#### 4.3.4 The Cost Report

The cost report must be reflective of the prototype vehicle that the team has brought to the competition. The cost report shall fit in one three ring binder with 8.5"x11" or A4 pages no more than 5" thick.

The cost report shall consist of the following:

- A Cover sheet
- A Table of Contents
- A Cost summary page listing each sections cost, and the total vehicle cost
- Tabs for each section

Eight Commodity report sections. Each commodity report section should include:

**Up to ten pages of process descriptions:**

**Not included in the ten pages but in each of the eight commodity sections**

- Bill of Materials, for end items only, of the prototype that the team has brought to the competition.
- Receipts
- Other backup (prints, photos, et al)

#### **Process Descriptions**

Process descriptions are only done for parts your team made from scratch, or parts that were purchased and modified. Process descriptions are not done for purchased parts. These descriptions explain how a part was manufactured. Process descriptions for discussion at the competition should not be included in the report.

#### **Bill of Materials (BOM)**

The BOM must have the columns as listed in A-4. The columns must be in the order shown in A-4, and there must be no other columns, nor must any be eliminated. BOM's are run through a program during judging prior

to the event, and reports that do not follow the layout of A-4 will not be scored.

### End Items – Definition

An end item is a part that is bolted onto the car as part of the final assembly process. Examples:

A control arm. The control arm is made up of several tubes welded or bonded together, with rod ends threaded to the arm. The parts in the control arm assembly are not included in the BOM. The arm is then bolted to the frame. Thus the control arm is an end item part.

A brake caliper. The caliper is made up of a housing, piston(s), o-rings, nipple, bleeder screw, and a cap. The parts in the caliper assembly are not included on the BOM. The caliper, as it is bolted to the car is an end item.

If your team is unsure if a part belongs as an end item, feel free to ask the Rules Committee. Furthermore, a typical list of end items can be found in the appendix of these rules.

#### 4.3.4.1 General Requirements

The Cost Report must:

**(A)** Reflect the actual, one-off, prototype vehicle brought to the event in terms of specification.

**(B)** List and cost every part on the prototype vehicle. This includes any data acquisition systems and radios if they are fitted on the vehicle at any time during the competition. The only exceptions are that, per Section 4.3.7 of the Rules, any finish and on-board fire suppression systems do not need to be included in the cost.

**(C)** Be based on the estimated costs of materials, fabrication and assembly of the car. They costs shall be calculated as defined in Section 4.3.6 of these rules.

**(D)** Be based on the actual manufacturing technique used on the prototype, e.g. cast parts on the prototype should be costed as cast, and fabricated parts as fabricated, etc.

The reported cost of the prototype vehicle will exclude R & D, tooling (e.g. jigs, moulds, patterns and dies), and capital expenditures (e.g. plant, machinery and tools). The prototype



vehicle's calculated cost should not exceed \$25,000.00. If the cost exceeds this outer boundary, it will be disqualified from the Cost Event and receive zero points for the event.

#### 4.3.4.2 Mandatory Report Format

-The BOM shall be divided into the eight (8) sections specified in Appendix A-3, and each section shall follow the format given in Appendix A-4.

-Each section shall not exceed ten (10) pages, (5 sheets of paper if double-sided), for a total of eighty (80) pages. This number does not include the receipts and any drawings and photographs. Cost reports that exceed eighty (80) pages will only be evaluated on the first eighty pages.

#### 4.3.4.3 Receipts

**(A)** The receipts should be numbered and labeled, and attached to each sub-assembly section with the quantities stated.

**(B)** The full retail cost of parts must be used in the Cost Report. Discounted or wholesale prices are not to be used. If a part is used, donated or discounted, the full retail cost for said part must still be given.

**(C)** The supplier/retailer's phone number must be included with each receipt.

**(D)** If the actual receipt for a part is not available, a photocopy of a page from a catalogue of the part in question will be acceptable.

#### 4.3.4.4 Report Submission and Deadline

**(A)** The submitted Cost Report must include both a printed ("hard") copy and an electronic copy of the costed BOM.

**(B)** The printed (hard) copy of the report shall be on 8 1/2 inch x 11 inch or A4 size paper, using a 10-point font size or larger.

**(C)** The electronic copy of the BOM must use Microsoft Excel on a single IBM compatible 3.5" disc or a CD ROM. It should NOT include copies of receipts or any back-up material.

These reports should be mailed to the address listed in the appendix.

#### 4.3.4.5 Late Submission of Cost Report

It is imperative that the cost judges have the Cost Reports in enough time for proper evaluation. Teams that submit reports with a postmark later than the specified date will be penalized -10 points per day late, with a maximum penalty of -80 points. Teams that do not submit a Cost Report will receive -100 points for the Cost & Manufacturing Analysis score.

#### 4.3.4.6 Addenda

Any addendum that reflects any changes or corrections made after the submission of the Cost Report must be submitted at Registration when the Team registers on-site at the Event. It will not be accepted at any other time or place. The addendum document must follow the template format specified in Appendix A-2, and cannot be more than a single page. No other format will be accepted.

#### 4.3.4.7 Cost Report Judging and Penalties

From the Bill of Material, the cost judges will determine if all parts and processes have been included in the analysis and if unreasonably low costs have been used (determined by the experience of the judges). In the case of any omission, error, or cost below reasonable, the judges will add a penalty equal to twice the cost error. The team's retail cost plus penalties will be used to determine the cost score. For example, if a car has tires listed at \$50 and the Cost Judges have evidence that the same or similar tires should actually cost \$110, then the judges will add 2 x \$60 for each tire to the cost. Errors of costs above reasonable prices are not penalized further and the error is not corrected. Further, the parts used in the cost estimate must be the actual parts used on the prototype and substitution of cheaper parts for the cost analysis is prohibited. For example, if styled wheels costing \$150 each are used on the prototype, then substitute wheels costing \$50 each can not be used in the cost analysis.

Cost reports that have not made a serious attempt at an accurate cost estimate or that claim to have a cost that is substantially below what the Cost Judges know to be appropriate for cars of this type will be disqualified as unresponsive and will be scored as unsubmitted.



#### 4.3.5 Discussion at the Competition

At this discussion, the Cost Judges will:

(A) Review whether the specification of the vehicle in the Cost Report accurately reflects the vehicle brought to the Competition,

(B) Review the manufacturing feasibility of the vehicle

(C) Require the team to outline the manufacturing processes involved for two (2) items chosen from the following list, which represents items that are normally purchased by the teams. The two (2) items for each team will be chosen at random at the event.

Throttle Body

Muffler

Wheel

Brake Pad

Battery

Tie Rod End

Suspension Spring

Safety Harness

The team must present their vehicle at the designated time to the Cost Judges for review of the cost report. Teams that miss their cost appointment will potentially lose all cost points for that day. The schedule for these appointments will be in the registration packets.

#### 4.3.6 Cost Calculations

The costs to be entered into the Cost Report comprise of the component cost and the cost of assembling that component into a sub-assembly, an assembly or onto the vehicle.

##### 4.3.6.1 Component Costs

Component costs consist of the material cost and the cost of the process(es) to manufacture the component. The time required to load, unload, machine, paint, fabricate, etc. is costed at \$35/hour if it is not explicitly costed in the Operations Cost Table. The table given in Section 4.3.9 provides some guidelines to the cost of various operations. Do not include overhead, costs of expendables, capital costs, and depreciation of machine equipment. The components on a team's (prototype) car can be from several sources. They can be purchased new, purchased

used, donated, “pirated” from a previous year’s car, modified from an acquired part, or fabricated/manufactured from basic raw materials. The cost calculations must follow the following guidelines:

**(A) Purchased New Part** – Use the full retail cost, even if it was actually acquired with a discount. (See Appendix A-4, example #1).

**(B) Purchased Used, Donated or “Pirated” Parts** – Use the full retail cost of a “new” part of exactly the same specification.

**(C) Modified (Purchase and Alter) Part** – Use the full retail cost of the part as above, plus the cost of the modifications taken from the Operations Cost Table in Section 4.3.9 of the Rules.

**(D) Fabricated/Manufactured Part** – Use the Common Materials Cost Minimums Table from 4.3.9 to determine the cost of the basic material, bearing in mind that the weight of the material must include any scrap from cutting or machining. If the material is not listed in 4.3.9, a receipt for the material used must be provided. The cost of making the part will then be added using the rates from the Operations Cost Table of 4.3.9.

The parts costs used must be the “full retail” cost of the part in question. Wholesale or discounted costs are not to be used, whether they be “educational”, volume or for other reasons.

Note that in calculating the labor costs to modify or fabricate a part, the team should assume that the process has been refined and reflects the time it would take if the part in question was being fabricated on a regular basis. The Cost Judges recognize that the time taken to make parts for the team’s actual prototype vehicle will have been far longer. Examples of cost calculations are given in Section 4.3.10 of these rules.

#### 4.3.6.2 Assembly Costs

**(A)** Assembly labor is to be costed at \$35.00 US per hour.

**(B)** Assembly of a component is to be included in the cost of that component.

**(C)** Assembly of components into a sub-assembly is to be listed as a separate line item in the section of the BOM in which that sub-assembly appears,

(D) Assembly of a sub-assembly or assembly onto the vehicle is to be listed as another separate line item in the section of the BOM in which that assembly appears.

#### 4.3.7 Costing of Finishes and Fire Safety Items

##### 4.3.7.1 Finishes

The car will be considered to be shipped as primed or gel coated and a cost recorded. Any finishes (paint, polish, etc.) that are only used to beautify need not be costed. Preservative finishes intended to protect the appearance or function of a component for an extended period of time must be costed (labor and material included).

##### 4.3.7.2 Fire Safety Systems

Hand held fire extinguishers are not allowed on the vehicle (as per Fire Protection rule 3.4.10.2), but if the car has an on-board fire suppression system, it is not required to be costed.

##### 4.3.7.3 Tires and Wheels

Only one set of tires and wheels needs to be included in the cost report. The tires and wheels that are declared as dry tires per rule 3.2.2 must be the tires included in the cost report, and must be the tires on the car during the cost event judging. Other tires that will be potentially used at the competition (i.e. rain tires) do not need to be included in the cost report.

#### 4.3.8 Engine Costing

The cost of the engine depends upon the performance rating of the engine. The engine performance rating is based upon the power potential of the manufacturer's specification of the engine without restrictor modification. The engine is considered low performance if it is capable of producing less than 5 horsepower per 100 cc displacement (industrial engines, etc.). A high performance engine is capable of 5-10 horsepower per 100 cc (normal motorcycle engines with 2 valves per cylinder, etc.). An ultra high performance engine is capable of more than 10 horsepower per 100 cc (new high tech engines, 3- or 4-valves per cylinder, etc.). The engine is considered to be purchased with all of the required components and systems necessary to run. The engine costs listed below include the transmission/CVT device regardless of whether it is integral to the engine



or not. Engines that come equipped with an integral transmission, differential, and U-jointed axles must estimate the cost of the differential and U-joints separately. Items driven by or beyond the general function of the engine and/or transmission must be costed. All other items: the carburetor (or fuel injection system), the ignition and/or electrical system (including spark plug(s), coils and wires), turbo or supercharger if used, the intake manifold, the exhaust manifold, cooling system (water & oil), and mufflers must be costed. These costs must be listed separately in the cost analysis.

The following table lists the costs of the engine:

<b>RATING</b>	<b>ENGINE &amp; TRANSMISSION/CVT</b>
Low	\$ 0.60/cc
High	\$ 1.00/cc
Ultra-high	\$ 1.25/cc

#### 4.3.9 COSTING TABLES

To assist in your process the following tables must be used in costing:

##### **Common Materials and Cost Minimums Table**

Mild steel, e.g. 1010, 1025	\$0.30/pound
Alloy steel, e.g. 4130, Chrome Moly	\$0.60/pound
Aluminum	\$0.75/pound
Magnesium	\$2.25/pound
Non-graphite composites	\$88.18/kg (\$40/pound)
Graphite-based composites	\$220.50/kg (\$100/pound)

Other materials such as plastics span such a vast range of uses and costs that a common price standard is impractical. Cost for composites and structural construction similar to fiberglass should be costed separately with a clear identification of the costs of all materials and processes. Obviously, process costs are in addition to the above material cost minimums.

### OPERATIONS COST TABLE

Labor (all activity)	\$35.00 / hr.
CNC Machine (time)	\$70.00 / hr.
Welds	\$0.14 / cm (\$0.35/inch)
Saw or tubing cuts	\$0.16 / cm (\$0.40/inch)
Tube bends	\$0.75 / bend
Non-metallic cutting	\$0.08 / cm (\$0.20 /inch)
Tube end preparation for welding	\$0.75 / end
Drilled holes less than 1" diameter, any depth	\$0.35 / hole
Drilled hole greater than 1" diameter	\$0.35 / inch / hole
Reamed hole	\$0.35 / hole
Tapping holes	\$0.35 / hole
Sheet metal shearing	\$0.20 / cut
Sheet metal punching	\$0.20 / hole
Sheet metal bends	\$0.05 / bend
Sheet metal stampings (process cost only)	\$0.008 / sq. cm (\$0.05 / sq. inch)
Sand castings (process cost only)	\$6.61 / kg (\$3.00 / pound)
Die castings (process cost only)	\$8.82 / kg (\$4.00 / pound)
Investment casting (process cost only)	\$17.64 / kg (\$8.00 / pound)
Plastic injection molding (process cost only)	\$6.06 / kg (\$2.75 / pound)

#### 4.3.10 Examples of Process Descriptions

##### 4.3.10.1 Purchase Example

The team purchased 3 widget “A’s” from Amalgamated Auto for \$12 each on sale and they retail for \$15. No process need be written for this part, it does have to be listed in the Bill of Material (See Appendix A-4, example #1).

Name: Widget A							
Material							
Purchased Component	Sub.	Qty.	Description	Volume	Weight	\$/Unit	Cost
	A	3	Widget A			\$15.00	\$45.00
						Total	\$45.00

This data would be listed in the BOM as in Appendix A-4, example #1. There would be no material in the process description sheets as this is a purchased, unmodified part.

#### 4.3.10.2 Purchase and Alter Example

A component requiring detail process would be as follows – the team purchased 3 widget B’s” from Amalgamated Auto for \$12 each on sale and they retail for \$15. You altered each of them by cutting two surfaces on the mill @ 5 minutes each.

Name: Widget B								
Purchase component, then modify.	Material							
	Sub.	Qty.	Description	Volume	Weight	\$/Unit	Cost	
	A	3	Widget B			\$15.00	\$45.00	
	Process Labor							
	Sub.	Qty.	Amount	Unit	Manning	Description	\$/Unit	Cost
	A	3	10	Min.	1	Mill Slot	\$0.58	\$17.50
							Total	\$62.50

This data would be listed in the BOM as in Appendix A-4, example #2. The process description would be in the ten-page written report pertaining to this section of the car.

#### 4.3.10.3 Manufacture Example

The team purchased or had on hand a round piece of aluminum bar stock 2” diameter x 7.5” long. The piece was centered and cut on a lathe that was set up for production (would take 10 minutes) and milled in two slots (5 minutes each). Additionally, you drill four holes less than 1” in diameter and tapped two of them. The process sheet could look as follows:



DaimlerChrysler Ford Motor Company General Motors



Team Manufactured Part	Name: Widget C							
	Material							
	Sub.	Qty.	Description	Volume	Weight	\$/Unit	Cost	
	A	3	Al bar - round 2" dia. X 7.5"	23.56	2.356	\$0.75	\$1.77	
							Subtotal	\$1.77
	Process Labor							
	Sub.	Qty.	Amount	Unit	Manning	Description	\$/Unit	Cost
	A	1	10	Min.	1	Lathe cut	\$0.58	\$5.83
	A	2	5	Min.	1	Mill Slot	\$0.58	\$5.83
	A	4	1	Holes	1	Drill Hole	\$0.35	\$1.40
A	2	1	Holes	1	Tap Hole	\$0.35	\$0.70	
						Subtotal	\$13.76	
						Total	\$15.53	

This data would be listed in the BOM as in Appendix A-4, example #3. The process description would be in the ten-page written report pertaining to this section of the car.

Note: If widget “C” were a component such as an exhaust manifold, weld and fixture time would be listed here and not in final assembly. Each individual component and process would have its own sub number or letter assignment. The total component cost would then be added to the BOM as a single line item.

#### 4.3.10.4 Off-Line Assembly Example

The team manufactured widget “D” and purchased widgets “E” and “F” (all of which are listed in the BOM) and assemble them at an offline assembly operation. It took 10 minutes. This is a final



assembly cost and would be a part of the total assembly cost listed at the end of the BOM (See A-4, example #4).

#### 4.3.11 Exchange Rates

It is mandatory that the Cost Report be submitted in US dollars. Teams that purchase components in other currencies must convert the costs of those components into US dollars using the official “Daily 12 noon buying” rate(s) for the first business day, e.g. January 2<sup>nd</sup> of the year of the competition published on the web site of the Federal Reserve Bank of New York at:

[www.ny.frb.org](http://www.ny.frb.org)

#### 4.3.12 Taxes

The cost of the parts shall not include any taxes paid on them when purchased.

**75 points**

### 4.4 PRESENTATION EVENT

#### 4.4.1 Presentation Event Objective

The concept of the presentation event is to evaluate the team’s ability to make a presentation to the executives of a manufacturing firm. The presentation should address the “Concept of the Competition” as described in section 1, and should convince the executives of the superiority of the team’s design. The presentation judges will evaluate the organization, content, and delivery of the presentation. The team that makes the best presentation (regardless of the quality of the car) will win the event.

#### 4.4.2 Presentation Schedule

Presentation will be made on the first day of the event. The presentation time will be randomly selected and will be posted in conjunction with the organizational meeting held in the morning. A team will receive zero (0) presentation points if they fail to make their presentation during the allotted period.



#### 4.4.3 Presentation Format

One (or more) team member(s) will give the presentation to the judging team. The organizer will provide details regarding the presentation in the newsletter. The presentation cannot last more than 10 minutes and should not be interrupted by questions. After the presentation, there will be approximately 5 minutes of questions. Only judges are permitted to ask questions. The audience may not ask questions or make any comments or distractions. During the question period, team members are encouraged to answer questions.

#### 4.4.4 Evaluation Criteria

The presentation judges will consider the content, organization, and delivery of the presentation and will only evaluate the team's ability to give a presentation. The judges will use the judging form given in Appendix A-5.

#### 4.4.5 Scoring Formula

The scoring of the event is based on the average of the two or three presentation judging forms. There is a maximum of 50 points from the Presentation Judging Form.

$$\text{PRESENTATION SCORE} = 75 \times P_{\text{your}}/P_{\text{max}}$$

Where:

“P<sub>max</sub>” is the highest score awarded to any team

“P<sub>your</sub>” is the score awarded to your team

It is intended that the scores will range from near zero (0) to seventy-five (75) to provide good separation. The Presentation Event Captain may at his/her discretion, normalize the scores of different judging teams.



## 4.5 DESIGN EVENT

150 points

### 4.5.1 Design Event Objective

The concept of the design event is to evaluate the engineering effort that went into the design of the car and how the engineering meets the intent of the market. The car that illustrates the best use of engineering to meet the design goals and the best understanding of the design by the team members will win the design event.

### 4.5.2 Design Report and Design Spec Sheet – Submission Requirements

Judging will start with a Design Review before the event. The principal document submitted for the Design Review is a Design Report. This report must not exceed eight (8) pages, consisting of not more than four pages of text, three pages of drawings (see 4.5.2.1, “Vehicle Drawings”) and one optional page containing content to be defined by the team (photo’s, graphs, etc...). This document should contain a brief description of the vehicle with a discussion of any important design features and vehicle concepts. Include a list of different analysis and testing techniques (FEA, dynamometer testing, etc.). Evidence of this analysis and back-up data should be brought to the competition and be available, on request, for review by the judges. These documents will be used by the judges to sort teams into the appropriate design groups based on the quality of their review.

In addition to the above document, a completed FSAE Design Spec Sheet must also be submitted. The FSAE Design Spec Sheet template can be found on the FSAE website at: <http://www.sae.org/students/fsae-designspecs.xls>. Please do not alter or re-format the template prior to submission.

The design judges realize that final design refinements and vehicle development may cause the submitted figures to diverge slightly from those of the completed vehicle. For specifications that are subject to tuning, an anticipated range of values may be appropriate.

The Design Report and the Design Spec Sheet, while related documents, should stand alone and be considered two separate submissions. Two separate file submissions are required.



#### 4.5.2.1 Vehicle Drawings

The Design Report must include one set of 3 view drawings showing the vehicle, from the front, top, and side. Each drawing shall appear on a separate page. The drawings can be manual or computer generated. Photos should be placed on the optional page and will not be counted as drawings.

#### 4.5.3 Design Report and Design Spec Sheet Formats

The Design Report must be submitted electronically in Adobe Acrobat® Format (\*.pdf file). This document is expected to be a single file (text, drawings, and optional content all inclusive). The Design Report file must be named as follows: schoolname\_carnumber.pdf using the complete school name (ex. University of xxxxxxx) and the FSAE assigned car number.

Design Spec Sheets must be submitted electronically in Microsoft Excel® Format (\*.xls file). Please do not make any alterations to the formatting of the spec sheet file. Similar to the Design Report, the Design Spec Sheet file must be named as follows: schoolname\_carnumber\_specs.xls using the complete school name (ex. University of xxxxxxx) and the FSAE assigned car number.

Penalties may be assessed for noncompliance with submission requirements.

#### 4.5.4 Submission Deadlines

The Design Report and the Design Spec Sheets must arrive at the specified e-mail address by the date shown in the Action Deadlines for the competition your team is entering. E-mail the Design Report and Design Spec Sheets to the address provided in the appendix. The two files must be e-mailed as separate files.

You will receive confirmation of receipt via email and/or the event website. Teams should have a printed copy of this reply available at the competition as proof of submission in the event of discrepancy.

#### 4.5.5 Penalty for Non-Submission

Teams who do not submit a Design Report and a Design Spec Sheet by the specified deadline will not compete in the design event, and will receive zero (0) points for design.





#### 4.5.6 Penalty for Unsatisfactory Submissions

At the discretion of the judges, teams that submit a Design Report or a Design Spec Sheet which is deemed to be unsatisfactory, will also not compete in the design event, but may receive between 5 and 20 pts. for their efforts.

#### 4.5.7 Design Event – Vehicle Condition

Cars must be presented for design judging in finished condition, i.e. fully assembled, complete and ready-to-run. The judges may, at their sole discretion, refuse to evaluate any car that is presented at the design event in what they consider to be an unfinished state. Unfinished cars that are refused judging will receive zero (0) points for design. Point penalties may be assessed for cars with obvious preparation issues, e.g. notably loose or missing fasteners.

**Note:** Cars can be presented for design judging without having passed technical and safety inspection, even if final tuning and setup is in progress.

#### 4.5.8 Judging Criteria

The design judges will evaluate the engineering effort based upon the team's Design Report, Spec Sheet, responses to questions and an inspection of the car. The design judges will inspect the car to determine if the design concepts are adequate and appropriate for the application (relative to the objectives set forth in the rules). It is the responsibility of the judges to deduct points on the design judging form, as given in Appendix A-6, if the team does not understand the engineering and construction of the car.

#### 4.5.9 Judging Sequence

The actual format of the design event may change from year to year as determined by the organizing body. The event will normally involve three parts:

1. Initial judging of all vehicles
2. Semi- final judging of the top 10 to 20 vehicles
3. Final judging ranking the top 4 to 8 vehicles.



#### 4.5.10 Scoring

Scoring will be from 0 to 150 pts. at the judges discretion.

#### 4.5.11 Second Year Cars - Penalties For Insufficient Redesign

##### *Formula Student and Formula SAE Australasia Only*

The judges will deduct 20 points from the final design score for cars without a new frame. An additional 30 points may be deducted if the photographic documentation shows that the remaining parts of the vehicle have not been significantly changed (e.g. the intake manifold is obviously the same or it is obvious that the old suspension was simply bolted to a new frame, or none of the team members show an understanding of the design of various components). If the new frame is similar to last years, it is advisable to bring along evidence of the change (bringing along the old frame is not a bad idea). **Second year cars are prohibited in Formula SAE.**

#### 4.5.12 Photographic Requirements

All teams should provide photos of their vehicle upon entering the design tent. These photos should show the basic design of the major components. A total of four photos are recommended. These photos are to aid the judges in selecting semi-finalists and are not the photos that will be used for yearly documentation.

## 5. DYNAMIC EVENTS

### 5.1 DYNAMIC EVENTS

The maximum possible scores in the dynamic events are:

Acceleration	75 points
Skid Pad	50 points
Autocross	150 points
Fuel Economy	50 points
Endurance	<u>350 points</u>
Total	675 points

### 5.2 WEATHER CONDITIONS

The organizer reserves the right to alter the conduct and scoring of the competition based on weather conditions.

## 5.2.1 Running in Rain

### 5.2.1.1 Operating Conditions

The following operating conditions will be recognized at Formula SAE:

**Dry** – Overall the track surface is dry.

**Damp** – Significant sections of the track surface are damp.

**Wet** – The entire track surface is wet and there may be puddles of water.

**Weather Delay/Cancellation** – Any situation in which all, or part, of an event is delayed, rescheduled or canceled in response to weather conditions.

### 5.2.1.2 Decision on Operating Conditions

The operating condition in effect at any time during Formula SAE will be decided by the competition officials.

### 5.2.1.3 Notification

If the competition officials declare the track(s) to be "Damp" or "Wet",

- i). This decision will be announced over the public address system, and
- ii). A sign with either "Damp" or "Wet" will be prominently displayed at both the starting line(s) or the start-finish line of the event(s), and the entry gate to the "hot" area.

### 5.2.1.4 Tire Requirements

The operating conditions will determine the type of tires a car may run as follows:

**Dry** – Cars must run their Dry Tires, except as covered in 5.2.1.8.B.iii.

**Damp** – Cars may run either their Dry Tires or Rain Tires, at each team's option.

**Wet** – Cars must run their Rain Tires.

#### 5.2.1.5 Event Rules

All event rules remain in effect.

#### 5.2.1.6 Penalties

All penalties remain in effect.

#### 5.2.1.7 Scoring

No adjustments will be made to teams' times for running in "Damp" or "Wet" conditions. The minimum performance levels to score points may be adjusted if deemed appropriate by the officials.

#### 5.2.1.8 Tire Changing

A - During the Acceleration, Skid-Pad or Autocross Events:

Within the provisions of 5.2.1.4 above, teams may change from Dry Tires to Rain Tires or vice versa at any time during those events at their own discretion.

B - During the Endurance Event:

Teams may change from Dry to Rain Tires or vice versa at any time while their car is in the staging area inside the "hot" area.

All tire changes after a car has received the "green flag" to start the Endurance Event shall take place in the Driver Change Area.

i) If the track was "Dry" and is declared "Damp":

- Teams may start on either Dry or Rain Tires at their option.
- Teams that are on the track when it is declared "Damp", may elect, at their option, to pit in the Driver Change Area and change to Rain Tires under the terms spelled out below in "Tire Changes in the Driver Change Area".

ii) If the track is declared "Wet":

- A Red Flag will be shown at the Start/Finish Line and all cars will enter the Driver Change Area.

- Those cars that are already fitted with "Rain" tires will be allowed re-start without delay subject to the discretion of the Event Captain/Clerk of the Course.
  - Those cars without "Rain" tires will be required to fit them under the terms spelled out below in "Tire Changes in the Driver Change Area". They will then be allowed to re-start at the discretion of the Event Captain/Clerk of the Course.
- iii) If the track is declared "Dry" after being "Damp" or "Wet":
- The teams will NOT be required to change back to "Dry" tires.
  - Teams may elect to change back to "Dry" tires. However, the time taken to make such a change will be included in the team's total time for the event, i.e. it will not be subtracted from the total elapsed time.
- iv) Tire Changes in the Driver Change Area:
- Per Rule 5.7.8, no more than three people for each team shall be present in the Driver Change Area during any tire change, e.g. a driver and two crew or two drivers and one crew member.
  - No other work may be performed on the cars during a tire change.
  - Teams changing from "Dry" to "Rain" tires will be allowed a maximum of ten (10) minutes to make the change.
  - If a team elects to change from "Dry" to "Rain" tires during their scheduled driver change, they may do so, and the total allowed time in the Driver Change Area will be thirteen (13) minutes.
  - The time spent in the driver change area of less than 10 minutes without driver change, or 13 minutes with driver change, will not be counted in the team's total time for the event. Any time in excess of these times will be counted in the team's total time for the event.
  - If a team elects to change from "Rain" tires back to "Dry" tires, the time taken to make such a change will be included in the team's total time for the event, i.e. it will not be subtracted from the total elapsed time. However, a

change from "Rain" tires back to "Dry" tires will not be permitted during the driver change.

v) Tire Changes at Team's Option:

- As noted above, a team will be permitted to change tires at their option, if during their car running in the Endurance Event, the track was "Dry" and is declared "Damp", or the track is declared "Dry" after being "Damp" or "Wet".
- To make such a change, the following procedure must be followed:
  - Team makes the decision,
  - Team has tires and equipment ready near Driver Change Area,
  - The team informs the Event Captain/Clerk of the Course they wish their car to be brought in for a tire change,
  - Officials inform the driver by means of a sign or flag at the checker flag station,
  - Driver exits the track and enters the Driver Change Area in the normal manner.

### 5.3 DRIVER LIMITATIONS

An individual team member cannot drive in more than three events. The fuel economy event is considered a separate event although it is conducted simultaneously with another event.

An individual may not drive in both heats of any event. It is the team's option to participate in any event. The team may forfeit their second heat in any performance event..

**Note:** A minimum of four drivers in required to participate in all heats of the dynamic events



75 points

## 5.4 ACCELERATION EVENT

### 5.4.1 Acceleration Objective

The acceleration event evaluates the car's acceleration in a straight line on flat pavement.

### 5.4.2 Acceleration Procedure

The cars will accelerate from a standing start over a distance of 75 m (82 yards) on a flat surface. The foremost part of the car will be staged at 0.30 m (11.8 inches) behind the starting line. A green flag will be used to indicate the approval to begin, however, time starts only after the vehicle crosses the start line. There will be no particular order of the cars in each heat. A driver has the option to take a second run immediately after the first.

### 5.4.3 Acceleration Heats

There will be two heats. Each heat must have a different driver and each driver can have two runs. Starting order will be based upon time of arrival to the staging area. Heat 1 and 2 will not be run sequentially, but simultaneously. Heat 1 drivers will have starting priority over heat 2 drivers.

### 5.4.4 Tire Traction - Limitations

Special agents that increase traction may not be added to the tires or track surface and "burnouts" are not allowed.

### 5.4.5 Acceleration Scoring

The acceleration score is based upon the corrected elapsed time. Elapsed time will be measured from the time the car crosses the starting line until it crosses the finish line. A two (2) second penalty will be added for each DOO (including entry and exit gate cones) that occurred on that particular run to give the corrected elapsed time.

An Off Course (OC) will result in a DNF for that run.

Cars that have not run by the end of the event (determined by the organizer) will receive a Did Not Finish (DNF).



#### 5.4.6 Acceleration Scoring Formula

The score for the acceleration event is spread between zero (0) and seventy-five (75) based upon the elapsed time. The following equation is used to determine the scores for the event:

$$\text{ACCELERATION SCORE} = 71.5 \times \frac{(5.8/T_{\text{your}}) - 1}{(5.8/T_{\text{min}}) - 1} + 3.5$$

Where:

$T_{\text{your}}$  is the best corrected elapsed time for the team including penalties.

$T_{\text{min}}$  is the elapsed time of the fastest car.

The maximum acceptable acceleration time is 5.8 seconds corresponding to an average speed of 46.55 km/hr.

Negative “performance” points will not be given. However, 3.5 points will be given for a car that completes a run, even if  $T_{\text{your}}$  exceeds 5.8 seconds.

In the above equation, the first term on the right hand side is “performance” points”, while the second term represents “completion points,” or the minimum score for having successfully completed the event.

DNF = zero (0) points

### 5.5 SKID-PAD EVENT

**50 points**

#### 5.5.1 Skid-Pad Objective

The concept of the skid-pad event is to measure the cornering ability of the car on a flat surface while making a constant-radius turn.

#### 5.5.2 Skid-Pad Heats

Each car may compete in two heats. Each heat must have a different driver, and each driver may have two (2) runs.

Two separate skid-pad locations may exist. Heat one (1) will be run on skid-pad one (1) and Heat two (2) will be run on skid-pad two (2).

Heat one (1) drivers must complete both of their runs on skid-pad one (1), and heat two (2) drivers must complete both their runs on skid-pad (2).





If there is only one skid-pad location, then both heat one (1) and heat two (2) will be run on the same skid-pad at the same time.

### 5.5.3 Skid-Pad Heat Priority

There will be no distinction between heat one (1) and heat two (2) and there will be no particular starting order. Heat one (1) drivers will have a starting priority over heat two (2) drivers. Cars which have not run by the event closing (determined by the organizer) will receive a DNF for the event.

### 5.5.4 Skid-Pad Layout

There will be two circles of 15.25 m (50.03 feet) diameter in a figure eight pattern. The circle centers will be separated by 18.25 m (59.88 feet), and a driving path 3.0 m (9.84 feet) in width will be marked with pylons and a chalk line just outside the pylons. The start/stop line is defined by the centers of the two (2) circles. A lap is defined as traveling around one (1) of the circles from the start/ stop line and returning to the start/stop line.

### 5.5.5 Skid-Pad Layout - Pylons

Sixteen (16) pylons will be placed around the inside of each circle and sixteen (16) around the outside of each circle. Additional pylons will establish the required entry and exit gates. Also, a cone will be placed in the middle of the exit gate to prevent drivethroughs until the finish lap.

### 5.5.6 Skid-Pad Procedure

The cars will enter perpendicular to the figure eight and will take one full lap on the right circle to establish the turn. The next lap will be on the right circle and will be timed. Immediately following the second lap, the car will enter the left circle for the third lap. The fourth lap will be on the left circle and will be timed. Immediately upon finishing the fourth lap, the car will exit the track. The car will exit at the intersection moving in the same direction as entered. A driver has the option to take a second run immediately after the first.

### 5.5.7 Skid-Pad Penalties

The elapsed time for the right and left circle will be averaged together after the following penalties have been assessed.

#### 5.5.7.1 Cones Down Or Out (DOO)

A penalty of 0.25 seconds will be added to the time for every cone that is knocked “down or out” (including gate cones).

#### 5.5.7.2 Off Course

Cars that spin-out can continue as long as they have not gone off course. Cars going off course are classified DNF.

#### 5.5.7.3 Incorrect Number of Laps

Cars that run an incorrect number of laps are classified as DNF.

### 5.5.8 Skid-Pad Scoring

The skid-pad score is computed based upon the lateral acceleration capability. Lateral acceleration (typically referred to as G’s) is computed from  $2.012 \text{ diameter}/t^2$ . A diameter of 17.10 m will be assumed in computing lateral G’s. If there are two separate skid-pad locations, then the score will be based on the best run from either skid-pad.

The first term on the right-hand side of the equation represent “performance points,” while the second term represents “completion points,” or the minimum score for having successfully completed the event. The following equation is used to determine the scores for the skid-pad event:

$$\text{SKID-PAD SCORE} = 47.5 \times \frac{(6.184/T_{\text{your}})^2 - 1}{(6.184/T_{\text{min}})^2 - 1} + 2.5$$

Where:

**T<sub>your</sub>** is the average of the left and the right timed laps on your best run including penalties.

**T<sub>min</sub>** is the elapsed time of the fastest car.

The minimum acceptable lateral acceleration to get “performance” points is 0.90 G’s corresponding to 6.184 seconds per circle. Negative “performance” points will not be given. However, 2.5 points will be given for a car that completes a run that exceeds 6.184 seconds per circle AND is not classified as a DNF.



## 5.6 AUTOCROSS EVENT

150 points

### 5.6.1 Autocross Concept

The concept of the autocross event is to evaluate the car's maneuverability and handling qualities on a tight course without the hindrance of competing cars. The autocross course will combine the performance features of acceleration, braking, and cornering into one event.

### 5.6.2 Autocross Procedure

There will be two Autocross-style heats, with each heat having a different driver. The car will be staged such that the front wheels are 2 m behind the starting line. The timer starts only after the car crosses the start line. There will be no particular order of the cars to run each heat but a driver has the option to take a second run immediately after the first. Two (2) timed laps will be run (weather and time permitting) by each driver and the best lap time will stand as the time for that heat. The organizer will determine the allowable windows for each heat and retains the right to adjust for weather or technical delays. Cars that have not run by the end of the heat will be disqualified for that heat.

### 5.6.3 Autocross Course Specifications & Speeds

The following specifications will suggest the maximum speeds that will be encountered on the course. Average speeds should be 40 km/hr (25 mph) to 48 km/hr (30 mph).

**Straights:** No longer than 60 m (200 feet) with hairpins at both ends (or) no longer than 45 m (150 feet) with wide turns on the ends.

**Constant Turns:** 23 m (75 feet) to 45 m (148 feet) diameter.

**Hairpin Turns:** Minimum of 9 m (29.5 feet) outside diameter (of the turn).

**Slaloms:** Cones in a straight line with 7.62 m (25 feet) to 12.19 m (40 feet) spacing.

**Miscellaneous:** Chicanes, multiple turns, decreasing radius turns, etc. The minimum track width will be 3.5 m (11.5 feet).

The length of each run will be approximately 0.805 km (1/2 mile) and the driver will complete a specified number of runs. The time required to



complete each run will be recorded and the time of the best run will be used to determine the score.

#### 5.6.4 Autocross Penalties

The cars are judged on elapsed time plus penalties. The following penalties will be added to the elapsed time:

##### 5.6.4.1 Cone Down or Out (DOO)

Two (2) seconds per cone, including any after the finish line.

##### 5.6.4.2 Off Course

Driver must re-enter the track at or prior to the missed gate or a twenty (20) second penalty will be assessed. Penalties will not be assessed for accident avoidance or other reasons deemed sufficient by the track officials.

If a paved road edged by grass or dirt is being used as the track, e.g. a go cart track, four (4) wheels off the paved surface shall count as an "off course". Two (2) wheels off will not incur an immediate penalty, however, consistent driving of this type may be penalized at the discretion of the event officials.

##### 5.6.4.3 Missed Slalom

Missing one or more gates of a given slalom will be counted as one "off-course" per occurrence. Each occurrence will incur a twenty (20) second penalty.

#### 5.6.5 Stalled & Disabled Vehicles

If a car stalls and cannot restart itself without external assistance, the care will be deemed disabled. Cars deemed disabled will be cleared from the track by the track workers. At that time, two (2) team members may retrieve the car to the paddock. The track workers will signal for more team members as required.

#### 5.6.6 Corrected Elapsed Time

The elapsed time plus any penalties from that specific run will be used as the corrected elapsed time. Cars that are unable to complete the course



with an average speed of 80% of the fastest car will not be awarded “performance” points. This means that any autocross time in excess of 125% of the fastest time will receive no “performance” points.

### 5.6.7 Autocross Scoring Formula

In the equation below, the first term on the right hand side represents “performance” points, while the second term, or “completion” points represents the minimum score for having successfully completed the event. The following equation is used to determine the autocross score:

$$\text{AUTOCROSS SCORE} = 142.5 \times \frac{(T_{\max}/T_{\text{your}}) - 1}{(T_{\max}/T_{\min}) - 1} + 7.5$$

Where:

**T<sub>min</sub>** is the lowest corrected elapsed time recorded for any competitor in either heat

**T<sub>max</sub>** is 125% of T<sub>min</sub>

**T<sub>your</sub>** is the lowest corrected elapsed time in either heat for the team being scored.

Negative “performance” points will not be given. However, 7.5 points will be given for a car that completes a run, even if T<sub>your</sub> exceeds 125% of the fastest time (T<sub>min</sub>)

## 5.7 ENDURANCE AND FUEL ECONOMY EVENT

**400 points**

Notice: At Formula SAE the endurance & fuel economy event will consist of a single heat.

### 5.7.1 Right to Change Procedure

The following are general guidelines for conducting the endurance and fuel economy event. The organizer reserves the right to establish procedures specific to the conduct of the event at the site. All such procedures will be made known to the teams through newsletters or the SAE website.



### 5.7.2 Endurance Objective—350 points

The Endurance Event is designed to evaluate the overall performance of the car and to test the car's reliability.

### 5.7.3 Fuel Economy—50 points

The car's fuel economy will be measured in conjunction with the endurance event. The fuel economy under racing conditions is important in most forms of racing and also shows how well the car has been tuned for the competition. This is a compromise event because the fuel economy score and endurance score will be calculated from the same heat. No refueling will be allowed during an endurance heat.

### 5.7.4 Endurance Course Specifications & Speeds

Course speeds can be estimated by the following course specifications. Average speed should be 48 km/hr (29.8 mph) to 57 km/hr (35.4 mph) with top speeds of approximately 105 km/hr (65.2 mph).

**Straights:** No longer than 77.0 m (252.6 feet) with hairpins at both ends (or) no longer than 61.0 m (200.1 feet) with wide turns on the ends. There will be passing zones at several locations.

**Constant Turns:** 30.0 m (98.4 feet) to 54.0 m (177.2 feet) diameter.

**Hairpin Turns:** Minimum of 9.0 m (29.5 feet) outside diameter (of the turn).

**Slaloms:** Cones in a straight line with 9.0 m (29.5 feet) to 15.0 m (49.2 feet) spacing.

**Miscellaneous:** Chicanes, multiple turns, decreasing radius turns, etc. The minimum track width will be 4.5 m (14.76 feet).

### 5.7.5 Endurance General Procedure

The event will be run as a single 22 km (13.66 mile) heat. Teams will not be allowed to work on their vehicles during the heat. A driver change must be made during a three-minute period at the mid point of the heat.

#### 5.7.6 Endurance Fuel Fill

Before entering the event each vehicle's fuel tank must be filled to the fuel level line (see section 3.5.3.3, Fuel Level Line) at the fueling station. During fueling, once filled to the scribe line, no shaking or tilting of the tank or fuel system (incl. entire vehicle) is allowed.

#### 5.7.7 Endurance Vehicle Starting/ Restarting

The vehicle must be capable of starting / restarting without external assistance at all times once the vehicle has begun the heat. If the vehicle cannot be started / restarted without external assistance, the car will be deemed disabled and will be disqualified from the heat.

#### 5.7.8 Endurance Driver Change Procedure

Elapsed time will begin when Driver A enters the course and crosses the timing line. Driver A will drive for 11 km, and pull into the driver change area. Three (3) minutes are allowed for the team to change drivers.

Driver A will exit the vehicle and any necessary adjustments will be made to the vehicle to fit Driver B (seat cushions, pedal position, etc.). Only three (3) team members, including the driver or drivers, will be allowed in the driver change area, and only the tools necessary to change drivers and/or tires will be carried into this area (no tool chests etc.). Extra people entering the driver change area will result in a 20 pt penalty to the final endurance score for each extra person entering the area.

Driver B will then be secured in the vehicle. The driver change area will be placed such that the timing system will see the driver change as an extra long lap. Unless this driver change takes longer than three minutes, this extra long lap will not count. If the driver change takes longer than three minutes, the extra time will be counted into the final time.

Driver B will drive for 11 km, and elapsed time will stop when the car completes the total 22 km distance.

Driver B will proceed directly to the fueling station. The tank will be filled to refill mark and the amount will be recorded.

#### 5.7.9 Entering the Track

Cars will be allowed to enter the track based upon the level of traffic on the course. The number of vehicles simultaneously on the course depends



on the track length and design as well as the operating conditions. In dry conditions, there are typically 5 to 7 vehicles allowed per kilometer of track. This includes cars in the driver change area.

Because repairs will not be allowed during the heat, and there will be no refueling during the heat, there will not be a restart queue of any kind.

#### 5.7.10 Endurance Run Order

The run order for the heat will be based off the results of the autocross event, with the fastest team first followed by the second fastest, etc. Teams will be expected to keep track of the run order and have their vehicle fueled and ready in time for their turn to run. If a team is not ready to start when their turn arrives (i.e. at the starting line, full of fuel and ready to start the vehicle), they will be penalized two minutes and be allowed to run at the end of the heat (time permitting). It is recommended that teams show up at the refueling station at least a half hour before the event, as it will be the team's responsibility to be refueled on time to run.

#### 5.7.11 Breakdowns & Stalls

If a vehicle breaks down it will be removed from the course and will not be allowed to re-enter the course (if a vehicle stalls, or ingests a cone, etc., it will be allowed to restart and re-enter the course where it went off, but no work may be performed on the vehicle). If the car stalls and cannot be restarted without external assistance, the track workers will push the car clear of the track. At that time, two (2) team members may retrieve the car under direction of the track workers.

#### 5.7.12 Endurance Minimum Speed Requirement

If a car is unable to maintain lap times within 133% of the fastest lap time for the course, then it must exit immediately.

#### 5.7.13 Exiting the Course

Vehicles must power down after leaving the course and be pushed into and out of the fueling area.

Fuel pumps will be turned on and fuel valves will be opened to insure complete refueling.





#### 5.7.14 Endurance Lap Timing

Each lap of the endurance event will be individually timed either by electronic means, or by hand. The time for an individual heat will be determined by subtracting the extra long lap for the driver change from the total time and adding any penalty points.

#### 5.7.15 Endurance Penalties

Penalties will not be assessed for accident avoidance or other reason deemed sufficient by the track official.

Further driving rules and the meaning of flags are discussed in the Driving Rules section.

The following penalties will be assessed:

##### 5.7.15.1 Cones

Cone down or out (DOO) - two (2) seconds per cone. This includes cones before the start line and after the finish line.

##### 5.7.15.2 Off Course (OC)

For an OC, the driver must re-enter the track at or prior to the missed gate or a twenty (20) second penalty will be assessed.

If a paved road edged by grass or dirt is being used as the track, e.g. a go kart track, four (4) wheels off the paved surface shall count as an "off course". Two (2) wheels off will not incur an immediate penalty. However, consistent driving of this type may be penalized at the discretion of the event officials.

##### 5.7.15.3 Missed Slalom

Missing one or more gates of a given slalom will incur a twenty (20) second penalty.

##### 5.7.15.4 Penalties for Moving Violations

The following are penalties and assessed times or disqualifications for moving violations:

- a. Failure to obey a flag: 1 minute
- b. Over Driving (After a closed black flag): 1 Minute
- c. Vehicle to Vehicle contact: DISQUALIFIED

#### 5.7.15.5 Out of Order

Running out of order – two (2) minute penalty.

#### 5.7.15.6 Mechanical Problem

No additional penalty other than the time lost to ensure that the car is safe to continue.

#### 5.7.15.7 Reckless or Aggressive Driving

Any reckless or aggressive driving behavior (such as forcing another car off the track, refusal to allow passing, or close driving that would cause the likelihood of car contact) will result in a black flag for that driver. When a driver receives a black flag signal, he must proceed to the penalty box to listen to a reprimand for his driving behavior. The amount of time spent in the penalty box will vary from zero to four minutes depending upon the severity of the offense.

#### 5.7.15.8 Inexperienced Driver

The Chief Course Judge may disqualify a driver in the interest of safety if the driver is too slow or too aggressive, resulting in a DNF.

#### 5.7.15.9 Poor Fuel Economy

Mileage exceeding 26 liters/100 km – four (4) minutes.

If it is impossible to impose a penalty by a stop under a black flag, e.g. not enough laps left, the event officials may add an appropriate time penalty to the team's elapsed time.

#### 5.7.16 Endurance Scoring

The score for the Endurance Track Event is the sum of the Endurance Time Score and the Endurance Finish Score. The Endurance Time Score is based on the team's time for the event, including penalties, compared to the fastest team. A car will also receive an Endurance Finish Score of fifty (50) points if the team's time for the event, including penalties, is less than



or equal to the maximum allotted time. The total Endurance Score is calculated using the formula below.

#### 5.7.17 Endurance Scoring Formula

The times for the endurance event will be based upon the sum of the times of each driver in the heat plus penalties.

The following equation is used to determine the time scores for the event:

If  $T_{\text{your}}$  is  $<$  or  $=$  to  $T_{\text{max}}$  :

$$\text{ENDURANCE SCORE} = 300 \times \frac{(T_{\text{max}}/T_{\text{your}})^{-1}}{(T_{\text{max}}/T_{\text{min}})^{-1}} + 50$$

If  $T_{\text{your}} > T_{\text{max}}$ : ENDURANCE SCORE = 0 (ZERO)

$T_{\text{min}}$  will be the lowest corrected time of the fastest team of the event.

$T_{\text{your}}$  will be the combined corrected times of the drivers in your heat.

$T_{\text{max}}$  will be based upon an average speed of 75% of the fastest team of the event; therefore,  $T_{\text{max}}$  will be 1.333 times  $T_{\text{min}}$ .

#### 5.7.18 Fuel Economy

The fuel economy score is based on the average liters per kilometer fuel economy obtained during the endurance heat.

#### 5.7.19 E85 Correction Factor

The volume of E85 fuel will be divided by a 1.40 correction factor to determine the gasoline equivalent volume. This correction factor is equal to the ratio of energy (lower heating value) per unit volume of gasoline to E85.

#### 5.7.20 Fuel Economy Scoring Formula

The following equation will be used to determine the fuel economy score:



$$\text{FUEL ECONOMY SCORE} = 50 \times \frac{(V_{\max}/V_{\text{your}}) - 1}{(V_{\max}/V_{\min}) - 1}$$

Where:

**V<sub>max</sub>** is equal to 5.72 liters (1.51 gallons) and will be adjusted to represent 26 liters/km (9.04mpg) if the course is shortened or lengthened

**V<sub>min</sub>** is the smallest volume of fuel used by any competitor

**V<sub>your</sub>** is the volume of fuel used by the team being scored

Vehicles which consume more than 5.72 liters of fuel during the course of the endurance heat or whose corrected time exceeds 1.333 times the corrected time of the fastest team, will receive 0 pts. for fuel economy.

For shortened courses, **V<sub>min</sub>** will be the low value per heat. Fuel economy scores can range from zero (0) to fifty (50) points.

#### 5.7.21 Post Event Engine Check

The organizer reserves the right to impound any vehicle immediately after the event to check engine displacement (method to be determined by the organizer) and restrictor size.

## 5.8 FLAGS

The flag signals convey the commands described below, and shall be obeyed immediately and without question.

### 5.8.1 Flagging for Formula SAE

There are two kinds of flags for the competition: Command flags and Informational flags. Command flags are just that, flags that send a message to the competitor that the competitor must obey without question. Informational flags, on the other hand, require no action from the driver, but should be used as added information to help him or her to maximize performance. What follows is a brief description of what each flag means for this competition.

## COMMAND FLAGS

**YELLOW FLAG** - Danger, SLOW DOWN, be prepared to take evasive action, something has happened beyond the flag station. NO PASSING unless directed by the corner workers.

**YELLOW FLAG (Waived)** - Great Danger, SLOW DOWN, evasive action is most likely required, BE PREPARED TO STOP, something has happened beyond the flag station, NO PASSING unless directed by the corner workers.

**BLUE FLAG** - Pull into the designated passing zone to be passed by a faster competitor. Obey the corner workers hand signals at the end of the passing zone to safely merge into competition.

**RED FLAG** - Come to an immediate safe controlled stop on the course. Pull to the side of the course as much as possible to keep the course open. Follow corner worker directions.

**BLACK FLAG** - Pull into the penalty box for discussion with the Director of Operations or other official concerning an incident. A time penalty may be assessed for such incident.

**BLACK FLAG With Orange Dot** - Pull into the penalty box for a mechanical inspection of your car, something has been observed that needs closer inspection.

**GREEN FLAG** - Your session has started, enter the course under direction of the starter. (NOTE: If you stall the vehicle, please restart and await another green flag as the opening in traffic may have closed.)

**CHECKER FLAG** - Your session has been completed. Exit the course at the first opportunity.

## INFORMATIONAL FLAGS

**RED AND YELLOW STRIPED FLAG** - Something is on the racing surface that should not be there. Be prepared for evasive maneuvers to avoid the situation. (Corner workers may be able to point out what and where it is located, but do not expect it.)

**WHITE FLAG** - There is a slow moving vehicle on the course that is much slower than you are. Be prepared to approach it at a cautious rate.



## 5.9 RULES OF CONDUCT

### 5.9.1 Competition Objective

The Formula SAE® event is a design engineering competition that requires performance demonstration of vehicles and is NOT a race. Engineering ethics will apply. It is recognized that hundreds of hours of labor have gone into fielding an entry into Formula SAE. It is also recognized that this event is an “engineering educational experience” but that it often times becomes confused with a high stakes race. In the heat of competition, emotions peak and disputes arise. Our officials are trained volunteers and maximum human effort will be made to settle problems in an equitable, professional manner.

### 5.9.2 Violations of Intent

In all events, violation of the intent of the rule will be considered a violation of the rule.

### 5.9.3 Loopholes & Problems

Any perceived loopholes or potential problems should be identified in writing to the organizer. The organizer will then clarify the matter and advise all participants.

### 5.9.4 Unsportsmanlike Conduct

In the event of unsportsmanlike conduct, the team will receive a warning from an official. A second violation will result in expulsion of the team from the competition.

### 5.9.5 Arguments with Officials

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

### 5.9.6 Alcohol and Illegal Material

No alcohol, illegal drugs, weapons or other illegal material will be permitted on the event site during the competition. This rule will be in



effect during the entire competition. Any violation of this rule by a team member will cause the expulsion of the entire team. This applies to both team members and faculty advisors. Any use of drugs, or the use of alcohol by an underage individual, will be reported to the local authorities for prosecution.

#### 5.9.7 Parties

Disruptive parties either on or off-site should be prevented by the Faculty Advisor.

#### 5.9.8 Trash Clean-up

Cleanup of trash and debris is the responsibility of the teams. The team's work area should be some defined area that should be kept uncluttered. At the end of the day, each team will clean all debris from their area and help with maintaining a clean paddock. Teams are required to remove all of their material and trash when leaving the site at the end of the competition

Teams that abandon furniture, or that leave a paddock that requires special cleaning, will be billed for removal and/or cleanup costs.

### 5.10 GENERAL RULES

#### 5.10.1 Dynamometer Usage

If a dynamometer is available, it may be used by any competing team during the specified time. All vehicles to be dynamometer tested must have acquired the safety & technical inspection decal prior to testing. Fuel, ignition and drivetrain tuning will be permitted while testing on the dynamometer.

#### 5.10.2 Problem Resolution

Any problems that arise during the competition will be resolved through the Operations Center and the decision will be final.

#### 5.10.3 Protests

**(A) Required Review** - Any team that intends to protest a rule, score, judge's decision or any other aspect of the competition, must present the



issue to SAE staff or the event captain for discussion, and possible resolution before the protest is filed.

**(B) Cause for Protest** - If a faculty advisor or team captain feels a complaint about an official action or rules interpretation was not properly addressed by event officials, he/she may protest. Protests should be filed by the team steward.

**(C) Protest Period** - Protests must be filed within one (1) hour after the scores for the activity involving the protest subject are posted.

**(D) Protest Format** - All protests must be in writing and submitted to designated organizer. Protest forms may be obtained from the organizer.

**(E) Protest Bond** - The protesting team must post a twenty (20) point bond to be deducted from their score if the protest is denied.

**(F) Decision** - The decision of the judges or organizers regarding any protest is final.

#### 5.10.4 Forfeit for Non-Appearance

It is the responsibility of teams to be in the right place at the right time. If a car is not ready to compete at the scheduled time, then the team forfeits the run of the event and will not be offered a late make-up.

#### 5.10.5 Drivers Meetings

All drivers for an event are required to attend the pre-event drivers meeting. The driver for an event will be disqualified if he does not attend the driver meeting for the event.

#### 5.10.6 Personal Vehicles

Personal cars and trailers must be parked in designated areas only. Only FSAE competition vehicles will be allowed in the track areas.

#### 5.10.7 Understanding the Rules

Teams are responsible for reading and understanding the rules in effect for each competition. The section and paragraph headings in these rules are provided only to facilitate reading; they do not affect paragraph contents.





### 5.10.8 Motorcycles, Bicycles, Rollerblades, etc.—Prohibited

The use of motorcycles, quads, bicycles, scooters, skateboards, rollerblades or similar person-carrying devices by team members in any part of the competition area, including the paddocks, is prohibited.

## 5.11 PIT RULES

### 5.11.1 Moving Vehicles

Vehicles may not move under their own power anywhere but the practice or competition tracks. Off track vehicles must be pushed at a normal walking pace and with a team member walking beside the car. Cars with wings are required to have two team members walking on either side of the vehicle whenever the vehicle is in motion. During the performance events when the excitement is high, it is particularly important that the car be moved at a very slow pace in the pits; the walking rule will be enforced and point penalties will be assessed for violations of this rule.

### 5.11.2 Smoking - Prohibited

Smoking is prohibited in all competition areas.

### 5.11.3 Refueling

Race officials must conduct all refueling.

### 5.11.4 Engine Running in the Paddock

Engines may be run in the paddock provided the car has passed technical and safety inspection **and** one or more of the following safety conditions is satisfied:

- (A) A driver wearing full safety gear is in the cockpit
- (B) The car is on an adequate stand and the drive wheels are at least 10.2 cm (4 in) off the ground
- (C) The drive wheels have been removed.



## 5.12 DRIVING RULES

### 5.12.1 Off Course Vehicle Movement

Cars may **not** have their engines running when moving the car outside the practice track or running in an event. Cars must be pushed at a normal walking pace with a second team member walking beside the car.

### 5.12.2 Driver Equipment

The driver safety equipment specified in 3.4.2 must be worn whenever the vehicle is moving under its own power or is running on a chassis dynamometer.

### 5.12.3 Practice Track

At the discretion of the organizer a practice area may be provided to test and tune the cars. The practice area will be supervised and the number of cars in the area controlled. The cars may not be driven under power anywhere except in the practice area and during the actual events. Practice at any location other than the authorized practice track is absolutely prohibited. Competition cars are prohibited from driving at any time (day or night) other than in official competition or the practice areas. Unauthorized testing will result in a point penalty or disqualification at the organizer's discretion.

Cars using the practice track must have all technical and safety inspection stickers.

### 5.12.4 Endurance Event Safety

The safety of this competition and especially the endurance track event will be considered as the ultimate responsibility of the competitors. Thus, aggressive driving, running cars off the track, not yielding to passing signals, etc. will result in a black flag and a discussion of the driving behavior with competition officials in the penalty box. The time spent in the penalty box will be included in run time and serve as a reprimand as well as to inform the driver exactly what he/she did wrong. Drivers should be especially aware that open-wheeled cars are inherently dangerous due to the possibility of two tires touching and throwing one car into the air. The endurance event is a timed event; each driver is competing with the



clock and is not racing other cars; therefore, aggressive driving is not necessary.

#### 5.12.5 Endurance Event - Passing

Passing during the Endurance Event is of primary concern. Two or more passing zones will be established on the track. Passing is allowed only in the passing zones and will be controlled by the track officials. These passing rules do not apply to a competing car passing cars that are disabled on the track or have spun-out and are not moving. The passing zones will be located at the exit of a turn onto a straightaway. There will be two parallel lanes separated by pylons. Upon entrance to the turn, the slower car will be blue flagged and will move to the inside of the turn and enter the inside passing lane; the faster car will move to the outside of the turn and will enter the outside lane. The faster car will make the pass in the outside lane and a flagman at the exit of the inside passing lane will signal the slower car when it can re-enter the track (after the faster car has completed the pass). All cars will use the outside lane under normal conditions.

**Driver's Meetings:** ALL DRIVERS OF AN EVENT MUST ATTEND THE DRIVER'S MEETING FOR THE EVENT OR BE DISQUALIFIED FOR THAT EVENT. THE FACULTY ADVISOR WILL VERIFY ATTENDANCE.

### 5.13 DEFINITIONS

DOO - A cone is "Down or Out"--If a cone has been knocked over or the entire base of the cone lies outside the box marked around the cone in its undisturbed position.

DNF- Did Not Finish

Gate - The path between two cones through which the car must pass. Two cones, one on each side of the course define a gate: Two sequential cones in a slalom define a gate.

Entry Gate -The path marked by cones which establishes the required path the vehicle must take to enter the course.

Exit Gate - The path marked by cones which establishes the required path the vehicle must take to exit the course.

Staging Area - An area prior to the entry to an event for the purpose of gathering those cars that are about to start.



OC - A car is Off Course if it does not pass through a gate in the required direction.

## **6. NOTICE OF POSSIBLE RULE CHANGES FOR THE 2005 FORMULA SAE SERIES**

This section is intended to provide teams with advance notice of possible changes to the Formula SAE Rules which are being considered by the Formula SAE Rules Committee. Only changes which may have a significant influence on a team's engineering design and manufacturing decisions are listed. This section is provided only for information and is not intended to be the final text of the rules under consideration.

For 2005 - No changes that are likely to have a significant impact on the design or fabrication of cars for the 2005 Formula SAE series have been proposed.



## 7. QUESTIONS ABOUT THE FORMULA SAE RULES

Questions about the rules governing the competitions of the Formula SAE series, including requests for interpretation, must be submitted in writing by e-mail to the rules respondent for the specific competition (s) your team is entering.

### **Teams entering Formula SAE:**

Send questions to:

Kathleen McDonald, Creative Consulting Services

Email: [katklauz@aol.com](mailto:katklauz@aol.com)

### **Teams entering only Formula Student:**

Send questions to:

Brian Robinson, IMechE

Email: [B\\_Robinson@imeche.org.uk](mailto:B_Robinson@imeche.org.uk)

### **Teams entering only Formula SAE-Australasia:**

Send questions to:

Pat Clarke

Email: [jpatc@ozemail.com.au](mailto:jpatc@ozemail.com.au)

All questions and responses concerning the rules and the competition will be made available to all participants.

## 8. IMPORTANT FORMS AND DOCUMENTS

The following forms and documents are available to download at <http://www.sae.org/students/formula.htm> in Microsoft Word or Excel Format:

- 1. FSAE Event Safety Structure Equivalency Form – see Appendix A-1**
- 2. FSAE Tech Sheet**
- 3. Cost Report Supplement – see Appendix A-2**
- 4. Design Specification Sheet**



### APPENDIX A-1

### FSAE™ SAFETY STRUCTURE EQUIVALENCY FORM

If required, this form must be completed and submitted **no later the date specified in the Action Deadlines**. The FSAE Technical Committee will review all submissions which deviate from the FSAE® rules for Roll-over Protection or Side Impact Protection. This form must also accompany the vehicle to Safety and Technical Inspection.

Safety Structure Equivalency Forms (SSEF) and supporting calculations must be submitted electronically in Adobe Acrobat Format (\*.pdf). The submissions must be named as follows: schoolname\_ssef.pdf using the complete school name. **Please submit to the person indicated in the Action Deadlines for each event.**

\*In the event that the FSAE Technical Committee requests additional information or calculations, teams have **one week from the date of the request** to submit the requested information.

University Name \_\_\_\_\_  
 Team Contact \_\_\_\_\_  
 Telephone Number & E-mail Address \_\_\_\_\_  
 Faculty Advisor \_\_\_\_\_  
 Telephone Number & E-mail address \_\_\_\_\_

- Rule Deviated: (check all that apply)
- 3.3.4.2 Main Roll Hoop
  - 3.3.4.2. Main Roll Hoop Attachment to Monocoque
  - 3.3.4.3 Front Roll Hoop Material
  - 3.3.5.1 Main Roll Hoop Bracing
  - 3.3.5.2 Front Roll Hoop Bracing
  - 3.3.5.3 Monocoque Bracing Attachment
  - 3.3.6.1 Front Bulkhead
  - 3.3.6.1 Monocoque Front Bulkhead
  - 3.3.8 Side Impact Protection Material
  - 3.3.8.2 Composite Monocoque Side Impact Protection
  - 3.3.8.3 Metal Monocoque Composite Side Impact Protection
  - 3.4.1.d Monocoque Safety Harness Attachment

### ATTACH PROOF OF EQUIVALENCY

Roll bar documentation should include material type(s), material certification(s), properties, heat treatment, and strength calculations showing equivalency. Side impact documentation should include material type(s), material certification(s), properties, heat treatment, cloth weights, resin type, fiber orientation, number of layers, core material, lay-up technique, and strength calculations showing equivalency.

### TECHNICAL COMMITTEE DECISION/COMMENTS

Approved by \_\_\_\_\_ Date \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



**APPENDIX A-2**  
**2004 FSAE COST EVENT ADDENDUM**

**School:** \_\_\_\_\_ **Car Number:** \_\_\_\_\_

(Please indicate decreases using bracketed numbers.)

	Section	Original Reported Total	New Reported Total	Difference	Cost Judge Initials
1					
2					
3					
4					
5					
6					
7					
8					

TOTAL VEHICLE     \$ \_\_\_\_\_     \$ \_\_\_\_\_     \$ \_\_\_\_\_

Explanation of differences listed above:

1
2
3
4
5
6
7
8

Accepted by: _____ Entered by: _____
Date: _____ Date/Time: _____

**Addendums will be accepted only at the time of registration on-site at the competition!**

These forms will then be forwarded to the cost judges the morning of the cost event.



### APPENDIX A- 3

The 2004 FSAE TM Cost Report must follow the organized list of systems and components outlined below. Any questions as to the correct location of the specific items **should be submitted to the rules committee by March 1, 2004 and clarification will be made.**

#### 1) Brake System . . .

Brake Fluid	Brake Master Cylinder	Area Total
Brake Lines	Brake Discs	Graphics and/or photos
Calipers	Fasteners	Receipts/Back-up
Brake Pads	Sub-totals of sub-components	

#### 2) Engine and Drivetrain . . .

Engine	Fuel Tank	Axles
Engine Mfr (Name)	Fuel Pump	Differential Mounts
Engine (cc)	Fuel Pressure Reg.	Sprocket/Pulleys
Displacement	Fuel Filter	Differential Bearings
Exhaust Manifold	Fuel Lines/Rails	Differential
Muffler	Fuel Vent/Check Valve	CV Joints/U Joints
Intake Manifold	Radiator	Shields
Restrictor	Coolant	Engine/Diff Oil
Air Filter	Overflow Bottles	Fasteners
Turbo/Super Charger	Coolant Lines	Sub-Totals of Sub-
Components		
Carburetor / Throttle Body	Radiator Fans	Area Total
Engine Mounts	Hose Clamps	Graphics And/Or
Photographs		
Oil Filter	Oil Cooler	Receipts/Back-Up
Spark Plugs	Chain / Belt	
Fuel Injectors	Ignition Coil / Wires	

#### 3) Frame & Body . . .

Pedals	Body Material	Shifter Cable/Linkage
Shifter	Body Processing	Final Assembly
Throttle Controls	Body Attachments	Fasteners
Frame / Frame Tubes	Mounts Integral to Frame	Sub-Totals of Sub-
Components		
Welding	Floor Pan	Area Total
Tubes Cuts/Bends	Clutch	Graphics and/or Photographs
Tube End Preps	Aerodynamic Wing (if used)	Receipts/Back-Up





#### 4) Instruments, Wiring and Accessories . . .

Tachometer	Brake Light Bulb	Fasteners
ECM/Engine Electronics	Solenoids	
Wire Harness/Connectors	Indicator Lights	Area Total
Oil Pressure Gage/Light	Battery	Graphics and/or Photographs
Dash Panel	Relays	Receipts/Back-Up
Kill Switch		
Fuses	Starter Button	
Water Temperature Gage		
Sub-Totals of Sub-Components		

#### 5) Miscellaneous, Safety, Finish and Assembly . . .

Seats		
On-Board Fire Suppression Sys.		
Sub-Totals of Sub-Components		
Safety Harness	Fire Wall Area	Total
Paint - Frame	Mirrors	Graphics/Photographs
Paint - Body	Safety Shields	Receipts/Back-Up
Brake Light - Housing	Headrest / Restraints	

#### 6) Steering System . . .

Steering Rack	Steering Wheel Quick Release	Area Total
Tie Rods	Fasteners	Graphics/Photographs
Steering Shaft	Sub-Totals of Sub-Components	Receipts/Back-Up
Steering Wheel		

#### 7) Suspension and Shocks . . .

Shocks		Rod Ends
Sub-Totals of Sub-Components		
Springs	Front Uprights	Area Total
Suspension Mechanism	Rear Uprights	Graphics And/Or
Photographs		
Pushrods/Pullrods	Fasteners	Receipts/Back-Up
A/Arms or Equivalent		



## 8) Wheels, Wheel Bearings and Tires . . .

Wheels	Wheel Bearings	
Sub-Totals of Sub-Components		
Lug Nuts	Front Hubs	Area Total
Tires	Rear Hubs	Graphics/Photographs
Valve Stems	Wheel Studs	Receipts/Back-Up
Wheel Weights	Fasteners	

### Report Evaluation (Overall Presentation)

The cost report will be evaluated for Content, Accuracy, and Organization.

It should contain:

Cover / Binder - including car number and school name (required)

Cover Sheet

Table of Contents

Cost Summary Page

Tabs for each section

Process descriptions of up to ten pages for each section (required)

Bill of Material (required)

Assembly Labor Total in each BOM section (required)

Back up Data

Graphics/Photos

Electronic copy of the BOM in Excel Office 97 (required) on a single 3.5" floppy disk (preferred) or a CD-ROM (accepted)

### Note:

**After each section or area, please include the corresponding pictures, sketches, diagrams, blueprints (if possible), back-up and receipts necessary for that area. The cost of fasteners and brackets are to be included in their respective sub-assemblies. The labor and operations to process the component or sub-assemblies must be included in each sub-assembly as if each assembly were purchased from a separate supplier and the car was assembled as a finished product.**



## APPENDIX A- 4

### Manufacturing and Cost Analysis Example

Area or Commodity	Part Name	Description / Model # or Part #	Purchased or Manufactured (P or M)	Quantity	What you paid	Retail Cost Each	Unit of Measure	Supplier's Name and Phone Number	Total Retail Cost
Commodity Name from Appendix A4	Items required in each section are listed in Appendix A4								= Quantity x Retail Cost Each
Brake System	"Widget A"	#304A	P	3	\$ 12.00	\$ 15.00	Each	Amalgamated Auto (248) 555-1212	\$ 45.00
Brake System	"Widget B"	Altered Widget	M	3		\$ 20.83	Each	Amalgamated Auto (248) 555-1212	\$ 62.50
Brake System	"Widget C"	Custom	M	1		\$ 15.53	Each	Whatsamatta U.	\$ 15.53
Brake Sub-total									\$XX.XX

Sub-Total for each Area or commodity									
Assembly Cost		M	X			\$Y	unit		\$ X*Y
Grand Total of Vehicle									\$\$\$



APPENDIX A- 5

SCHOOL \_\_\_\_\_ CAR NUMBER \_\_\_\_\_

PRESENTATION JUDGING

Score the following categories on the basis of 0-10 points each according to the following scale (any number or fraction along this scale may be used).

- 0.0 = inadequate or no attempt
- 2.5 = attempted but below expectation
- 5 = average or expected
- 7.5 = above average but still lacking
- 10 = excellent, perfectly meets intent

\_\_\_\_\_ **CONTENT:** Were the concepts presented appropriate and adequate to explain how the car meets the intent of the customer? Were enough technical details presented without being boring?

\_\_\_\_\_ **ORGANIZATION:** Were the concepts presented in a logical order progressing from basic concept and showing how the engineering accomplished the concept? Was it clear to the audience what was to be presented and what was coming next? Were distinct introduction and overviews as well as summary and conclusions given?

\_\_\_\_\_ **VISUAL AIDS:** Were visual aids used or clear visual references made to the car? Were the illustrations visible for all of the audience?

\_\_\_\_\_ **DELIVERY:** Did the presenter speak in a clear voice? Did the presenter show enthusiasm and promote confidence in the technical aspects? Did he maintain eye contact?

\_\_\_\_\_ **QUESTIONS:** Did the answer illustrate that the team fully understood the question? Is there doubt that the team understood the answer? Did the team promote complete confidence in their response to the questions?

\_\_\_\_\_ **TOTAL = PRESENTATION POINTS (50 points maximum)**

COMMENTS: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



**APPENDIX A- 6**

**SCHOOL** \_\_\_\_\_ **CAR NUMBER** \_\_\_\_\_

**DESIGN JUDGING**

\_\_\_\_\_ **AESTHETICS (0-5)** - Does the vehicle look attractive? Does it have a high performance appearance?

\_\_\_\_\_ **MECHANICAL DESIGN (0-20)** - Do components appear to have been sized properly for the load? Does form follow function? Do brackets serve more than one purpose?

\_\_\_\_\_ **CHASSIS DESIGN (0-30)** - Does the suspension design consider kinematics, roll center placement or load transfer? How was vehicle handling designed for and developed? How was brake system designed? Was weight distribution and C.G. height optimized?

\_\_\_\_\_ **MANUFACTURABILITY (0-10)** - Can 1000 units per year be economically produced? Was manufacturing and ease of assembly a major consideration?

\_\_\_\_\_ **SERVICEABILITY (0-15)** - Is the engine easy to service or remove? Is the suspension easy to adjust?

\_\_\_\_\_ **INNOVATIVENESS (0-15)** - Are any of the components or systems unique? Do the innovations add to the product's functions?

\_\_\_\_\_ **ERGONOMICS/INTERIORS/SAFETY (0-20)** - Is the vehicle designed to accommodate & function with a wide variety of body sizes? Are controls and instruments easy to use? Does the design consider occupant safety beyond the requirements?

\_\_\_\_\_ **POWERTRAIN (0-30)** - Does the engine have significant modifications with respect to fuel injection, turbocharging, intake or exhaust? Was the drivetrain well done? Were throttle, drive controls designed well?

\_\_\_\_\_ **BUILD QUALITY (0-5)** - Fit and finish, quality of materials, detail work, quality appearance.

\_\_\_\_\_ **MISCELLANEOUS (0 to -50)** - If this is a carry over from last year and did not undergo significant improvements, or if the team does not exhibit a good understanding of the car, then a penalty may be applied.

\_\_\_\_\_ **TOTAL = DESIGN POINTS (150 points maximum)**

**COMMENTS:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



## APPENDIX A- 7a

### Action Deadlines for 2004 Formula SAE, May 19-23, 2004

**All submissions except the Cost Report must be received by the deadline  
NOT POSTMARKED**

- 1. Registration** **January 31, 2004**  
Register on-line at: <http://www.sae.org/students/student.htm> on or after October 1, 2003  
  
**Registration Fee** **\$600.00**
  - 2. Safety Structure Equivalency Form** **February 1, 2004**  
Available online  
Send via email:  
Kathleen McDonald, [katklauz@aol.com](mailto:katklauz@aol.com)
  - 3. Design Report & Design Spec Sheet** **March 1, 2004**  
See Section 4.5  
Send via email to: [collegiatecompetitions@sae.org](mailto:collegiatecompetitions@sae.org)
  - 4. Cost Report must be postmarked by** **April 1, 2004**  
available online  
Send via mail to:     Attn: Suzy Zukowski  
                              Team SAE - DaimlerChrysler Corporation  
                              CIMS 483-01-14  
                              800 Chrysler Drive East  
                              Auburn Hills Michigan 48326-2757
  - 5. Fuel Type Order** **April 15, 2004**  
Notify Kathleen McDonald of the type of fuel you will use.  
[katklauz@aol.com](mailto:katklauz@aol.com)
- Rules Inquiries concerning Formula SAE only**  
Send via email to:     Kathleen McDonald, [katklauz@aol.com](mailto:katklauz@aol.com)



## APPENDIX A- 7b

### Action Deadlines for 2004 Formula Student

See [www.formulastudent.com](http://www.formulastudent.com) for rules specific to Formula Student

**All submissions must be received by the deadline-NOT POSTMARKED**

#### 1. Registration

**March 31, 2004**

Registration forms may be obtained by:

Email to: [fs2004@imeche.org.uk](mailto:fs2004@imeche.org.uk)  
Online form: [www.formulastudent.com](http://www.formulastudent.com)

Once completed, email to: [fs2004@imeche.org.uk](mailto:fs2004@imeche.org.uk)  
or post to: Formula Student, IMechE  
1 Birdcage Walk  
London SW1 H9JJ, UK  
or fax to: +44 (0)207 973 1292

#### 2. Safety Structure Equivalency Form

**April 1, 2004**

Available online form: [www.formulastudent.com](http://www.formulastudent.com)

Once completed, email to: [fs2004@imeche.org.uk](mailto:fs2004@imeche.org.uk)  
or post to: Formula Student, IMechE  
1 Birdcage Walk  
London SW1 H9JJ, UK  
or fax to: +44 (0)207 973 1292

#### 3. Design Report & Design Spec Sheet

**June 1, 2004**

See Section 4.5  
Send via email to: [fs2004@imeche.org.uk](mailto:fs2004@imeche.org.uk)

#### 4. Cost Report

**June 1, 2004**

See Section 4.3  
Send via post to: Formula Student, IMechE  
1 Birdcage Walk  
London, SW1 H9JJ, UK

#### Rules Inquiries for Formula Student

Send via email to: [formulastudent@imeche.org.uk](mailto:formulastudent@imeche.org.uk)



## APPENDIX A- 7c

### Action Deadlines for 2004 Formula SAE Australasia

See [www.sae-a.com.au/fsae/index.htm](http://www.sae-a.com.au/fsae/index.htm) for rules specific to FSAE-A

**All submissions must be received by the deadline-NOT POSTMARKED**

#### 1. Registration

**August 2, 2004**

Registration forms may be obtained by:

Email from the SAE-A office: [formulasae@sae-a.com.au](mailto:formulasae@sae-a.com.au)

On-line from SAE: [www.sae-a.com.au/fsae/index.htm](http://www.sae-a.com.au/fsae/index.htm)

#### 2. Safety Structure Equivalency Form

**September 1, 2004**

See Section A-1

Send via fax/mail: Formula SAE-A Technical Committee  
SAE –Australasia  
Suite 3, 21 Vale Street  
North Melbourne, Vic 3051  
Australia  
Fax: +61 3 9326 7244

#### 3. Design Report & Design Spec Sheet

**October 1, 2004**

See Section 4.5

Send via email to: [formulasae@sae-a.com.au](mailto:formulasae@sae-a.com.au)

Or mail to: Formula SAE-A Technical Committee  
SAE –Australasia  
Suite 3, 21 Vale Street  
North Melbourne, Vic 3051  
Australia

#### 4. Cost Report

**November 1, 2004**

See Section 4.3

Send via mail to: Formula SAE-A Cost Report  
SAE –Australasia  
Suite 3, 21 Vale Street  
North Melbourne, Vic 3051  
Australia

#### Rules Inquiries concerning Formula SAE Australasia only

Send via email to: [fasetech@ozemail.com.au](mailto:fasetech@ozemail.com.au)