SUPRA SAEINDIA
Rule Book 2025

Student Formula Event

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CONTENTS

TITLE

INTRODUCTION

This introduction highlights some areas of the STUDENT FORMULA rules that teams should understand and consider. This introduction only summarizes parts of the rules of the revised text and do not change or replace the rules.

Caution - Neither this introduction, nor any other summary, is a substitute for reading and understanding the Rules. The Rules are both a controlling and a reference document and should be used for those purposes. Do not attempt to design your car based on the parts of the Rules you happen to remember from the last time you read them. We cannot stress it too strongly - Read the Rules thoroughly and repeatedly.

Revised Part Designations - The designations of some of the Parts of the STUDENT FORMULA rules have been revised to better indicate their contents. The new designations are:

Part	A	Administrative Regulations
Part	T	General Technical Requirements
Part	EV	Electric Vehicles
Part	S	Static Event Regulations
Part	D	Dynamic Event Regulations

T3.10.4 on the location of the 95th percentile template - The location of the template in relation to the face of the pedals has been specified.

T5.6 Head Restraint - The head restraint regulations have been revised and clarified.

Part EV – Electric Vehicle – Rules related to the electric vehicle fabrication and operation have been added here for EV participants.

S3.1 Business Logic Case - Each team is required to submit a brief "business logic case" which states the primary considerations and goals that influenced their design and fabrication choices. This submission replaces the Student Activity Disclosure Form.

ABBREVIATIONS

AIP	Anti intrusion plate	**EBS**	Emergency brake system
AIR	Accumulator isolation relay	**ECU**	Electronic control unit
AMS	Accumulator management system	**EDR**	Engineering design report
APPS	Accelerator pedal position sensor	**EI**	Flexural rigidity
BOM	Bill of Material	**ESF**	Electrical system form
BOTS	Brake over-travel switch	**ESO**	Electrical system officer
BPP	Business plan presentation	**ESOQ**	Electrical system officer qualification
BPPV	Business plan pitch video	**ETC**	Electronic throttle control
BSPD	Brake system plausibility device	**EV**	Electric vehicle
CBOM	Costed Bill of Material	**HPI**	High pressure injection
CRD	Cost report documents	**LPI**	Low pressure injection
DBOM	Detailed Bill of Material	**HV**	High voltage
DI	Direct injection	**HVD**	High voltage disconnect
DNA	Did not attempt	**IA**	Impact attenuator
DNF	Did not finish	**IAD**	Impact attenuator data
DOO	Down or out	**IMD**	Insulation monitoring device
DQ	Disqualified	**LV**	Low voltage
DSS	Design specification sheet	**LVMS**	Low voltage master switch
TPS	Throttle position sensor	**LVS**	Low voltage system
TSMP	Tractive system measuring point	**OC**	Off-course
USS	Unsafe stop	**OEM**	Original equipment manufacturer
TSMS	Tractive system master switch	**PCB**	Printed circuit board
TS	Tractive system	**R2D**	Ready-to-drive
TSAC	Tractive system accumulator container	**RES**	Remote emergency system
TSAL	Tractive system active light	**SCS**	System critical signal
VSV	Vehicle status video	**SDC**	Shutdown circuit
SES	Structural equivalency spreadsheet	**SE3D**	Structural equivalency 3d model

STUDENT FORMULA RULES

PART A - ADMINISTRATIVE REGULATIONS

ARTICLE 1: STUDENT FORMULA OVERVIEW AND COMPETITION

A1.1 STUDENT FORMULA Competition Objective

The STUDENT FORMULA competitions challenge teams of university undergraduate and graduate students to conceive, design, fabricate, develop and compete with small, formula style vehicles.

A1.1.1 To give teams the maximum design flexibility and the freedom to express their creativity and imaginations there are very few restrictions on the overall vehicle design. The challenge to teams is to develop a vehicle that can successfully compete in all the events described in the STUDENT FORMULA Rules. The competitions themselves give teams the chance to demonstrate and prove both their creativity and their engineering skills in comparison to teams from other universities around the world.

A1.2 Vehicle Design Objectives

For the purpose of the STUDENT FORMULA competition, teams are to assume that they work for a design firm that is designing, fabricating, testing and demonstrating a prototype vehicle for the non-professional, weekend, competition market.

A1.2.1 The vehicle should have very high performance in terms of acceleration, braking and handling and be sufficiently durable to successfully complete all the events described in the STUDENT FORMULA Rules and held at the STUDENT FORMULA competitions.

A1.2.2 The vehicle must accommodate drivers whose stature ranges from 5th percentile female to 95th percentile male and must satisfy the requirements of the STUDENT FORMULA Rules.

A1.2.3 Additional design factors to be considered include aesthetics, cost, ergonomics, maintainability, manufacturability, and reliability.

A1.2.4 Once the vehicle has been completed and tested, your design firm will attempt to "sell" the design to a "corporation" that is considering the production of a competition vehicle. The challenge to the design team is to develop a prototype car that best meets the STUDENT FORMULA vehicle design goals, and which can be profitably marketed.

A1.2.5 Each design will be judged and evaluated against other competing designs to determine the best overall car.

A1.3 Good Engineering Practices

Vehicles entering STUDENT FORMULA competitions are expected to be designed and fabricated in accordance with good engineering practices.

A1.4 Judging Categories

The cars are judged in a series of static and dynamic events including technical inspection,

cost, presentation Marketing Presentation, and engineering design, solo performance trials, and high-performance track endurance.

A1.4.1 The dynamic events are scored to determine how well the car performs. Each dynamic event has specified minimum acceptable performance levels that are reflected in the scoring equations.

The following points are possible:

Static Events:	**Max Points**
Business Presentation	75
Engineering Design	150
Cost Evaluation	100
Dynamic Events	
Acceleration	75
Skid-Pad	50
Autocross	150
Engineering Excellence	100
Endurance	300
Total Points	**1000**

ARTICLE 2: THE STUDENT FORMULA SERIES

A2.1 Open Registration

STUDENT FORMULA competitions have open registration policies and accept registrations by student teams representing universities Which Have a SAEINDIA Collegiate Club in the country.

A2.2 Rule Variations

All competitions in the STUDENT FORMULA Series may post some minor rule variations specific to the operation of the events in the country. However, the vehicle design requirements and restrictions will remain unchanged. Any rule variations will be posted on the website specific to the competition.

A2.3 Official Announcements and Competition Information

Teams are required to read the published announcements by SAEINDIA and the other organizing bodies and to be familiar with all official announcements concerning the competitions and rules interpretations released by the STUDENT FORMULA Rules Committee.

A2.3.1 STUDENT FORMULA news is published online and can be found at: www.suprasaeindia.org

A2.4 Official Languages

The official language of the STUDENT FORMULA series is English. Document submissions, presentations and discussions in English are acceptable at all competitions in the series.

ARTICLE 3: STUDENT FORMULA RULES AND ORGANISER AUTHORITY

A3.1 Rules Authority

The STUDENT FORMULA Rules are the responsibility of the STUDENT FORMULA Rules Committee and are issued under the authority of the SAEINDIA Collegiate Design Series.

A3.1.1 Official announcements from the STUDENT FORMULA Rules Committee, SAEINDIA or the other SUPRA SAEINDIA organizing bodies shall be considered part of and shall have the same validity as these rules.

A3.1.2 Ambiguities or questions concerning the meaning or intent of these rules will be resolved by the STUDENT FORMULA Rules Committee, SAEINDIA.

A3.2 Rules Validity

The STUDENT FORMULA Rules posted on the SUPRASAEINDIA website and dated for the calendar year of the competition are the rules in effect for the competition.

A3.2.1 Rule sets dated for other years are invalid.

A3.3 Rules Compliance

By entering a STUDENT FORMULA competition the team, members of the team as individuals, faculty advisors and other personnel of the entering university agree to comply with, and be bound by, these rules and all rule interpretations or procedures issued or announced by SAEINDIA, the STUDENT FORMULA Rules Committee and the other organizing bodies.

A3.3.1 Any rules or regulations pertaining to the use of the competition site by teams or individuals, and which are posted, announced and/or otherwise publicly available are incorporated into the STUDENT FORMULA Rules by reference. As examples, all event site waiver requirements, speed limits, parking and facility use rules apply to SUPRA SAEINDIA participants.

A3.3.2 All team members, faculty advisors and other university representatives are required to cooperate with, and follow all instructions from, competition organizers, officials and judges.

A3.4 Understanding the Rules

Teams, team members as individuals and faculty advisors, are responsible for reading and understanding the rules in effect for the competition in which they are participating.

A3.5 Participating in the Competition

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

A3.6 Violations on Intent

The violation of intent of a rule will be considered a violation of the rule itself.

A3.6.1 Questions about the intent or meaning of a rule may be addressed to the STUDENT

FORMULA Rules Committee.

A3.7 Right to Impound

SAEINDIA and other competition organizing bodies reserve the right to impound any onsite registered vehicles at any time during a competition for inspection and examination by the organizers, officials and technical inspectors.

A3.8 Restriction on Vehicle Use

Teams are cautioned that the vehicles designed in compliance with these STUDENT FORMULA Rules are intended for competition operation only at the official STUDENT FORMULA competitions.

A3.9 Headings

The article, section and paragraph headings in these rules are provided only to facilitate reading: they do not affect the paragraph contents.

A3.10 General Authority

SAEINDIA and the competition organizing bodies reserve the right to revise the schedule of any competition and/or interpret or modify the competition rules at any time and in any manner that is, in their sole judgment, required for the efficient operation of the event or the STUDENT FORMULA series as a whole.

A list of SAE Technical Standards can be found in Appendix S.

A3.11 Removing the Vehicle from the Site

Teams which remove their vehicle from the competition site after the competition has begun will be disqualified from the competition.

A3.12 Team Briefing

All team captains, designated team representatives and drivers on a particular day must attend the team briefing for that day

A3.13 Testing and Work Safety

Competition organizers are not responsible for the use of vehicles outside of their competition.

The competition officials disassociate themselves from all activities of the teams besides their own competition and associated events.

ARTICLE 4: INDIVIDUAL PARTICIPATION REQUIREMENTS

A4.1 Eligibility Limits

Eligibility is limited to undergraduate and graduate students to ensure that this is an engineering design competition.

A4.2 Student Status

Team members must be enrolled as degree seeking undergraduate or graduate students

in the college or university of the team with which they are participating. Team members who have graduated during the seven (7) month period prior to the competition remain eligible to participate (Example: Final Year Students of **2023** cannot participate in the 2024 event. But final year students graduating in 2024 can participate).

A4.3 Society Membership

Team members must be members **(+1 Membership)** of at least one of the following societies: (1) SAEINDIA,

(2) SAE International, (3) SAE Australasia, (4) SAE Brazil, (5) JSAE, (6) TSAE. Proof of membership, such as membership cards, are required at the competition.
Note: Students can join SAEINDIA online at: www.saeindia.org.

A4.4 Age

Team members must be at least eighteen (18) years of age.

A4.5 Driver's License

Team members who will drive a competition vehicle at any time during a competition must hold a valid, government issued driver's license.

A4.6 Liability Waiver

All on-site participants, including students, faculty and volunteers, are required to sign a liability waiver upon registering on-site.

A4.7 Medical Insurance

Individual medical insurance coverage is required and is the sole responsibility of the participant. Participants without valid medical insurance will not be allowed to participate in the Dynamic Events.

A4.9 Onsite Registration Requirement

ONSITE REGISTRATON IS REQUIRED OF ALL TEAM MEMBERS AND FACULTY ADVISORS. Bring your (1) Government issued driver's license or passport and (2) your medical insurance card (Mandatory for Drivers) (3) College ID (4) SAEINDIA Membership Card, Approval Letter from College in college letter Head and documentation to onsite registration.

ARTICLE 5: FACULTY ADVISOR

A5.1 Faculty Advisor

A5.1.1 Each team is expected to have a Faculty Advisor appointed by the university. It is Mandatory for the Faculty Advisor to accompany the team to the competition and will be considered by competition officials to be the official university representative. Failure to abide by this rule may deny participation of the team in Dynamic Events.

A5.1.2 Faculty Advisors may advise their teams on general engineering and engineering project management theory.

A5.1.3 Faculty Advisors may not design any part of the vehicle nor directly participate in the development of any documentation or presentation.
Additionally, Faculty Advisors may not fabricate nor assemble any components nor assist in the preparation, maintenance, testing or operation of the vehicle.
In Brief - Faculty Advisors may not design, build or repair any part of the car.

ARTICLE 6: VEHICLE ELIGIBILITY

A6.1 Student Developed Vehicle

Vehicles entering STUDENT FORMULA competitions must be conceived, designed, fabricated and maintained by the student team members without direct involvement from professional engineers, automotive engineers, racers, machinists or related professionals.

A6.2 Information Sources

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.

A6.3 Professional Assistance

Professionals may not make design decisions or drawings, and the Faculty Advisor may be required to sign a statement of compliance with this restriction.

A6.4 Student Fabrication

The intent of the SAEINDIA Collegiate Design Series competition is to provide direct hands-on experience to the students. Therefore, students should perform all fabrication tasks whenever possible.
The Fabrication should be done on-campus using in-house facilities of college / university.
All work done outside the Campus needs to be informed to the SUPRA SAEINDIA
Rules Committee and prior approval acquired for the same.

A6.5 The STUDENT FORMULA Competition Year - First Year Cars

A Vehicle may only be used for the one year, counting from the first day onsite of its first competition.
To be classified as new, a vehicle must have a minimum, a newly manufactured chassis with significant changes in the primary structure to its predecessor.
Note: Teams are reminded that their vehicles must comply with the rules in effect for each competition they enter.

ARTICLE 7: REGISTRATION

A7.1 Registration - STUDENT FORMULA Competitions

Registration for STUDENT FORMULA competitions must be completed online. Online registration must be done by either (a) an SAEINDIA member or (b) the official faculty advisor connected with the registering university and recorded as such in the SAEINDIA

record system. **Team Once Registered, No Changes will be allowed in the Team list (Members) including Faculty Advisor without genuine reason.**

A7.2 Entries per University - STUDENT FORMULA Competitions - Registering Teams – For the purposes of registering and competing, a university's teams are considered to be separate and independent entities if they are from a different campus. **A university may register as many teams in the same competition.**

Teams from a common university, either autonomous or through affiliations, shall register under their college/ campus name.

A team formed with members from two (2) or more universities shall be treated as a single team.

A7.3 Team communication liaisons:

A team member may only be part of one team.

Each team must have one team member identified as the team captain. The team captain is the main contact person for the officials during the registration process and the competition.

Each team is also required to identify two additional team members during the registration process who will serve as communication liaisons between the team and the officials, should the team captain not be available.

These additional team members must have a *'current student'* status at the attended College or University, at the time of the competition.

A7.3.1 Those who have previously attended any official event as a judge are not allowed to participate as a team member. Counting from the year of their first competition, team members can only participate for four additional full years.

A7.3 Registration Limits - STUDENT FORMULA Competitions

Registration limits for the STUDENT FORMULA competitions will be posted on the SUPRA SAEINDIA website.

Registration for each SUPRA SAEINDIA competition closes as soon as the registration limit is reached. We strongly advise teams to register as soon as registration opens. (First come First Serve Basis)

A7.4 Registration Dates - STUDENT FORMULA Competitions

Registration for the STUDENT FORMULA competitions will close at the date and time posted on the competition website/ social media official page or when all the registration slots have been taken, whichever occurs first.

There are no exceptions to this registration policy.

A7.6 Registration Fees

A7.6.1 Registration fees must be paid to the organizer by the deadlines specified on the respective competition website.

A7.6.2 Registration fees are **not refundable** and **will not be transferred** to a subsequent year's competition.

A7.7 Withdrawals

A7.7.1 Registered teams that find that they will not be able to attend the competition are requested to officially withdraw by notifying the following no later than two (2) Months before the event:

A7.7.2 STUDENT FORMULA Event withdrawals: Send official email to suprasaeindia@saeindia.org

A7.10 On-site Registration

All team members and faculty advisors must complete the on-site registration procedures immediately after they arrive at the competition site.

On-site registration must be completed, and the credentials and/or other identification issued by the organizers properly worn before the car can be unloaded, uncrated or worked upon in any manner.

ARTICLE 8: VEHICLE DOCUMENTATION, DEADLINES AND PENALTIES

A8.1 Required Documents, Required Forms and Required Video

The following documents supporting each vehicle must be submitted by the action deadlines posted on each competition website or otherwise published by the organizers.

T3.9 "Structural Equivalency Spreadsheet (SES)"

Note: SES is not required for teams using a steel tube frame chassis.

T3.22 "Impact Attenuator Data Requirement"

I6.1 Electrical System Form

I6.2 Failure Modes and Effects Analysis

S3 "Business Presentation"

S4 "Cost Report" - Report must comply with the Cost Event Rules. Both an electronic version and a hard copy version are required.

S6.2 "Design Report" - Report must comply with the Design Event Rules

S6.3: “Self-evaluation Safety Scrutiny Sheet”- Need to be filled by teams, approved by faculty advisor before dispatching vehicle for final event.

S6.4 “Vehicle Running Video”: Before the final event team will be asked to submit the running vehicle video.

Note: Guidelines and Format for the above will be shared with team along with submission deadlines with registered teams later.

A8.2 Deadlines, Submission Address and Late Submission Penalties

Deadlines to Submit the required things as per A8.1 will be shared with the registered

teams along with formats through email/website/social media official accounts.

The address for submitting the documents will be shared with the formats. All teams need to submit the documents of that email only. In case teams submit to any other email it will be considered as non-submission.

For delay in submission there will be a penalty for each day's delay and will be informed along with the formats.

Non-Submission of the above documents may lead to disqualification from evaluation or from the overall event.

If the officials request a correction for a document and the team has not uploaded a corrected version after 168 hours (7 days) following the request, the team will be de-registered from the competition.

If the corrected version of the document does not completely contain all requested corrections, the team will be de-registered from the competition

ARTICLE 9: ROTESTS

It is recognized that thousands of hours of work have gone into fielding a vehicle and that teams are entitled to all the points they can earn. We also recognize that there can be differences in the interpretation of rules, the application of penalties and the understanding of procedures. The officials and SAEINDIA staff will make every effort to fully review all questions and resolve problems and discrepancies quickly and equitably

A9.1 Preliminary Review - Required

If a team has a question about scoring, judging, policies or any official action it must be brought to the organizers or SAEINDIA staff's attention for an informal preliminary review before a protest can be filed.

A9.2 Cause for Protest

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

A9.3 Protest Format and Forfeit

All protests must be filed in writing and presented to the organizer or SAEINDIA staff by the team captain. In order to have a protest considered, a team must post a twenty-five (25) point protest bond which will be forfeited if their protest is rejected.

A9.4 Decision

The decision of the competition protest committee regarding any protest is final.

ARTICLE 10: QUESTIONS ABOUT THE STUDENT FORMULA RULES

A10.1 Question Publication

By submitting a question to the STUDENT FORMULA Rules Committee or the competition's organizing body you and your team agree that both your question and the official answer can be reproduced and distributed by SAEINDIA, in both complete and edited versions, in any medium or format anywhere in the world.

A10.2 Question Types

The Committee will answer questions that are not already answered by the rules or FAQs or that require new or novel rule interpretations. The Committee will not respond to questions that are already answered in the rules. For example, if a rule specifies a minimum dimension for a part the Committee will not answer questions asking if a smaller dimension can be used.

A10.3 Question Format

A10.3.1 All rules' questions must include (1) the full name and email address of the student submitting the question, (2) the name of the university - no abbreviations, (3) the number of the applicable rule and (4) the specific competition your team has, or is planning to, enter.

A10.3.2 The following limits apply to questions submitted to the STUDENT FORMULA Rules Committee (1) No photograph, drawing or other attachment may exceed 500 KB in size (2) The total size of any question, with all attachments, must not exceed 2 MB.

A10.4 Response Time

A10.4.1 Please allow a minimum of two (2) weeks for a response. The Rules Committee will respond as quickly as possible, however responses to questions presenting new issues, or of unusual complexity, may take more than two weeks.

A10.4.2 Participants are requested not to resend any questions.

A10.5 Submission Addresses:

A10.5.1 Teams entering STUDENT FORMULA competitions in INDIA:
Follow the current submission instructions published on www.suprasaeindia.org.

APPENDIX S - SAE TECHNICAL STANDARDS

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

The technical documents listed below include both (1) standards that are identified in the rules

and (2) standards that the TSB and the various rules committees believe are valuable references or which may be mentioned in future rules sets.

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

STUDENT FORMULA
SAE 4130 steel is referenced but no specific standard is identified
SAE Grade 5 bolts are required but no specific standard is identified

Standards Relevant to STUDENT FORMULA

J183 - Engine Oil Performance and Engine Service Classification - Standard

J306 - Automotive Gear Lubricant Viscosity Classification Standard

J429 - Mechanical and Material Requirements for Externally Threaded Fasteners - Standard

J452 - General Information - Chemical Compositions, Mechanical and Physical Properties of SAE Aluminum Casting Alloys - Information Report

J512 - Automotive Tube Fittings - Standard

J517 - Hydraulic Hose - Standard

J637 - Automotive V-Belt Drives - Recommended

Practice **J829 -** Fuel Tank Filler Cap and Cap Retainer

J1153 - Hydraulic Cylinders for Motor Vehicle Brakes - Test Procedure

J1154 - Hydraulic Master Cylinders for Motor Vehicle Brakes - Performance Req. - Standard

J1703 - Motor Vehicle Brake Fluid - Standard

J2045 - Performance Requirements for Fuel System Tubing Assemblies - Standard **J2053**

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

Standard Relevant to all CDS Competitions

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

STUDENT FORMULA RULES

PART T - GENERAL TECHNICAL REQUIREMENTS

ARTICLE 1: VEHICLE REQUIREMENTS & RESTRICTIONS

T1.1 Technical Inspection

The following requirements and restrictions will be enforced through technical inspection. Non-compliance must be corrected, and the car re-inspected before the car is allowed to operate under power.

T1.2 Modifications and Repairs

T1.2.1 Once the vehicle has been presented for judging in the Cost or Design Events or submitted for Technical Inspection, and until the vehicle is approved to compete in the dynamic events, i.e. all the three inspection stickers are awarded, the only modifications permitted to the vehicle are those directed by the Inspector(s) and noted on the Inspection Form.

T1.2.2 Once the vehicle is approved to compete in dynamic events, the ONLY modifications permitted to the vehicle are those listed below. They are also referenced in Part S of the STUDENT FORMULA Rules -Static Event Regulations.

a. Adjustment of belts, chains and clutches.
b. Adjustment of brake bias.
c. Adjustment of the driver restraint system, head restraint, seat and pedal assembly.
d. Substitution of the head restraint or seat insert for different drivers.
e. Adjustment to engine operating parameters, e.g. fuel mixture and ignition timing, and any software calibrating changes.
f. Adjustment of mirrors.
g. Adjustment of the suspension where no part substitution is required, (except that springs, sway bars and shims may be changed).
h. Adjustment of tire pressure
i. Adjustment of wing angle, but not the location
j. Replenishment of fluids
k. Replacement of worn tires or brake pads
m. Recharging low voltage batteries

T1.2.3 The vehicle must maintain all required specifications, e.g. ride height, suspension travel, braking capacity, sound level and wing location throughout the competition.

T1.2.4 Once the vehicle is approved for competition, any damage to the vehicle that requires repair, e.g. crash damage, electrical or mechanical damage will void the Inspection Approval. Upon the completion of the repair and before re-entering into any dynamic competition, the vehicle MUST be re-submitted to Technical Inspection for re-approval.

ARTICLE 2: GENERAL DESIGN REQUIREMENTS

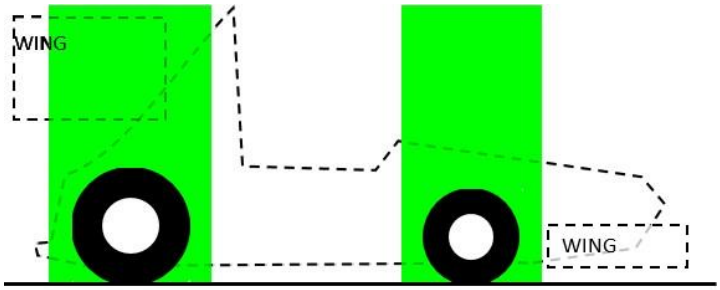
T2.1 Vehicle Configuration

The vehicle must be open-wheeled and open-cockpit (a formula style body) with four (4) wheels that are not in a straight line.

Definition of "Open Wheel" - Open Wheel vehicles must satisfy all of the following criteria:

1) The top 180 degrees of the wheels/tires must be unobstructed when viewed from vertically above the wheel.
2) The wheels/tires must be unobstructed when viewed from the side.
3) No part of the vehicle may enter a keep-out-zone defined by two lines extending vertically from positions 75mm in front of and 75mm behind, the outer diameter of the front and rear tires in the side view elevation of the vehicle, with tires steered straight ahead. This keeps out zone will extend laterally from the outside plane of the wheel/tire to the inboard plane of the wheel/tire. See the figure “Keep Out Zones” below.
4) Must also comply with the dimensions/requirements of ARTICLE 9: Aerodynamic Devices.

Note: The dry tires will be used for all inspections. For technical inspection the keep-out-zone may be inspected by use of a tennis ball fastened to the end of a stick. The ball will be 75mm in diameter and must be freely moved around the outside of the tire without contacting any portion of the car other than the tire.



T2.2 Bodywork

There must 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.

T2.3 Wheelbase

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.

T2.4 Vehicle Track

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

T2.5 Visible Access

All items on the Inspection Form must be clearly visible to the technical inspectors without using instruments such as endoscopes or mirrors. Visible access can be provided by removing body panels or by providing removable access panels.

T2.6 Design Competition

The design report submitted by teams prior to the main event should be 100% incompliance with the vehicle presented during the main event.

ARTICLE 3: DRIVER'S CELL

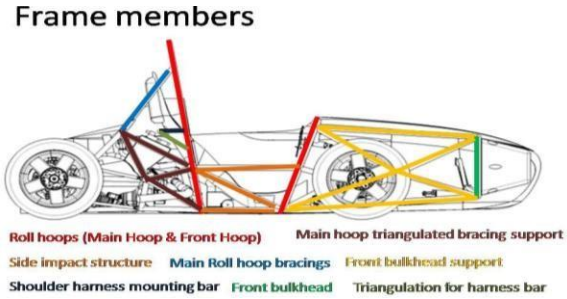
T3.1 Vehicle Structure

Teams may, at their option, design their vehicle to comply with **Part** T Article 3 "Drivers Cell" as defined below.

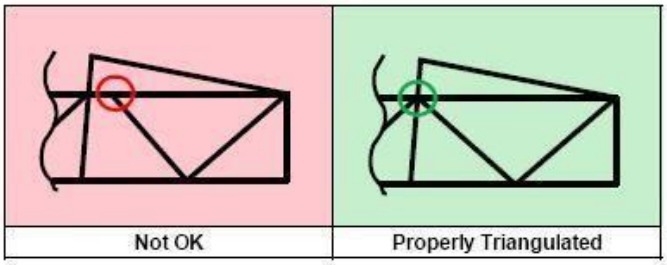
T3.2 General Requirements

Among other requirements, the vehicle's structure must include two roll hoops that are braced, a front bulkhead with support system and Impact Attenuator, and side impact structures.

T3.3 Definitions: The following definitions apply throughout the Rules document:



- Main Hoop - A roll bar located alongside or just behind the driver's torso.
- Front Hoop - A roll bar located above the driver's legs, in proximity to the steering wheel.
- Roll Hoops - Both the Front Hoop and the Main Hoop are classified as "Roll Hoops"
- Roll Hoop Bracing Supports - The structure from the lower end of the Roll Hoop Bracing back to the Roll Hoop(s).
- Frame Member - A minimum representative single piece of uncut, continuous tubing.
- Frame - The "Frame" is the fabricated structural assembly that supports all functional vehicle systems. This assembly may be a single welded structure, multiple welded structures or a combination of composite and welded structures.
- Primary Structure - The Primary Structure is comprised of the following Frame components: 1) Main Hoop, 2) Front Hoop, 3) Roll Hoop Braces and Supports, 4) Side Impact Structure, 5) Front Bulkhead, 6) Front Bulkhead Support System and 7) all Frame Members, guides and supports that transfer load from the Driver's Restraint System into items 1 through 6.
- Major Structure of the Frame - The portion of the Frame that lies within the envelope defined by the Primary Structure. The upper portion of the Main Hoop and the Main Hoop *Bracing* are not included in defining this envelope.
- Front Bulkhead - A planar structure that defines the forward plane of the Major Structure of the Frame and functions to provide protection for the driver's feet.
- Impact Attenuator - A deformable, energy absorbing device located forward of the Front Bulkhead.
- Side Impact Zone - The area of the side of the car extending from the top of the floor to 350 mm (13.8 inches) above the ground and from the Front Hoop back to the Main Hoop.
- Node-to-node triangulation - An arrangement of frame members projected onto a plane, where a co-planar load applied in any direction, at any node, results in only tensile or compressive forces in the frame members. This is also what is meant by "properly triangulated".



T3.4 Minimum Material Requirements

T3.4.1 Baseline Steel Material

The Primary Structure of the car must 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 Rules T3.4, T3.5, T3.6 and T3.7.

Note: "Only seamless pipe to be used."

ITEM or APPLICATION	OUTSIDE *DIMENSION* X WALL THICKNESS
Main & Front Hoops, Shoulder Harness Mounting Bar	Round 1.0-inch (25.4 mm) x 0.095 inches (2.4 mm) or Round 25.0 mm x 2.50 mm metric
Side Impact Structure, Front Bulkhead, Roll Hoop Bracing, Driver's Restraint Harness Attachment (except as noted above)	Round 1.0-inch (25.4 mm) x 0.065 inch (1.65 mm) or Round 25.0 mm x 1.75 mm metric or Round 25.4 mm x 1.60 mm metric or Square 1.00-inch x 1.00-inch x 0.049 inch or Square 25.0 mm x 25.0 mm x 1.25 mm metric or Square 26.0 mm x 26.0 mm x 1.2 mm metric
Front Bulkhead Support, Main Hoop Bracing Supports	Round 1.0-inch (25.4 mm) x 0.049 inch (1.25 mm) or Round 25.0 mm x 1.5 mm metric or Round 26.0 mm x 1.2 mm metric

Note 1: The use of alloy steel does not allow the wall thickness to be thinner than that used for mild steel.
Note 2: For a specific application:

- Using tubing of the specified outside diameter but with greater wall thickness,
- **Or** of the specified wall thickness and a greater outside diameter,
- **Or** replacing round tubing with square tubing of the same or larger size to those listed above, Are NOT rules deviation requiring approval.

Note 3: Except for inspection holes, any holes drilled in any regulated tubing require the submission of an SES.
Note 4: Baseline steel properties used for calculations to be submitted in an SES may not be lower than the following:
Bending and buckling strength calculations:

Young's Modulus (E) = 200 GPa (29,000 ksi)
Yield Strength (Sy) = 305 MPa (44.2 ksi)
Ultimate Strength (Su) = 365 MPa (52.9 ksi)

Welded tube joint calculations:

Yield Strength (Sy) = 180 MPa (26ksi)
Ultimate Strength (Su) = 300 MPa (43.5 ksi).

Where welded tubing reinforcements are required (e.g. inserts for bolt holes or material to support suspension cutouts) the tubing **must** retain the baseline cold rolled strength while using the welded strength for the additional reinforcement material.

T3.5 Alternative Tubing and Material - General

T3.5.1 Alternative tubing geometry and/or materials may be used except that 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 for these components is prohibited.

T3.5.2 Titanium or magnesium on which welding has been utilized may not be used for any part of the Primary Structure. This includes the attachment of brackets to the tubing or the attachment of the tubing to other components.

T3.5.3 If a team chooses to use alternative tubing and/or materials they must submit a "Structural Equivalency Spreadsheet" per Rule T3.9. The teams must submit calculations for the material they have chosen, demonstrating equivalence to the minimum requirements found in Section T3.4.1 for yield and ultimate strengths in bending, buckling and tension, for buckling modulus and for energy dissipation. (The Buckling Modulus is defined as EI, where E = modulus of Elasticity, and I = area moment of inertia about the weakest axis.)

T3.5.4 Tubing cannot be of thinner wall thickness than listed in T3.6 or T3.7.

T3.5.5 If a bent tube (or member consisting of multiple tubes that are not in a line) is used anywhere in the primary structure, other than the front and main roll hoops, an additional tube must be attached to support it. The attachment point must be the position along the tube where it deviates farthest from a straight line connecting both ends. The support tube must have the same diameter and thickness as the bent tube, terminate at a node of the chassis, and be angled no more than 30 degrees from the plane of the bent tube. **Braces attached to the upper side impact member are not required to meet the 30 degrees from the plane of the bent tube requirement.**
Note: It is allowable for the properties of tubes and laminates to be combined to prove equivalence. E.g. in a side-impact structure consisting of one tube as per T3.4 and a laminate panel, the panel only needs to be equivalent to two side-impact tubes.

T3.6 **Alternative Steel Tubing**

Minimum Wall Thickness Allowed:

MATERIAL & APPLICATION	**MINIMUM WALL THICKNESS**
Steel Tubing for Front and Main Roll Hoops, and Shoulder Harness Mounting Bar	2.0 mm (0.079 inch)
Steel Tubing for Roll Hoop Bracing, Roll Hoop Bracing Supports, Side Impact Structure, Front Bulkhead, Front Bulkhead Support, Driver's Harness Attachment (except as noted above)	1.2 mm (0.047 inch)

Note 1: 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.
Note 2: To maintain EI with a thinner wall thickness than specified in T3.4.1, the outside diameter MUST be increased.
Note 3: To maintain the equivalent yield and ultimate tensile strength the same cross-sectional area of steel as the baseline tubing specified in T3.4.1 **MUST** be maintained.

T3.7 Aluminum Tubing Requirements

T3.7.1 Minimum Wall Thickness: Aluminum Tubing 3.0 mm (0.118 inch)

T3.7.2 The equivalent yield strength must be considered in the "as-welded" condition, (Reference: WELDING ALUMINUM (latest Edition) by the Aluminum Association, or THE

WELDING HANDBOOK, Volume 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.

T3.7.3 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 fixture used.

T3.8 Composite Materials

T3.8.1 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, and resin type, number of layers, core material, and skin material if metal) must 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 T3.4.1. Equivalency calculations must be submitted for energy dissipation, yield and ultimate strengths in bending, buckling, and tension. Submit the completed "Structural Equivalency Spreadsheet" per Section T3.9.

T3.8.2 Composite materials are not allowed for the Main Hoop or the Front Hoop.

T3.9 Structural Documentation - SES Submission

All equivalency calculations must prove equivalency relative to steel grade SAE/AISI 1010.

T3.9.1 All teams MUST submit a STRUCTURAL EQUIVALENCY SPREADSHEET (SES).

Teams complying with the Part T Article 3 "Drivers Cell" rules MUST submit a Structural Equivalence Spreadsheet (SES), even if they are NOT planning to use alternative materials or tubing sizes to those specified in T3.4.1 Baseline Steel Materials.

T3.9.2 the use of alternative materials or tubing sizes to those specified in T3.4.1 "Baseline Steel Material," is allowed, provided they have been judged by a technical review to have equal or superior properties to those specified in T3.4.1.

T3.9.3 Approval of alternative material or tubing sizes will be based upon the engineering judgment and experience of the chief technical inspector or his appointee.

T3.9.4 The technical review is initiated by completing the "Structural Equivalency Spreadsheet" (SES) using the format given in Appendix T-1.

T3.9.5 Structural Equivalency Spreadsheet - Submission

a. Address - SESs must be submitted to the officials at the competition you are entering at the address shown in the Appendix or indicated on the competition website.

b. Due Date - SESs must be submitted no later than the date indicated on the competition website. Do Not Resubmit SES's unless instructed to do so.

T3.9.6 Vehicles completed under an approved SES must be fabricated in accordance with the materials and processes described in the SES.

T3.9.7 Teams must bring a copy of the approved SES with them to Technical Inspection.

Comment - The resubmission of an SES that was written and submitted for a competition in the previous year is strongly discouraged. Each team is expected to perform their own tests and to submit SESs based on their original work. Understanding the engineering that justifies equivalency is essential to discussing your work with the officials.

T3.10 Main and Front Roll Hoops - General Requirements

T3.10.1 The driver's head and hands must not contact the ground in any rollover attitude.

T3.10.2 The Frame must include both a Main Hoop and a Front Hoop as shown in Figure 1.

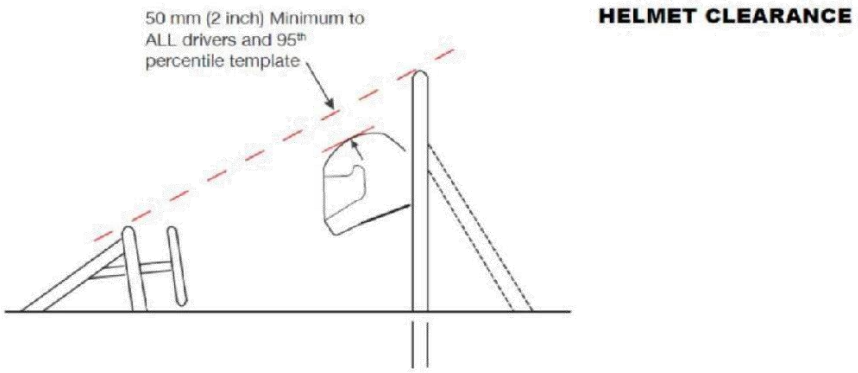


FIGURE 1a

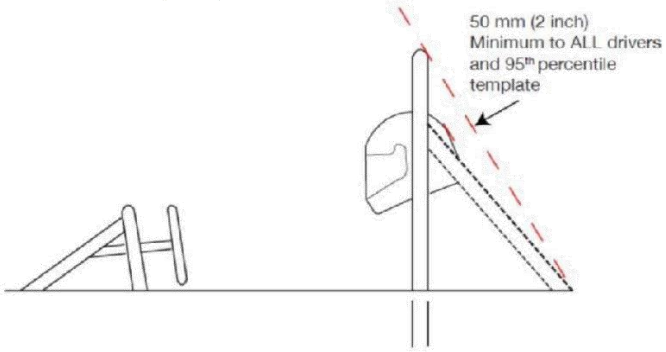


FIGURE 1b

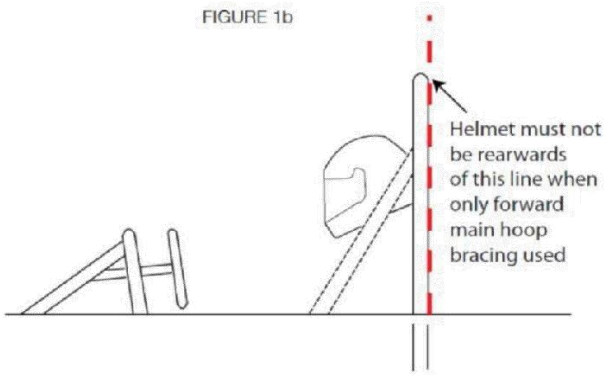


FIGURE 1c

T3.10.3 When seated normally and restrained by the Driver's Restraint System, the helmet of a 95th percentile male (anthropometrical data) and all of the team's drivers must:

a. Be a minimum of 50.8 mm (2 inches) from the straight line drawn from the top of the main hoop to the top of the front hoop. (Figure 1a)
b. Be a minimum of 50.8 mm (2 inches) from the straight line drawn from the top of the main hoop to the lower end of the main hoop bracing if the bracing extends rearwards. (Figure 1b)
c. Be no further rearwards than the rear surface of the main hoop if the main hoop bracing extends forwards. (Figure 1c)

95th Percentile Male Template Dimensions

A two-dimensional template used to represent the 95th percentile male is made to the following dimensions:

- A circle of diameter 200 mm (7.87 inch) will represent the hips and buttocks.
- A circle of diameter 200 mm (7.87 inch) will represent the shoulder/cervical region. A circle of diameter 300 mm (11.81 inch) will represent the head (with helmet).
- A straight line measuring 490 mm (19.29 inch) will connect the centers of the two 200 mm circles.
- A straight line measuring 280 mm (11.02 inch) will connect the centers of the upper 200 mm circle and the 300 mm head circle.

T3.10.4 The 95th percentile male template will be positioned as follows: (See Figure 2.)

- The seat will be adjusted to the rearmost position,
- The pedals will be placed in the most forward position.
- The bottom 200 mm circle will be placed on the seat bottom such that the distance between the center of this circle and the rearmost face of the pedals is no less than 915 mm (36 inches).
- The middle 200 mm circle, representing the shoulders, will be positioned on the seat back
- The upper 300 mm circle will be positioned no more than 25.4 mm (1 inch) away from the head restraint (i.e. where the driver's helmet would normally be located while driving).

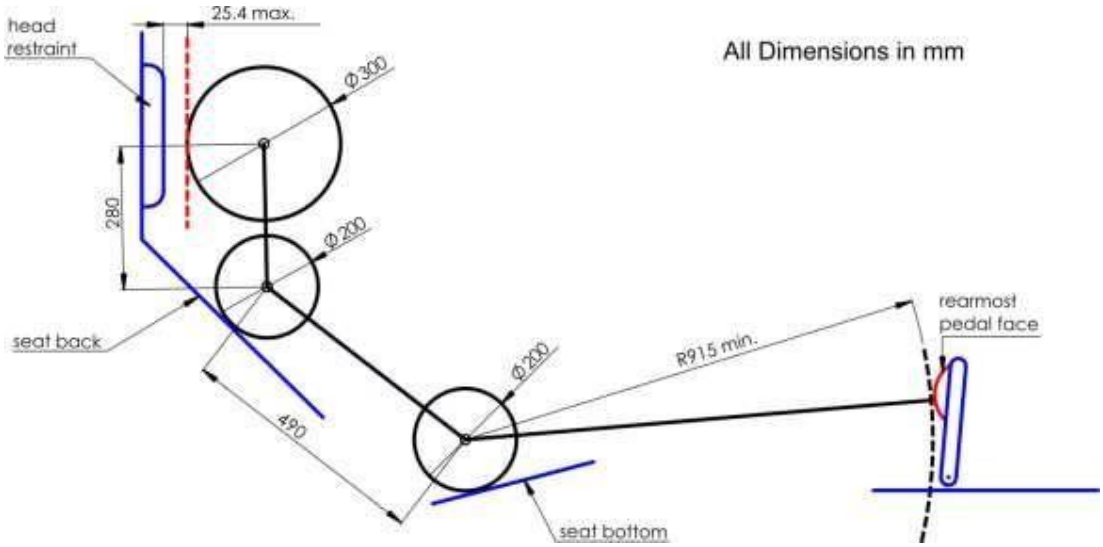


FIGURE 2

T3.10.5 if the requirements of T3.10.4 are not met with the 95th percentile male template, the car will NOT receive a Technical Inspection Sticker and will not be allowed to compete in the dynamic events.

T3.10.6 Drivers who do not meet the helmet clearance requirements of T3.10.3 will not be allowed to drive in the competition.

T3.10.7 The minimum radius of any bend, measured at the tube centerline, must be at least three times the tube outside diameter. Bends must be smooth and continuous with no evidence of crimping or wall failure.

T3.10.8 The Main Hoop and Front Hoop must be securely integrated into the Primary Structure using gussets and/or tube triangulation

T3.11 Main Hoop

T3.11.1 The Main Hoop must be constructed of a single piece of uncut, continuous, closed section steel tubing per Rule T3.4.1.

T3.11.2 The use of aluminum alloys, titanium alloys or composite materials for the Main Hoop is prohibited.

T3.11.3 The Main Hoop must extend from the lowest Frame Member on one side of the Frame, up, over and down to the lowest Frame Member on the other side of the Frame.

T3.11.4 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 Frame must be within ten degrees (10°) of the vertical.

T3.11.5 In the side view of the vehicle, any bends in the Main Roll Hoop above its attachment point to the Major Structure of the Frame must be braced to a node of the Main Hoop Bracing Support structure with tubing meeting the requirements of Roll Hoop Bracing as per Rule T3.4.1.

T3.11.6 In the side view of the vehicle, the portion of the Main Roll Hoop that lies below the upper side impact member attachment point may be inclined at any angle to the vertical in the forward direction but, it must be inclined rearward no more than ten degrees (10°) of the vertical.

T3.11.7 In the front view of the vehicle, the vertical members of the Main Hoop must be at least 380 mm (15 inch) apart (inside dimension) at the location where the Main Hoop is attached to the Major Structure of the Frame.

T3.12 Front Hoop

T3.12.1 The Front Hoop must be constructed of closed section metal tubing per Rule T3.4.1.

T3.12.2 The Front Hoop must extend from the lowest Frame Member to one side of the Frame, up, over and down to the lowest Frame Member to the other side of the Frame.

T3.12.3 With proper gusseting and/or triangulation, it is permissible to fabricate the Front Hoop from more than one piece of tubing.

T3.12.4 The top-most surface of the Front Hoop must be no lower than the top of the steering wheel in any angular position.

T3.12.5 The Front Hoop must be no more than 250 mms (9.8 inches) forward of the steering wheel. This distance shall be measured horizontally, on the vehicle centerline, from the rear surface of the Front Hoop to the forward most surface of the steering wheel rim with the steering in the straight-ahead position.

T3.12.6 In side-view, no part of the Front Hoop can be inclined at more than twenty degrees (20°) from the vertical.

T3.13 Main Hoop Bracing

T3.13.1 Main Hoop braces must be constructed of closed section steel tubing per Rule T3.4.1.

T3.13.2 The Main Hoop must be supported by two braces extending in the forward or rearward direction on both the left and right sides of the Main Hoop.

T3.13.3 In the side view of the Frame, the Main Hoop and the Main Hoop braces must not lie on the same side of the vertical line through the top of the Main Hoop, i.e. if the Main Hoop leans forward, the braces must be forward of the Main Hoop, and if the Main Hoop leans rearward, the braces must be rearward of the Main Hoop.

T3.13.4 The Main Hoop braces must be attached as near as possible to the top of the Main Hoop but not more than 160 mm (6.3 in) below the top-most surface of the Main Hoop. The included angle formed by the Main Hoop and the Main Hoop braces must be at least thirty degrees (30°). See Figure 3.

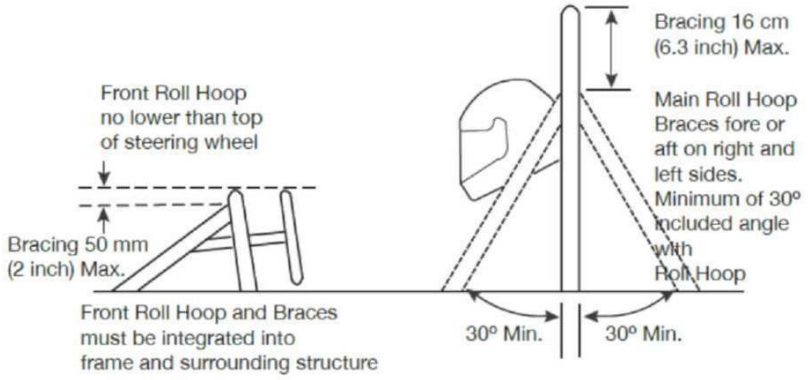


FIGURE 3

T3.13.5 The Main Hoop braces must be straight, i.e. without any bends.

T3.13.6 the attachment of the Main Hoop braces must be capable of transmitting all loads from the Main Hoop into the Major Structure of the Frame without failing. From the lower end of the braces there must be a properly triangulated structure back to the lowest part of the Main Hoop and the node at which the upper side impact tube meets the Main Hoop. This structure must meet the minimum requirements for Main Hoop Bracing Supports (see Rule T3.4) or an SES approved alternative. Bracing loads must not be fed solely into the engine, transmission or differential, or through suspension components.

T3.13.7 If any item which is outside the envelope of the Primary Structure is attached to the Main Hoop braces, then additional bracing must be added to prevent bending loads in the braces in any rollover attitude.

T3.14 Front Hoop Bracing

T3.14.1 Front Hoop braces must be constructed of material per Rule T3.4.1.

T3.14.2 The Front Hoop must be supported by two braces extending in the forward direction on both the left and right sides of the Front Hoop.

T3.14.3 The Front Hoop braces must be constructed such that they protect the driver's legs and should extend to the structure in front of the driver's feet.

T3.14.4 The Front Hoop braces must be attached as near as possible to the top of the Front Hoop but not more than 50.8 mm (2 in) below the top-most surface of the Front Hoop. See Figure 3.

T3.14.5 If the Front Hoop leans rearwards by more than ten degrees (10°) from the vertical, it must be supported by additional bracing to the rear. This bracing must be constructed of material per Rule T3.4.1.

T3.14.6 The Front Hoop braces must be straight, without any bends

T3.15 Other Bracing Requirements

Where the braces are not welded to steel Frame Members, the braces must be securely attached to the Frame using 8 mm Metric Grade 8.8 (5/16 in SAE Grade 5), or stronger, bolts. Mounting plates welded to the Roll Hoop braces must be at least 2.0 mm (0.080 in) thick steel.

T3.16 Other Side Tube Requirements

If there is a Roll Hoop brace or other frame tube alongside the driver, at the height of the neck of any of the team's drivers, a metal tube or piece of sheet metal must be firmly attached to the Frame to prevent the drivers' shoulders from passing under the roll hoop brace or frame tube, and his/her neck contacting this brace or tube.

T3.17 Mechanically Attached Roll Hoop Bracing

T3.17.1 Roll Hoop bracing may be mechanically attached.

T3.17.2 Any non-permanent joint at either end must be either a double lug joint as shown in Figures 4 and 5, or a sleeved butt joint as shown in Figure 6.

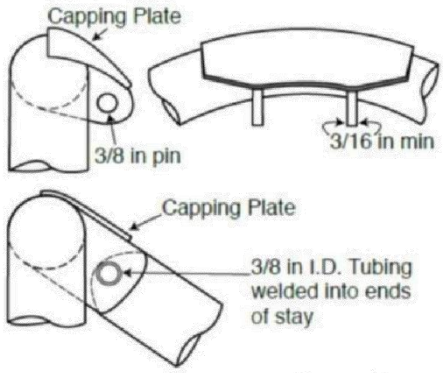


FIGURE 4

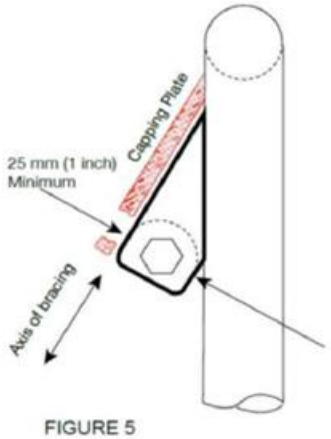


FIGURE 5

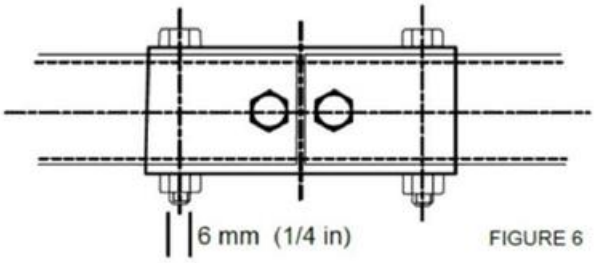


FIGURE 6

T3.17.3 The threaded fasteners used to secure non-permanent joints are considered critical fasteners and must comply with ARTICLE 11.

T3.17.4 No spherical rod ends are allowed.

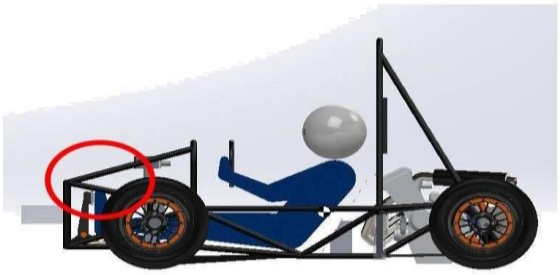
T3.17.5 For double-lug joints, each lug must be at least 4.5 mm (0.177 in) thick steel, measure 25 mm (1.0 in) minimum perpendicular to the axis of the bracing and be as short as practical along the axis of the bracing.

T3.17.6 All double-lug joints, whether fitted at the top or bottom of the tube, must include a capping arrangement (Figures 4 & 5).

T3.17.7 In a double lug joint the pin or bolt must be 10 mm Metric Grade 9.8 (3/8 in. SAE Grade 8) minimum. The attachment holes in the lugs and in the attached bracing must be a close fit with the pin or bolt.

T3.17.8 For sleeved butt joints (Figure 6), the sleeve must have a minimum length of 76 mm (3 inch); 38 mm (1.5 inch) either side of the joint and be a close-fit around the base tubes. The wall thickness of the sleeve must be at least that of the base tubes. The bolts must be 6 mm Metric Grade 9.8 (1/4-inch SAE Grade 8) minimum. The holes in the sleeves and tubes must be a close fit with the bolts.

T3.18 Frontal Impact Structure


Driver's feet must be completely inside the frame structure

T3.18.1 The driver's feet *and legs* must be completely contained within the Major Structure of the Frame. While the driver's feet are touching the pedals, in, side and front views no part of the driver's feet *or legs* can extend above or outside of the Major Structure of the Frame.

T3.18.2 Forward of the Front Bulkhead must be an energy-absorbing Impact Attenuator.

T3.19 Bulkhead

T3.19.1 The Front Bulkhead must be constructed of closed section tubing per Rule T3.4.1.

T3.19.2 Except as allowed by T3.19.3, The Front Bulkhead must be located forward of all non-

crushable objects, e.g. batteries, master cylinders, hydraulic reservoirs.

T3.19.3 The Front Bulkhead must be located such that the soles of the driver's feet, when touching but not applying the pedals, are rearward of the bulkhead plane. (This plane is defined by the forward-most surface of the tubing.) Adjustable pedals must be in the forward most position.

T3.20 Front Bulkhead Support

T3.20.1 The Front Bulkhead must be securely integrated into the Frame.

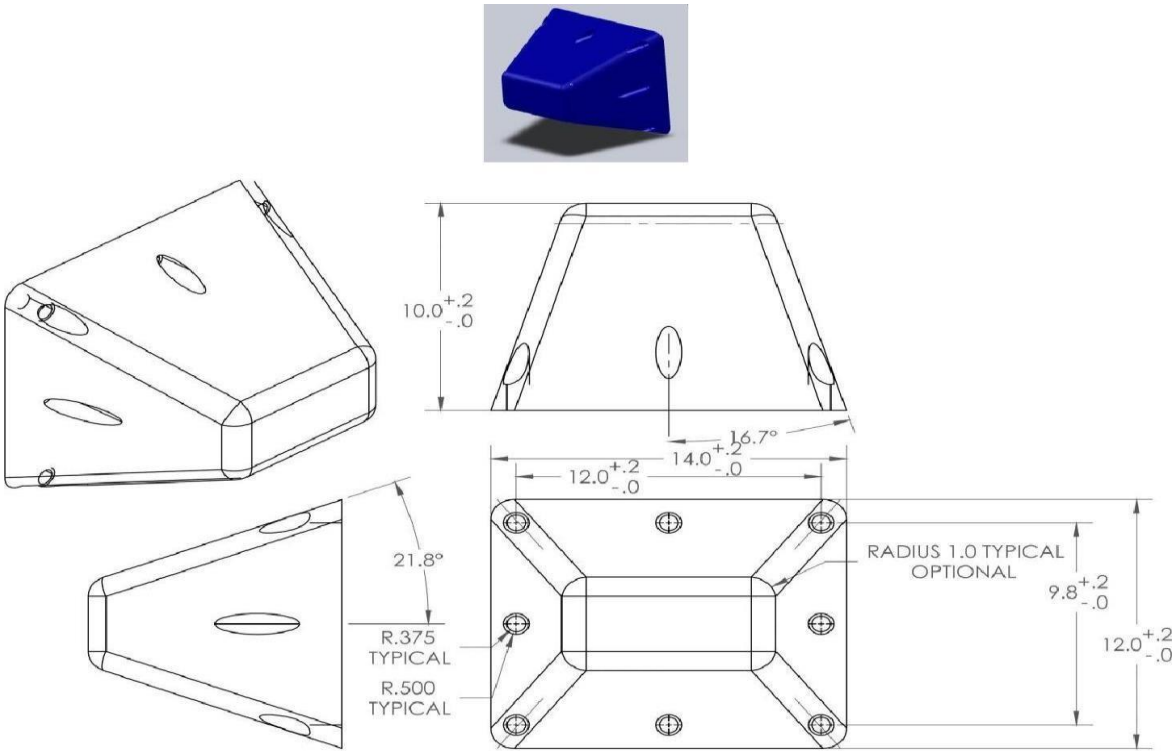
T3.20.2 The Front Bulkhead must be supported back to the Front Roll Hoop by a minimum of three (3) Frame Members on each side of the vehicle with one at the top (within 50.8 mm (2inches) of its top-most surface), one (1) at the bottom, and one (1) as a diagonal brace to provide triangulation.

T3.20.3 The triangulation must be node-to-node, with triangles being formed by the Front Bulkhead, the diagonal and one of the other two required Front Bulkhead Support Frame Members.

a) The upper support member must be attached within 50 mm of the top surface of the Front Bulkhead and attached to the Front Hoop within a zone extending 100 mm above and 50 mm below the Upper Side Impact member.
b) If the upper support member is further than 100 mm above the Upper Side Impact member, then properly triangulated bracing is required to transfer load to the Main Hoop, either via the Upper Side Impact member, or an additional member transmitting load from the junction of the Upper Support Member with the Front Hoop.
c) The lower support member must be attached to the base of Front Bulkhead and the base of the Front Hoop.
d) The diagonal brace must properly triangulate the upper and lower support members.

T3.20.4 All the Frame Members of the Front Bulkhead Support system listed above must be constructed of closed section tubing per Section T3.4.1.

T3.21 Impact Attenuator



T3.21.1 The Impact Attenuator must be:

a. Installed forward of the Front Bulkhead.
b. At least 200 mm (7.8 in) long, with its length oriented along the fore/aft axis of the Frame.
c. At least 100 mm (3.9 in) high and 200 mm (7.8 in) wide for a minimum distance of 200 mm (7.8 in) forward of the Front Bulkhead.
d. Such that it cannot penetrate the Front Bulkhead in the event of an impact.
e. Attached securely and directly to the Front Bulkhead and not by being part of non-structural bodywork.

T3.21.2 The attachment of the Impact Attenuator must be constructed to provide an adequate load path for transverse and vertical loads in the event of off-center and off-axis impacts.

T3.21.3 The attachment of the Impact Attenuator to a monocoque structure requires an approved "Structural Equivalency Spreadsheet" per Article T3.9 that shows equivalency to a minimum of four (4) 8 mm Grade 8.8 (5/16-inch Grade 5) bolts.

T3.21.4 On all cars, a 1.5 mm (0.060 in) solid steel or 4.0 mm (0.157 in) solid aluminum "anti-intrusion plate" must be integrated into the Impact Attenuator. If the IA plate is bolted to the Front Bulkhead, it must be the same size as the outside dimensions of the Front Bulkhead. If it is welded to the Front Bulkhead, it must extend at least to the centerline of the Front Bulkhead tubing, where the welds are either continuous or interrupted. If interrupted, the weld/space ratio must be at least 1:1. All weld lengths must be greater than 25 mm.

T3.21.5 If the anti-intrusion plate is not integral with the frame, i.e. welded, a minimum of four (4) 8 mm Metric Grade 8.8 (5/16-inch SAE Grade 5) bolts must attach the Impact Attenuator to the Front Bulkhead.

T3.21.6 Alternative designs of the anti-intrusion plate required by T3.21.4 that do not comply with the minimum specifications given above require an approved "Structural Equivalency Spreadsheet" per Article T3.9. Equivalency must also be proven for perimeter shear strength of the proposed design.

T3.22 Impact Attenuator Data Requirement

T3.22.1 The team must submit test data to show that their Impact Attenuator, when mounted on the front of a vehicle with a total mass of 300 kgs (661 lbs) and run into a solid, non-yielding impact barrier with a velocity of impact of 7.0 meters/second (23.0 ft/sec), would give an average deceleration of the vehicle not to exceed 20 g's, with a peak deceleration less than or equal to 40 g's. Total energy absorbed must meet or exceed 7350 Joules.
Note: These are the attenuator functional requirements, not the test requirements.
Quasi- static testing is not allowed.

T3.22.2 When using acceleration data, the average deceleration must be calculated based on the raw data. The peak deceleration can be assessed based on the raw data, and if peaks above the 40g limit are apparent in the data, it can then be filtered with a Channel Filter Class (CFC) 60 (100 Hz) filter per SAE Recommended Practice J211 "Instrumentation for Impact Test", or a 100 Hz, 3rd order, lowpass Butterworth (-3dB at 100 Hz) filter.

T3.22.3 A schematic of the test method must be supplied along with photos of the attenuator before and after testing.

T3.22.4 The test piece must be presented at technical inspection for comparison to the photographs and the attenuator fitted to the vehicle.

T3.22.5 The test data and calculations must be submitted electronically in Adobe Acrobat ® format (*.pdf file) to the address and by the date provided in the Action Deadlines provided on the relevant competition website. This material must be a single file (text, drawings, data or whatever you are including).

T3.22.6 The Impact Attenuator Data must be named as follows: car number_ school name_ competition code_IAD.pdf using the assigned car number, the complete school's name and competition code

[Example: 087_University of SAEINDIA_IAD.pdf]

Competition Codes are listed in Rule A.2.6

T3.22.7 Teams that submit their Impact Attenuator Data Report after the due date will be penalized 10 points per day up to a maximum of 50 points, which will be taken off the team's Total Score.

T3.22.8 Impact Attenuator Reports will be evaluated by the organizers and the evaluations will be passed to the Design Event Captain for consideration in that event.

T3.22.9 During the test, the attenuator must be attached to the anti-intrusion plate using the intended vehicle attachment method. The anti-intrusion plate must be spaced at least 50 mm (2 inches) from any rigid surface. No part of the anti-intrusion plate may permanently deflect more than 25.4 mm (1 inch) beyond the position of the anti-intrusion plate before the test.

Note: The 25.4 mm (1 inch) spacing represents the front bulkhead support and ensures that the plate does not intrude excessively into the cockpit

T3.22.10 Dynamic testing (sled, pendulum, drop tower, etc.) of the impact attenuator may only be done at a dedicated test facility. The test facility may be part of the University but must be supervised by professional staff or University faculty. Teams are not allowed to construct their own dynamic test apparatus.

T3.22.11 Standard Attenuator -

Teams may choose to use that style of impact attenuator and need not submit test data with their IAD Report. The other requirements of the IAD Report must still be submitted including, but not limited to, photos of the team's actual attenuator with evidence that it meets the design criteria given on the website.

T3.23 Non-Crushable Objects

T3.23.1 Except as allowed by T3.23.2, all non-crushable objects (e.g. batteries, master cylinders, hydraulic reservoirs) must be rearward of the bulkhead. No non-crushable objects are allowed in the impact attenuator zone. All non-crushable objects inside the primary structure must have a minimum 25mm clearance to the rear face of the Anti-intrusion plate.

T3.23.2 The front wing and wing supports may be forward of the Front Bulkhead but may NOT be located in or pass through the Impact Attenuator. If the wing supports are in front of the Front Bulkhead, the supports must be included in the test of the Impact Attenuator for T3.22.

T3.24 Front Bodywork

T3.24.1 Sharp edges on the forward-facing bodywork or other protruding components are prohibited.

T3.24.2 All forward facing edges on the bodywork that could impact people, e.g. the nose, must have forward facing radii of at least 38 mm (1.5 inches). This minimum radius must extend to at least forty-five degrees (45°) relative to the forward direction, along the top, sides and bottom of all affected edges.

T3.25 Side Impact Structure for Tube Frame Cars

The Side Impact Structure must meet the requirements listed below, either of the rules.

Rule-A

T3.25.1 The Side Impact Structure for tube frame cars must be comprised of at least three (3) tubular members located on each side of the driver while seated in the normal driving position, as shown in Figure 7.

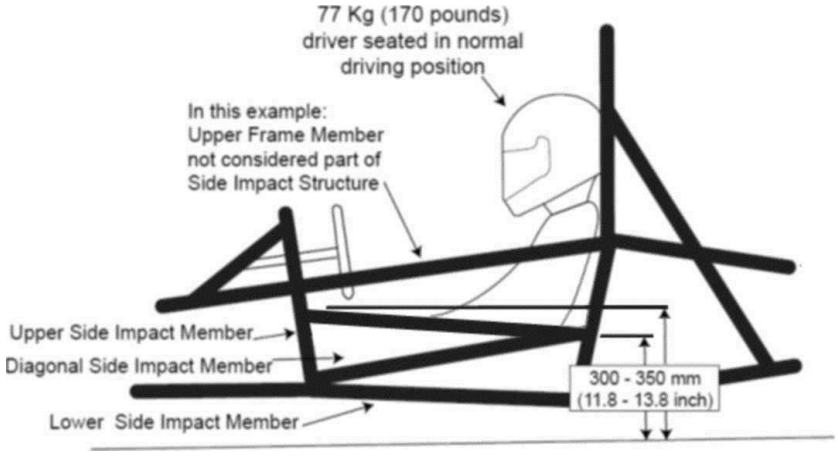


FIGURE 7

T3.25.2 The three (3) required tubular members must be constructed of material per Section T3.4.

T3.25.3 The locations for the three (3) required tubular members are as follows:

The upper Side Impact Structural member must connect the Main Hoop and the Front Hoop. With a 77kg (170 pound) driver seated in the normal driving position all of the members must be at a height between 300 mm (11.8 inches) and 350 mm (13.8 inches) above the ground. The upper frame rail may be used as this member if it meets the height, diameter and thickness requirements.

- The lower Side Impact Structural member must connect the bottom of the Main Hoop and the bottom of the Front Hoop. The lower frame rail/frame member may be this member if it meets the diameter and wall thickness requirements.
- The diagonal Side Impact Structural member must connect the upper and lower Side Impact Structural members forward of the Main Hoop and rearward of the Front Hoop.

Rule-B

- The upper member must connect the main hoop and the front hoop. It must be at a height between 240 mm and 320 mm above the lowest inside chassis point between the front and main hoop (Refer FIGURE 8)
- The lower member must connect the bottom of the main hoop and the bottom of the front hoop
- The diagonal member must triangulate the upper and lower member between the roll hoops node-to-node.

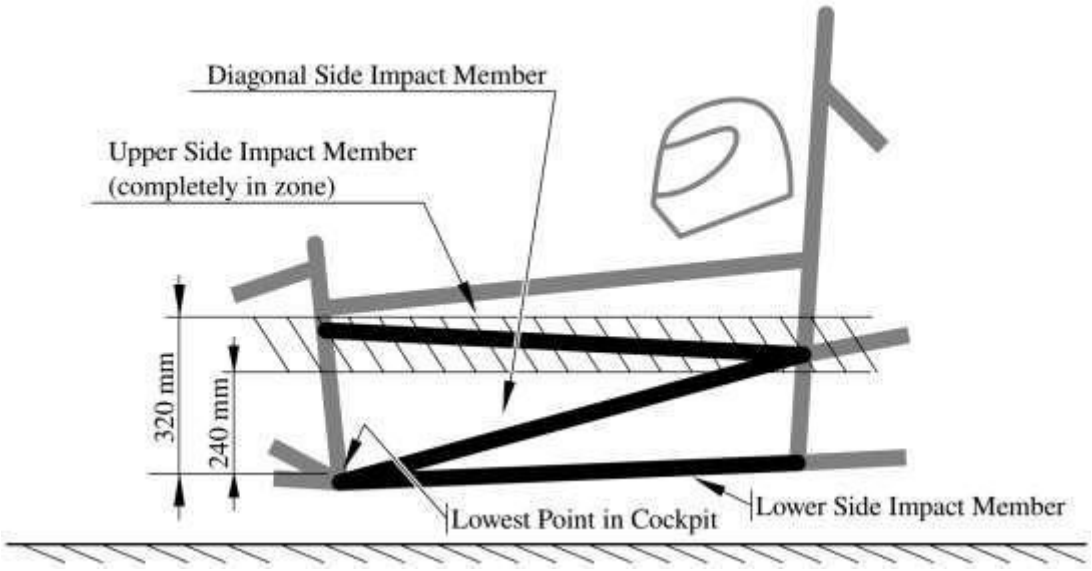


FIGURE 8

NOTE: Students should follow only one of the Rule, either A or B.

T3.25.4 With proper gusseting and/or triangulation, it is permissible to fabricate the Side Impact Structural members from more than one piece of tubing.

T3.25.5 Alternative geometry that does not comply with the minimum requirements given above requires an approved "Structural Equivalency Spreadsheet" per Rule T3.9.

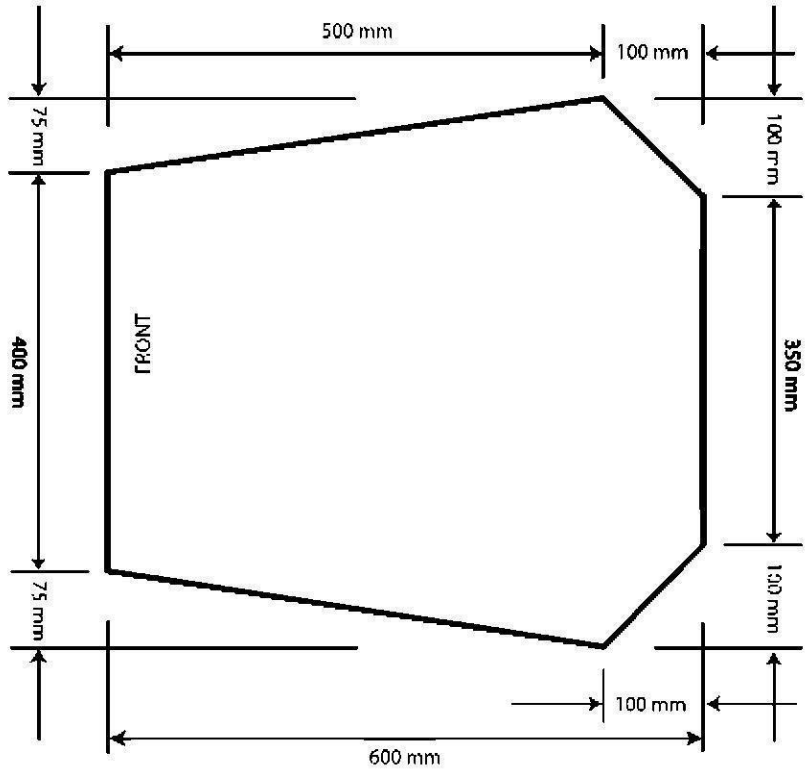
T3.26 Inspection Holes

T3.26.1 The Technical Inspectors may check the compliance of all tubes. This may be done by the use of ultra-sonic testing or by the drilling of inspection holes at the inspector's request.

ARTICLE 4: COCKPIT

T4.1 Cockpit Opening

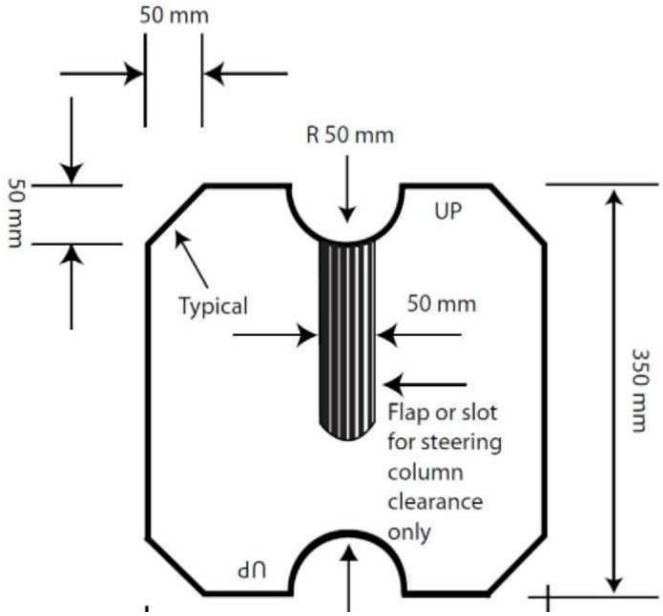
T4.1.1 In order to ensure that the opening giving access to the cockpit is of adequate size, a template shown in Figure 8 will be inserted into the cockpit opening. It will be held horizontally and inserted vertically until it has passed below the top bar of the Side Impact Structure (or until it is 350 mm (13.8 inches) above the ground for monocoque cars). No fore and aft translation of the template will be permitted during insertion.



T4.1.2 During this test, the steering wheel, steering column, seat and all padding may be removed. The shifter or shift mechanism may not be removed unless it is integral with the steering wheel and is removed with the steering wheel. The firewall may not be moved or removed. Note: As a practical matter, for the checks, the steering column will not be removed. The technical inspectors will maneuver the template around the steering column shaft, but not the steering column supports.

T4.2 Cockpit Internal Cross Section:

T4.2.1 A free vertical cross section, which allows the template shown in Figure 9 to be passed horizontally through the cockpit to a point 100 mm (4 inches) rearwards of the face of the rearmost pedal when in the inoperative position, must be maintained over its entire length. If the pedals are adjustable, they will be put in their most forward position.



T4.2.2 The template, with maximum thickness of 7mm (0.275 inch), will be held vertically and inserted into the cockpit opening rearward of the Front Roll Hoop, as close to the Front Roll Hoop as the car's design will allow.

T4.2.3 The only items that may be removed for this test are the steering wheel, and any padding required by Rule T5.8 "Driver's Leg Protection" that can be easily removed without the use of tools with the driver in the seat. The seat may NOT be removed.

T4.2.4 Teams whose cars do not comply with T4.1.1 or T4.2.1will not be given a Technical Inspection Sticker and will NOT be allowed to compete in dynamic events.
Note: Cables, wires, hoses, tubes, etc. must not impede the passage of the templates required by T4.1.1 and T4.2.

T4.3 Driver's Seat

T4.3.1 The lowest point of the driver's seat must be no lower than the bottom surface of the lower frame rails or by having a longitudinal tube (or tubes) that meets the requirements for Side Impact tubing, passing underneath the lowest point of the seat.

T4.3.2 When seated in the normal driving position, adequate heat insulation must be provided to ensure that the driver will not contact any metal or other materials which may become heated to a surface temperature above sixty degrees C (60°C). The insulation may be external to the cockpit or incorporated with the driver's seat or firewall. The design must show evidence of addressing all three (3) types of heat transfer, namely conduction, convection and radiation, with the following between the heat source, e.g. an exhaust pipe or coolant hose/tube and the panel that the driver could contact, e.g. the seat or floor:

a. Conduction Isolation by:
   i. No direct contact between the heat source and the panel, or

ii. A heat resistant, conduction isolation material with a minimum thickness of 8 mm (0.3 in) between the heat source and the panel.

b. Convection Isolation by a minimum air gap of 25 mm (1 inch) between the heat source and the panel

c. Radiation Isolation by:
   i. A solid metal heat shield with a minimum thickness of 0.4 mm (0.015 in) or
   ii. Reflective foil or tape when combined with (a. ii.) above.

T4.4 Floor Close-out

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 prevent track debris from entering the car. The panels must be made of solid, non-brittle material.

T4.5 Firewall

T4.5.1 A firewall must separate the driver compartment from all components of the fuel supply, the engine oil, the liquid cooling systems and any high voltage system (PART EV - EV1.1). It must protect the neck of the tallest driver. It must 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.

T4.5.2 The firewall must be a non-permeable surface made from rigid, fire-resistant material.

T4.5.3 Any firewall must seal completely against the passage of fluids, especially at the sides and the floor of the cockpit, i.e. there can be no holes in a firewall through which seat belts pass.

T4.5.4 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.

T4.6 Accessibility of Controls

All vehicle controls, including the shifter, must be operated from inside the cockpit without any part of the driver, e.g. hands, arms or elbows, being outside the planes of the Side Impact Structure defined in Rule T3.25 and T3.34.

T4.7 Driver Visibility

T4.7.1 General Requirement

The driver must have adequate visibility to the front and sides of the car. With the driver seated in a normal driving position he/she must have a minimum field of vision of two hundred degrees (200°) (a minimum one hundred degrees (100°) 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.

T4.7.2 Mirrors

If mirrors are required to meet Rule T4.7.1, they must remain in place and adjusted to enable the required visibility throughout all dynamic events.

T4.8 Driver Egress

T4.8.1 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 and wearing the required driver equipment. Egress time will stop when the driver has both feet on the pavement.

T4.8.2 Driver Egress will be conducted for the two (2) main and the one (1) reserve driver.

ARTICLE 5: DRIVERS EQUIPMENT (BELTS AND COCKPIT PADDING)

T5.1 Belts – General

T5.1.1 Definitions

a. A 5-point system - consists of a 76 mm (3 inch) wide lap belt, approximately 76 mm (3 inch) wide shoulder straps and a single approximately 51 mm (2 inch) wide anti-submarine strap. The single anti-submarine strap must have a metal-to-metal connection with the single release common to the lap belt and shoulder harness.

b. A 6-point system - consists of a 76 mm (3 inch) wide lap belt, approximately 76 mm (3 inch) wide shoulder straps and two (2) approximately 51 mm (2 inch) wide leg or anti-submarine straps.

c. A 7-point system - system is the same as the 6-point system except it has three (3) anti- submarine straps, two (2) from the 6-point system and one (1) from the 5-point system. Note: 6 and 7-point harnesses to FIA specification 8853/98 and SFI Specification 16.5 with approximately 51 mm (2 inch) lap belts are acceptable.

d An "upright driving position" is defined as one with a seat back angled at thirty degrees (30°) or less from the vertical as measured along the line joining the two 200 mm circles of the template of the 95th percentile male as defined in Rule T3.10.3 and positioned per T3.10.4.

e A "reclined driving position" is defined as one with a seat back angled at more than thirty degrees (30°) from the vertical as measured along the line joining the two 200 mm circles of the template of the 95th percentile male as defined in Rule T3.10.3 and positioned per T3.10.4.

f The "chest-groin line" is the straight line that in side-view follows the line of the shoulder belts from the chest to the release buckle.

T5.1.2 Harness Requirements

All drivers must use a 5-, 6- or 7-point restraint harness meeting the following specifications:

a. All driver restraint systems must meet SFI Specification 16.1, SFI Specification 16.5, or FIA specification 8853/98.

b. The belts must bear the appropriate dated labels.

c. The material of all straps must be in perfect condition.

d. There must be a single release common to the lap belt and shoulder harness using a

metal-to-metal quick release type latch.

e. To accommodate drivers of differing builds, all lap belts must have a "quick adjuster" feature. Lap belts with "pull-up" adjusters are recommended over "pull-down" adjusters.

f. Cars with a "reclined driving position" (see 5.1.2.f above) must have either a 6 point or 7-point harness, AND have either anti-submarine belts with "quick adjusters" or have two (2) sets of anti-submarine belts installed.

g. The shoulder harness must be the over-the-shoulder type. Only separate shoulder straps are permitted (i.e. "y"-type shoulder straps are not allowed). The "H"-type configuration is allowed.

h. It is mandatory that the shoulder harness, where it passes over the shoulders, be 76 mm (3 inch) wide, except as noted below. The shoulder harness straps must be threaded through the three bar adjusters in accordance with manufacturer's instructions.

i. When the HANS device is used by the driver, FIA certified 51 mm (2 inch) wide shoulder harnesses are allowed. Should a driver, at any time not utilize the HANS device, then 76 mm (3 inch) wide shoulder harnesses are required.

T5.1.3 Harness Replacement

SFI spec harnesses must be replaced following December 31st of the 2nd year after the date of manufacture as indicated by the label.

FIA spec harnesses must be replaced following December 31st of the expiry year marked on the label.

The harness must be in new or like new condition, with no signs of wear, cuts, chaffing or other issues. All Harness must be manufactured in or after 2021.

(Note: FIA belts are normally certified for five (5) years from the date of manufacture.)

T5.1.4 The restraint system must be worn tightly at all times.

T5.2 Belt, Strap and Harness Installation - General

T5.2.1 The lap belt, shoulder harness and anti-submarine strap(s) must be securely mounted to the Primary Structure. Such structure and any guide or support for the belts must meet the minimum requirements of T3.4.1.

Note: Rule T3.5.5 applies to these tubes as well so a non-straight shoulder harness bar would require support per T3.5.5

T5.2.2 The tab to which any harness is attached must have:

a. A minimum cross-sectional area of 40 sq. mm (0.062 sq. in) of steel to be sheared or failed in tension at any point of the tab, and

b. A minimum thickness of 1.6 mm (0.063 inch).

c. Where lap belts and anti-submarine belts use the same attachment point, a minimum cross-sectional area of 90 sq. mm (0.140 sq in) of steel to be sheared if failed in tension at any point of the tab.

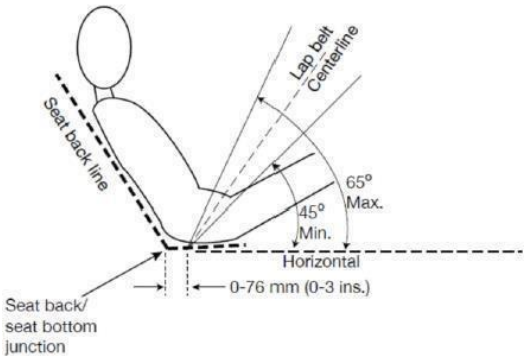
Note: Double shear mounting is preferred.

T5.2.3 Harnesses, belts and straps must not pass through a firewall, i.e. all harness attachment points must be on the driver's side of any firewall.

T5.2.4 The attachment of the Driver's Restraint System to a monocoque structure requires an approved Structural Equivalency Spreadsheet per Rule T3.9.

T5.2.5 The restraint system installation is subject to approval of the Chief Technical Inspector.

FIGURE 10
Lap Belt Angle



T5.3 Lap Belt Mounting

T5.3.1 The lap belt must pass around the pelvic area below the Anterior Superior Iliac Spines (the hip bones).

T5.3.2 The lap belts should not be routed over the sides of the seat. 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.

T5.3.3 Where the belts or harness pass through a hole in the seat, the seat must be rolled or grommeted to prevent chafing of the belts.

T5.3.4 To fit drivers of differing statures correctly, inside view, the lap belt must be capable of pivoting freely by using either a shouldered bolt or an eye bolt attachment, i.e. mounting lap belts by wrapping them around frame tubes is no longer acceptable.

T5.3.5 With an "upright driving position", in side-view the lap belt must be at an angle of between forty-five degrees (45°) and sixty-five degrees (65°) to the horizontal. This means that the centerline of the lap belt at the seat bottom should be between 0 - 76 mm (0 - 3 inches) forward of the seat back to seat bottom junction. (See Figure 10)

T5.3.6 With a "reclined driving position", inside view the lap belt must be between an angle of sixty degrees (60°) and eighty degrees (80°) to the horizontal.

T5.4 Shoulder Harness

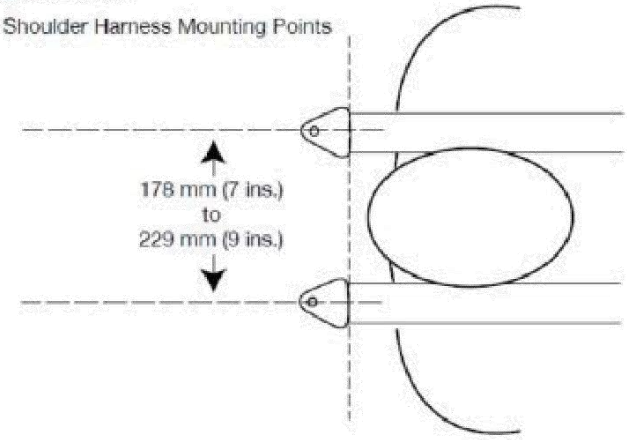
T5.4.1 The shoulder harness must be mounted behind the driver to structure that meets the requirements of T3.4.1. However, it cannot be mounted to the Main Roll Hoop Bracing or attendant structure without additional bracing to prevent loads being transferred into the Main Hoop Bracing.

T5.4.2 If the harness is mounted to a tube that is not straight, the joints between this tube and the structure to which it is mounted must be reinforced inside view by gussets or triangulation tubes to prevent torsional rotation of the harness mounting tube.

T5.4.3 The shoulder harness mounting points must be between 178 mm (7 inches) and 229 mm (9 inches) apart. (See Figure 11)

FIGURE 11

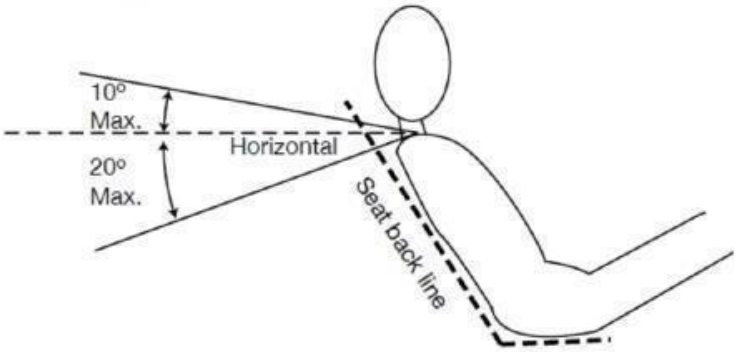
Shoulder Harness Mounting Points



T5.4.4 From the driver's shoulders rearwards to the mounting point or structural guide, the shoulder harness must be between ten degrees (10°) above the horizontal and twenty degrees (20°) below the horizontal. (See Figure 12).

FIGURE 12

Shoulder Harness Angle



T5.5 Anti-Submarine Belt Mounting

T5.5.1 The anti-submarine belt of a 5-point harness should be mounted in line with or angled slightly forward (up to twenty degrees (20°)) of the driver's chest-groin line.

T5.5.2 The anti-submarine belts of a 6-point harness should be mounted either:

a. With the belts going vertically down from the groin or angled up to twenty degrees (20°) rearwards. The anchorage points should be approximately 100 mm (4 inches) apart. Or

b. With the anchorage points on the Primary Structure at or near the lap belt anchorages, the driver sitting on the anti-submarine belts, and the belts coming up around the groin to the release buckle.

T5.6 Head Restraint

T5.6.1 A head restraint must be provided on the car to limit the rearward motion of the driver's head.

T5.6.2 The restraint must:

- Be vertical or near vertical in side-view.

- Be padded with an energy absorbing material with a minimum thickness of 38 mm (1.5 inches).
- Material that meets either SFI Spec 45.2, or is listed in the FIA Technical List No. 17 as a "Type B Material for single seater cars": CONFOR M foam CF-42 (pink) or CF-42M (pink). CF-42AC (pink) is acceptable.
- Have a minimum width of 15 cm (6 in).
- Have a minimum area of 325 sq. cm (36 sq. ins) AND have a minimum height adjustment of 17.5 cm (7 inches) OR have a minimum height of 28 cm (11 inches).
- Be located so that for each driver:
- The restraint is no more than 25 mm (1 inch) away from the back of the driver's helmet, with the driver in their normal driving position.
- The contact point of the back of the driver's helmet on the head restraint is no less than 50 mm (2 inch) from any edge of the head restraint.

  Note: (1): Head restraints may be changed to accommodate different drivers (See T1.2.2).

  Note: (2): The above requirements must be met for all drivers.

  Note: (3): Approximately 100mm (4") longitudinal adjustment is required to accommodate 5th to 95th Percentile drivers. This is not a specific rules requirement, but teams must have sufficient longitudinal adjustment and/or alternative thickness head restraints available, such that the above requirements are met by all their drivers.

T5.6.3 The restraint, its attachment and mounting must be strong enough to withstand a force of 890 Newtons (200 lbs. force) applied in a rearward direction.

T5.7 Roll Bar Padding

Any portion of the roll bar, roll bar bracing or frame which might be contacted by the driver's helmet must be covered with a minimum thickness of 12 mm (0.5 inch) of padding which meets SFI spec 45.1 or FIA 8857-2001.

T5.8 Driver's Leg Protection

T5.8.1 To keep the driver's legs away from moving or sharp components, all moving suspension and steering components, and other sharp edges inside the cockpit between the front roll hoop and a vertical plane 100 mm (4 inches) rearward of the pedals, must be shielded with a shield made of solid material. Moving components include, but are not limited to springs, shock absorbers, rocker arms, anti-roll/sway bars, steering racks and steering column CV joints.

T5.8.2 Covers over suspension and steering components must be removable to allow inspection of the mounting points.

ARTICLE 6: GENERAL CHASSIS RULES

T6.1 Suspension

T6.1.1 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 handling inappropriate for an autocross circuit.

T6.1.2 All suspension mounting points must be visible at Technical Inspection, either by direct view or by removing any covers.

T6.2 Ground Clearance

Ground clearance must be sufficient to prevent any portion of the car, other than the tires, from touching the ground during track events. Intentional or excessive ground contact of any portion of the car other than the tires will forfeit a run or an entire dynamic event.

Comment: The intention of this rule is that sliding skirts or other devices that by design, fabrication or as a consequence of moving, contact the track surface are prohibited and any unintended contact with the ground which either causes damage, or in the opinion of the 'dynamic event organizers' could result in damage to the track, will result in forfeit of a run or an entire dynamic event

T6.3 Wheels

T6.3.1 The wheels of the car must be 203.2 mm (8.0 inches) or more in diameter.

T6.3.2 Any wheel mounting system that uses a single retaining nut must incorporate a device to retain the nut and the wheel in the event that the nut loosens. A second nut ("jam nut") does not meet these requirements.

T6.3.3 Standard wheel lug bolts are considered engineering fasteners, and any modification will be subject to extra scrutiny during technical inspection. Teams using modified lug bolts or custom designs will be required to provide proof that good engineering practices have been followed in their design.

T6.3.4 Aluminum wheel nuts may be used, but they must be hard anodized and in pristine condition.

T6.4 Tires

T6.4.1 Vehicles may have two types of tires as follows:

- 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 must be treaded for the Student Formula Event.
- Rain Tires - Rain tires may be any size or type of treaded or grooved tire provided:
- The tread pattern or grooves were molded in by the tire manufacturer.
- 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.

T6.4.2 Within each tire set, the tire compound or size, or wheel type or size may not be changed after static judging has begun. Tire warmers are not allowed. No traction enhancers may be applied to the tires after the static judging has begun.

T6.5 Steering

T6.5.1 The steering wheel must be mechanically connected to the wheels, i.e. "steer-by-wire" is prohibited, *or electrically actuated steering is prohibited.*

T6.5.2 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.

T6.5.3 Allowable steering system free play is limited to seven degrees (7°) total measured at the steering wheel.

T6.5.4 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.

T6.5.5 The steering wheel must have a continuous perimeter that is near circular or near oval, i.e. the outer perimeter profile can have some straight sections, but no concave sections. "H", "Figure 8", or cutout wheels are not allowed.

T6.5.6 In any angular position, the top of the steering wheel must be no higher than the top-most surface of the Front Hoop. See Figure 3.

T6.5.7 steering systems using cables for actuation are not prohibited by T6.5.1 but additional documentation must be submitted. The team must submit a failure modes and effects analysis report with design details of the proposed system as part of the structural equivalency spreadsheet (SES). The report must outline the analysis that was carried out to show the steering system will function properly, potential failure modes and the effects of each failure mode and finally failure mitigation strategies used by the team. The organizing committee will review the submission and advise the team if the design is approved. If not approved, a non-cable-based steering system must be used instead.

T6.6 Jacking Point

T6.6.1 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.

T6.6.2 The jacking point is required to be:

- Visible to a person standing 1 meter (3 feet) behind the car.
- Painted Bright orange.
- Oriented horizontally and perpendicular to the centerline of the car
- Made from round, 25 - 29 mm (1 - 1 1/8 inch) O.D. aluminum or steel tube
- A minimum of 300 mm (12 inches) long
- Exposed around the lower 180 degrees (180°) of its circumference over a minimum length of 280 mm (11 in)
- The height of the tube is required to be such that:
  - There is a minimum of 75 mm (3 in) clearance from the bottom of the tube to the ground measured at tech inspection.
  - 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.
- Access from the rear of the tube must be unobstructed for at least 300mm of its length

Comment on Disabled Cars - The organizers and the Rules Committee remind teams that cars disabled on course must be removed as quickly as possible. A variety of tools may be used to move disabled cars including quick jacks, dollies of different types, tow ropes and occasionally even boards. We expect cars to be strong enough to be easily moved without damage. Speed is important in clearing the course and although the course crew exercises due care, parts of a vehicle can be damaged during removal. The organizers are not

responsible for damage that occurs when moving disabled vehicles. Removal/recovery workers will jack, lift, carry or tow the car at whatever points they find easiest to access. Accordingly, we advise teams to consider the strength, location and identify all obvious jacking, lifting and towing points during the design process.

T6.7 Rollover Stability

T6.7.1 The track and center of gravity of the car must combine to provide adequate rollover stability.

T6.7.2 Rollover stability will be evaluated on a tilt table using a pass/fail test. The vehicle must not roll when tilted at an angle of sixty degrees (60°) 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.

ARTICLE 7: BRAKE SYSTEM

T7.1 Brake System - General

The car must be equipped with a brake system that acts on all four wheels and is operated by single control.

T7.1.1 It must have two (2) independent hydraulic circuits such that in the case of a leak or failure at any point in the system, effective braking power is maintained on at least two (2) wheels. Each hydraulic circuit must have its own fluid reserve, either by the use of separate reservoirs or by the use of a dammed, OEM-style reservoir.

T7.1.2 A single brake acting on a limited-slip differential is acceptable.

T7.1.3 The brake system must be capable of locking all four (4) wheels during the test specified below.

T7.1.4 "Brake-by-wire" systems are prohibited.

T7.1.5 Unarmored plastic brake lines are prohibited.

T7.1.6 The braking systems must be protected with scatter shields from failure of the drive train (see T8.4) or from minor collisions.

T7.1.7 In side-view no portion of the brake system that is mounted on the sprung part of the car can project below the lower surface of the frame or the monocoque, whichever is applicable.

T7.1.8 The brake pedal shall be designed to withstand a force of 2000 N without any failure of the brake system or pedal box. This may be tested by pressing the pedal with the maximum force that can be exerted by any official when seated normally.

T7.1.9 The brake pedal must be fabricated from steel or aluminum or machined from steel, aluminum or titanium.

T7.2 Brake Test

T7.2.1 The brake system will be dynamically tested and must demonstrate the capability of locking all four (4) wheels and stopping the vehicle in a straight line at the end of an acceleration run at a minimum speed of 40KMPH as specified by the brake inspectors.

T7.3 Brake Over-Travel Switch

T7.3.1 A brake pedal over-travel switch must be installed on the car as part of the shutdown system and wired in series with the shutdown buttons. This switch must be installed so that in the event of brake system failure such that the brake pedal over travels it will result

in the shutdown system being activated and controlling the systems as defined in Part IC Article 4 (IC vehicles)

T7.3.2 Repeated actuation of the switch must not restore power to these components, and it must be designed so that the driver cannot reset it.

T7.3.3 The switch must be implemented with analog components, and not through recourse to programmable logic controllers, engine control units, or similar functioning digital controllers.

*T7.3.*4 The Brake Over-Travel switch must be a mechanical single pole, single throw (commonly known as a two-position) switch (push-pull or flip type) as shown below.

T7.4 Brake Light

T7.4.1 The car must be equipped with a red brake light. The brake light itself has to have a black background and a rectangular, triangular or near round shape with a minimum shining surface of at least 15cm². Each brake light must be clearly visible from the rear in very bright sunlight.

T7.4.2 This light must be mounted between the wheel centerline and driver's shoulder level vertically and approximately on vehicle centerline laterally.

T7.4.3 When LED lights are used without a diffuser, they must not be more than 20 mm apart.

T7.4.4 If a single line of LEDs is used, the minimum length should be 150 mm.

ARTICLE 8: POWERTRAIN

T8.1 Coolant Fluid Limitations

Water-cooled engines must only use plain water as coolant. Glycol-based antifreeze, "water wetter", water pump lubricants of any kind, or any other additives are strictly prohibited.

T8.2 System Sealing

T8.2.1 Any cooling or lubrication system must be sealed to prevent leakage.

T8.2.2 Separate catch cans must be employed to retain fluids from any vents for the coolant system or lubrication system. Each catch-can must have a minimum volume of ten (10) percent of the fluid being contained or 0.9 liter (one U.S. quart) whichever is greater.

T8.2.3 Catch cans must be capable of containing boiling water without deformation, and be located rearwards of the firewall below driver's shoulder level, and be positively retained, i.e. no tie-wraps or tape.

T8.2.4 Any catch can on the cooling system, must vent through a hose with a minimum internal diameter of 3 mm (1/8 inch) down to the bottom levels of the Frame.

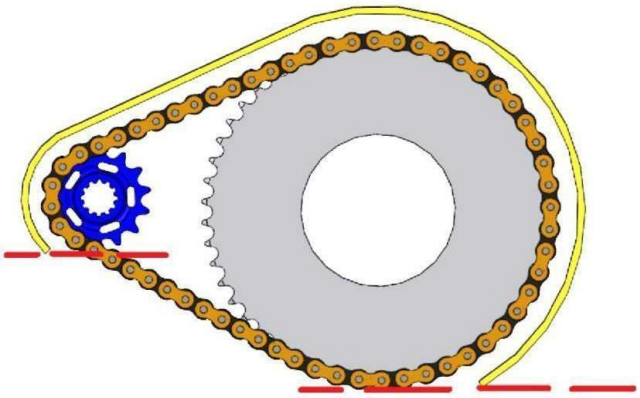
T8.3 Transmission and Drive

Any transmission and drivetrain may be used.

T8.4 Drive Train Shields and Guards

T8.4.1 Exposed high-speed final drivetrain equipment such as Continuously Variable Transmissions (CVTs), sprockets, gears, pulleys, torque converters, clutches, belt drives, clutch drives and electric motors, must be fitted with scatter shields in case of failure. The final drivetrain shield must cover the chain or belt from the driver sprocket to the driven sprocket/chain wheel/belt or pulley. The final drivetrain shield must start *and end* parallel to the lowest point of the chain wheel/belt/pulley. (See figure below) Body panels or other existing covers are not acceptable unless constructed from approved materials per T8.4.3 or T8.4.4.

Note: If equipped, the engine drive sprocket cover may be used as part of the scatter shield system.



Comment: Scatter shields are intended to contain drivetrain parts which might separate from the car.

T8.4.2 Perforated material may not be used for the construction of scatter shields.

T8.4.3 Chain Drive - Scatter shields for chains must be made of at least 2.66 mm (0.105 inch) steel (no alternatives are allowed) and have a minimum width equal to three (3) times the width of the chain. The guard must be centered on the center line of the chain and remain aligned with the chain under all conditions.

T8.4.4 Non-metallic Belt Drive - Scatter shields for 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 1.7 times the width of the belt. The guard must be centered on the center line of the belt and remain aligned with the belt under all conditions.

T8.4.5 Attachment Fasteners - All fasteners attaching scatter shields and guards must be a minimum 6mm Metric Grade 8.8 (1/4-inch SAE Grade 5) or stronger.

T8.4.6 Finger Guards - Finger guards are required to cover any drivetrain parts that spin while the car is stationary with the engine running. Finger guards may be made of lighter material, sufficient to resist finger forces. Mesh or perforated material may be used but must prevent the passage of a 12 mm (1/2 inch) diameter object through the guard.

Comment: Finger guards are intending to prevent finger intrusion into rotating equipment while the vehicle is at rest.

T8.5 Integrity of systems carrying fluids - Tilt Test

T8.5.1 Tilt Test - Fluids

During technical inspection, the car must be capable of being tilted to a forty-five-degree (45°) angle without leaking fluid of any type.

T8.5.2 The tilt test will be conducted with the vehicle containing the maximum number of fluids it will carry during any test or event.

ARTICLE 9: AERODYNAMIC DEVICES

T9.1 Bodywork and Components

T9.1.1 There must 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.

T.9.1.2 All forward facing edges on the bodywork that could impact people, including the nose, must have forward facing radii of at least 38 mm. This minimum radius must extend to at least 45° relative to the forward direction, along the top, sides and bottom of all affected edges.

T.9.1.3 All forward facing wing edges including wings, end plates, Gurney flaps, wicker bills and undertrays that could contact a pedestrian must have a minimum radius of 5 mm for all horizontal edges and 3 mm for vertical edges (end plates).

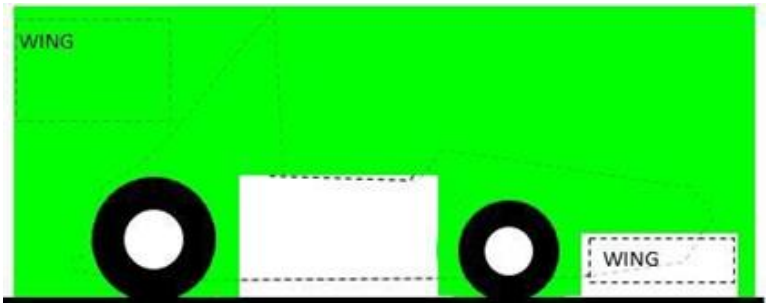
If the edges themselves do not meet this requirement, additional permanently attached pieces designed to meet this requirement must be used.

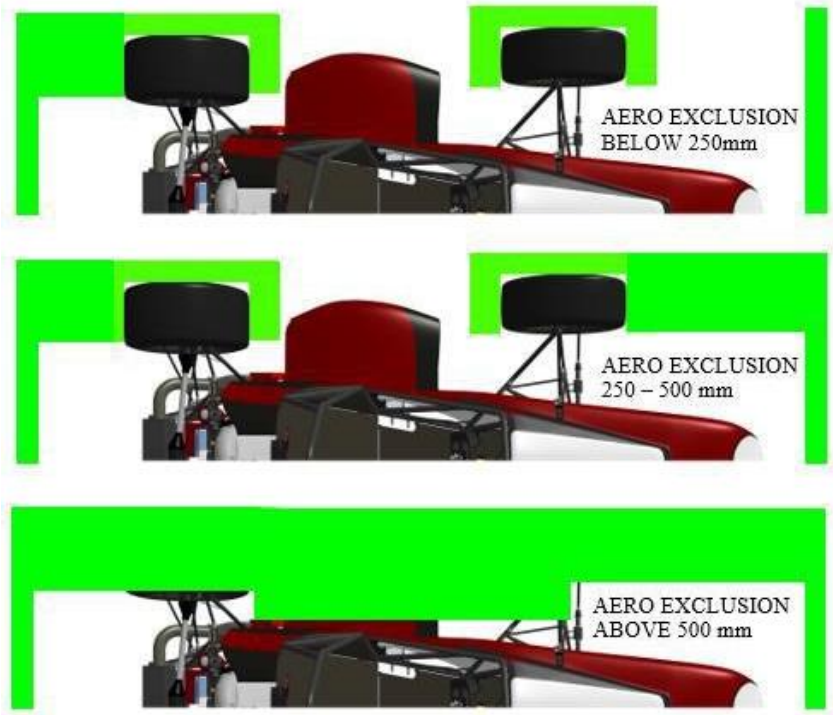
T9.2.1 Aerodynamic Device

A part on the vehicle intended to guide airflow for generation of downforce and reduction of drag. Examples include wings, undertray, splitter, endplates, vanes

T9.2.2 No power device may be used to move or remove air from under the vehicle except fans designed exclusively for cooling. Power ground effects are prohibited. T9.2.3 All aerodynamic devices must be designed such that the mounting system provides adequate rigidity in the static condition and such that the aerodynamic devices do not oscillate or move excessively when the vehicle is moving.

T9.2.4 All aerodynamic device limitations apply with the wheels pointing in the straight-ahead position





T9.3 Front Mounted

T9.3.1 In plain view, any part of any aerodynamic device must be:

a. No more than 700 mm forward of the fronts of the front tires
b. Within a vertical plane parallel to the centerline of the chassis touching the outside of the front tires at the height of the hubs.

T9.3.2 When viewed from the front of the vehicle, the part of the front wheels/tires that are more than 250 mm above ground level must be unobstructed when measured without a driver in the vehicle.

T9.4 Rear Mounted

T9.4.1 In plain view, any part of any aerodynamic device must be:

a. No more than 250 mm rearward of the rear of the rear tires
b. No further forward than a vertical plane through the rearmost portion of the front face of the driver head restraint support, excluding any padding, set (if adjustable) in its fully rearward position (excluding undertrays).
c. Inboard of two vertical planes parallel to the centerline of the chassis touching the inside of the rear tires at the height of the hub centerline.

T9.4.2 In side-elevation, any part of an aerodynamic device must be no higher than 1.2 meters above the ground when measured without a driver in the vehicle.

T9.5 Between Wheels

T9.5.1 Between the centerlines of the front and rear wheel axles, an aerodynamic device may extend outboard in plain view to a line drawn connecting the outer surfaces of the front and rear tires at the height of the wheel centers

T9.5.2 Except as permitted under **T9.4.1 above**, any aerodynamic devices, or other bodywork, located between the transverse vertical planes positioned at the front and rear axle centerlines must not exceed a height of 500 mm above the ground when measured without a driver in the vehicle.

Bodywork within vertical fore and aft planes set at 400 mm outboard from the centerline on each side of the vehicle is excluded from this requirement.

Note: For this year, Aerodynamics rules as described in 2019 rulebook are also acceptable.

T9.6 Driver Egress Requirements

T9.6.1 Egress from the vehicle within the time set in Rule T4.8 "Driver Egress," must not require any movement of the wing or wings or their mountings.

T9.6.2 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.

ARTICLE 10: COMPRESSED GAS SYSTEMS AND HIGH-PRESSURE HYDRAULICS

T10.1 Compressed Gas Cylinders and Lines

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

a. Working Gas-The working gas must be nonflammable, e.g. air, nitrogen, carbon dioxide.
b. Cylinder Certification- 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.
c. Pressure Regulation-The pressure regulator must be mounted directly onto the gas cylinder/tank.
d. Protection - The gas cylinder/tank and lines must be protected from rollovers, collision from any direction, or damage resulting from the failure of rotating equipment.
e. Cylinder Location- The gas cylinder/tank and the pressure regulator must be located either rearward of the Main Roll Hoop and within the envelope defined by the Main Roll Hoop and the Frame (see T3.3), or in a structural side-pod. In either case it must be protected by a structure that meets the requirements of T3.25 or T3.34. It must not be located in the cockpit.
f. Cylinder Mounting- The gas cylinder/tank must be securely mounted to the Frame, engine or transmission.
g. Cylinder Axis- The axis of the gas cylinder/tank must not point at the driver.
h. Insulation- The gas cylinder/tank must be insulated from any heat sources, e.g. the exhaust system.
i. Lines and Fittings- The gas lines and fittings must be appropriate for the maximum possible operating pressure of the system.

T10.2 High Pressure Hydraulic Pumps and Lines

The driver and anyone standing outside the car must be shielded from any hydraulic pumps and lines with line pressures of 2100 kPa (300 psi) or higher. The shields must be steel or aluminum with a minimum thickness of 1 mm (0.039 inch).

Note: Brake lines are not classified as "hydraulic pump lines" and as such brake lines are excluded from T10.2.

ARTICLE 11: FASTENERS

T11.1 Fastener Grade Requirements

T11.1.1 All threaded fasteners utilized in the driver's cell structure, and the steering, braking, driver's harness and suspension systems must meet or exceed, SAE Grade 5, Metric Grade 8.8 and/or AN/MS specifications.

T11.1.2 The use of button head cap, panhead, flat head or round head screws or bolts in critical locations is prohibited. These locations include the driver's cell structure, and driver's harness attachment.

Note: Hexagonal recessed drive screws or bolts (sometimes called Socket head cap screws or Allen screws/bolts) are permitted.

T11.2 Securing Fasteners

T11.2.1 All critical bolts, nuts, and other fasteners on the steering, braking, driver's 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.

T11.2.2 There must be a minimum of two (2) full threads projecting from any lock nut.

T11.2.3 All spherical rod ends and spherical bearings on the steering or suspension must 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.

T11.2.4 Adjustable tie-rod ends must be constrained with a jam nut to prevent loosening.

ARTICLE 12: ELECTRICAL COMPONENTS

T12.1 Low Voltage System

T12.1.1 The Low Voltage System (LVS) is defined as every electrical part that is not part of the TS, see EV2.1.1

T12.1.2 The maximum permitted voltage that may occur between any two electrical connections in the LVS is 60VDC or 25VACRMS.

T12.1.3 All LVS parts must be adequately insulated.

T12.1.4 The LVS must not use orange wiring or conduit.

T13.1.5 The LVS must be grounded to the chassis.

T12.2 Low Voltage Batteries

T12.2.1 LV batteries are all batteries connected to the LVS.

T12.2.2 LV batteries must be securely attached to the chassis and located within the Primary Structure.

T12.2.3 Any wet-cell battery located in the cockpit must be enclosed in a non-conductive, waterproof (according to IPX7 or higher, IEC 60529) and acid-resistant container.

T12.2.4 LV batteries must have rigid and sturdy casing.

T12.2.5 Completely closed LV battery cases must have overpressure relief. Venting gases must

be separated from the driver by a firewall.

T12.2.6 LV batteries must be protected from short circuits, not more than 100mm from ungrounded terminals.

T12.2.7 Battery packs based on lithium chemistry other than lithium iron phosphate (LiFePO4):

- Must have a fire-retardant casing.
- Must include overcurrent protection that trips at or below the maximum specified discharge current of the cells.
- Must include over temperature protection of at least 30% of the cells, meeting EV4.7.5, that trips when any cell leaves the allowed temperature range according to the manufacturer's data sheet, but not more than 60°C, for more than 1s and disconnects the battery.
- Must include voltage protection of all cells, that trip when any cell leaves the allowed voltage range according to the manufacturer's data sheet for more than 500ms and disconnects the battery.
- It must be possible to display all cell voltages and measured temperatures, e.g., by connecting a laptop.
- Must meet EV4.7.11
- Signals needed to fulfil these requirements are SCS, see T12.9.

T12.3 Master Switches

T12.3.1 Master switches, see T12.4, EV5.2 must be a mechanical switch of the rotary type, with a red, removable handle. The handle must have a width of at least 50mm and must only be removable in an electrically open position. They must be direct acting, i.e. they must not act through a relay or logic.

T12.3.2 Master switches must be located on the right side of the vehicle, in proximity to the main hoop, at the 95th percentile male driver's shoulder height, as defined in T3.10.3, and be easily actuated from outside the vehicle The center of any master switch must not be mounted lower than the vertical distance of the template's, see T4.3, middle circle center to the ground surface multiplied by 0.8.

T12.3.3 The "ON" position of the switch must be in the horizontal position and must be marked accordingly. The "OFF" position of the master switch must also be clearly marked.

T12.3.4 Master switches must be rigidly mounted to the vehicle and must not be removed during maintenance.

T12.3.5 Master switches must be mounted next to each other

T12.4 Low Voltage Master Switch

T12.4.1 An LVMS according to T12.3 must completely disable. power to the LVS

T12.4.2 The LVMS must be mounted in the middle of a completely red circular area of ≥50mm diameter placed on a high contrast background.

T12.4.3 The LVMS must be marked with "LV" and a symbol showing a red spark in a white edged blue triangle.

12.5 Shutdown Buttons

T12.5.1 A system of three shutdown buttons must be installed on the vehicle.

T12.5.2 Each shutdown button must be a push-pull or push-rotate mechanical emergency switch where pushing the button opens the shutdown circuit, see EV5.1.

T12.5.3 One button must be located on each side of the vehicle behind the driver's compartment at approximately the level of the driver's head. The minimum allowed diameter of the shutdown buttons on both sides of the vehicle is 40mm.The buttons must be easily reachable from outside the vehicle.

T12.5.4 One shutdown button serves as a cockpit-mounted shutdown button and must.

- have a minimum diameter of 24mm.
- be in easy reach of a belted-in driver.
- be alongside of the steering wheel and unobstructed by the steering wheel or any other part of the vehicle

T12.5.5 The international electrical symbol consisting of a red spark on a white-edged blue triangle must be affixed near each shutdown button.

T12.5.6 Shutdown buttons must be rigidly mounted to the vehicle and must not be removed during maintenance.

T12.6 Inertia Switch

T12.6.1 An inertia switch must be part of the shutdown circuit, see EV5.1, such that an impact will result in the shutdown circuit being opened. The inertia switch must latch until manually reset.

T12.6.2 The device must trigger due to an omnidirectional peak acceleration of ≤8g for a half sine test pulse of ≥50ms length and ≤13g for a half sine test pulse of ≥20ms length. The "Sensate Resettable Crash Sensor" should meet those requirements.

T12.6.3 The device must not include any semiconductor components.

T12.6.4 The device must be rigidly attached to the vehicle. It must be possible to demount the device so that its functionality may be tested by shaking it.

T12.7 Brake System Plausibility Device [EV ONLY]

T12.7.1 A standalone non-programmable circuit, the BSPD, must open the shutdown circuit, see EV5.1, when hard braking occurs, whilst. • ≥5kW power is delivered to the motors. The shutdown circuit must remain open until power cycling the LVMS or the BSPD may reset itself if the opening condition is no longer present for more than 10s.

T12.7.2 The action of opening the shutdown circuit must occur if the implausibility is persistent for more than 500ms.

T12.7.3 The BSPD must be directly supplied from the LVMS, see T12.4.

T12.7.4 Standalone is defined as there is no additional functionality implemented on all required Printed Circuit Boards (PCBs). The interfaces must be reduced to the minimum necessary signals, i.e., power supply, required sensors and the shutdown circuit. Supply and sensor signals must not be routed through any other devices before entering the BSPD.

T12.7.5 To detect hard braking, a brake system pressure sensor must be used. The threshold must be chosen that there are no locked wheels, and the brake pressure is ≤30bar.

T12.7.6 To measure power delivery, a DC circuit current sensor only must be used. The threshold must be chosen as an equivalent of ≤5kW for maximum TS voltage.

T12.7.7 It must be possible to separately disconnect each sensor signal wire for technical inspection.

T12.7.8 All necessary signals are System Critical Signal (SCS), see T12.9.

T12.7.9 The team must prove the function of the BSPD during technical inspection by sending an appropriate signal that represents the current, to achieve ≤5kW whilst pressing the brake pedal. This test must prove the functionality of the complete BSPD except for any commercially available current sensors.

T12.7.10 The BSPD including all required sensors must not be installed inside the TSAC.

T12.8 Accelerator Pedal Position Sensor

T12.8.1 The APPS must be actuated by foot pedal.

T12.8.2 Pedal travel is defined as percentage of travel from fully released position to fully applied position where 0% is fully released and 100% is fully applied.

T12.8.3 The foot pedal must return to the 0% position when not actuated. The foot pedal must have a positive stop preventing the mounted sensors from being damaged or overstressed. Two springs must be used to return the foot pedal to the 0% position and each spring must work when the other is disconnected. Springs in the APPS are not accepted as return springs.

T12.8.4 At least two separate sensors must be used as APPSs. Separate is defined as not sharing supply or signal lines.

T12.8.5 If analog sensors are used, they must have different, non-intersecting transfer functions. A short circuit between the signal lines must always result in implausibility EV according to T12.8.8

T12.8.6 The APPS signals are SCSs, see T12.9.

T12.8.7 If an implausibility occurs between the values of the APPSs and persists for more than 100ms

- The power to the motor(s) must be immediately shut down completely. It is not necessary to completely deactivate the tractive system, the motor controller(s) shutting down the power to the motor(s) is sufficient.

T12.8.8 Implausibility is defined as a deviation of more than ten percentage points pedal travel between any of the used APPSs or any failure according to T12.9.

T12.8.9 If three sensors are used, then in the case of an APPS implausibility, any two sensors that are plausible may be used to define the torque target and the 3rd APPS may be ignored.

T12.8.10 It must be possible to separately disconnect each APPS signal wire to check all functionalities.

T12.8.11 A fully released accelerator pedal in manual mode must result in:
A wheel torque of ≤0Nm

T12.9 System Critical Signal [EV ONLY]

T12.9.1 SCS are defined as all electrical signals which:

- Influence actions on the shutdown circuit, see EV5.1.
- Influence the wheel torque.
- Influence indicators according to EV4.7.9, EV3.10 or EV5.3.6.

T12.9.2 Any of the following SCS single failures must result in a safe state of all connected

systems:

(a) Failures of signals transmitted by cable:
- Open circuit
- Short circuit to the ground.

(b) Failures of analog sensor signals transmitted by cable:
- Short circuit to supply voltage.

(c) Failures of sensor signals used in programmable devices:
- Implausibility due to out-of-range signals, e.g., the mechanically impossible angle of an angle sensor.

(d) Failures of digitally transmitted signals by cable or wireless:
- Data corruption (e.g., checked by a checksum)
- Loss and delay of messages (e.g., checked by transmission time outs)

Signals might be a member of multiple signal classes, e.g., analog signals transmitted by cable might be a member of T12.9.2.a, T12.9.2.b and T12.9.2.c

If a signal failure is correctable, e.g., due to redundancy or worst-case values, the safe state must be entered as soon as an additional non-correctable failure occurs.

T12.9.3 The maximum allowed delay of messages according to T12.9.2.d must be chosen depending on the impact of delayed messages to the connected system but must not exceed 500ms.

T12.9.4 Safe state is defined depending on the signals as follows:
- signals only influencing indicators – Indicating a failure of its own function or of the connected system.
- low voltage battery signals – At least one pole is electrically disconnected from the rest of the vehicle.
- [EV ONLY] For all other signals – opened shutdown circuit and opened AIRs.

T12.9.5 Indicators according to T12.9.1 with safe state “illuminated” (e.g., absence of failures is not actively indicated) must be illuminated for 1s to 3s for visible check after power cycling the LVMS.

T12.10 Sensors & Electrical Components Mounting

T12.10.1 All sensors and components must be securely mounted.

T12.10.2 Sensors and components may not come into contact with the driver’s helmet under any circumstances.

T12.10.3 All sensors and components must be positioned within the surface envelope,, or within the box defined in T9.

T12.10.4 Passive antennas which do not incorporate active electronic parts, e.g., amplifiers with the longest side

ARTICLE 13: TRANSPONDERS

T13.1 Transponders – SUPRA SAEINDIA Competition

T13.1.1 Transponders will be used as part of the timing system for the dynamic events at the SUPRA SAEINDIA competitions which will be provided by the organizer SAEINDIA.

T13.2 Transponder Mounting - All Events

The transponder mounting requirements are:

a. Orientation - The transponder must be mounted vertically and orientated so the number can be read "right-side up".

b. Location - The transponder must be mounted on the driver's right side of the car forward of the front roll hoop. The transponder must be no more than 60 cm (24 in) above the track.

c. Obstructions - There must be an open, unobstructed line between the antenna on the bottom of the transponder and the ground. Metal and carbon fiber may interrupt the transponder signal. The signal will normally transmit through fiberglass and plastic. If the signal is obstructed by metal or carbon fiber, a 10.2 cm (4 in) diameter opening can be cut, the transponder mounted flush with the opening, and the opening covered with a material transparent to the signal.

d. Protection - Mount the transponder where it will be protected from obstacles.

ARTICLE 14: VEHICLE IDENTIFICATION

T14.1 Car Number

T14.1.1 Each car will be assigned a number at the time of its entry into a competition.

T14.1.2 Car numbers must appear on the vehicle as follows:

Locations: In three (3) locations: the **front** and both **sides.**

a. Height: At least 152.4 mm (6 inch) high.

b. Font: Block numbers (i.e. sans-serif characters). Italic, outline, serif, shadow, or cursive numbers are prohibited.

c. Stroke Width and Spacing between Numbers: At least 18 mm (3/4 inch).

d. Color: Either white numbers on a black background or black numbers on a white background. No other color combinations will be approved.

e. Background shape: The number background must be one of the following: round, oval, square or rectangular. There must be at least 25.4 mm (1 inch) between the edge of the numbers and the edge of the background.

f. Clear: The numbers must not be obscured by parts of the car, e.g. wheels, side pods, exhaust system, etc.

T14.1.3 Car numbers for teams registered for SUPRASAEINDIA competitions can be found on the "Registered Teams" section of the relevant SUPRASAEINDIA website.

Comment: Car numbers must be quickly read by course marshals when your car is

moving at speed. Make your numbers easy to see and easy to read.

Example:

T14.2 School Name

T14.2.1 Each car must clearly display the school's name (or initials - if unique and generally recognized) in roman characters at least 50 mm (2 inch) high on both sides of the vehicle. The characters must be placed on a high contrast background in an easily visible location.

T14.2.2 The school's name may also appear in non-roman characters, but the roman character version must be uppermost on the sides.

T14.3 SAEINDIA Logo

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

T14.4 Technical Inspection Sticker Space

T14.4.1 Technical inspection stickers will be placed on the upper nose of the vehicle. Cars must have a clear and unobstructed area at least 25.4 cm wide x 20.3 cm high (10" x 8") on the upper front surface of the nose along the vehicle centerline.

T14.4.2 Vehicles that are being entered into multiple competitions in the SUPRASAEINDIA series must allow sufficient space along the nose centerline for all inspection stickers.

On Vehicle Publicity

The following are the mandatory locations for various stickers (Logos):

A - Number Sticker
B - Team's Name
C - Event Sponsor
D - Team Sponsor
E - SAEINDIA Logo
F - OK Sticker (SUPRASAEINDIA Logo)

At the above locations, only the specified stickers can be stuck. At any point of time, the Numbers Sticker has to be prominently visible. After sticking all the above mandatory stickers, if extra space is available, the team can use it as per its choice.

ARTICLE 15: EQUIPMENT REQUIREMENTS

T15.1 Driver's Equipment

The equipment specified below must be worn by the driver anytime he or she is in the cockpit with the engine running.

T15.2 Helmet

A well-fitting, closed face helmet that meets one of the following certifications and is labeled as such:

Example:

- Snell K2000, K2005, K2010, M2000, M2005, M2010, SA2000, SA2005, SA2010
- SFI 31.2A, SFI 31.1/2005
- FIA 8860-2004, *FIA 8860-2010*
- British Standards Institution BS 6658-85 Type A/FR rating (Types B are not accepted).
- EN 22-05.

Open-faced helmets are not approved.

All helmets to be used in the competition must be presented during the 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.

T15.3 Balaclava

A balaclava which covers the driver's head, hair and neck, is made from acceptable fire-resistant material as defined in T14.12, or a full helmet skirt of acceptable fire-resistant material. The balaclava requirement applies to drivers of either gender, with any hair length.

T15.4 Eye Protection

Impact resistant goggles or helmet face shield, made from approved impact resistant materials. The face shield supplied with approved helmets (See T14.2 above) meets this requirement.

T15.5 Suit

A fire-resistant one-piece suit, made from a minimum of two (2) layers that cover the body from the neck down to the ankles and the wrists. The suit must be certified to one of the following standards and be labeled as such:

- SFI 3-2A/5 (or higher)

- FIA Standard 1986

NORME 1986/ 1986 STANDARD

FIA Standard 8856-2000

T15.6 Underclothing

It is strongly recommended that all competitors wear fire resistant underwear (long pants and long sleeve t-shirt) under their approved driving suit. This fire-resistant underwear should be made from acceptable fire-resistant material as listed in T14.12 and should cover the driver's body completely from neck down to ankles and wrists.

Note: If you do not wear fire resistant underwear it is strongly recommended that you wear cotton underwear (a T-shirt and long underpants) under your approved driving suit.

T15.7 Socks

Fire resistant socks made from acceptable fire-resistant material as defined in T14.12, below, that cover the bare skin between the driver's suit and the boots or shoes.

T15.8 Shoes

Fire resistant shoes made from acceptable fire-resistant material as defined in T14.12. The shoes must be certified to the standard and labeled as such:

- SFI 3.3

- FIA 8856-2000

T15.9 Gloves

Fire resistant gloves made from made from acceptable fire-resistant material as defined in T14.12. Gloves of all leather construction or fire-resistant gloves constructed using leather palms with no insulating fire resisting material underneath are not acceptable.

T15.10 Arm Restraints

Arm restraints are required and must be worn such that the driver can release them and exit the vehicle unassisted regardless of the vehicle's position. Arm restraints must be commercially manufactured. Note: Arm restraints certified to SFI Standard 3.3 and labeled as such meet this requirement.

T15.11 Driver's Equipment Condition

All driving apparel covered by ARTICLE 14: must be in good condition. Specifically, driving apparel must not have any tears, rips, open seams, areas of significant wear or abrasion or stains which might compromise fire resistant performance.

T15.12 Fire Resistant Material

For the purpose of this section some, but not all, of the approved fire-resistant materials are Carbon X, Indura, Nomex, Polybenzimidazole (commonly known as PBI) and Proban.

T15.13 Synthetic Material – Prohibited

T-shirts, socks or other undergarments (not to be confused with FR underwear) made from nylon or any other synthetic material which will melt when exposed to high heat are prohibited.

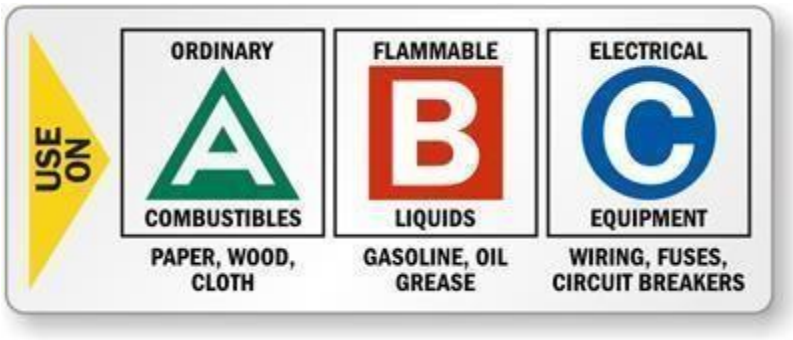
T15.14 Fire Extinguishers

Each team must have at least two (2) 0.9 kg (2 lb.) dry chemical/dry powder.

T14.14.1 The following are the minimum ratings, any of which are acceptable at any STUDENT FORMULA Series event:

- Powder or any other extinguisher homologated by the FIA.
- 1A10BC rated fire extinguisher is to be used

Extinguishers of larger capacity (higher numerical ratings) are acceptable.



T15.14.2 All extinguishers must be equipped with a manufacturer-installed pressure/charge gauge.

T15.14.3 Except for the initial inspection, one extinguisher must readily be available in the team's paddock area, and the second must accompany the vehicle wherever the vehicle is moved. Both extinguishers must be presented with the vehicle at Technical Inspection.

T15.14.4 As a team option, commercially available on-board fire systems are encouraged as an alternative to the extinguisher that accompanies the vehicle.

T15.14.5 Handheld fire extinguishers are **not** permitted to be mounted on or in the car.

T15.14.6 On-board fire extinguishers are not required but if used must be of AFFF type, no dry chemical extinguishers allowed as an on-board extinguisher.
Minimum acceptable ratings:

- USA, Canada & Brazil: 10BC or 1A 10BC
- Europe: 34B or 5A 34B
- Australia: 20BE or 1A 10BE

Note: Halon extinguishers and systems are prohibited.

Note: AFFF extinguishers are permitted.

T15.15 Camera Mounts

T15.15.1 The mounts for video/photographic cameras must be of a safe and secure design.

T15.15.2 All camera installations must be approved at Technical Inspection.

T15.15.3 Helmet mounted cameras and helmet camera mounts are prohibited.

T15.15.4 The body of a camera or recording unit that weighs more than 0.25 kg must be secured at a minimum of two points on different sides of the camera body.

T15.15.5 If a tether is used to restrain the camera, the tether length must be limited so that the camera cannot contact the driver.

ARTICLE 16: POSSIBLE FUTURE RULES CHANGES

Notice of Possible Rule Changes for the STUDENT FORMULA Series

This section is intended to provide teams with advance notice of possible changes to the STUDENT FORMULA Rules that are being considered by the STUDENT FORMULA Rules Committee. Only changes that might have a significant influence on a team's design, manufacturing or operating decisions are listed.

The changes presented in this section are only possibilities and may not be implemented. This section is provided as information and is not intended to be the final text of the rules under consideration.

Restriction on Team Membership - The Committee is considering limiting the students who present to judges or drive during the competition to students registered at the university that registers the team.

5th Percentile Female Mannequin - The committee is considering her introduction of 5^{th} percentile mannequin to confirm that the driver cell will fit both a 95^{th} percentile male and a 5^{th} percentile female driver.

Drive by Wire Throttle - The Committee is considering that drive by wire throttles can be used on STUDENT FORMULA cars if they include the brake panic switch. Feedback on this topic and whether you would like to adopt a throttle by wire throttle would be appreciated.

Noise Test - To improve the sound quality of single cylinder engines for track workers the sound

measuring units may be changed to dB. This is more consistent with human hearing at the higher volumes called out in the rules. Cheap, commercially available sound meters are generally able to display dB.

APPENDIX T-1 STRUCTURAL EQUIVALENCY SPREADSHEET

APPENDIX T-2 IMPACT ATTENUATOR DATA REPORT

Appendix T-1 & T-2 is posted at www.suprasaeindia.org or on official social media platfor


SUPRA SAEINDIA
Student Formula


SAEINDIA

STUDENT FORMULA RULES

PART EV – ELECTRIC VEHICLES

ARTICLE 1: TEAM REQUIREMENTS

EV1.1 Electrical system officer (ESO)

EV1.1.1 Every participating team must appoint one (1) to four (4) ESOs for the competition. The ESOs are responsible for all electrical work carried out on the vehicle during the competition.

EV1.1.2 The ESOs are the only members in the team who may declare the vehicle electrically safe, for work to be performed on any system of the vehicle by the team. The ESOs must be always reachable by phone during the competition.

EV1.1.3 An ESO must accompany the vehicle whenever it is operated or moved around at the competition site. If only one ESO is appointed by the team, this ESO shall not be a driver.

EV1.1.4 An appropriate ESO qualification requires proof of practical and theoretical training for working with HV power systems. Regarding content, the training should be based on DGUV 209-093 stage 2E/3E and held by an external expert.

EV1.1.5 For two or more ESOs, a team must have a minimum of two ESOs trained in 3E and a minimum of one ESO trained in 2E. Only ESOs with 3E training are allowed to work on live high voltage systems.

It is recommended that all other team members receive 1E training instruction. This can be provided by an external provider or from one of the teams certified ESO itself.

EV1.2 Electrical system advisor

EV1.2.1 The Electrical System Advisor (ESA) shall be a professionally competent person(s) nominated by the team who can advise on electrical and control systems that will be integrated into the vehicle. The faculty advisor may also be the ESA if all requirements below are met.

EV1.2.2 The ESA must provide details of their experience of electrical and/or control systems engineering as used in vehicles on the ESO/ESA form for approval by the organizers.

EV1.2.3 The ESA must be adequately qualified to advise the team on their proposed electrical and control system designs based on significant experience of the technology being developed and its implementation into vehicle or other safety critical systems.

More than one person may be needed.

EV1.2.4 The ESA must advise the team on the merits of any relevant engineering solutions. Solutions should be discussed, questioned, and approved before they are implemented into the final vehicle design. The ESA should advise the students on any required training to work with the systems on the vehicle.

EV1.2.5 The ESA must review the electrical system form and confirm that in principle, the vehicle has been designed using good engineering practices.

The ESA must ensure that the team communicates any unusual aspects of the design to the organizers to reduce the risk of exclusion or significant changes to pass TI.

ARTICLE 2: ELECTRIC POWERTRAIN

EV2.1 Definitions

EV2.1.1Tractive system – Every part that is electrically connected to the motor(s) and TS accumulators.

EV2.1.2TS enclosures – Every housing or enclosure containing parts of the TS.

EV2.1.3Galvanic isolation – Two electric circuits are defined as galvanically isolated if all the following are true:

- Resistance between both circuits is ≥500Ω/V, at a test voltage of maximum TS voltage or 250V, whichever is higher.
- The rms of the isolation voltage, AC for 1min, between both circuits are higher than three times the maximum TS voltage or 750V, whichever is higher.

EV2.2 Requirements

EV2.1 Motors

EV2.1.1 Only electric motors are allowed.

EV2.1.2 Motor attachments must follow T11.

EV2.1.3 Motor casings must follow T8.4.

EV2.1.4 The motor(s) must be connected to the accumulator through a motor controller.

EV2.2 Power limits

EV2.2.1 The TS power at the outlet of the TSAC must not exceed 80kW. Details of estimated power output for each dynamic event shall be provided in electrical system forms (to be shared later).

EV2.2.2 Regeneration of energy is allowed and unrestricted.

EV2.2.3 Wheels must not spin in reverse.

EV2.3 APPS/ Brake pedal plausibility check

EV2.3.1 The commanded motor torque must be 0Nm, if hard braking, refer T12.7.5, and the APPS (refer T12.8) signals pedal travel equivalent to ≥25% and desired motor torque of ≥5kW, whichever is lower, at the same time for more than 500m

EV2.3.2 The commanded motor torque must remain at 0Nm until the APPS signals less than 5% pedal travel and desired motor torque of 0Nm, regardless of whether the brakes are still actuated or not.

EV2.4 Grounding

EV2.4.1 TS enclosures (refer EV2.1) must consist of either of the following –

- A grounded layer made of at least 0.5mm thick electrically conductive material, aluminum or better, having a resistance below 300mΩ, measured with a current of 1A, to LVS ground and can continuously carry at least 10% of the TS accumulator main fuse current rating or
- Be Fully made of electrically insulating materials having an isolation resistance of at least 2MΩ, measured with a voltage of 500V. The enclosure must be rigid and must prevent possible mechanical penetrations. Protruding electrically conductive parts, such as fasteners or connectors, must follow EV2.4.2

The TSAC may use at least 0.9mm thick steel layer as the grounded layer.

EV2.4.2 Electrically conductive seat, driver harness, and firewall mounting points as well as the TS firewall must have a resistance below 300mΩ, measured with a current of 1A, to LVS ground and can continuously carry at least 10% of the TS accumulator main fuse current rating.

EV2.4.3 Parts of the vehicle which are or may become electrically conductive within 100mm of any TS component must have a resistance below 100Ω to LVS ground.

EV2.4.4 The rotating part of the wheels shall not be grounded.

EV2.5 Overcurrent Protection

EV2.5.1 All electrical systems must have appropriate overcurrent protection.

EV2.5.2The continuous current rating of the overcurrent protection must not be greater than the continuous current rating of any electrical component, for example, wire, busbar, or other conductors that it protects. If multiple pins of a connector are used to carry currents in parallel, each pin must be appropriately protected.

EV2.5.3 All overcurrent protection devices must have an interrupt current rating which is higher than the theoretical short circuit current of the system that it protects.

EV2.5.4 All overcurrent protection devices must be rated for the highest voltage in the systems they protect. All devices used must be rated for DC.

EV2.5.5 All overcurrent protection devices which are part of the TS must not rely on programmable logic. The overcurrent protection function of unmodified commercially available motor controllers/inverters for the motor outputs may rely on programmable logic.

EV2.5.6 The overcurrent protection must be designed for the expected surrounding temperature range but at least for zero (0) °C to eighty-five (85) °C.

EV2.5.7 The TS high current path through the accumulator(s) must be fused.

EV2.6 Charging

EV2.6.1 There shall be a separate charging area at the competition site. Charging TS accumulators is only allowed inside this area.

EV2.6.2 Accumulators must be removed from the vehicle and placed on the TSAC hand cart, see EV4.3, EV4.4 for charging.

EV2.6.3 The label EV4.2.5 or an additional label according to EV4.2.5 must be visible during charging.

EV2.6.4 No grinding, drilling, etc. is allowed in the charging area.

EV2.6.5 At least one team member with prior experience of the charging process must stay with the accumulator(s) during charging.

ARTICLE 3: TRACTIVE SYSTEM

EV3.1 General Requirements

EV3.1.1 The maximum permitted voltage that may occur between any two electrical connections is 600VDC and for motor controller/inverters internal low power control signals 630VDC.

EV3.1.2 All components in the TS must be rated for the maximum TS voltage. The TS area of PCB,

see EV3.3.5, is considered as one component. Every input connected to the TS must be rated to the maximum TS voltage.

EV3.1.3 All components must be rated as the maximum possible temperature which may occur during usage.

EV3.1.4 Fans with >50W power must not be connected to the TS.

EV3.2 Tractive System Enclosures

EV3.2.1 TS enclosures, see EV2.1.2, must be labelled with (a) reasonably sized sticker(s) according to "*ISO 7010-W012*" (triangle with a black lightning bolt on yellow background). The sticker must also contain the text "*High Voltage*" if the voltage is more than $60V_{DC}$ or $25VAC_{RMS}$. (Δ^2)

EV3.3 Traction System and Grounded LVS isolation

EV3.3.1 The entire TS and LVS must be galvanically isolated, see EV2.1 and I6.5.1.

EV3.3.2 All connections from a TS component to external devices, such as laptops must include galvanic isolation, see EV2.1.

EV3.3.3 TS and LVS circuits must be physically segregated such that they are not running through the same conduit or connector, except for interlock circuit connections.

EV3.3.4 Where both TS and LVS are present within an enclosure, they must be separated by barriers made of moisture-resistant insulating materials or maintain the following spacing through air, or over a surface:

Voltage	Spacing
U <100V_{DC}	10mm
100V_{DC} < U <200V_{DC}	20mm
U >200V_{DC}	30mm

Components and cables capable of movement must be positively restrained to maintain spacing.

EV3.3.5 If TS and LVS are on the same PCB, they must be on separate well-defined areas of the board, meeting the spacing requirements in table 5, each area clearly marked with "TS" or "LV". The outline of the area required for spacing must be marked.

Voltage (V_{DC})	Over Surface (mm)	Through Air (Cut in board) (mm)	Conformal (Coating) (mm)
0-50	1.6	1.6	1.0
50-150	6.4	3.2	2.0
150-300	9.5	6.4	3.0
300-600	12.7	9.5	4.0

Table

5: Spacing required between TS and LV.

"Conformal coating" is referring to a coating insulator. Solder resist shall not be considered a coating.

If integrated circuits are used such as optocouplers which are rated for the respective maximum TS voltage, refer EV2.1, but do not fulfil the required spacing, then they may still be used and the given spacing does not apply to this integrated circuit.

Teams must be prepared to demonstrate spacing on team-built equipment. For inaccessible circuitry, fully assembled spare boards must be available.

EV3.4 Positioning of Tractive System Parts

EV3.4.1 Outboard wheel motors are allowed only if –

- An interlock is routed along the TS wiring such that the shutdown circuit, see EV5, is opened before the TS wiring or its clamping fails.
- An interlock is routed along a suspension member such that the shutdown circuit, see EV5, is opened if the suspension fails.
- TS wiring is not able to reach the cockpit opening or the driver regardless of where it breaks.
- Wiring outside of the surface envelope is minimum length.
- Wiring outside of an impact structure or front bulkhead support structure (refer EV3.4.2) is minimum length.

EV3.4.2 Any part of the TS that is less than 350mm above ground must be shielded from side and rear impact collisions by structure according to T3.25 and must follow Primary Structure requirement, when having bolted attachments. TS wiring in front of the front roll hoop may alternatively be shielded by the front bulkhead support structure according to T3.20.

EV3.4.3 Except for what is permitted according to EV3.4, all parts belonging to the TS including cables and wiring must be located within the Surface envelope. "Part" is the whole device such as the complete HVD.

EV3.4.4 Inside or front view any part of the TS must not project below the lower surface of the chassis.

Additional regulations apply for TS accumulators (refer **EV**).

EV3.5 Tractive System Insulation, Wiring, and Conduit

EV3.5.1 All live parts of the TS must be protected from being touched. This must include team members working on or inside the vehicle. This is evaluated with a 100mm long, 6mm diameter insulated test probe when the TS enclosures are in place.

EV3.5.2 Insulation material that is appropriate for the expected surrounding temperatures and rated for the maximum TS voltage must be used. Using only insulation tape or rubber-like paint for insulation is prohibited.

EV3.5.3 The temperature rating for TS wiring, connections, and insulation must be at least eighty-five (85) °C.

EV3.5.4 TS components and containers must be protected from moisture in the form of rain or puddles,

EV3.5.5 It must be possible to clearly assign and prove wire gauge, temperature rating, and insulation voltage to each used wire.

EV3.5.6 All TS wiring must be completed to professional standards with appropriately sized conductors and terminals and with adequate strain relief and protection from loosening due to vibration etc. TS wiring must be located out of the way of snagging or damage.

EV3.5.7 All TS wiring that runs outside of TS enclosures must –

- Be enclosed in separate orange non-conductive conduit or use an orange shielded cable. The conduit must be securely anchored to the vehicle, but not to the wire, at least at each end.
- Be securely anchored at least at each end so that it can withstand a force of 200N without straining the cable end crimp.

Bodywork is not sufficient to meet this enclosure requirement.

Any shielded cable must have the shield grounded.

EV3.5.8 Every TS connector outside of a housing must include a pilot contact/interlock line which is part of the shutdown circuit. **Housing only used to avoid interlocks is prohibited.**

EV3.5.9 All TS connections must be designed so that they use intentional current paths through conductors such as copper or aluminum and should not rely on steel bolts to be the primary conductor. All TS connections must not include compressible material such as plastic in the stack-up or as a fastener. FR-4 is allowed.

EV3.5.10 TS connectors outside of TS enclosures must be designed in a way that it is physically impossible to electrically connect them in any way other than the design intent configuration.

EV3.5.11 All electrical connections, including bolts, nuts, and other fasteners, in the high current path of the TS must be secured from unintentional loosening using positive locking mechanisms that are suitable for elevated temperatures, refer T11.2.

EV3.5.12 Components, e.g., inverters (certified for automotive use) might be allowed without positive locking features, if connections are completed as recommended by the manufacturers' datasheet and no positive locking is possible.

Teams must be prepared to demonstrate positive locking. For inaccessible connections, appropriate photographs must be available.

Soldered connections in the high current path are only allowed if all of the following are true:

- Connections on PCBs
- The connected devices are not cells or wires.

The devices are additionally mechanically secured against loosening.

EV3.6 Data Logger

EV3.6.1 A calibrated data logger will be provided by the officials and must be inserted during the competition. The data logger measures TS voltage and TS current. The data logger must

be in an easily accessible location so that it is possible to insert, remove or replace it within 15min in ready to race condition.

EV3.6.2 **The data logger must not be placed within the TSAC**. All current supplying the TS must run through the data logger. The data logger must be inserted in the negative TS supply, between the most negative AIR(s) and the inverters.

EV3.6.3 The TS voltage sense connection of the data logger must be directly connected to the most positive AIR(s) on vehicle side.

The data logger must be directly supplied, from the LVMS.

The specification of the data logger will be available in the competition handbook.

EV3.7 Tractive System Measuring point.

EV3.7.1 Two TSMPs must be installed directly next to the master switches, see EV5.2. The TSMPs must be directly connected to the intermediate circuit capacitors even if the HVD has been opened or the TS accumulator is disconnected. 4mm shrouded banana jacks rated for 1000V CAT III or better must be used.

EV3.7.2 The TSMPs must be marked *"TS+"* and *"TS-"* and exclusively mounted on orange background.

EV3.7.3 The TSMPs must be protected by non-conductive housing that can be opened without tools. The housing must always be mechanically linked to the vehicle.

EV3.7.4 Each TSMP must be secured with a current limiting resistor according to the following table. Fusing the TSMPs is prohibited. The resistor's power rating must be chosen such that they are able to continuously carry the current if both TSMPs are short-circuited.

Maximum TS voltage (V_{DC})			Resistor Value (KΩ)
	$U_{max} <$	200	5
200	$< U_{max} \leq$	400	10
400	$< U_{max} \leq$	600	15

EV3.7.5 All electrical connections needed for TSMP, including bolts, nuts, and other fasteners, must be secured from unintentional loosening using positive locking mechanisms.

EV3.7.6 Next to the TSMPs an LVS ground measuring point must be installed. A 4mm black shrouded banana jack must be connected to LVS ground and must be marked "GND".

EV3.8 High Voltage Disconnect

EV3.8.1 It must be possible to disconnect at least one pole of the TS accumulator by quickly removing an unobstructed and directly accessible element, fuse, or connector. It must be possible to disconnect the HVD without removing any bodywork. The HVD must be above 350mm from the ground and easily visible when standing behind the vehicle. Remote actuation of the HVD through a long handle, rope, or wire is not permitted.

EV3.8.2 An untrained person must be able to remove the HVD within 10s when the vehicle is in ready-to-race condition.

EV3.8.3 A dummy connector or similar may be required to restore the system's isolation, see EV4.5. The dummy connector must be attached to the push bar, see D12.2, if not in use, the HVD must be clearly marked with "HVD".

No tools must be necessary to open the HVD. An interlock is required, see EV3.5.8.

EV3.9 Discharge Circuit

EV3.9.1 If a discharge circuit is required to meet EV5.1.4, it must be designed to handle the maximum TS voltage permanently.

EV3.9.2 After three subsequent discharges within 15sec in total, the discharge time specified in EV5.1.4 may be exceeded. Full discharge functionality must be given after a reasonable time with a deactivated discharge circuit.

EV3.9.3 The discharge circuit must be wired in such a way that it is always active whenever the shutdown circuit is open. Furthermore, the discharge circuit must be fail-safe such that it still discharges the intermediate circuit capacitors if the HVD has been opened or the TS accumulator is disconnected. Fusing of the discharge main current path is prohibited.

EV3.10 Tractive System Active Light

EV3.10.1 The vehicles must include a single TSAL that must indicate the TS status. The TSAL must not perform any other functions. A TSAL with multiple LEDs in one housing is allowed.

EV3.10.2 The TSAL itself must have a red light, flashing continuously with a frequency between 2Hz and 5Hz and a duty cycle of 50%, active if and only if the LVS is active and the voltage across any DC-link capacitor exceeds.

- $60V_{DC}$ or $25VAC_{RMS}$

Half the nominal TS voltage whichever is lower.

EV3.10.3 The TSAL itself must have a green light, continuously on, active if and only if the LVS is active and ALL the following conditions are true:

- All AIRs are opened.
- The pre-charge relay, see EV4.6.3, is opened.

The voltage at the vehicle side of the AIRs inside the TSAC does not exceed $60V_{DC}$ or $25VAC_{RMS}$.

EV3.10.4 The mentioned voltage detection must be performed inside the respective TS enclosure.

EV3.10.5 The mentioned states of the relays (opened/closed) are the actual mechanical states. The mechanical state can differ from the intentional state, i.e., if a relay is stuck. Any circuitry detecting the mechanical state must meet EV3.5.2.

EV3.10.6 The voltage detection circuit of the red light and the relay state and voltage detection circuit of the green light must be independent. Any plausibility check between both lights is not allowed. A TSAL state with both lights simultaneously active might occur and must not be prevented.

EV3.10.7 The TSAL must:

- Be located lower than the highest point of the main hoop and including the mounting within the Surface envelope.
- Be no lower than 75mm from the highest point of the main hoop.

- Not be able to contact the driver's helmet in any circumstances.

EV3.10.8 The entire illuminated surface of the TSAL must be clearly visible:

- Except for angles less than 10° which are blocked by the main hoop.
- From a point 1.60m vertically from ground level, within 3m horizontal radius from the TSAL in direct sunlight.

EV3.10.9 The TSAL and all needed circuitries must be hard-wired electronics. Software control is not permitted.

EV3.10.10 A green indicator light in the cockpit that is easily visible even in bright sunlight and clearly marked with "TS off" must light up if TSAL green light is on, see EV3.10.3.

EV3.10.11 Signals influencing the TSAL and the indicator according to EV3.10.10 are SCS, see T12.9. The individual safe state of each of the TSAL lights is off. The TSAL has an active indication of the absence of failures (continuous green illumination) and thus the red light must not be illuminated for a visible check, see T12.9.5.

EV3.10.12 The TSAL's red light voltage detection circuit, see EV3.10.2, does not need to detect an open circuit, as required by T12.9, when no voltage is present. A plausibility check must not be implemented.

EV3.10.13 The TSAL's green light relay state detection circuit, see EV3.10.3, does not need to detect an open circuit, as required by T12.9, when the intentional state of the used (auxiliary) contact is opened. A plausibility check against the intentional relay state must be implemented in such a way that the TSAL's green light stays off after the open circuit is detectable.

EV3.10.14 The TSAL's green light voltage detection circuit, see EV3.10.3, does not need to detect an open circuit, as required by T12.9, when no voltage is present. A plausibility check against the intentional relay states must be implemented in a way that the TSAL's green light stays off after the open circuit of the accumulator voltage detection circuit is detectable.

EV3.10.15 The latch required by EV3.10.13 and EV3.10.14 must not be triggered during normal operation conditions and must only be reset by power cycling the LVS.

EV3.11 Activating the Tractive System

EV3.11.1 The TS is active if any of the AIRs or the pre-charge relay is closed. The driver must be able to activate and deactivate the TS from within the cockpit without the assistance of any other person.

EV3.11.2 Closing the shutdown circuit by any part defined in EV5.1.1 must not (re-)activate the TS. Additional action must be required. The vehicle is ready-to-drive as soon as the motor(s) will respond to the input of the APPS.

EV3.11.3 After the TS has been activated, additional actions must be required by the driver to set the vehicle to ready-to-drive mode (e.g., pressing a dedicated start button). The transition to ready-to-drive mode must only be possible during the actuation of the mechanical brakes and simultaneously dedicated additional action.

The ready-to-drive mode must be left immediately when the shutdown circuit is opened.

EV3.12 Ready-To-Drive Sound

EV3.12.1 The vehicle must make a characteristic sound, continuously for at least one second and a maximum of three (3) seconds when it enters ready-to-drive mode.

EV3.12.2 The sound level must be a minimum of 80dBA and a maximum of 90dBA, fast weighting in a radius of 2m around the vehicle.

EV3.12.3 The used sound must be easily recognizable. No animal voices, song parts, or sounds that could be interpreted as offensive will be accepted.

The vehicle must not make any other sounds like the ready-to-drive sound.

ARTICLE 4: ENERGY STORAGE

EV4.1 Definitions

Cell – a battery cell or super-capacitor.
Cell Energy – the maximum cell voltage times the nominal capacity of the used cell.
TS Accumulator – all cells that store the electrical energy to be used by the TS.
TSAC – the container itself, which contains the TS accumulator.
TS Acc. Segments – sub-divisions of the TS accumulator.

- All types of cells except molten salt and thermal batteries are allowed.
- Fuel cells are prohibited.

EV4.2 General Requirements

EV4.2.1 All cells which store the TS energy must be enclosed in (an) TSAC(s). Each TS accumulator segment must not exceed a maximum static voltage of 120VDC, a maximum energy of 6MJ, see EV4.1, and a maximum mass of 12kg.

EV4.2.2 If spare TS accumulators are used, they must be of the same size, weight, and type as those that are replaced. Spare cells must be stored in an electrically insulated container made of fire-retardant material. The container must be labelled according to EV5.3.8.

EV4.2.3 Spare accumulators and spare cells must be presented at technical inspection. It must be possible to open the TSAC for technical inspection.

EV4.2.4 Each TSAC must be removable from the vehicle while remaining rules compliant without the need to install extra components. A dummy connector or similar may be used to restore the system's isolation, see EV4.5.

EV4.2.5 The vehicle number, the university name, and the ESO phone number(s) must be displayed and written in Roman Sans-Serif characters of at least 20mm high on the lid of

each TSAC. The characters must be clearly visible and placed on a high-contrast background.

EV4.3 Electrical Configuration

EV4.3.1 If the TSAC is made from an electrically conductive material, the insulation barrier must be adequately protected against conductive penetrations.

EV4.3.2 Every TSAC must contain at least one fuse and at least two AIRs, see EV5.6 and EV3.2.7.

EV4.3.3 LVS must not be included in the TSAC except where inherently required. Exceptions include the AIRs, TS DC/DC converters, the AMS, the Insulation Monitoring Device (IMD), parts of the TSAL, and cooling fans.

Maintenance plugs must allow electrical separation of all accumulator segments, see **EV5.3.2**. The separation must affect both poles of all segments.
Maintenance plugs must –

- Not require tools to separate the TS accumulator segments.
- Be non-conductive on surfaces that do not provide any electrical connection.
- Be designed in a way that is physically impossible to electrically connect them in any way other than the design intent configuration.
- Protected against accidental reconnection.
- Be designed such that it is clearly visible whether the connection is open or closed. Electrically controlled switches must not be used.
- Upon removal of all maintenance plugs, no voltage should be present at the accumulator side of AIR.

EV4.3.4 Each TS accumulator segment must be electrically insulated by the use of suitable rigid and fire-retardant material, see T1.2.1, between the segments and on top of the segment to prevent arc flashes caused by inter-segment contact or by parts/tools accidentally falling into the TSAC during maintenance.

EV4.3.5 Every wire used in a TSAC, regardless of whether it is part of the LVS or TS, must be rated to the maximum TS voltage.

EV4.3.6 Each TSAC must have a prominent indicator, a voltmeter, or a red LED visible even in bright sunlight that will illuminate whenever a voltage greater than 60VDC or half the maximum TS voltage, whichever is lower, is present at the vehicle side of the AIRs.

EV4.3.7 The indicator must be clearly visible while disconnecting the TSAC from the vehicles. The indicator must be clearly marked with “Voltage Indicator.”

EV4.3.8 The indicator must be hard-wired electronics without software control and directly supplied by the TS and always working, even if the accumulator is disconnected from the LVS or removed from the vehicle.

EV4.4 Mechanical Configuration

EV4.4.1 All TSACs must lie within and be attached to the primary structure, or any additional structures fixed to the primary structure which meets the minimum specification for side impact structures, see table 4, no higher than the top of the side impact structure, see T1.1.16.

EV4.4.2 The TSAC(s) must be protected from side and rear impact collisions by structure equivalent to that defined in T3.15 (with exception of the first point under T3.15.1) and must follow T3.16 when having bolted attachments. The TSAC must not be part of this structure.

EV4.4.3 All TSAC materials as well as all structural parts must be fire retardant, see T1.2.1.

EV4.4.4 The TSAC(s) must be constructed of steel or aluminum. With the following requirements:

- The bottom of the TSAC must be at least 1.25mm thick if made from steel or 3.2mm if made from aluminum.
- The internal and external vertical walls, covers, and lids must be at least 0.9mm thick if made from steel or 2.3mm if made from aluminum.

EV4.4.5 Alternative materials are allowed with proof of equivalency per T3.3 or for composite materials per EV5.5.5. This must be documented in the SES. When alternative materials are used, test samples must be presented at technical inspection.

EV4.4.6 Composite TSAC(s) must satisfy the following requirements:

- Data obtained from the laminate perimeter shear strength test and three-point bending test, see T3.5, should be used to prove adequate strength is provided.
- Each attachment point requires steel backing plates with a minimum thickness of 2mm. Alternate materials may be used for backing plates if equivalency is approved.
- The calculations and physical test results must be included in the SES.

EV4.4.7 The floor and walls of the TSAC must be joined by welds, bonding, and/or fasteners.

EV4.4.8 The TSAC must consist of electrically insulating internal vertical walls with a minimum of 75% of the height of the external vertical walls, that divide the TSAC into sections of a maximum of 12kg. These walls must not divide any accumulator segment, see EV5.3.2.

EV4.4.9 The accumulator segments, see EV5.3.2, must be separated by a rigid, electrically insulating, and fire-retardant barrier, see T1.2.1.

EV4.4.10 The TSAC itself, the mounting of the TSAC to the chassis, and the mounting of each cell to the TSAC must be designed to withstand the following accelerations:

- 40g in the longitudinal direction (forward/aft)
- 40g in the lateral direction (left/right)
- 20g in the vertical direction (up/down)

EV4.4.11 Accumulator Attachment – Load Based

a. The minimum number of attachment points depends on the total mass of the container

Accumulator Weight	Minimum Attachment Points
< 20 kg	4
20 – 30 kg	6
30 – 40 kg	8
> 40 kg	10

b. Any brackets which attach the Accumulator Container to the chassis must:

- Be made of steel 1.6 mm minimum thickness or aluminum 4 mm minimum thickness
- Have guests to carry bending loads.
- Each attachment point, including any brackets, backing plates and inserts, must be able to withstand 15 kN in any direction

c. Fasteners must space a minimum 50 mm apart to be counted as separate attachment points.

EV4.4.12 Calculations and/or tests must be documented in the SES. All considered TSAC attachment points must follow EV5.5.13. TSAC(s) made of materials as stated in EV5.5.4 or EV5.5.5 may need further reinforcement to comply with this rule. Tabs of pouch cells must not carry mechanical loads. Pouch cells must only carry mechanical loads on the large surface areas.

EV4.4.13 All fasteners used within or to mount the TSAC must comply with T10. Fasteners within the accumulator used for non-structural accumulator parts (e.g., PCBs etc.) do not have to follow T10.1.2. Fasteners made of electrically non-conductive material within the accumulator used for non-structural accumulator parts do not have to follow T10.

EV4.4.14 The AIRs and the main fuse, see EV3.2.7, must be separated with electrically insulated and fire-retardant material, see T1.2.1, from the rest of the TS accumulator. Air is not considered to be a suitable insulation material in this case.

EV4.4.15 Any brackets used to mount the TSAC must be made of steel 1.6mm thick or aluminum 4mm thick and must have gussets to carry bending loads. Each attachment point including brackets, backing plates, and inserts, must be able to withstand 20kN in any direction.

EV4.4.16 Holes, both internal and external, in the TSAC are only allowed for the wiring harness, ventilation, cooling, or fasteners. TSAC must still be compliant with all other rules, especially the ones concerning its structural requirements. External holes must be sealed according to EV4.5. External openings for cooling or mounted connected cooling ducts must not point towards the driver, or if the accumulator is out of the car, towards the operator of the accumulator hand cart.

EV4.4.17 A sticker according to “ISO 7010-W012” (triangle with a black lightning bolt on yellow background) with the triangle side length of at least 100mm and the text “Always Energized” must be applied on every TSAC. The sticker must also contain the text “High Voltage” if the voltage is more than 60VDC or 25VACRMS.

EV4.4.18 Any TS accumulators that may vent an explosive gas must have a ventilation system to prevent the vented gas from reaching an explosive concentration. Every TSAC which is completely sealed must also have a pressure relief valve to prevent high-pressure in the TSAC.

EV4.4.19 The design of the TSAC and its contents must be documented in the SES including materials used, drawings, images, fastener locations, segment weight, cell, and segment position.

EV4.5 Accumulator Isolation Relays

EV4.5.1 At least two AIRs must be fitted inside each TSAC.

EV4.5.2 The AIRs must open both poles of the TS accumulator. If the AIRs are open, no TS voltage may be present outside of the TSAC and the vehicle side of the AIRs must be galvanically isolated from the accumulator side, see EV1.2.1.

EV4.5.3 The AIRs must be mechanical relays of a “normally open” type. Solid-state relays are prohibited. The fuse protecting the accumulator TS circuit must have a rating lower than the maximum switch-off current of the AIRs.

EV4.6 Pre-Charge Circuit

EV4.6.1 A circuit that ensures that the intermediate circuit is pre-charged to at least 95% of the actual.

EV4.6.2 TS accumulator voltage before closing the second AIR must be implemented. Therefore, the intermediate circuit voltage must be measured.

EV4.6.3 The pre-charge circuit must use a mechanical, normally open-type relay. All pre-charge current must pass through this relay.

EV4.7 Accumulator Management System

EV4.7.1 An AMS must monitor each TS accumulator whenever the LVS is active, or the accumulator is connected to a charger.

EV4.7.2 Every TSAC must contain its full AMS including its own and AMS exclusive SDC power stage, see EV6.1

EV4.7.3 The AMS must continuously measure.

- all cell voltages
- the TS current.
- the temperature of thermally critical cells

EV4.7.4 For lithium-based cells: the temperature of at least 30% of the cells equally distributed within the TSAC(s)

EV4.7.5 Cell temperature must be measured at the negative terminal of the respective cell and the sensor used must be in direct contact with the negative terminal or less than 10mm along the high current path away from the terminal in direct contact with the respective busbar. It is acceptable to monitor multiple cells with one sensor if this requirement is met for all cells sensed by the sensor.

EV4.7.6 The maximum cell temperature is sixty (60) °C or the limit stated in the cell data sheet, whichever is lower. An independent cell temperature monitoring device may be provided by the officials during accumulator inspection and must be installed, see IN3. The device must be placed on the warmest negative cell terminal of the TSAC and in direct contact with the terminal or less than 30mm away from it on the busbar.

EV4.7.7 The AMS must switch off the TS via the shutdown circuit, if critical voltage, temperature, or current values according to the cell manufacturer's data sheet or these rules persistently occur for more than:

- 500ms for voltage and current values
- 1sec for temperature values

The accuracy, noise, and sample rate of the measurement must be considered.

EV4.7.8 AMS cell voltage measurement inputs, temperature measurement inputs, and supply voltage of decentralized AMS slaves may be rated below the maximum TS voltage if the team has proven by calculations in the Electrical System Form (ESF), see EV9, that the input voltage rating is chosen.

EV4.7.9 A red indicator light in the cockpit that is easily visible from inside and outside the cockpit even in bright sunlight and clearly marked with the lettering "AMS" must light up if and only if the AMS opens the shutdown circuit. It must stay illuminated until the error state has been manually reset, see EV6.1.6. Signals controlling this indicator are SCS, see T12.9.

EV4.7.10 AMS signals are System Critical Signals, see T12.9.

EV4.7.11 It must be possible to individually disconnect the current sensor, one temperature sensor, and one cell voltage measurement wire during technical inspection, if any wire is used.

EV4.7.12 The AMS must be able to read and display all measured values according to EV5.8.3 e.g.,

by connecting a laptop to the AMS.

EV4.7.12 AMS shall provide a mechanism to provide TSAC voltage, current, temperature etc. logging provision by external device by providing external communication port (e.g. CAN etc.)

EV4.8 Accumulator container hand cart

EV4.8.1 A hand cart(s) must be used for transporting the TSAC(s) around the competition site. The hand cart must have at least four wheels and a brake that is always on and only released if someone pushes the handle, or similar. The brake must be capable of safely stopping the fully loaded hand cart.

EV4.8.2 The hand cart must be able to carry the load of the TSAC(s) & provide a firewall to protect the person while moving the hand cart. The firewall must have the same width as the hand cart, start at the lowest point of the hand cart excluding the wheels and be at least 30cm higher than the hand cart handle and the TSAC.

EV4.8.3 The TSAC(s) must be mechanically fixed to the hand cart to enable safe transportation & protected from vibrations and shocks during normal operation of the cart, e.g., by the use of air tires.

EV4.8.4 The label on the TSAC or an additional label according to EV4.2.5 must be clearly visible if the TSAC is on the hand cart.

EV4.8.5 The overall floor space used by the fully loaded hand cart must not exceed 1200mm x 800mm. If the TSAC is larger than the allowed floor space, exceptions may be approved by the officials prior to the competition.

ARTICLE 5: SHUT-DOWN CIRCUIT

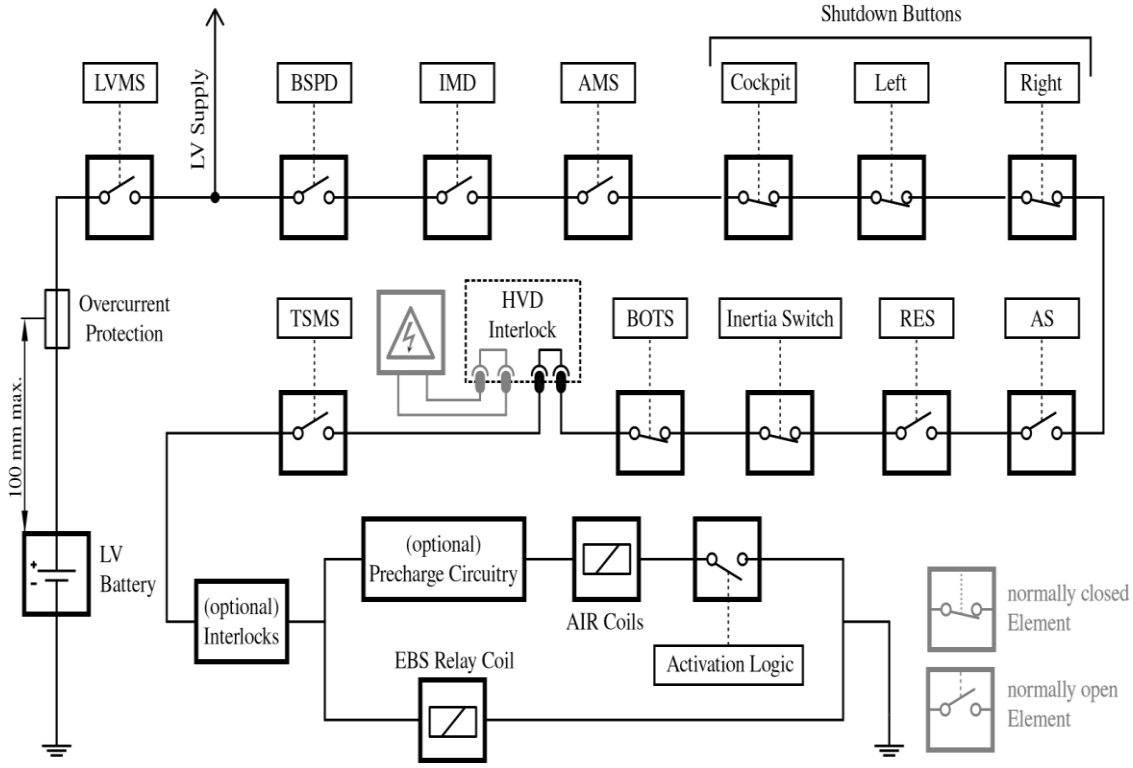


Figure: Explanatory example schematic of the required shutdown circuit

EV 5.1 The shutdown circuit directly carries power, driving the AIRs, see EV4.5, and the pre-charge circuitry, see EV4.6.

EV5.1.1 The shutdown circuit is defined as a series connection of at least two master switches, three shutdown buttons, the BOTS, see T7.3, the IMD, the inertia switch, see T12.6, the BSPD, see T12.7, all required interlocks, and the AMS.

EV5.1.2 An explanatory schematic of the required shutdown circuit, excluding any interlock circuitry, is shown in Figure 22. All parts of the shutdown circuit defined in EV5.1.1 must be on the high-side connection of the AIR coils and the pre-charge circuitry.

EV5.1.3 The Tractive System Master Switch (TSMS), see EV5.2, must be the last switch before the AIRs except for pre-charge circuitry and hardwired interlocks.

EV5.1.4 If the shutdown circuit is opened, the TS must be shut down by opening all AIRs and the voltage in the TS must drop to below 60VDC and 25VACRMS in less than five seconds. All accumulator current flow must stop immediately.

EV5.1.5 The action of opening the AIRs may be delayed by ≤250ms to signal the action to the motor controllers and reduce the TS current before the AIRs are opened. The AIR supply must be abruptly switched off before reaching the minimum AIR supply voltage.

EV5.1.6 If the shutdown circuit is opened by the AMS or the IMD, it must be latched open by a non-programmable logic that can only be manually reset by a person at the vehicle who is not the driver.

EV5.1.7 All circuits that are part of the shutdown circuit must be designed in a way that in the de-energized/disconnected state they open the shutdown circuit. It must be possible to demonstrate that all features of the shutdown circuit function correctly. This includes all the interlocks.

EV5.1.8 Every system that is required to or can open the shutdown circuit must have its own, non-programmable, power stage to achieve this. The respective power stages must be designed to be able to carry the shutdown circuit current, e.g., AIR inrush currents, and such that a failure cannot result in electrical power being fed back into the electrical shutdown circuit.

EV5.1.9 The shutdown buttons, the BOTS, the TSMS, and all interlocks must not act through any power stage. All signals influencing the shutdown circuit are SCSs, see T12.9.

EV5.2 Tractive System Master Switch

EV5.2.1 An TSMS according to EV5.2 must be part of the shutdown circuit. The TSMS must be fitted with a *"lockout/tagout"* capability to prevent accidental activation of the TS. ESO must ensure that it is locked in the off position whenever work is done on the vehicle or no ESO is present.

EV5.2.2 The TSMS must be mounted in the middle of a completely orange circular area of ≥50mm diameter placed on a high-contrast background. The TSMS must be marked with *"TS"* and a symbol according to *"ISO 7010-W012"* (triangle with a black lightning bolt on yellow background).

EV5.3 Insulation Monitoring Device

EV5.3.1 Every vehicle must have an IMD installed in the TS system.

EV5.3.2 The IMD must be a Bender A-ISOMETER® iso-F1 IR155-3203 or -3204 or equivalent IMD approved for automotive use. Equivalency may be approved by the officials based on the following criteria: robustness to vibration, operating temperature range, IP rating, availability of a direct output, a self-test facility, and must not be powered by the system which is monitored.

EV5.3.3 The response value of the IMD must be set to ≥500Ω/V, related to the maximum TS voltage. The IMD must be connected to the vehicle side of the AIRs.

EV5.3.4 One IMD chassis ground measurement line must be connected to the grounded TSAC or

the respective grounded enclosure of the IMD. The other chassis ground measurement line must be connected to the main hoop. Each connection must use a separate conductor, rated for at least maximum TS voltage. An open circuit in any of these ground measurement connections must result in an opened shutdown circuit.

EV5.3.5 In case of an insulation failure or an IMD failure, the IMD must open the shutdown circuit. This must be done without the influence of any programmable logic. See also EV5.1.6 regarding the re-activation of the TS after an insulation fault.

EV5.3.6 A red indicator light in the cockpit that is easily visible from inside and outside the cockpit even in bright sunlight and clearly marked with the lettering “IMD” must light up if and only if the IMD opens the shutdown circuit. It must stay illuminated until the error state has been manually reset, see EV5.1.6. Signals controlling this indicator are SCS, see T12.9.

EV5.4 CHARGERS

EV5.4.1 General Requirements

EV5.4.1.1 Only chargers presented and sealed at technical inspection are allowed. All connections of the charger(s) must be insulated and covered. No open connections are allowed.

EV5.4.1.2 Exposed conductive parts and the TSAC must be connected to protective earth (PE).

EV5.4.1.3 All components interfacing to mains must be accredited to a recognized standard e.g. CE. All remaining parts must comply with all electrical requirements for the vehicle TS, e.g., EV3.3, EV2.4, and EV3.2.

EV5.4.1.4 TS charging leads must be orange. When charging, the AMS must be live and must be able to turn off the charger if a fault is detected.

EV5.4.1.5 The charger must include a push-type emergency stop button which has a minimum diameter of 24mm and must be clearly labelled.

EV5.4.1.6 When charging the accumulator, the IMD must be able to shut down the charger. Either the charger must incorporate an active IMD or an active IMD must be within the accumulator. Other than stated in EV5.3, the second chassis ground measurement line must be connected to the casing of the charger instead of the main hoop.

EV5.4.1.7 An IMD indicator light as defined in EV5.3.6 must be available during charging. The charger must include TSMPs as described in EV3.7. Other than stated, the TSMPs must be connected to the TS output of the charger.

EV5.4.2 Charging Shutdown Circuit

EV5.4.2.1 When charging, the charging shutdown circuit consists of at least the charger shutdown button, see EV5.4.1.5, the IMD, and the AMS.

EV5.4.2.2 If the shutdown circuit is opened the charging system must remain disabled and the shutdown circuit opened until it is manually reset.

EV5.4.2.4 All signals influencing the charger shut down circuit are SCS, see T12.9.

ARTICLE 6: INSPECTION

EV6.1 Electrical System Form

EV6.1.1 Prior to the competition, all teams must submit clearly structured documentation of their entire electrical system (including control and TS) called the ESF.

EV6.1.2 Submission and approval of the ESF does not mean that the vehicle will automatically pass Electrical Technical Inspection with the described items / parts. (Δ^2)

EV6.1.3 Templates for the ESF shall be made available on the competition website.

EV6.2 Failure Modes and Effects Analysis (FMEA)

EV6.2.1 Teams must submit a complete failure modes and effects analysis (FMEA) of the TS by the deadline published on the competition website.

EV6.2.2 A template including required failures to be described will be made available online. Pictures, schematics and data sheets referenced in the FMEA must be included in the FMEA on additional table pages.

EV6.3 Accumulator Pre-Tech Inspection (ACC-PT)

EV6.3.1 Teams will be required to participate in a pre-technical inspection for the accumulator system, prior to the competition, by the deadline highlighted on the competition website.

EV6.3.2 A document will be required to be submitted prior to this inspection. A checklist of views required, including the method of submission, shall be specified on the competition website.

EV6.4 Accumulator inspection

EV6.4.1 General requirements

Cell modules or stacks do not need to be disassembled when AIRs, fuses, pre- and discharge circuit and positive locking mechanism of the maintenance plugs are reachable and visible for the officials.

An official temperature logging device must be installed if used by the competition, see EV4.7.6. The accumulator charger will be inspected and sealed.

The set of basic tools will be checked.

The following items must be presented at accumulator inspection:

- All TS accumulators
- Accumulator hand cart
- Accumulator charger
- Basic Tools
- Tools needed for the (dis)assembly of parts.
- Samples of self-designed PCBs that are part of the tractive system and inside the TSAC, see EV3.3.5
- Data sheets for all parts used in the accumulator.
- Original delivery notes for material without serial number printed on it.
- Printouts of rules' questions (if applicable)

The following basic tools in good condition must be presented:

- Insulated cable shears.
- Insulated screw drivers.
- Multi meter with protected probe tips and two 4mm banana plug test leads rated for 1000V CAT III or better.
- Insulated tools if screwed connections are used in the tractive system.
- Face shield
- at least two pairs of HV insulating gloves (not expired)
- Two HV insulating blankets of at least 1.0m^2 each.
- Safety glasses with side shields for all team members that might work on the tractive system or accumulator.

All electrical safety items must be rated for at least the maximum tractive system voltage

EV6.5 Electrical inspection

EV6.5.1 General requirements

The insulation resistance between the TS and LVS ground will be measured. Vehicles with a maximum TS voltage less than or equal to 250V will be probed with 250V and vehicles with a maximum TS voltage greater than 250V with 500V.

To pass this test, the measured insulation resistance must be at least 500Ω/V related to the maximum TS voltage of the vehicle.

The IMD will be tested by connecting a resistor between the TSMP, see EV4.7 and LVS ground connector, see EV4.7.8.

The test is passed if the IMD shuts down the TS within 30s at a fault resistance of 50% below the response value which corresponds to 250Ω/V.

The following items must be presented at electrical inspection:

- One ESO
- Vehicle with mounted TS accumulator
- Jacks and push bar

- Samples of self-designed PCBs that are part of the tractive system and are outside of the TSAC, see EV3.7
- Tools needed for the BSPD check, see T12.7.9
- Data sheets for all parts used in the tractive system.
- Original delivery notes for material without serial number printed on according to it.
- Tools needed for the (dis)assembly of parts for electrical inspection.
- Printouts of rules' questions (if applicable)
- The connectors needed.
  – to safely close the SDC while the HVD is removed and
  – to safely supply the TS using the same shrouded receptacles as used for TSMP when the TS accumulator is unconnected

STUDENT FORMULA
PART S - STATIC EVENT REGULATIONS

ARTICLE 1: STATIC EVENTS AND MAXIMUM SCORES

The maximum possible scores in the static events are:

Technical Inspection (Safety Scrutiny, Tilt, Noise, Brake Test, Rain test)	No Points
Cost and Manufacturing	100 Points
Business Presentation	75 Points
Design Evaluation	150 Points
Total	325 Points

ARTICLE 2: TECHNICAL INSPECTION

S2.1 Objective of Technical Inspection

The objective of technical inspection is to determine if the vehicle meets the STUDENT FORMULA Rules requirements and restrictions and if, considered as a whole, it satisfies the intent of the Rules.

S2.1.1 For purposes of interpretation and inspection the violation of the intent of a rule is considered a violation of the rule itself. (See Rule A3.6)

S2.1.2 Technical inspection is a non-scored activity.

S2.2 Inspection & Testing Requirement

Each vehicle must pass all parts of technical inspection and testing, and bear the inspection stickers, before it is permitted to participate in any dynamic event or to run on the practice track.

S2.2.1 All items on the Inspection Form must be clearly visible to the technical inspectors.

S2.2.2 Visible access can be provided by removing body panels or by providing removable access panels.

S2.3 Team Responsibility

Teams are responsible for confirming that their vehicle, and the required equipment, satisfies the requirements and restrictions of the SUPRASAEINDIA Rules before presenting it for Technical Inspection.

S2.3.1 Presenting a vehicle for Technical Inspection constitutes a declaration by the team that they have determined by self-inspection that the vehicle complies with the Rules.

S2.4 Items to be Inspected

Following items must be brought to Technical Inspection: Vehicle

- Technical Inspection Form
- Dry and wet tires
-

Driver's equipment - for all drivers including arm restraints, helmets, suits, gloves, eye protection, balaclavas, socks and shoes.

- Fire extinguishers
- Push bar
- Structural Equivalency Spreadsheet (SES) copies as appropriate for your car.
- Impact Attenuator Report copies
- Copies of any rules questions you submitted with the answer you received.
- All drivers must be present at inspection.

S2.5 Technical Inspection Procedure

Technical inspection will examine all items included on the Inspection Form found on the SUPRASAEINDIA website plus any other items the inspectors may wish to examine to ensure conformance with the Rules. The exact procedures and instruments employed for inspection and testing are entirely at the discretion of the Chief Technical Inspector.

S2.5.1 Decisions of the inspectors and the Chief Technical Inspector concerning vehicle compliance are final and are not permitted to be appealed.

S2.6 Inspection Condition

Vehicles must be presented for technical inspection in finished condition, i.e. fully assembled, complete and ready-to-run. Technical inspectors will not inspect any vehicle presented for inspection in an unfinished state.

Note: Cars may be presented for technical inspection even if final tuning and set-up has not been finished. Exterior panels or body work are to be kept open when the vehicle is bought for Technical Inspection as for access for pedals and BOT.

S2.7 Inspection Process

Vehicle inspection will consist of three separate parts as follows:

S2.7.1 Part 1 - Safety Scrutineering

Each vehicle will be inspected to determine if it complies with the requirements of the rules. This inspection will include an examination of the driver's equipment (Part T Article
14) and a test of the driver’s egress time (Rule T4.8).
Part 1 must be passed before a vehicle may apply for Part 2 and Part 3 inspection.

S2.7.2 Part 2 - Tilt Table Tests

Each vehicle will be tested to ensure it satisfies both the forty-five-degree (45°) fuel and fluid tilt requirement (Rule T8.5) and the sixty-degree (60°) rollover stability requirement

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

S2.7.3 Part 3 - Noise, Air Intake, Master Switch, Ready-To-Drive-Sound, and Brake Tests

IC Vehicles - Noise will be tested by the specified method (Rule IC3.2). If the vehicle passes the noise test, then its master switches (Rule IC4.1) will be tested.

S2.8 Correction and Re-inspection

S2.8.1 If any part of a vehicle does not comply with the Rules, or is otherwise deemed to be a concern, then the team must correct the problem and have the car re-inspected.

S2.8.2 **The judges and inspectors have the right to re-inspect any vehicle at any time during the competition and require correction of non-compliance**.

S2.9 Inspection Stickers

Inspection stickers issued following the completion of any part of Technical Inspection will be placed on the upper nose of the vehicle as specified in Rule T13.4 "Technical Inspection Sticker Space".

S2.9.1 Inspection stickers are issued contingent on the vehicle remaining in the required condition throughout the competition.

S2.9.2 Inspection stickers may be removed from vehicles that are not in compliance with the Rules or are required to be re-inspected.

S2.10 "As-Approved Condition"

Once a vehicle has passed inspection, except as specifically allowed under Rule T1.2 "Modification and Repairs", it must remain in the "As-approved" condition throughout the competition and must not be modified.

S2.11 Inspection Validity

Technical approval is valid only for the duration of the specific STUDENT FORMULA competition during which the inspection is conducted.

S2.12 Rain test

S2.12.1 Rain Test General Definitions

Vehicles must have passed electrical inspection, see IN4, to attempt the rain test.

S2.12.2 Rain Test Procedure

The vehicle must be in ready-to-race condition. All components and constructions used to protect the vehicle from water during the rain test must be used during the entire competition.

The tractive system must be active during the rain test.

The vehicle must be jacked up using the jacks, see T13.2, and all driven wheels must be removed.

The vehicle must not be in ready-to-drive mode, see EV4.11.

The test will be conducted without a driver.

Water will be sprayed at the vehicle from any possible direction. The water spray is similar to a vehicle driving in rain and not a direct high-pressure stream of water.

The test is passed if the IMD is not triggered while water is sprayed at the vehicle for 120s and 120s after the water spray has stopped.

ARTICLE 3: BUSINESS LOGIC CASE

S3.1 The Objectives of the Business Logic Case are to:

a. Teach participants about the factors that need to be considered when a company

embarks on the development of a new product. These include cost; identification of market and likely sales volume; profitability; the key features applicable to the selected vehicle concept and target market size.

b. Ensure teams develop the concept of their entry with all of these aspects correctly considered, from the outset.
c. Ensure that all three static events are approached with a single common concept and presented to each set of static judges in the same manner.
d. Ensure that participants gain experience in producing a business case and balancing potentially conflicting attributes.

S3.2 **The Design, Cost and Business Presentation judges will use the business logic case to verify that the information presented at each static event is consistent with the overall objectives as outlined in the Static Events Rules.**

a. In the Design event, the business logic case will be used to identify how the team determined the tradeoff between design for performance and design for manufacture and cost, how these requirements were considered in the overall concept and whether these were achieved in the final vehicle.
b. In the Cost event, the business logic case will be used to determine that the cost target was met for the same design solution and how Cost was integrated into the overall concept and the iterative design process.
c. In the Business Presentation event, the business logic case will be used to assess whether the business presentation is appropriate for the market and business strategy that the team has identified

S3.3 All teams must submit a Business Logic Case report in accordance with the general format applicable for the year of competition " SUPRA SAEINDIA Business Logic Plan 20XX". The report must be submitted on the template. Refer to the applicable competition website/social media account to acquire the template.

This report must be submitted by the deadline. Refer to the deadlines posted on the website/social media account for each specific competition.

ARTICLE 4: COST AND MANUFACTURING EVENT

Important Notice: Additional information about the Cost and Manufacturing Event including Cost Tables and other information can be obtained from the www.suprasaeindia **website which is also linked off the STUDENT FORMULA Rules and Important Documents page on the SUPRASAEINDIA Website.**

S4.1 Event Objective

The objectives of the Cost and Manufacturing Event are:

a. To teach the participants that cost, and budget are significant factors that must be considered in any engineering exercise.
b. For teams to make trade off decisions between content and cost based on the performance advantage of each part and assembly.
c. To gain experience with creating and maintaining a Bill of Material (BOM).

d. For the participants to learn and understand the principles of Design for Manufacture and Assembly, lean manufacturing and Minimum Constraint Design

S4.2 Rules Objective

The objectives of the Cost and Manufacturing Event rules are:

a. To provide a logical, simple and time efficient rule set enabling students to achieve the event's objectives.
b. To improve fairness by providing consistent pricing guidelines independent of team geographical location by using standardized Cost Tables.
c. To require the minimal burden of supporting documentation such as receipts or catalog pages. However, in order to convey design information to cost judges engineering documentation (drawings, process descriptions, etc.) is required.

S4.3 Event Requirements

This event is comprised of three (3) parts

S4.3.1 Part 1 "Cost Report"

The preparation and submission of a report (the "Cost Report"), which is to be sent to the Cost Judges prior to the competition. See S4.1.

S4.3.2 Part 2 "Discussion"

1. A discussion at the Competition with the Cost Judges around the team's vehicle. See Section S4.3.2. This evaluates not only the cost of the car, but also the team's ability to prepare accurate engineering and manufacturing cost estimates and team’s knowledge about the BOM”

S4.3.3 Part 3 Cost report preparedness

Cost Judges will evaluate the cost report submitted by the team.]

S4.5 Public Cost Reports

By submitting a cost report to the competition's organizing body for judging you and your team agree that your cost report can be reproduced and distributed by the competition organization, in both complete and edited versions, in any medium or format anywhere in the world.

Note: For the current competition season, it is the plan of the STUDENT FORMULA Rules Committee and the competition organizers to publish all cost reports, in as-submitted format, to the SUPRASAEINDIA website. It is the intent of this move to make the cost event more transparent and improve the educational experience of the students by providing the full range of cost reports for teams to review. Cost reports for that competition season will not be published before the end of the calendar year. Support materials, such as technical drawings, will not be released

S4.6 Definitions

The following definitions will apply throughout the Cost Event rules:

S4.6.1 Adjusted Cost - The final cost for the vehicle including penalties

S4.6.2 Amended Cost - The cost of the vehicle after modification by the competition addendum

S4.6.3 Bill of Material - A hierarchical list of all parts of the vehicle. A BOM lists every item that is on the vehicle but also shows the relationships between these items, for example showing the parts that make up an assembly. A Costed Bill of Material (CBOM) is a standard BOM that includes cost information including cost of purchased parts, raw materials and processes that go into manufacturing the vehicle.

S4.6.4 Category - Each table has numerous entries which describe a classification of entry. For example, there are several types of hose clamps, and all have various costs. The category of hose clamp may be worming drive, constant tension, etc.

S4.6.5 Cost - The cost for each item from the materials table is simply the quantity multiplied by the unit cost.

S46.6 Cost Report - All materials, including electronic and hard copy, submitted for judging

S4.6.7 Cost Score - Refers to the total number of points out of 100 earned in the Cost Event

S4.6.8 Cost Tables - All tables that list costs for objects and processes

S4.6.9 Design for Manufacture and Assembly (DFMA) - The process where parts are designed for ease of manufacture and assembly, resulting in lower cost.

S4.6.10 Fasteners Table - A Cost Table that consists of not only traditional fasteners such as bolts, nuts and rivets but also adhesives, hose clamps and retaining rings.

S4.6.11 Fixed Cost - Costs associated with production that are independent of volume produced. Fixed cost items, such as tooling, are converted to variable costs when included in the Cost Report.

S4.6.12 Initial Cost - The cost of the vehicle submitted for initial judging in the Cost Report.

S4.6.13 Lean Manufacture - A methodology for producing goods that emphasizes the elimination of waste and improvement in process flow with the goal of optimizing the cost and quality of goods.

S4.6.14 Materials Table - Lists the costs for raw materials used to manufacture parts built by the teams and also of finished parts purchased by the teams.

S4.6.15 Minimum Constraint Design (MCD) - A design methodology emphasizing elimination of redundant constraints in the attachment of parts. Each part requires constraint in six degrees of freedom and additional constraints can make assembly difficult, force tight tolerances and increase the cost of manufactured goods.

S4.6.15 Minimum Constraint Design (MCD) - A design methodology emphasizing elimination of redundant constraints in the attachment of parts. Each part requires constraint in six degrees of freedom and additional constraints can make assembly difficult, force tight tolerances and increase the cost of manufactured goods.

S4.6.16 Parameters - Used to create an equation describing the cost of an object as a function of some characteristic of that object. For example, the cost of steel is proportional to the mass (or volume) of steel. In this case steel has been parameterized by mass. Rubber hose could be parameterized by diameter. The equations can be linear or non-linear and both 1st and 2nd order equations are used as necessary to build the Cost Tables.

S4.6.17 Process Multipliers - Modify the standard costs of different operations to account for material and geometric differences in the part.

S4.6.18 Purchased Parts - Also called bought parts; these items are listed in the Cost Tables in near as-installed condition. For example, wheels, engines and turbochargers are purchased parts. In some cases, purchased parts may still require additional processing before they can be assembled into the car. Wheels, for example, do not include the machined features for mounting to the hub. The purchased parts do not include fasteners unless specifically noted in the Cost Tables.

S4.6.19 Quantity - The amount of the item

S4.6.20 Raw Materials - Materials used for manufacturing parts, such as aluminum, steel and rubber hose.

S4.6.21 Tools - Tools refer to hand or power tools used to assemble the vehicle. The costs of these tools **are not included** in the Cost Report. The effect of the tools used for assembly are captured in the process tables for labor as different costs are given based on the tools used for assembly.

S4.6.22 Tooling - Is the production tooling associated with processes that are specific to the part geometry. The costs of the tooling **must be included** in the Cost Report. For example, the dies to stamp out a chassis bracket are tooling. The press used to stamp the bracket is not and is considered production equipment which is not part of the Cost Event.

S4.6.23 Unit - Is the measurement system used to define the quantity of a parameter. For example, millimeters and kilograms are units. The hose clamp diameter unit is mm. When calculating the cost of the clamp the unit of measurement used by the team must match the Unit specified in the tables. For example, a US team mistakenly calculates the hose clamp cost by using the expression with a diameter of 1, because their radiator hose is 1 inch in diameter. They should have used 25.4mm for the diameter and their cost is wrong because of it. For the penalties associated with this type of error see S4.19

S4.6.24 Unit Cost - Is the cost for something assuming a numerical value of one (1) of the unit used to measure the item. The cost is the quantity of an item multiplied by the unit cost.

S46.25 Variable Cost - Is a cost associated with production that is proportional to the vehicle volume produced. All costs submitted with the Cost Report will be variable costs.

S4.7 General Requirements

S4.7.1 The Cost Report must:

a. Use the standardized Cost Tables. The tables are designed to reflect a hypothetical

car built for production at the annual volume of 10000 units per year.

b. List and cost every part on the prototype vehicle. This includes any equipment fitted on the vehicle at any time during the competition. The only exceptions are that, per S4.23 "Cost Report Exempt Items" of the Rules, the cost of any finish, on-board fire suppression system, rain tires, video or radio system, does not need to be included in the Cost Report.

c. Be based on the estimated costs of materials, fabrication, purchased parts, and assembly of the car. The costs shall be calculated as defined in these rules.

d. Be based on the actual manufacturing technique used on the prototype, e.g. cast parts on the prototype must be cost as cast, and fabricated parts as fabricated, etc.

e. Include tooling (e.g. welding jigs, molds, patterns and dies) for processes requiring it.

f. Exclude R & D and capital expenditures (e.g. plant, machinery, hand tools and power tools).

Note: There is no maximum cost. Receipts are not required for any

S4.7.2 The Cost Tables have been designed to:

a. Be verifiable at the event. Differentiating between different types of materials (for example different alloys of steel) is not possible so no differentiation is made in the table cost.

b. Minimize influence on safety equipment content. For example, driver harnesses are cost independent of the style chosen.

c. The higher costs of some goods must reflect actually the higher value of those goods. However, the costs must still allow for team innovation and vehicle content, with some reduction in cost scores.

S3.8 Scoring

<u>The points for the Cost and Manufacturing Event will be broken down as follows:</u>

$40x[(P_{max})/(P_{your})-1]$ $[(P_{max})/P_{min})-1]$	40 Points	Lowest cost - each of the participating schools will be ranked by total adjusted cost from the BOM and given 0-40 points based on the formula on the left.
	40 Points	Accuracy, Clarity & Event Day/Visual Inspection - The cars will be reviewed for part content, manufacturing feasibility and accuracy of the cost information. Supporting documentation will be assessed based on its quality, accuracy and thoroughness. The range for the score is 0-40 points.

		20 Points	port preparedness- It will be judged on the basis of How well teams has prepare their cost report and how well team will be able to explain the content of their reports, whether the report is as per the cost template provided to teams).
Total		100 Points	

Where:

Pyour is the adjusted cost of your car (with penalties) in INR.
Pmin is the adjusted cost of the lowest cost car in INR.
Pmax is the cost of the highest cost car in INR.

S4.9 Cost Report

S4.9.1 The Cost Report consists of a full vehicle BOM with cost data derived from the Cost Tables and supporting documentation. The Cost Report must be submitted in two (2) forms:

a. Electronic Version- The Electronic Version must be identified as follows: Carnumber_collegename_competitioncode_CR.xls using the assigned car number, the complete college name and the competition code.
Example: 087_university of STUDENT_SUPRA SAEINDIA_CR.xls

S4.9.2 Cost Report Identification

The cover of the Cost Report must include the following:
(a) university name, (b) competition name, and (c) vehicle number.

S4.9.3 The Cost Report must consist of the following:

- A Cover sheet
- A Table of Contents
- A Cost Summary page listing each section's cost, and the total vehicle cost
- Eight commodity report sections with the parts placed in the sections as specified in Appendix S-3.
- Tabs for each section

S4.10 Bill of Materials (BOM)

The BOM is a parts list for every vehicle part. It also shows the relationships between the items.

S4.10.1 The following terminology will be used when referring to the BOM.

- The overall vehicle is broken down into eight (8) systems which are defined in Appendix S-3.
- Systems are made up of Assemblies.
- Assemblies are made up of Parts.
- Parts consist of materials, processes and fasteners.
- Tooling is associated with each process that requires production tooling.

S4.10.2 An example BOM structure is shown below:

· Engine & Drivetrain	System
	Assembly
○ Engine	
	Assembly
○ Differential	
▪ Housing	Part
▪ Aluminum	Material
▪ Needle Bearing	Material
▪ Sand cast	Process
· Die & Core Package #4	Tooling
▪ Machining-Turn	Process
▪ Weld	Process
▪ M6x1.25 Grade 8.8	Fastener
▪ Internals	Part
▪ End Cap	Part

The BOM must follow the format given above. There must be no other BOM levels added or removed. Deviations from the published structure will be penalized by Section S4.18.

S4.10.3 All assemblies, parts and fasteners in the BOM must use a standard numbering convention explained in Appendix S-2.

S4.11 The Cost Tables

S4.11.1 All costs in the Cost Report come from the standardized Cost Tables. These tables have been compiled to represent the cost of parts and processes that a manufacturing compan

could be expected to pay for manufacturing a vehicle at 1000 units per year. Generally, the tabulated value represents ½ of the Manufacturer's Suggested Retail Price (MSRP) for finished parts. Raw materials, commodities and fasteners also intended to represent the production volume of a company rather than the purchase price of the University teams.

S4.11.2 Requests to alter the cost of goods in the tables because of changing world markets or individual team purchase price will not be approved. The tables are intended to provide a fair, unchanging (within a given competition year) cost for parts and to reduce regional variations in price that may help or hurt certain teams. All teams must use the costs given in the tables. If a team wishes to use any parts, processes or materials not included in the tables an "Add Item Request" must be submitted as per Section S4.14.

S4.11.3 The tables represent cost based on specific parameters. For example, the cost of steel is given per unit of volume (or mass). Likewise, engine costs are listed by displacement and specific power output.

S4.11.4 The following Cost Tables are used

- Materials
- Processes
- Process Multipliers
- Fasteners
- Tooling

S4.11.5 In general, most items have a cost expressed as a function of one parameter. In cases where more than one parameter is necessary additional categories are listed. For example, the power output of the engine has three Categories and for each Category a different expression calculates the cost as a function of the engine displacement, which is the Parameter. The Unit would be cubic centimeters in this case.

S4.11.6 Process Multipliers are used to modify the standard costs of different operations to account for material and geometric differences in the part. For every process included in the Cost Report the list of process multipliers must be checked to determine if any apply, and if they do their effect on the cost must be included.

S4.11.7 When adding items from tables to the BOM the comments section should be reviewed thoroughly to understand what is included in the table entry. For example, is spring included in the damper cost? Do the spark plugs come with the engine or are they a separate line item? In cases where the explanation is not clear please contact the Rules Committee for clarification.

S4.12 Cost Models & Costing Methodology

The cost models are the underlying methodology and equations that relate the final cost of a part or process to the different operations and goods used in that part. Detailed

Explanation of the Cost Models and Costing Methodology is included in Appendix S-1 and should be referenced for understanding the use of the Cost Tables.

S4.13 Make Versus Buy

Every part of an individual car can be classified as "made" or "bought". This designation does not necessarily refer to whether a team actually purchased or fabricated a part but reflects how the part must be cost from the Cost Tables.

a. Made (or manufactured) parts must be cost as if the company manufacturing the vehicle was going to make the part internally. That is by purchasing raw materials and processing them into a finished product.
b. Bought parts must be cost as if the company manufacturing the vehicle was going to outsource the fabrication of that part. These parts would be received by the vehicle manufacturer in a relatively finished state (see the particular table entry comments field for specific information).

S4.13.1 The Cost Tables have been constructed as a tradeoff between complexity for the organizers and fairness for the teams. The make versus buy designation enables certain parts to be simplified to a relatively few numbers of entries. For example, some teams may purchase axles, but the majority of teams manufacture them. Axles are designated "make" parts so teams that purchase axles **must** cost them as if they had made them start with the raw materials, in this case probably steel tubing. Made parts can be distinguished because they do not appear explicitly in the Cost Tables or appear with a "cost as made" option.

S4.13.2 If a team genuinely makes a part listed on the table as a bought part, they may alternatively cost it as a made part **if and only if** a place holder entry is listed in the tables enabling them to do so. For example, in the category of dampers a "student built" entry is included. This line item must be included in the BOM (it has zero cost). Then they must proceed to cost the damper they actually designed and built.

S4.13.3 A table summary of options is given below:

	How Team Actually Acquired the Part	
How Table Lists Part	Team Made	Team Bought
Table Lists Part as "Made", or Part is not Listed in the Tables	Cost as "Made"	Cost as "Made"
Table Lists Part as "Bought"	Team made option NOT in table cost as "Bought". If team made option in table team can choose either "Bought" or "Made"	Cost as "Bought"

S4.13.4 For example a snap ring does not have a "team made" entry in the Cost Tables. A team who made their own would still have to use the table cost based on diameter, even if they could cost it less expensively by buying steel and processing it.

S4.13.5 Any part which is normally purchased that is optionally shown as a maid part must have supporting documentation submitted to prove team manufacture. This might include engineering drawings, pictures of machining, etc. Teams found costing bought parts as made parts will be penalized appropriately.

S4.14 Add Item Request

S4.14.1 The cost tables are intended to include all materials, processes and fasteners needed by the teams to accurately reflect the content, manufacture and assembly of their vehicle. However, it will be necessary to add items to the tables to suit individual team requirements. To do this an "Add Item Request" must be submitted to the Rules Committee. After reviewing the item will be added to the tables with the next table update with a cost appropriate to the overall Cost Table framework and spirit of the competition. The tables will be updated throughout the competition year as required.

S4.14.2 The form should be completely filled out and contain the necessary instructions. Some supporting documentation will be required such as receipts or website links. The Add Item request is the only time receipts will be needed for the Cost Event.
Note: Since all teams work off the same tables once a team requests an item be added to the tables all teams will see the addition. Any team using the newly added item will use the same cost. The identity of the school that made the request will not be published.

S4.15 Report Submission and Deadline

a. The Cost Report must be submitted in the designated format for each event.
b. For some events, a printed copy of the report must also be submitted and must be on 8 1/2-inch x 11 inch or A4 size paper, using a 10-point font size or larger.
c. Submission Address and Deadline - The submission requirements, address and deadline will be published in the appendix or released on the website of the specific competition.

S4.16 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 late will be penalized as per rule A8.4

S4.17 Addenda

S4.17.1 An 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 C-5. No other format will be accepted.

S4.17.2 Addenda applies only to the competition at which they are submitted. A separate addendum is permitted for every competition a vehicle attends.

S4.17.3 Any items added to the Cost Report through addenda will be cost at 1.25 times the table cost. Any items removed through the addenda will only be credited 0.75 times the table cost. **Note:** Late changes to designs impact on costs in the real world. Contracts need to be altered, commodity costs can change, cancellation fees may be incurred, and information needs to be transmitted to suppliers. The scaling factors for the addenda capture this as well as encourage teams to submit full and accurate information with the initial Cost Report.

S4.18 Cost Report Judging and Penalties Process

S4.18.1 The following procedure will be used in determining penalties:

1. Penalty A will be calculated first using procedure S4.19
2. Penalty B will then be calculated using alternative procedure S4.20
3. The greater of the two penalties will be applied against the cost score
   a. Penalty A expressed in points will be deducted from the Accuracy score
   b. Penalty B expressed in INR will be added to the Adjusted Cost of the vehicle
4. If no additional points remain to be deducted from the Accuracy score the penalty will be applied using method B against the Adjusted Cost

S4.18.2 If the alternative penalty is used because no additional accuracy points remain then the highest of the A type penalties will be converted to B type penalties. In effect, the order the penalties are calculated and applied against the team does not matter.

S4.18.3 Any error that results in a team over-reporting a cost in their Cost Report will not be further penalized. For example, when the Cost Report is prepared the thickness of the brake rotors has not yet been determined. The team conservatively costs the rotors as 10mm thick. The final thickness is 8mm and no change is made in the addendum. The team rotor price is higher than necessary, but no penalty is applied.

Note: The penalty system is intended to reward accuracy and minimize workload at the competition for students and judges. In most cases the standard points deductions will be made to the accuracy score.

Note: Any instance where a team's score benefits from an intentional or unintentional error on the part of the students will be corrected on a case-by-case basis.

S4.19 Penalty Method A- Fixed Point Deductions

S4.19. From the Bill of Material, the cost judges will determine if all parts and processes have been included in the analysis. In the case of any omission or error the judges will add a penalty proportional to the BOM level of the error.

The following standard points deductions will apply:

- Missing/inaccurate material, process, fastener 1 pt.
- Missing/inaccurate part 3 pt.
- Missing/inaccurate assembly 5 pt.

Note: Each of the penalties listed above supersedes the previous penalty. If a 5-point deduction is given for a missing assembly the missing parts are ignored for Method A. Method B would include the cost of the missing parts in the calculation.

S4.19.2 Differences other than those listed above will be deducted at the discretion of the cost judges. Examples of errors leading to points deductions:

- Five M6 fasteners listed, six used - 1 pt.
- Three kilograms of steel listed, 4.4 used - 1 pt.
- Bearing carrier face machined, mill operation not included - 1 pt.
- Installation labor for steering wheel missing - 1 pt.
- The upright cost as cast but actual part billet machined - 3 pt.
- Pneumatic shifter not included on BOM - 5 pt.

The penalties above will be deducted from the points awarded for Accuracy of the Cost Report.

S4.20 Penalty Method B - Adjusted Cost Deductions

The alternative penalty will be calculated using the following equation:

Penalty = 2 x (Table Cost - Team Reported Cost)

The table cost will be calculated from the standard Cost Tables. The penalty calculation will result in a dollar value equal to twice the difference between the team cost and the correct cost for all items in error.

This penalty, if applied, will be given to the Adjusted Cost of the vehicle.

Note: The table costs of all items in error are included in the calculation. A missing assembly would include the price of all parts, materials, processes and fasteners making up the assembly.

S4.21 Penalty Calculation Example

For example, the pneumatic shifter was inadvertently left off the Cost Report. As this is an assembly the standard error is 5 points. The cost of all air shifter parts and processes from

The Cost Tables is `500. This means the total penalty cost is `1000. To see which is greater, 5 points or `1000, the INR penalty needs to be converted to points by reference to the Cost Points formula:

$$\text{Points} = \frac{40 \times [(P_{max})/(P_{your}) - 1]}{[(P_{max})/(P_{min}) - 1]}$$

Substitute the cost of the vehicle (Pyour) with `15,000 while the minimum vehicle cost (Pmin) was `10,000. The maximum vehicle cost (Pmax) was `50,000. Calculating the points equivalent for this Rupee amount yields 2.5 points. This is less than the standard penalty. In this case the 5 points would be deducted from the Accuracy score.

If the team had made many small errors and had no more accurate points available, then `1000 would be added to the team's adjusted cost.

S4.22 Discussion at the Competition

S4.22.1 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. Assess penalties for missing or incorrect information in the Cost Report compared to the vehicle presented at inspection.

S4.22.2 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 the cost points for that day. The schedule for these appointments will be in the registration packets and/or posted on the website.

S4.23 Cost Report Exempt Items

S4.23.1 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 part for an extended period of time must be costed (labor and material included).

S4.23.2 Fire Extinguisher and Suppression System

Handheld fire extinguishers are not allowed on the vehicle (See Rule T14.14 "Fire Extinguishers"), but if the car has an on-board fire suppression system, it is not required to be costed.

S4.23.3 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 T6.4 "Tires" must be the tires included in th

Cost Report and must be the tires on the car during the Cost Event judging. Other tires that will be potentially used in the competition (i.e. rain tires) do not need to be included in the Cost Report.

S4.23.4 Transponders, Video and Radio Systems

Transponders, video and radio systems need not be included in the Cost Report.

S4.23.5 Data Acquisition Systems

Data acquisition systems must be included in the Cost Report using the published table costs. This includes display screens, control modules and all sensors. The table costs for control modules and screens have been set to match an equivalent product **without** the data acquisition functionality. In essence, "stand-alone" data acquisition systems excluding sensors and wiring will have no influence on vehicle cost. Systems that include driver displays or other vehicle control functionality will have the cost of those features included in the total vehicle cost.

In summary, all data acquisition systems, sensors and wiring must be included in the Cost Report using the Cost Table prices.

S4.24 Exchange Rates & Unit Systems

The currency of the Cost Report will be referred to as INR. Since all items have a cost from the Cost Tables the actual currency unit is irrelevant.

S4.24.1 All Cost Tables are presented using metric units. The tables do not differentiate between parts designed in metric and US systems of measure. For example, "a ¼ bolt" is simply input as a 6.35mm bolt. Tubing with a wall thickness of 0.035 inches is input as 0.889mm tubing. All sizes are assumed to be standard for the part being cost and no surcharge applies for any size, even if the size is non-standard. For example, a team makes a custom 6.112mm bolt which took several hours of student time. However, this bolt was chosen from the Cost Tables and is less than one Rupee. The assumption is in high volume production these bolts would be purchased in bulk.

S4.24.2 The comment section for each material, process or fastener may, at the student's discretion, refer to the specific part by actual local designation. For example, a 6.35mm bolt is cost but the comments would say "¼inch A-arm bolt".

S4.24.3 Because the Cost Report reflects a production cost of 1000 units per year all material and commodity sizes are assumed to be available for the necessary volume without cost penalty.

ARTICLE 5: PRESENTATION EVENT

S5.1 Presentation Event Objective - Business Case

S5.1.1 The objective of the presentation event is to evaluate the team's ability to develop and deliver a comprehensive business case that will convince the executives of a corporation that the team's design best meets the demands of the amateur, weekend competition market, and that it can be profitably manufactured and marketed. (See also A1.2)

S5.1.2 The judges should be treated as if they are investors.

S5.1.3 Teams should assume that the "Judges" represent different areas of a corporate organization, including engineering, production, marketing and finance, and thus may not all be engineers.

S5.1.4 Presentations will be evaluated on the contents, organization and visual aids as well as the presenters' delivery and the team's response to questions.

S5.1.5 The presentation must relate to the car entering into the competition and although the actual quality of the prototype itself will not be considered as part of the presentation judging, the presentation must be consistent with the Business Logic Case that is submitted prior to the competition.

S5.2 Presentation Schedule

S5.2.1 Presentations will be made on the static events day. Presentation times will be scheduled by the organizers and either, or both posted in advance on the competition website or released during on-site registration.

S5.2.2 Teams that fail to make their presentation during their assigned time period will receive zero (0) points for the event.

S5.3 Presentation Format

S5.3.1 Maximum 5 team members will give the presentation to the judges.

S5.3.2 All team members who will give any part of the presentation, or who will respond to the judges' questions, must be in the podium area when the presentation starts and must be introduced to the judges. Team members who are part of this "presentation group" may answer the judge's questions even if they did not speak during the presentation itself.

S5.3.3 Presentations are limited to a maximum of twenty (20) minutes. The judges will stop any presentation exceeding time.

S5.3.4 The presentation itself will not be interrupted by questions. Immediately following the presentation there will be a question-and-answer session of up to five (5) minutes

S5.3.5 Only judges may ask questions. Only team members who are part of the "presentation group" may answer the judges' questions.

S5.4 Data Projection Equipment

S5.4.1 Projection equipment is provided by the organizers.

S5.5 Evaluation Criteria

S5.5.1 Presentations will be evaluated on content, organization, visual aids, delivery and the team's response to the judges' questions. The scoring criteria are detailed in Appendix S-6 "Presentation Judging".

S5.5.2 The criteria are applied only to the team's presentation itself. The team that makes the best presentation, regardless of the quality of their car, will win the event.

S5.6 Scoring Formula

S5.6.1 The Presentation Events score is based on the average of the judges' scores.

S5.6.2 There is a maximum of fifty (50) points from the Presentation Judging Form. PRESENTATION SCORE = 75 x Pyour/Pmax
Where:
"Pmax" is the highest score awarded to any team "Pyour" is the score awarded to your team

S5.6.3 It is intended that the scores will range from near zero (0) to seventy-five (75) to provide good separation.

S5.6.4 The Presentation Event Captain may at his/her discretion normalize the scores of different judging teams.

S5.7 Presentations without a Completed Car

Teams that are unable to bring a vehicle to the competition may participate in the Presentation Event and will receive a score for that event.

Note: Participating in the Presentation event without bringing a vehicle to the competition will not affect the status of the car you have under construction at your school. When you finish it and bring it to a competition it will still be a first-year vehicle under Rules A6.6 and A6.8

ARTICLE 6: DESIGN EVENT

S6.1 Design Event Objective

S6.1.1 The concept of the design event is to evaluate the engineering effort that went into the design of the car and how engineering meets the intent of the market.

S6.1.2 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.
Comment: Teams are reminded that SUPRA SAEINDIA is an engineering design competition and that in the Design Event; teams are evaluated on their design. Components and systems that are incorporated into the design as finished items are not evaluated as a student designed unit but are only assessed on the team's selection and application of that unit. For example, teams that design and fabricate their own shocks are evaluated on the shock design itself as well as the shock's application within the suspension system. Teams using commercially available shocks are evaluated only on selection and application within the suspension system.

S6.1.3 The design judges may also consult the Business Logic Case that is submitted before the event. It is expected that the car that is presented at the design event should reflect the design concept that is developed in the Business Logic Case.

S6.2 Design Report - Required Submission

S6.2.1 Design Report - Judging will start with a Design Review before the event. The principal document submitted for Design Judging is a Design Report.

S6.2.2 The Design Report must not exceed twelve (12) pages, consisting of not more than Eight (8) pages of text, three (3) pages of drawings and one (1) optional page containing content to be defined by the team (photos, graphs, etc..). Final Format will be released afterward.

S6.2.3 The document should contain a brief description of the vehicle with a review of your team's design objectives, and 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.

S6.2.4 These documents will be used by the judges to sort teams into the appropriate design groups based on the quality of their review.
Comment: Consider your Design Report to be the "resume of your car".

S6.3 Design Spec Sheet - Required Submission

S6.3.1 Design Spec Sheet - A completed SUPRA SAEINDIA Design Spec Sheet must be submitted.

S6.3.2 The SUPRA SAEINDIA Design Spec Sheet template will be shared later.
Do not alter or reformat the template prior to submission.

S6.3.3 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.

S6.3.4 The Design Report and the Design Spec Sheet, while related, are independent documents and must be submitted as two (2) separate files,

S6.4 Vehicle Drawings

S6.4.1 The Design Report must include one set of three (3) view drawings showing the vehicle,

from the front, top, and side.

S6.4.2 Each drawing shall appear on a separate page. The drawings can be manual, or computer generated.

S6.4.3 Photos should be placed on the optional page and will not be counted as drawings.

S6.5 Design Report and Design Spec Sheet Formats

S6.5.1 The Design Report must be submitted electronically in Adobe Acrobat® Format (*.pdf file). This document must be a single file (text, drawings, and optional content all inclusive).

S6.6 Excess Size Design Reports

If a team submits a Design Report that exceeds Eight (8) pages of text, three (3) pages of drawing and one (1) optional page, then only the first eight pages of text, three pages of drawings and the first optional page will be read and evaluated by the judges and team can also be penalized for the same.

S6.7 Submission Deadlines

S6.7.1 The Design Report and the Design Spec collectively constitute the "Design Documents". The Design Documents must be submitted in compliance with the specific procedure and by the deadline shown on the website for the competition your team is entering. Submit the documents in accordance with the instructions on the individual competition websites.

S6.7.2 The Design Documents must be submitted as separate files.

S6.7.3 Document submission will be acknowledged either on the competition website or by email. Teams should have a printed copy of this acknowledgement available at the competition as proof of submission in the event of discrepancy.

S6.8 Penalty for Late Submission or Non-submission

The Design Report and Design Spec Sheet collectively constitute the "Design Documents". Late submission or failure to submit all, or anyone, of the Design Documents will be penalized as per rule A 8.2

S6.9 Penalty for Unsatisfactory Submissions

At the discretion of the judges, teams that submit a Design Report or a Design Spec Sheet which, in the opinion of the judges does not represent a serious effort to comply with the requirements of Rules S6.2, S6.3 and S6.4 will also not compete in the design event, but may at the design judges' discretion receive between five (5) and twenty (20) points for their efforts

S6.10 Design Event - Vehicle Condition

S6.10.1 Cars must be presented for design judging in finished condition, i.e. fully assembled, complete and ready-to-run.

S6.10.2 The judges will not evaluate any car that is presented at the design event in what they consider to be an unfinished state.

S6.10.3 Unfinished cars that are refused judging will receive zero (0) points for design.

S6.10.4 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 inspection, and even if final tuning and setup is in progress.

S6.11 Judging Criteria

S6.11.1 The design judges will evaluate the engineering effort based upon the team's Design Report, Design Spec Sheet, responses to questions and an inspection of the car.

S6.11.2 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).

S6.11.3 It is the responsibility of the judges to deduct points if the team cannot adequately explain the engineering and construction of the car.

S6.12 Judging Sequence

S6.12.1 All STUDENT FORMULA organizing bodies reserve the right to organize Design Judging into one, two or three steps at their sole discretion.

S6.13 Scoring

S6.13.1 Scoring may range from 0 to 150 points at the judge's discretion.

S6.13.2 The judges may at their discretion award the highest placing team less than 150 points.

S6.14 Support Material

Teams may bring with them to the Design Event any photographs, drawings, plans, charts, and example components or other materials that they believe are needed to support the presentation of the vehicle and the discussion of their development process.

S6.15 Second year cars

S6.15.4 Second year cars are prohibited at the SUPRASAEINDIA 2025 competitions.

APPENDIX S - 1 COST MODEL AND COST METHODOLOGY

1 Cost Models & Costing Methodology

The cost models are the underlying methodology and equations that relate the final cost of a part to the different operations and goods used in that part. These descriptions are accurate at the time of the rule's publications. The models may be expanded as necessary based on evolving requirements.

2 Raw materials

2.1 Raw materials refer to the material stocks used to produce parts from scratch, such as billet steel for machining or aluminum ingot for casting. Bar, sheet and tube stock are purchased using raw material costs. The raw material purchased must include a machining allowance. Standard allowances are given in 4.1 and must be used

2.2 Gross weight will refer to the weight of the raw material, including all machining stock

2.3 Net weight will refer to the weight of the finished machined part

2.4 Material costs are based on part-gross weight. For example, a steel hub is machined from solid bars. The interior is removed by boring. The cost of the bar must include this interior material. Raw materials are normally cost by volume. The cost by weight is also given using an official density listed in the tables. Any parts that are weighed at competition to confirm cost will use the official density in calculating cost.

3 Assembly Labor

The assembly labor model is based on the following parameters:

3.1 Mass - The mass of the part influences the time it takes the operator to assemble the part to the assembly or vehicle. Light parts can be installed with one hand. Heavier parts require two hands, and the heaviest parts need a lift assist apparatus. These factors are accounted for by selecting the appropriate entry from the process labor tables. The actual part mass must be equal to or less than the value selected. For example, a 300g part would have an assembly labor category of 1 kg.

3.2 Interfaces - The more interfaces a part has with the surrounding parts the longer it takes to assemble. Parts designed for minimal constraint are the easiest and cheapest to assemble.

3.3 Fit type - The ease with which a part can be assembled is described by the fit. There are three categories of fits:

3.3.1 Loose - the part assembles with no force. Examples include a quick release steering wheel onto the steering shaft and a bracket bolted to a monocoque.

3.3.2 Line on line - the part is designed to have a close fit to the surrounding parts and some build up of force is required to get the part started. Examples include a rod end inserted between two tabs in double shear and a splined axle shaft into the differential gear.

3.3.3 3.3.3 Interference - significant force is required to insert the part and mechanical assistance may be necessary. Examples include a rubber hose onto a barbed fitting and a ball bearing into a bore.

4 Machining

Costs for machining operations are based on the volume of material removed. The actual machine used, whether mill, lathe or otherwise, is the same unless a specific line item is included for that machine, such as gear hob.

Note: the machining model has been simplified from previous years. There are no longer rough and finish cuts nor near net shape processes.

4.1 All processes require a minimum of 1mm (0.040 inches) of machining stock to be removed from each surface of the part with machining.

4.7 The process multiplier for the material must also be used to calculate the total process cost of the operation. If a process multiplier is required, it will be listed in the processes table in the column labeled 'Multiplier Type Used'. If the column is blank for a process none is required.

4.8 When costing the raw materials that go into making machined parts the machine stock must be included in the purchased material mass, even though this material is machined away to produce the final part. This represents the cost of the purchased material. For example, an upright bore is machined into a piece of billet aluminum. The interior material that is milled away must be included in the billet mass and hence cost. The same feature machined into a casting need only include 1mm of machine stock of the machined away material

4.9 Machining requires labor operations to account for the time it takes an operator to fix the part onto the machine. Every machined part requires at least a 'Machining Setup, Install and Remove' operation. This is the time it takes to pick up the work piece, fixture on the machine, and remove it when the machining is complete. For a part that requires an intermediate change in position, such as to machine the back of the part which would not be accessible in a single fixture setup, the labor step of 'Machining Setup, Change' is also required. For example, an upright that requires three different orientations on a mill to fully machine would require two of the 'Machining Setup, Change' and the 'Machining Setup, Install and Remove' labor operations.

4.10 In certain cases, it is possible to fix a work piece of raw material and machine more than one part out of it. For example, a self-feeding lathe could machine 10 suspension inserts out of a single piece of bar stock. In this case the quantity of the 'Machining Setup, Install and Remove' may be set to 0.1. This represents the 10 parts that can be machined per setup. This assumption should clearly be noted in the Cost Report along with enough details for the Cost Judges to verify the part geometry is appropriate for the machine being used

5 Tooling & Fixturing

Tooling is necessary when certain processes are used. These can be identified in the tables because the tooling required will be indicated. Sometimes several types of tooling are available for the same process. Each has a description and an associated process with which it can be used. If a process has more than one tooling type associated with it the team must use the tooling that is closest to the actual tooling used in their prototype vehicle construction. Most tooling costs are independent of part shape, the assumption being that tooling for smaller parts will be built with multiple cavities to create optimal cost effectiveness.

5.1 After calculating the total tooling cost for a part, the cost must be divided by the Production Volume Factor (PVF) before being included in the Cost Report. PVF represents the ability of the tooling to produce parts in volume production.

Production Volume Factor (PVF)

All parts not otherwise listed: 3000 Composite
Monocoque (composite tub): 120

The following equation is used to calculate the tooling cost to be included for each part:

$$\text{Part Tooling Cost} = \frac{\text{Table Tooling Cost}}{\text{PVF} * \text{Number of Parts using Exact Tooling}}$$

The tooling cost should be included with the appropriate part on the BOM. Tooling is not a separate section.

5.2 For example, a cast aluminum upright uses a 2-piece sand core package. Total table price is `5000 + `5000 = `10000. The team has designed the casting to be used for both the left- and right-hand rear corners. Calculating the Part Tooling Cost gives:

$$\text{Part Tooling Cost} = \frac{`10000}{\text{upright } 3000 * 2} = `1.67 \text{ per}$$

The `1.67 must be included as a line item on the Costed Bill of Material for each Upright.

5.3 Another example is a team manufacturing a composite monocoque. The tub is constructed by building the top and bottom separately and bonding it together. Both the top and bottom use a two-piece composite tool and the cost of all four tools is `45000. The PVF for tub tooling is only 120 because of the amount of time required to construct each tub so the tub Part Tooling Cost is:

$$\text{Part Tooling Cost} = \frac{`45000}{\text{tub } 120 * 1} = `375 \text{ per}$$

6 Fastener Installation

The cost to tighten or loosen fasteners is based on the tool (or motion) needed to turn it, the diameter, length and whether the fastener requires a secondary tool for reacting to the torque (such as a wrench on a nut).

6.1 Hand - When no tool is necessary for tightening, such as quick release fasteners or hand tightened nuts, the hand should be selected. Loose operations are accomplished by using the fingers of the hand. If the entire hand is moving to rotate the fastener the tight category should be used.

6.2 Screwdriver - A tool that can be held in the hand and turned with the wrist. Any type of bit can be fitted such as straight, Philips, Torx, etc.

6.3 Wrench - An open-ended or box wrench or similar tool requiring motion of the hand. After a turn the wrench may have to be removed and repositioned for the next turn.

6.4 Ratchet - A tool with internal clutch that allows the hand to be moved and returned to the starting position without removal of the tool. Compatible with any bolt head style such as 6-point hex, 12-point hex, Torx or other.

6.5 Power Tool - An electric, pneumatic or other power assisted tool for running down fasteners. To qualify for power tool, using a fastener must meet the following requirements:

6.5.1 A socket of the size needed to drive the fastener must fit in the fully secured position

6.5.2 One power tool with minimum dimensions given in Appendix S-4 must fit onto the socket.

6.5.3 An extension may be used to fit the power tool, but it may not exceed 0.35m in length.

6.6 Reaction Tool - In the case where the fastener is not being attached into the part but requires a nut or other separate threaded piece then a reaction tool will be required. This will appear as a separate line item and should appear whenever a nut is used on a bolt.

7 Composites

Composite manufacture is defined by following steps:

7.1 Laminate - Used to build the laminate one (1) ply at a time. A ply is a single layer of laminate consisting of a single sheet of material, regardless of material or thickness. A ply may consist of woven carbon, unidirectional glass, adhesive film or honeycomb core, for example

7.2 Curing Operations - Used to take a laminate and convert it to a finished composite structure. All curing operations include vacuum bagging, peel ply, breather cloth and other consumable materials and labor. Costs also include part removal from the mold.

7.2.1 Room temperature cure - used for room temperature curing resin systems.

7.2.2 Oven cure - used for higher temperature cure cycles for composites. Limited to one (1) atmosphere of external pressure.

7.2.3 Autoclave cure - used for high temperature and pressure composites curing.

7.3 Curing Operations - Used to take a laminate and convert it to a finished composite structure. All curing operations include vacuum bagging, peel ply, breather cloth and other consumable materials and labor. Costs also include part removal from the mold.

7.3.1 Room temperature cure - used for room temperature curing resin systems.

7.3.2 Oven cure - used for higher temperature cure cycles for composites. Limited to one (1) atmosphere of external pressure.

7.3.3 Autoclave cure - used for high temperature and pressure composites curing.

7.4 Curing operations require tooling. Tooling must reflect the type of tooling actually used (composite, aluminum, steel, etc.).

7.5 If hybrid weaves are used the cost can reflect the ratio of the materials in the ply. For example, a 50% carbon fiber, 50% glass woven ply, may use the average cost of the carbon and glass materials. If the actual fiber ratio is not used, then the cost of the ply must be the cost of the highest cost material present.

7.6 When costing composite materials, the total mass of the part in the Cost Report must match the actual mass of the part as presented on the vehicle for Cost Judging. The composite material, whether carbon fiber or other must be the cost of both the fiber and resin together. This is true for both prepreg and dry fiber systems and is further stated in the Materials Table. The mass of each ply can be adjusted to make the finish part mass match the Cost Report. Parts can be weighed during judging and the Cost Report mass must be equal to or greater than the actual mass of the part, even including clear coat, paint and other finishes. Note: The paint mass is being included to avoid debates in Cost Judging about how much weight the paint (or clear coat) has added. The cost of the paint and paint application need not be included if it is solely for cosmetic purposes (see S4.23.1) but the mass of paint must be included in the composite cost.

8 Electronics and Wiring

The wiring harness is cost as a number of connectors of a certain style, each interconnected by a number of wires of a certain type. The electrical system is composed of three types of wiring.

8.1 Signals - Inputs to the control system such as wheel speed, mass airflow or the position of a driver toggle switch.

8.2 Controls - Control system outputs. These can be digital signals, pulse width modulated or voltage outputs.

8.3 Power - Wires carrying current for vehicle distribution or actuators. These include vehicle power from the battery, engine starter, solenoids, motors etc.

8.4 Additionally, the following terms will be used for the Cost Tables:

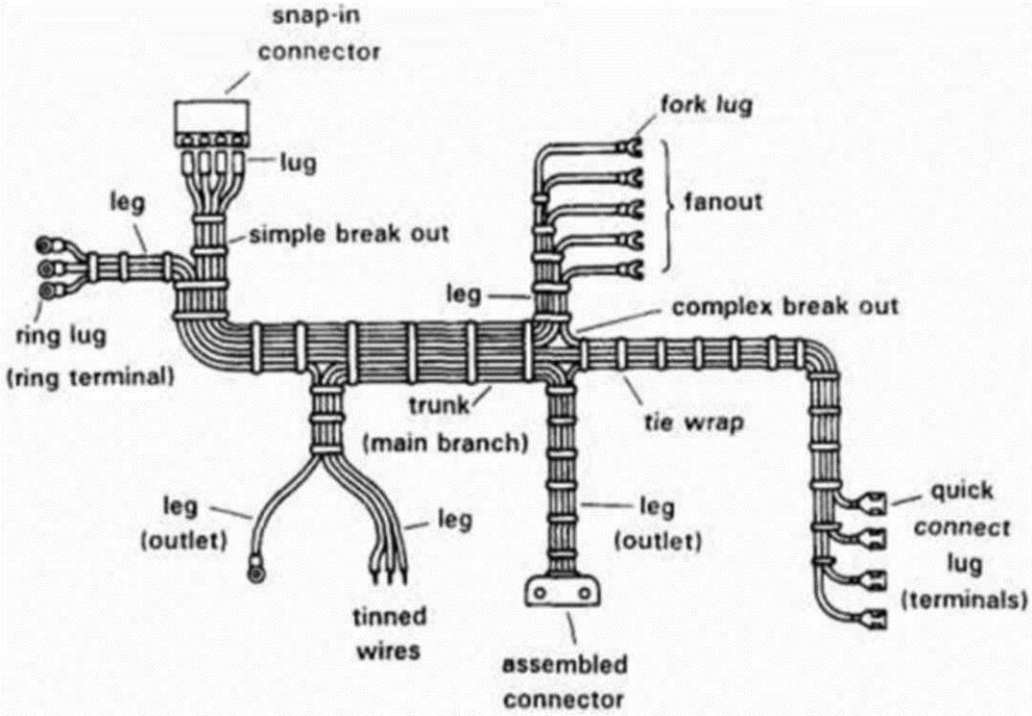


Figure E-1.1

From "Product Design for Manufacture & Assembly" by Geoffrey Boothroyd, 1994.

APPENDIX S – 2 STANDARD PART NUMBERING

1 All assemblies and parts in the BOM must have a part number using the following convention:
Competition Code - Date Code - Car Number - System Designation - Base Number - Suffix

1.1 Competition Code - A code for the competition entered. Refer to A2.6.

1.2 Date Code - Last two digits of the year of the event.

1.3 Car Number - A three (3) digit number assigned to the car for the specific event

1.4 System Designation - A two (2) letter code for the system with which the part is associated. These can be found in Appendix S-3.

1.5 Base Number - Five (5) digit numbers assigned at the student's discretion. For assemblies this becomes a four (4) digit number with preceding character of "A".

1.6 Suffix - Two-character code showing part change history. These are provided for student use only so if desired all can be "AA".

1.6.1 The first character refers to the part design revision level.

1.6.2 The second character refers to the part process revision level.

1.7 For example, a part entered into the chassis section for car number 27 competing at an event with code "SUPRASAEINDIAM" that the students have decided is part one would be:

SUPRASAEINDIAM - 08 - 027 - CH - 00001 - AA

1.8 The same part, after significant design changes would become:

SUPRASAEINDIAM - 08 - 027 - CH - 00001 - BA

The differential assembly that the students have decided is the third assembly for the Engine & Drivetrain group would be:
SUPRASAEINDIAM - 08 - 027 - EN - A0003 - AA

1.9 In the printed version of the Cost Report the competition code, date and car number fields of the part numbers do not need to be printed. They do need to be included in the digital files submitted. The event code and car numbers are for SUPRA SAEINDIA use when the different digital files are combined into the master database.

2 All fasteners in the BOM must have a part number using the same convention as parts. All fasteners use system code "FS" even though they are included in the BOM under the part and assembly where they are used.

APPENDIX S - 3 ORGANIZED LIST OF SYSTEMS & ASSEMBLIES

The Cost Report must follow the organized list of systems and assemblies/parts outlined below. Any questions as to the correct location of the specific items **must be submitted to the rules committee by March 1 of the competition year.**

The two-letter abbreviation after each system name is to be used in the part number.

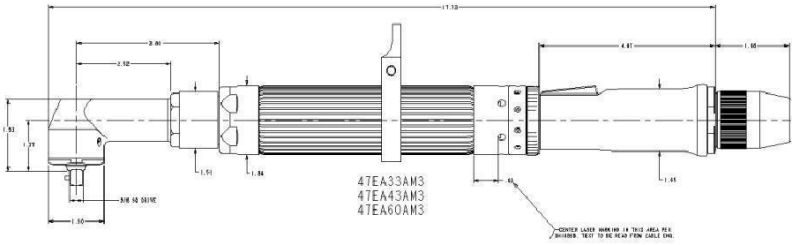
1) Brake System - BR	**2) Engine and Drivetrain – EN**	**3) Frame & Body - FR**
Brake Fluid	Air Filter	
Brake Master Cylinder	Axles	Aerodynamic Wing (if used)
Fasteners	Carburetor	Body Attachments
Brake Lines	Chain / Belt	Body Material
Brake Discs	Coolant	Body Processing
Brake Pads	Coolant Lines	Clutch
Balance Bar	CV Joints/U Joints	Floor Pan
Calipers	Differential	Frame / Frame Tubes
Proportioning Valve	Differential Bearings	Mounts Integral to Frame
	Differential Mounts	Pedals
	Engine	Shifter
	Engine Mounts	Shifter Cable/Linkage
	Engine/Diff Oil	Throttle Controls
	Exhaust Manifold	Tube End Preps
	Fuel Filter	Tubes Cuts/Bends
	Fuel Injectors	
4) Electrical – EL	Fuel Lines/Rails	**5) Miscellaneous, Finish and Assembly – MS**
	Fuel Pressure Reg.	
Battery	Fuel Pump	
Brake Light	Fuel Tank	Driver's Harness
Bulbs	Fuel Vent/Check Valve	Fire Wall
Dash Panel	Hose Clamps	Headrest / Restraints
ECM/Engine Electronics	Intake Manifold	Mirrors
Fuses	Muffler	Paint – Body
Indicator Lights	Oil Cooler	Paint – Frame
Kill Switch	Overflow Bottles	Seats
Oil Pressure Gage/Light	Radiator	Shields
Relays	Radiator Fans	
Solenoids	Restrictor	
Starter Button	Shields	
Tachometer	Sprocket/Pulleys	
Water Temperature Gage	Throttle Body	
Wire Harness/Connectors	Turbo/Super Charger	
6) Steering System – ST	**7) Suspension System – SU**	**8) Wheels, Wheel Bearings and Tires - WT**
Steering Rack	Bell Cranks	
Steering Shaft	Front A/Arms or Equivalent	Front Hubs
Steering Wheel	Front Uprights	Lug Nuts
Steering Wheel Quick Release	Pushrods/Pull rods	Rear Hubs
Tie Rods	Rear A/Arms or Equivalent	Tires
	Rear Uprights	Valve Stems
	Rod Ends	Wheel Bearings
	Shocks Front	Wheel Studs
	Springs	Wheel Weights
	Suspension Mechanism	Wheels

APPENDIX S - 4 POWER TOOL PACKAGE ENVELOPES

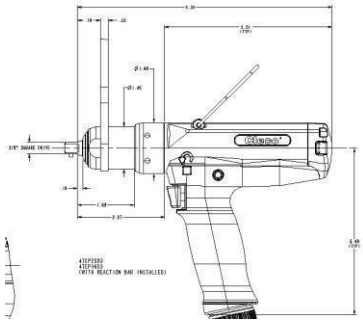
1 Any power tool may be used. There are no restrictions on size or shape. Teams should bring the actual power tool with them to the discussion at the Competition along with sockets and extensions, if applicable, and be prepared to prove to the judges the tool has access to each fastener that used the power tool cost.

2 Future years may use simplified versions of the following power tools shown below. These are included only for reference.

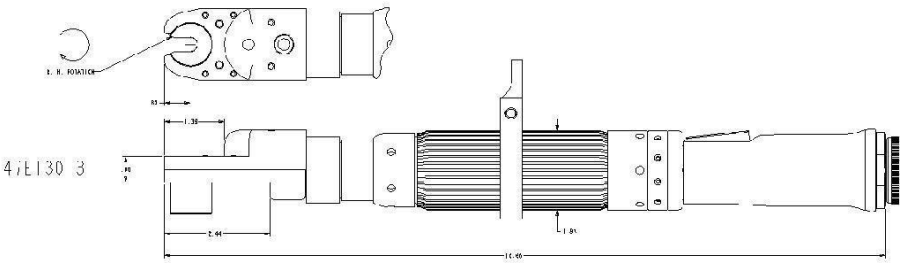
3 Right Angle Electric Power Tool:



4 Pistol Grip Electric Power Tool:



3 Nut Runner Electric Power Tool:



APPENDIX S – 5 SUPRASAEINDIA 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								

Summary of differences listed above. Attach fully detailed Costed Bill of Material for changes.

INR	INR	INR

1												
2												
3												
4												
5												
6												
7												
8												
		Accepted by:_____				Entered by:_____						
		Date: _____				Date/Time: _____						

APPENDIX S – 6 PRESENTATION JUDGING

SCHOOL_____**CAR NUMBER**_____

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).

0.1 = 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 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: _____

STUDENT FORMULA RULES
PART D - DYNAMIC EVENT REGULATIONS

ARTICLE 1: DYNAMIC EVENTS AND MAXIMUM SCORES

The maximum scores in the dynamic events are:

Acceleration	75 points
Skid Pad	50 points
Autocross	150 points
Engineering Excellence	100 points
Endurance	300 points
Total	675 points

DI.I Vehicle Integrity and Disqualification

D1.1.1 During Dynamic Events, the mechanical integrity of the vehicle must be maintained.

D1.1.2 Any vehicle condition that could compromise vehicle integrity or could compromise the track surface or could pose a potential hazard to participants, e.g. damaged suspension, brakes or steering components, fluid leaks, dragging bodywork, or lost or loose body panels, will be a valid reason for exclusion by the official until the problem is rectified.
Note: If this happens during the Endurance Event, it means disqualification from the heat.

ARTICLE 2: WEATHER CONDITIONS

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

ARTICLE 3: RUNNING IN RAIN

D3. I Operating Conditions

The following operating conditions will be recognized at STUDENT FORMULA:

D3.1.1 Dry - Overall the track surface is dry.

D3.1.2 Damp - Significant sections of the track surface are damp.

D3.1.3 Wet - The entire track surface is wet and there may be puddles of water.

D3.1.4 Weather Delay/Cancellation - Any situation in which all, or part, of an event is delayed, rescheduled or canceled in response to weather conditions.

D3.2 Decision on Operating Conditions

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

D3.3 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.

D3.4 Tire Requirements

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

D3.4.1 Dry - Cars must run their Dry Tires, except as covered in Rule D3.8.2.

D3.4.2 Damp - Cars may run either their Dry Tires or Rain Tires, at each team's option.

D3.4.3 Wet - Cars must run their Rain Tires.

D3.5 Event Rules All event rules remain in effect.

D3.6 Penalties

All penalties remain in effect.

D3.7 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.

D3.8 Tire Changing

D3.8.1 During the Acceleration, Skid-Pad or Autocross Events:

Within the provisions of Rule D3.4 above, teams may change from Dry Tires to Rain Tires or vice versa at any time during those events at their own discretion.

D3.8.2 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 have received the "green flag" to start the Endurance Event shall take place in the Driver Change Area.

(a) 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 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".

(b) 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 to re-start without delay subject to the discretion of the Event Captain/Chief Marshall.

- 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/Chief Marshall.

(c) If the track is declared "Dry" after being "Damp" or "Wet":

- The teams will NOT be required to change back to "Dry" tires.

(d) Tire Changes at Team's Option:

- Within the provisions of Rule D3.4 above and Rule D3.8.2 (b) above, a team will be permitted to change tires at their option.
- If a team elects to change from "Dry" to "Rain" tires, the time to make the change will NOT be included in the team's total time.
- If a team elects to change from "Rain" tires back to "Dry" tires, the time taken to make the 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.
- 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/Chief Marshall 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.

e Tire Changes in the Driver Change Area:

- Per Rule D8.12, no more than three people for each team may 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.

ARTICLE 4: DRIVER LIMITATIONS

D4.1 Restriction on Professional Drivers - The Committee has prohibited individuals (Drivers) who have been paid to drive in a race car and or anyone who has finished in the top 5 in any national race, from driving in STUDENT FORMULA dynamic events.

D 4.2 Three Event Limit

D 4.2.1 An individual team member may not drive in more than three events.

D 4.2.3 A minimum of two drivers is required to participate in all of the dynamic events.

Note: Decision regarding the event limit per driver can be changed during the event by the organizer depending upon the actual situation.

ARTICLE 5: ACCELERATION EVENT

D5.1 Acceleration Objective

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

D5.2 Acceleration Procedure

Course Layout - The acceleration course length will be 75 m (82 yards) from starting line to finish line. The course will be at least 4.9 m (16 ft) wide as measured between the inner edges of the bases of the course edge cones. Cones are placed along the course edges at intervals of about 5 paces (roughly 20 feet). Cone locations are not marked on the pavement.

D5.2.1 Staging - The foremost part of the car will be staged at 0.30 m (11.8 inches) behind the starting line. Cars will accelerate from a standing start.

D5.2.2 Starting - A green flag will be used to indicate the approval to begin, however, timing starts only when the vehicle crosses the starting line as measured by the timing system.

D5.2.3 Second Run Option - A driver has the option to make a second run immediately after his/her first run.

D5.3 Acceleration Heats (There will not be Heats in Student Formula Event)

Each team may attempt up to four runs, using two drivers, limited to two runs for each driver However, the limit for the maximum number of attempts can be changed by organizers during the event depending upon the time available.

D5.3.2 Starting order will be based upon time of arrival at the staging area.

D5.4 Tire Traction - Limitations

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

D5.5 Acceleration Scoring

The acceleration score is based upon the corrected elapsed time. The elapsed time will be measured from the time the car crosses the starting line until it crosses the finish line.

D5.6 Acceleration Penalties

D5.6.1 Cones Down or Out (DOO)

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.

D5.6.2 Off Course

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

D5.7 Did Not Attempt

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

D5.8 Acceleration Scoring Formula

D5.8.1 The score for the acceleration event is spread between zero (0) and seventy-five (75) based upon the elapsed time.

D5.8.2 The following equation is used to determine the scores for the event:

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

Where:

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

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

T_{max} *is 150% of* T_{min}

D5.8.3 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

ARTICLE 6: SKID-PAD EVENT

D6.l Skid-Pad Objective

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

D6.2 Skid-Pad Heats (There will not be Heats in Student Formula Event

Each **team may attempt up to four runs, using two drivers, limited to two runs for each driver. However, based on the event conditions the organizing committee reserve the right to change the max number of attempts.**

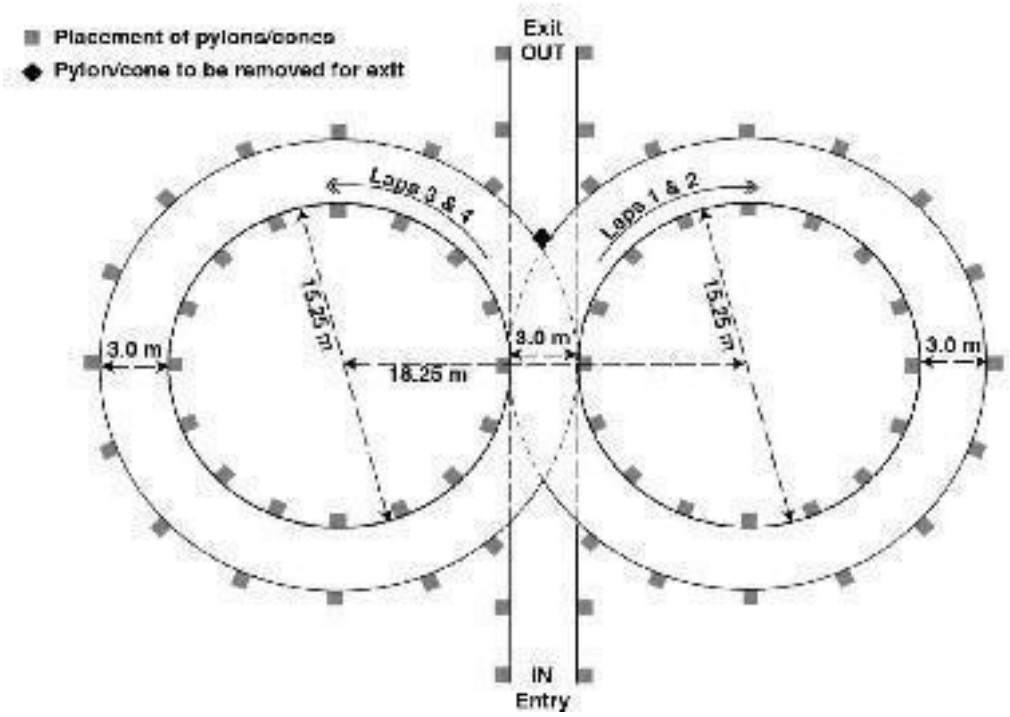
D6.4 Skid-Pad Layout

There will be two (2) pairs of concentric circles in a figure of eight patterns. The centers of these circles will be 18.25 m (59.88 feet) apart. The inner circles will be 15.25 m (50.03 feet) in diameter, and the outer circles will be 21.25 m (69.72 feet) in diameter. The driving path will be the 3.0 m (9.84 feet) path between the inner and outer circles. The cars will

enter and exit through gates on a 3.0 m wide path that is tangential to the circles where they meet.

The line between the centers of the circles defines the start/stop line. A lap is defined as traveling around one (1) of the circles from the start/stop line and returning to the start/stop line.

FSAE SKIDPAD LAYOUT



D6.5 Skid-Pad Layout - Marking

D6.5.1 Sixteen (16) pylons will be placed around the inside of each inner circle thirteen (13) pylons positioned around the outside of each outer circle in the pattern shown in the SUPRASAEINDIA skid pad layout diagram.

D6.5.2 Each circle will be marked with a chalk line, inside the inner circle and outside the outer circle, i.e. not on the driving path.

D6.5.3 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 unintended exits until the finish lap.
Note: The diagram in section D6.4 shows the circles for cone placement, not for course marking. Chalk lines are marked on the opposite side of the cones, i.e. not in the driving path.

D6.6 Skid-Pad Procedure

The cars will enter perpendicular to 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.

D6.7 Skid-Pad Penalties

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

D6.7 Skid-Pad Penalties

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

D6.7.1 Cones Down or Out (DOO)

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.

D6.7.2 Off Course

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

D6.7.3 Incorrect Laps

Cars that do not follow D6.6 above, i.e. run an incorrect number of laps or run the laps in the wrong sequence will be classified as DNF.

D6.8 Skid-Pad Scoring

D6.8.1 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 diameter/t^2. A diameter of 17.10 m will be assumed in computing lateral G's.

D6.8.2 If there are two separate skid-pad locations, then the score will be based on the best run from either skid-pad.

D6.8.3 The following equation is used to determine the scores for the skid-pad event: SKID

PAD SCORE = (47.5 x (Tmax/Tyour) ^2 -1) / (Tmax/Tmin) ^2 -1) + 2.5

Where:

Tyour is the average of the left and the right timed laps on your best run including penalties.

$\mathbf{T_{min}}$ is the elapsed time of the fastest car $\mathbf{T_{max}}$ is 125% of Tmin

D6.8.4 The first term on the right-hand side of the equation represents "performance points," while the second term represents "completion points," or the minimum score for having successfully completed the event.

D6.8.5 Negative "performance" points will not be given. However, 2.5 points will be given for a car that completes a run, even if Tyour exceeds 125% of the fastest time (Tmin).

ARTICLE 7: AUTOCROSS EVENT

D7.1 Autocross Objective

The objective 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.

D7.2 Autocross Course Specifications & Speeds

D7.2.1 The following standard 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).

Note: the actual average speed for any track will depend on the prevailing conditions and the area available to the organizers at which the track is setup, therefore the quoted speeds are intended as a rough guide only.

Straights: No longer than 60 m (200 feet) with hairpins at both ends (or) no longer than45 m (150 feet) with wide turns at 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 trackwidth will be 3.5 m (11.5 feet).

D7.2.2 The length of each run will be approximately 0.805 km (1/2 mile), and the driver will complete a specified number of runs.

D7.2.3 The organizers reserve the right to run the Autocross Event on courses of different lengths.

D7.2.4 The organizers reserve the right to deviate from the parameters specified in this rule, D7.2, when they determine it is appropriate given the characteristics of a particular competition site.

D7.3 Autocross Procedure (There will not be Heats in Student Formula Event)

D7.3.2 Starting order will be based upon time of arrival in the staging area.

D7.3.4 The car will be staged such that the front wheels are 6 m (19.7 feet) behind the starting line. The timer starts only after the car crosses the start line.

D7.4 Autocross Penalties

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

D7.4.1 Cone Down or Out (DOO)

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

D7.4.2 Off Course (OC)

a. An "off course" occurs when the vehicle has all four (4) wheels outside the course boundary as indicated by (a) cones, (b) edge marking or (c) the edge of the paved surface. Where more than one boundary indicator is used on the same course, at any given point the narrowest track will be used when determining off course penalties.
b. When an OC occurs, the driver must reenter the track at or prior to the point of exit or a twenty (20) second penalty will be assessed

c. An "off course" occurs when the vehicle has all four (4) wheels outside the course boundary as indicated by (a) cones, (b) edge marking or (c) the edge of the paved surface. Where more than one boundary indicator is used on the same course, at any given point the narrowest track will be used when determining off course penalties.
d. When an OC occurs, the driver must reenter the track at or prior to the point of exit or a twenty (20) second penalty will be assessed.
e. Two (2) wheels off will not incur an immediate penalty. However, repeated driving of this type is the cause for a black flag..
f. Penalties will not be assessed for accident avoidance or other reasons deemed sufficient by the track officials.

D7.4.3 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.

D7.5 Stalled & Disabled Vehicles

D7.5.1 If a car stalls and cannot restart without external assistance, the car will be deemed disabled.

D7.5.2 Disabled cars are scored DNF for that attempt.

D7.5.3 Disabled cars will be cleared from the track by the track workers. At the direction of the track officials team members may be instructed to retrieve the vehicle. Vehicle recovery may only be done under the control of the track officials.

D7.6 Corrected Elapsed Time

D7.6.1 The elapsed time plus any penalties from that specific run will be used as the corrected elapsed time.

D7.6.2 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.

D7.7 Best Run Scored

The time required to complete each run will be recorded and the team's best corrected elapsed time will be used to determine the score.

D7.8 Autocross Scoring Formula

D7.8.1 The following equation is used to determine the autocross score:

AUTOCROSS SCORE = (142.5 x (Tmax/Tyour) -1) /((Tmax/Tmin) -1) + 7.5

Where:

If **Tyour**>Tmax: Autocross score = 0 (ZERO) will only get 7.5 for completion

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

T_{your} will be your team's best time.

T_{max} will be 1.45 times Tmin

D7.8.2 In the equation above, 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.

D7.8.3 Negative "performance" points will not be given. However, 7.5 points will be given for a car that completes a run, even if Tyour exceeds 145% of the fastest time (Tmin)

ARTICLE 8: ENDURANCE

D8.1 At STUDENT FORMULA competitions the Endurance will consist of a single heat. For competitions outside INDIA please check the event website.

D8.2 Engineering Excellence

Fuel efficiency changed to an engineering excellence score.

D8.3 Right to Change Procedure

This Article, D8, contains the general guidelines for conducting the Endurance event, however, the organizers reserve the right to establish procedures specific to the conduct of the event at each competition site. All such procedures will be made known to the teams through email or the specific STUDENT FORMULA competition news page website.

D8.4 Endurance Objective—300 points

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

D8.5 Engineering Excellence—100 points

Engineering excellence scores will be based on the combined performance of teams in static (Design Evaluation) and dynamic events (Acceleration, Autocross) along with some good engineering practices like lesser weight of the vehicle and performance during the main event (Lesser time to clear TI and lesser usage of hot pits) will be considered.

D8.6 Endurance Course Specifications & Speeds

D8.6.1 Course speeds can be estimated by the following standard 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).

Note: the actual average speed for any track will depend on the prevailing conditions and the area available to the organizers at which the track is set up, therefore the quoted speeds are intended as a rough guide only

D8.6.2 The standard specifications for the SUPRASAEINDIA Endurance Course are:

Straights: No longer than 77.0 m (252.6 feet) with hairpins at both ends (or) no longer than61.0 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 standard minimum track width is 4.5 m (14.76 feet).

D8.6.3 The organizers reserve the right to deviate from the parameters specified in this rule, D8.6, when they determine it is appropriate given the characteristics of the particular competition site.

D8.7 Endurance General Procedure

D8.7.1 The event will be run as a single heat approximately 22 km long. It may vary to a few extents based on actual track condition and availability. D8.7.2 Teams are not allowed to work on their vehicles during the heat.

D8.7.3 A driver change must be made during a three (3) minute period at the midpoint of the heat.

D8.7.4 Wheel-to-wheel racing is prohibited.

D8.7.5 Vehicles must not be driven in reverse

D8.7.6 Passing another vehicle may only be done in an established passing zone or under control of a course marshal.

D8.7.7 Elapsed time will begin when Driver A enters the course and crosses the timing line.

D8.8 Endurance Run Order

D8.8.2 The run order for endurance will typically be derived from the finish order for the acceleration event.

The organizer has the option to order the cars from fastest to slowest or from slowest to fastest and to designate groups, e.g. design finalists, ordered for other purposes.

Teams without an acceleration score, the finish order for the autocross event may be substituted. For teams without a score in either autocross or acceleration, the finish order for skid pad may be substituted. Teams without a score in the event used to determine the run order may run at the end of the heat.

D8.8.3 Based on the results of all dynamic events, and considering the operating conditions under which they were run, the endurance event captain may, at his sole discretion, move teams to different positions within the starting order.

D8.8.4 Teams are required to keep track of the running order and have their cars fueled, in line and prepared to start when their turn-to-run arrives.

D8.8.5 Teams that are not ready-to-run when their turn arrives will be penalized two (2) minutes and permitted to run at the end of the heat (time permitting) or at the discretion of the event captain.

D8.9 Endurance Fuel Fill - IC cars

Before entering the event, each vehicle's fuel tank must be filled to the fuel level line (see Rule IC2.6.6, "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.

D8.11 Endurance Vehicle Starting/ Restarting

D8.11.1 The vehicle must be capable of starting / restarting without external assistance at all times once the vehicle has begun the heat.

D8.11.2 If a vehicle stalls out on the track, one (1) lap by the car that is following it (approximately one (1) minute) will be allowed to restart.

D8.11.3 If a vehicle has a restart problem at the end of Driver Change, it will be allowed to restart a further two (2) minutes to restart the engine.

D8.11.4 If restarts are not accomplished within the above times, the car will be deemed disabled and scored DNF for the heat.

D8.12 Endurance Driver Change Procedure

D8.12.1 Three (3) minutes are allowed for the team to change drivers.

D8.12.2 Only three (3) team members, including the driver or drivers, will be allowed in the driver change area, and only the tools necessary adjust the car to accommodate the second driver and/or change tires will be carried into this area (no tool chests etc.). Extra people entering the driver change area will result in a twenty-point (20 pt) penalty for the final endurance score for each extra person entering the area.

D8.12.4 Other than changes to accommodate the second driver or covered by D3.8.2 *"Tire Changing"* and turning on and off the car with the master switch(es), the team is not permitted to perform any work on the car during Driver Change.

D8.12.5 Driver A will drive for 11 km (6.83 miles), and then be signaled into the driver change area.

D8.12.6 Driver A will exit the vehicle, and any necessary adjustments will be made to the vehicle to fit Driver B (seat cushions, head restraint, pedal position, etc.). Driver B will then be secured in the vehicle.

D8.12.7 Driver B will drive for 20 km and elapsed time will stop when the car completes the total 40 km distance.

D8.12.8 Driver B will proceed directly to the fuel station. The tank will be filled to refill mark, and the amount will be recorded

D8.12.10 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 (3) 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.

D8.13 Entering the Track

D8.13.1 Cars will be allowed to enter the track based upon the level of traffic on the course.

D8.13.2 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 per kilometer of track. This includes cars in the driver change area.

D8.13.3 Because repairs are not allowed during the heat, and there will be no refueling during the heat, there will not be a restart queue of any kind.

D8.14 Breakdowns & Stalls

D8.14.1 If a vehicle breaks down it will be removed from the course and will not be allowed to re-enter the course.

D8.14.2 If a vehicle stalls, or ingests a cone, etc., it will be allowed to restart (See D8.10 "Endurance Vehicle Starting/Restarting") and re-enter the course where it went off, but no work may be performed on the vehicle.

D8.14.3 If a car stalls and cannot be restarted without external assistance, the track workers will push the car clear of the track. At the discretion of event officials, two (2) team members may retrieve the car under the direction of the track workers.

Comment - Teams are reminded that although course crews exercise due care, the organizers are not responsible for any damage that may occur when moving a disabled vehicle. Please consider the comment to Rule T6.6 "Jacking Point".

D8.15 Endurance Minimum Speed Requirement

D8.15.1 If a car is unable to maintain lap times within one hundred forty five percent (145%) of the fastest lap time for the course, then it must exit immediately.

D8.15.2 Disqualification for failure to maintain the minimum speed will be made at the discretion of the Chief Marshall/Director of Operations.

D8.16 Post Event Refueling

Vehicles must power down after leaving the course and be pushed to the fueling area for IC cars

FOR IC cars, Fuel pumps will be turned on and fuel valves will be opened to ensure complete refueling.

D8.17 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, and the time taken for any stop under a mechanical black flag, from the total time and adding any penalty points.

D8.18 Endurance Penalties

D8.18.1 Penalties will not be assessed for accident avoidance or other reasons deemed sufficient by the track official.

D8.18.2 The penalties in effect during the Endurance Event are listed below.

D8.18.3 Cones

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

D8.18.4 Off Course (OC)

a. An "off course" occurs when the vehicle has all four (4) wheels outside the course boundary as indicated by (a) cones, (b) edge marking or (c) the edge of the paved

surface. Where more than one boundary indicator is used on the same course, at any given point the narrowest track will be used when determining off course penalties.

b. When an OC occurs, the driver must reenter the track at or prior to the point of exit or a twenty (20) second penalty will be assessed.
c. Two (2) wheels off will not incur an immediate penalty. However, repeated driving of this type is the cause for a black flag. .

D8.18.5 Missed Slalom

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

D8.18.6 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: 2 Minutes up to disqualification depending on the nature of the incident.

D8.18.7 Out of Order

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

D8.18.8 Mechanical Problem

No time penalty. The time taken for mechanical inspection under a "mechanical black flag" is considered officials' time and is not included in the teams' total time. However, if the inspection reveals a mechanical integrity problem the vehicle may be disqualified under Rule D 1.1 "Vehicle Integrity and Disqualification".

D8.18.9 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 one (1) to four (4) minutes depending upon the severity of the offense.

If it is impossible to impose a penalty by stopping 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.

D8.18.10 Vehicle Control Issues

The Chief Marshall/Director of Operations may disqualify a vehicle if, for any reason including driver inexperience and mechanical problems, it is too slow or driven in a manner that, in the sole opinion of the event, officials demonstrate an inability to properly control the car. Disqualification for a vehicle control issue is scored as DNF.

D8.19 Endurance Scoring

D8.19.1 The score for the Endurance Event is the sum of the Endurance Time Score and the Endurance Finish Score.

D8.19.2 The Endurance Time Score is based on the team's time for the event, including penalties, compared to the fastest team.

D8.19.3 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.

D8.19.4 Endurance time will only be calculated if team complete the full endurance race

D8.20 Endurance Scoring Formula

D8.20.1 The times for the endurance event will be based upon the sum of the times of each driver in the heat plus penalties.

D8.20.2 The following equation is used to determine the time scores for the event:

Endurance Score=

$$(250 \times (T_{max}/T_{your}) -1) / (T_{max}/T_{min}) -1) + 50$$

If $\mathbf{T_{your}} > T_{max}$: ENDURANCE SCORE = 0 (ZERO) will only get 50 for completion

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

$\mathbf{T_{your}}$ will be the combined corrected times of both of your team's drivers in the heat.

$\mathbf{T_{max}}$ will be 1.45 times T_{min}.

D8.20.3 If, in the opinion of the officials, course conditions change significantly during the running of the event then they may, at their sole discretion, set Tmax to a higher value.

Note: Organizer reserves the right to make any changes in the above dynamic event rules except scoring considering the actual condition during the event

Engineering Excellence

It is to judge the overall engineering skills of the teams to design, fabricate and validate the vehicle along with performance during the main event.

Engineering Excellence Scoring

Engineering excellence score will be based on the combined performance of teams in technical inspection, static and dynamic performance along with some good engineering practices.

Engineering Excellence Score = Average of (TI Score + Noise score+ Safety Scrutiny Attempt Score + Light Weight score+ Hot Pit Access Score + Brake Attempt score + Design Score + Acceleration Score)

TI Score = 100 (Directly not in overall score, Only to calculate Engineering Excellence Score)

Teams cleared the TI first will get maximum score and other teams will get relative scoring

Noise Score = 100 (Directly not in overall score, only to calculate Engineering Excellence Score)

Team with least noise dB measurement will get maximum score and other teams will get relative scoring

Safety Scrutiny Attempt Score = 100 (Directly not in overall score, only to calculate Engineering Excellence Score) Team clearing Safety Scrutiny is less attempt will get maximum score and other teams will get relative scoring

Light Weight Score = 100 (Directly not in overall score, only to calculate Engineering Excellence Score) Team will least weight will get maximum score, and other teams will get relative scores.

Hot Pit Access Score = 100 (Directly not in overall score, only to calculate Engineering Excellence Score) Teams using the hot pit for least number of times during the entire main event will get maximum marks and other teams will get relative scores. Teams not using hot pit even once to clear TI will get maximum marks.

Brake Attempt Score = 100 (Directly not in overall score, only to calculate Engineering Excellence Score) Team clearing brake test is less attempt will get maximum score and other teams will get relative scoring.

Design and Acceleration scores directly from event.

Teams not able to complete any of the above events used for engineering excellence will get zero score for engineering excellence irrespective of performance in other events.

D8.25 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.
POST ENDURANCE
Technical Inspection Required
After Endurance and refueling are completed, all vehicles must report to Technical Inspection.
Vehicles may then be subject to Reinspection
Post Endurance Penalty Guidelines
Penalties may be applied to the Endurance and/or Efficiency events based on Post Endurance Technical Inspection.
Any imposed penalty will be at the discretion of the officials.
One or more minor violations (rules compliance, but no advantage to team): 15-30 sec
Violation which is a potential or actual performance advantage to team: 120-360 sec
Violation with potential to affect safety or environment: 240 sec up to DNF or DQ Team may be DNF or DQ for:
a. Multiple violations involving safety, environment, or performance advantage
b. A single substantial violation

D8.26 Endurance Event - Driving

D8.26.1 During Endurance when multiple cars are running on the course it is paramount that the drivers strictly follow all of the rules and driving requirements.

D8.26.2 Aggressive driving, failing to obey signals, not yielding for passing, etc. will result in a black flag and a discussion in the penalty box with course officials. The amount of time spent in the penalty box is at the discretion of the officials and is included in the running time. Penalty box time serves as a reprimand as well as informing the driver of what he/she did wrong. Drivers should be aware that contact between open wheel vehicles is especially dangerous because tires touching can throw one car into the air.
Endurance is a timed event in which drivers compete only against the clock not against

other cars. Aggressive driving is unnecessary.

D8.27 Endurance Event - Passing

D8.27.1 Passing during Endurance may only be done in the designated passing zones and under the control of the track officials.

D8.27.2 Passing zones have two parallel lanes - a slow lane for the cars that are being passed and a fast lane for the cars that are making a pass. On approaching a passing zone, a slower leading car will be blue flagged and must shift into the slow lane and decelerate. The following faster car will continue in the fast lane and make the pass. The car that had been passed may reenter traffic only under the control of the passing zone exit flagman.

D8.27.3 Passing, i.e. slow, lanes may be either to the left or right of the fast lane depending on the design of the specific course.

D8.27.4 These passing rules do not apply to cars that are passing disabled cars on the course or cars that have spun out and are not moving. When passing a disabled or off-track car it is critical to slow down, drive cautiously and be aware of all the vehicles and track workers in the area.

D8.27.5 Under normal driving conditions when not being passed all cars use the fast lane.

D8.28 Endurance Event - Driver's Course Walk

The endurance course will be available for walk by drivers prior to the event. All endurance drivers are required to walk the course before the event starts.

ARTICLE 9: FLAGS

D9.1 Flag Effect

Flag signals are commands that must be obeyed immediately and without question.

D9.2 Flag Types

There are two kinds of flags for the competition: Command flags and Informational flags.

D9.2.1 Command flags are just flags that send a message to the competitor that the competitor must obey without question.

D9.2.2 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.

D9.3 Command Flags

The following is a brief description of the flags used at the competitions in North America and what each flag means.

Note: Not all of these flags are used at all competitions and some alternate designs are occasionally displayed. Any variations from this list will be explained at the drivers' meetings.

D9.3.1 BLACK FLAG-Pull into the penalty box for discussion with the Chief Marshall/Director of Operations or other official concerning an incident. A time penalty may be assessed for such an incident.

D9.3.2 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.

D9.3.3 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 merge into competition.

D9.3.4 CHECKER FLAG - Your session has been completed. Exit the course at the first opportunity.

D9.3.5 GREEN FLAG - Your session has started, enter the course under direction of the starter. (NOTE: If you stall the vehicle, please restart and wait for another green flag as the opening in traffic may have closed.)

D9.3.6 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 workers' directions.

D9.3.7 YELLOW FLAG (Stationary) - Danger, SLOW DOWN, be prepared to take evasive action, something has happened beyond the flag station. NO PASSING unless directed by the corner workers.

D9.3.8 YELLOW FLAG (Waved) - 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.

D9.4 Informational Flags

D9.4.1 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.)

D9.4.2 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.

ARTICLE 10: RULES OF CONDUCT

D10.1 Competition Objective - A Reminder

The STUDENT FORMULA 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 STUDENT FORMULA. 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.

D10.2 Unsportsmanlike Conduct

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

D10.3 Official Instructions

Failure of a team member to follow an instruction or command directed specifically to that team or team member will result in a twenty-five (25) point penalty.
Note: This penalty can be individually applied to all members of a team.

D10.4 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.

D10.5 Alcohol and Illegal Material

D10.5.1 Alcohol, illegal drugs, weapons or other illegal material are prohibited on the event site during the competition. This rule will be in effect during the entire competition

D10.5.2 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.

D10.5.3 Any use of drugs, or the use of alcohol by an underage individual, will be reported to the local authorities.

D10.6 Parties

In the interest of responsible citizenship, it is expected that any disruptive parties, either on or off-site, will be prevented by the Faculty Advisor.

D10.7 Trash Clean-up

D10.7.1 Cleanup of trash and debris is the responsibility of the teams. The team's work area should be kept uncluttered. At the end of the day, each team must clean all debris from their area and help with maintaining a clean paddock.

D10.7.2 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.

ARTICLE 11: GENERAL RULES

D11.1 Dynamometer Usage

If a dynamometer is available, it may be used by any competing team. Vehicles to be dynamometer tested must have passed all parts of technical inspection.
Fuel, ignition and drivetrain tuning will be permitted while testing on the dynamometer.

D11.2 Problem Resolution

Any problems that arise during the competition will be resolved through the operations center and the decision will be final.

D11.3 Forfeit for Non-Appearance

D11.3.1 It is the responsibility of each team to be in the right place at the right time.

D11.3.2 If a team is not present and ready to compete at the scheduled time they forfeit their attempt at that event.

D11.3.3 There is no make-ups for missed appearances.

D11.4 Drivers Meetings - Attendance Required

All drivers for an event are required to attend the pre-event drivers meeting(s). The driver for an event will be disqualified if he/she does not attend the driver's meeting or course walk for the event.

D11.5 Personal Vehicles

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

D11.6 Motorcycles, Bicycles, Rollerblades, etc. Prohibited

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

D11.7 Self-propelled Pit Carts, Toolboxes, etc. - Prohibited

The use of self-propelled pit carts, toolboxes, tire carriers or similar motorized devices in any part of the competition site, including paddocks, is prohibited.

D11.8 Work safety

All teams are advised to follow common practices and common sense when working on the vehicle and when operating the vehicle, before, during and after a competition.
Appropriate personal protective equipment must always be used while working on the vehicle.
Any operation producing litter or debris, e.g., cutting carbon fiber, shall not be performed in the pits.

The vehicles must not participate in events not suitable for this type of vehicle like hill climbs, drag races or similar.
Teams must never use their vehicles for wheel-to-wheel races.

The following requirements are minimum for a testing/operating environment to qualify as safe. These guidelines do not guarantee safety under all circumstances:

- Driver wearing full protection gear according to TR13.3
- Working TSAL, IMD, AMS, RES, EBS, APPS/brake pedal plausibility check, APPS, and ETC plausibility check if applicable **(applicable only for EV)**
- No other passenger cars, trucks etc. being parked or driven on the same premises at the same time, unless the areas are clearly separated.

No running in areas where crashing into obstacles at the height of the driver's head is possible, e.g. parts of the vehicle may pass below an obstacle, but the driver's head can be trapped between the obstacle and the main hoop.

D11.9 Working on Tractive systems

Activities on the TS, except for the accumulator (see AR6.9) must take place in the pit.
All activities require the attendance of the ESO.

For activities on the inactive TS, the following procedure must be conducted:

- The vehicle must be barred from anyone, not involved in the work, by using barrier tape.
- TSMS must be switched off.
- It must be assured that the TS cannot be activated by, at a minimum, using the lockout/tag out of the TSMS.
- A check for zero potential must be done.
- A sign that declares the vehicle is electrically safe must be installed. The name of the ESO who is supervising the activities must be noted on the sign.
- ESO is the only person allowed to remove the sign and the barrier.

In the case of measurements on the active TS or an activation of the TS in the pit for testing purposes, the following steps must be followed:

- The vehicle must be barred from anyone not involved in the work, by using barrier tape.
- The vehicle must be jacked up and the driven wheels removed. – only rear wheels removal would be okay
- One team member must be prepared to push a shutdown button at any time.
- The TS must only be activated for as long as necessary.
- Appropriate insulated tools and equipment must be used.
- Safety glasses with side shields and compliant safety gloves must be worn by all participating team members when parts of the TS are exposed.
- No other work on the vehicle is permitted when the TS is active.

If the TSAL is flashing red or malfunctioning, the TS shall be considered as active.
There must be at least one team member present, who is not directly involved in the work, but who could assist in case of an incident.
Turning on the TS inside pit is restricted. Working on the vehicle with TS ON is only allowed in the designated areas specified by the officials.

D11.10 Working on TS Accumulators

- Opening or working on TSACs is only allowed in the provided workplaces in the charging area, see AR6.10.
- All activities require the presence of an ESO.
- Whenever the TSAC is opened, the cell segments must be separated with the maintenance plugs, see EV5.4.4.
- Appropriate insulated tools and equipment must be used.
- Safety glasses with side shields and compliant safety gloves must be worn by all participating team members.
- There must be at least one team member present, who is not directly involved in the work conducted on the accumulator, but who could assist in case of an incident.
- Moving accumulator cells and/or accumulator segment(s) around at the competition site is only permitted if they are inside a completely closed TSAC.

- All parts and modules of the TSAC that are not currently being worked on must be covered at least according to IPxxB while working on the accumulator container.
- Additional safety measures may be included in the respective competition handbook.
- The TSAC and any spare cells must be stored in a designated area specified by competition officials.
- The TSAC must be stored in designated areas specified by competition officials after the competition's daily operational hours, even after a vehicle passes technical inspections. The TSAC shall not be stored in the team's pit.

D11.8 Starting

D11.8.1 Push starts are prohibited.

D11.8.2 The use of auxiliary batteries is prohibited once a car has moved to the starting line of any event.

D11.9 Footwear

Everyone in a "dynamic" area (an area where cars can be moved under their own power) must wear closed-toed shoes.

ARTICLE 12: PIT RULES

D12.1 Vehicle Movement

D12.1.1 Vehicles may not move under their own power anywhere but on the practice or competition tracks, or as otherwise directed by the organizers.

D12.1.3 Off track vehicles must be pushed at a normal walking pace by means of a "Push Bar", (See D12.2) and with a driver in the cockpit and with another team member walking beside the car.

The team has the option to move the car either with (a) all four (4) wheels on the ground or with (b) the rear wheels supported on dollies, by push bar mounted wheels, or other means as long as the person in the cockpit has full control of vehicle movement and can steer and brake normally. The external wheels supporting the rear of the car must be non-pivoting, so the vehicle travels only where the front wheels are steered. The driver must always be able to steer and brake the car normally.

When the push bar is attached to the car the engine must remain off.

D12.1.4 Cars with wings are required to have two team members walking on either side of the vehicle whenever the vehicle is being pushed.

D12.1.5 The detachable handle or key of the TSMS must be completely removed and kept by an ESO. The lockout/tagout function of the TSMS, see EV6.2.2, must be used.

If the vehicle has not passed the electrical inspection, the HVD, see EV4.8, must be disconnected, while the vehicle is moved around on the competition site. This also includes taking part in static events.

D12.1.5 During performance events when the excitement is high, it is particularly important that the car be moved at a slow pace in the pits.

D12.1.6 The walking rule will be enforced and a point penalty of twenty-five (25) points will be assessed for each violation.

D12.2 Push Bar

D12.2.1 Each car must have a removable device that attaches to the rear of the car that allows two

(2) people, standing erect behind the vehicle, to push the car around the event site.

D12.2.2 This device must also be capable of decelerating, i.e. slowing and stopping the forward motion of the vehicle and pulling it rearwards. It must be presented with the car at Technical Inspection.

D12.2.3 A fire extinguisher has to be mounted to the push bar in a way that it is quickly accessible.

D12.3 Smoking - Prohibited

Smoking is prohibited in all competition areas.

D12.4 Fueling and Refueling

Officials must conduct all fueling and refueling.

D12.5 Engine and Vehicle Running Requirements

Engines may be run in the paddock provided the car has passed Parts 1 and 2 of Technical Inspection (S2.7) and the following conditions are satisfied:

a. The car is on sturdy and adequate stand, and
b. The drive wheels are at least 10.2 cm (4 in) off the ground, or the drive wheels have been removed.

ARTICLE 13: DRIVING RULES

D13.1 Driving Under Power

D13.1.1 Cars may only be driven under power (a) when running in an event, (b) on the practice track and (c) during brake test or (d) during any powered vehicle movement specified and authorized by the organizers.

D13.1.2 For all other movements cars must be pushed at a normal walking pace using a push bar (D12.2).

D13.1.3 Driving a vehicle outside of scheduled events or scheduled practice will result in a two hundred (200) point penalty for the first violation and disqualification for a second violation.

D13.1.4 Organizers reserve the right to disqualify a team registered for their competition in case of unsafe driving behavior, especially if the reputation of the competition, sponsors and other teams is compromised.

This includes any questionable material posted on social media by registered participating team under the competition.

Vehicles shall not be driven under low visibility conditions at any time.

D13.2 Driving Off-site - Prohibited

Driving off-site is absolutely prohibited. Teams found to have driven their vehicle at an off-site location during the period of the competition will be excluded from the competition.

D13.3 Practice Track

D13.3.1 A practice track for testing and tuning cars may be available at the discretion of the organizers. The practice area will be controlled and may only be used during the scheduled practice times.

D13.3.2 Practice or testing at any location other than the practice track is absolutely forbidden.

D13.3.3 Cars using the practice track must have all parts of the technical inspection sticker.

D13.4 Situational Awareness

Drivers must maintain a high state of situational awareness at all times and be ready to respond to the track conditions and incidents. Flag signals and hand signals from course marshals and officials must be immediately obeyed.

ARTICLE 14: DEFINITIONS

D14.1 DOO - A cone is "Down or Out" - If the cone has been knocked over or the entire base of the cone lies outside the box marked around the cone in its undisturbed position.

D14.2 DNF - Did Not Finish

D14.3 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.

D14.3.1 Entry Gate -The path marked by cones which establishes the required path the vehicle must take to enter the course.

D14.3.2 Exit Gate - The path marked by cones which establish the required path the vehicle must take to exit the course.

D14.4 Staging Area - An area prior to the entry to an event for the purpose of gathering those cars that are about to start.

D14.5 OC - A car is "Off Course" if it does not pass through a gate in the required direction. Please refer to the sections on Autocross and Endurance for further definitions of OC as applied to those events.

RELATED PICTURES FOR STUDENT FORMULA

TILT TEST TABLE

QUICK REALESE COUPLING

SEAT BELT MOUNTING

SCATTER SHIELD

ROLL BAR PADING

PUSH BAR

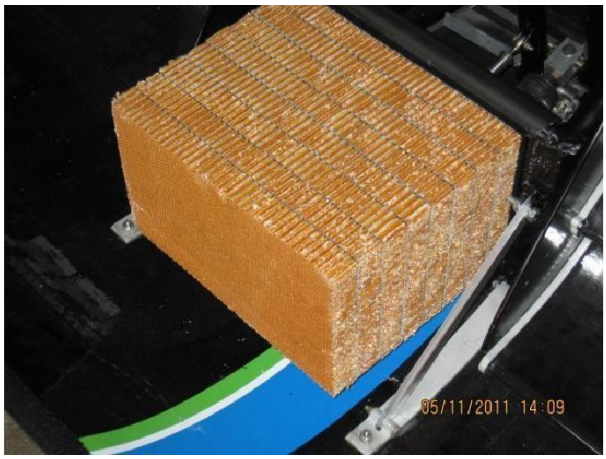
NOISE TEST LOCATION

HELMET CLEARANCE

HEAD RESTRAINT

HEAD RESTRAIN

GAS CANNISTER



FRONTAL IMPACT ACTUNUATOR

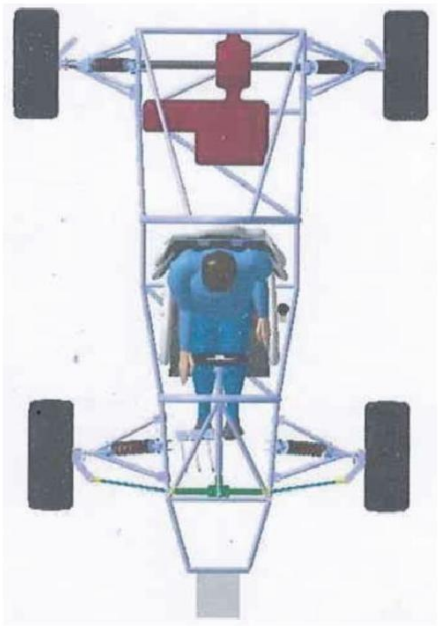
COCKPIT OPENING CHECKING TEMPLATE

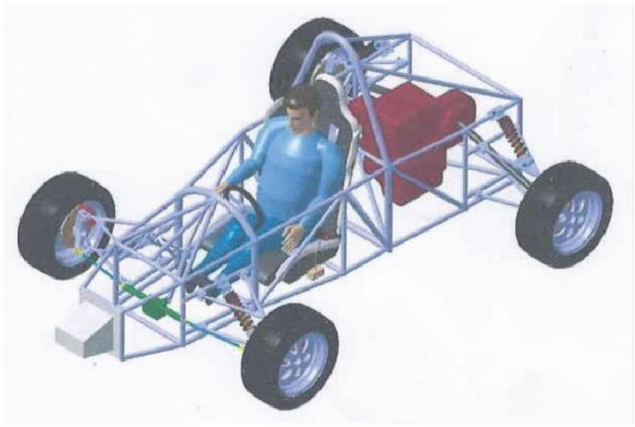
COCKPIT INTERNAL CROSS SECTION CHECKING TEMPLATE

OCKPIT INTERNAL CROSS SECTION CHECKING

95th PERCENTIL MALE TEMPLATE

3D VIEWS OF THE VEHICLE





Quick jack 1

Quick jack 2

Quick jack 3

Quick jack 4

For Further Details Related to event Please contact: suprasaeindia@saeinida.org
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