5th FORMULA IMPERIAL-HVC TECHNICAL RULEBOOK 2019

RECOMMENDED BY

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Ministry of New and Renewable Energy
Government of India

VENUE

ACCREDITED BY

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Advice from Our Tech Inspectors

Formula Imperial technical inspection team welcomes you to the most challenging ISIEINDIA Design Series competitions. Many of us are former competitors of various motorsports, working to promote E-mobility and Skill development who are now professionals in the automotive industry.

We have two goals: to have a safe competition and see every team on the track.

Top Tips for Building a Formula Hybrid or Electric Race vehicle and Passing Tech Inspection

- Start work early. Everything takes longer than you expect
- Read all rules vehicleefully. If you don't understand something, ask for clarification.
- Start Testing your vehicle early.
- Make brake Testing an early priority.

PART A

A1 FORMULA IMPERIAL OVERVIEW AND COMPETITION

A1.1 Formula Imperial Objective

A1.1.1 The Formula Imperial competition challenges teams of university undergraduate and graduate students to conceive, design, fabricate, develop and compete with small, formula-style, hybrid-powered and electric vehicles.

A1.1.2 The Formula Imperial competition is intended as an educational program requiring students to work across disciplinary boundaries, such as those of electrical and mechanical engineering.

A1.1.3 To give teams the maximum design flexibility and the freedom to express their creativity and imagination there are very few restrictions on the overall vehicle design apart from the requirement for a mechanical/electrical hybrid or electric-only drivetrain.

A1.1.4 Teams typically spend six to eight months designing, building, testing and preparing their vehicles before a competition. 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 Energy Limits

A1.2.1 Competitiveness and high efficiency designs are encouraged through limits on accumulator capacities and the amount of energy that a team has available to complete the endurance event.

A1.2.2 The accumulator capacities and endurance energy allocation will be reviewed by the Formula Hybrid rules committee each year, and posted as early in the season as possible.

Hybrid	
Endurance Energy Allocation	35.5 MJ
Maximum Accumulator Capacity	4,449 Wh
Electric	
Maximum Accumulator Capacity	5,400 Wh

Table 1 – 2019 Energy and Accumulator Limits

A1.3 Good Engineering Practices

A1.3.1 Vehicles entered into Formula Hybrid competitions are expected to be designed and fabricated in accordance with good engineering practices.

Note: *in particular, that the high-voltage electrical systems in a Formula Imperial vehicle present health and safety risks unique to a hybrid/electric vehicle, and that poor engineering can result in serious injury or death.*

A1.4 Judging Categories

A1.4.1 The vehicles are judged in a series of static and dynamic events including: technical inspections, project management skills, engineering design, solo performance trials, and high performance track endurance. These events are scored to determine how well the vehicle performs.

Dynamic Events	
Acceleration	100
Cross Pad	300
Endurance	450
Efficiency Test	100
Semi-Autonomous Event	100
Static Events	
Engineering Design Event	150
Business Plan Presentation	100
Cost And Manufacturing Event	100
Innovation Event	100

Table 2 - Event Points

A1.4.2 A team's final score will equal the sum of their event scores plus or minus penalty and/or bonus points.

Note: *If a team's penalty points exceed the sum of their event scores, their final score will be Zero (0). I.e. negative final scores will not be given*.

A2 FORMULA IMPERIAL-HVC VEHICLE CATEGORIES

A2.1 Hybrid

A2.1.1 A Hybrid vehicle is defined as a vehicle using a propulsion system which comprises both a Internal Combustion Engine (ICE) and electrical storage (accumulator) with electric motor drive.

A2.1.2 A hybrid drive system may deploy the ICE and electric motor in any configuration, including series and/or parallel. Coupling through the road surface is permitted.

A2.2 Electric

A2.2.1 An Electric vehicle is defined as a vehicle wherein the accumulator is charged from an external electrical source (and/or through regenerative braking) and propelled by electric drive only.

A2.2.2 There is no minimum power requirement for electric-only drive motor.

A2.3 Electric vs. Hybrid Vehicles

A2.3.1 The Electric and Hybrid categories are separate. Although they compete in the same events, and may be on the endurance course at the same time, they are scored separately and receive separate awards for scoring round. However, The overall Champion and Runner Up will be chosen two highest scorer from all Electric and Hybrid Vehicle Team

A2.3.2 The event scoring formulas will maintain separate baselines (T_{max}, T_{min}) for Hybrid and Electric categories.

Note*: Electric vehicles, because they are not vehiclerying the extra weight of engine and generating systems, may demonstrate higher performances in some of the dynamic events. Design scores should not be compared, as the engineering challenge between the two classes is different and scored accordingly.*

A3 THE FORMULA IMPERIAL – HVC19 COMPETITION

A3.1 Open Registration

The Formula Imperial Competition has an open registration policy and will accept registrations by student teams representing universities in any country.

A3.2 Official Announcements and Competition Information

A3.2.1 All the official announcements and the information regarding the competition will be displayed on the official website. Our official sites are http://www.formulaimperial.

A3.2.2 Team can also join us through Facebook for quick updates: Official Facebook page: https://www.facebook.com/studentformulahybrid/

A3.2.3 After completion of registration, important information will be sent through the emails to the respective team captains/Faculty Advisor. The rules will be same throughout the event and any amendments done will immediately be informed the entire participating team through mail/facebook page/website.

A3.3 Official Language

The official language is English.

A4 FORMULA IMPERIAL – HVC RULES AND JURISDICTION

A4.1 Rules authority

A4.1.1 All the authority of rules is under ISIEINDIA organizing Committee. Official announcements from ISIE Organizing Committee shall be considered part of and have the same validity as these rules.

A4.1.2 Query regarding event questions concerning the meaning or intent of these rules will be resolved by the Technical committee of ISIEINDIA

A4.2 Rules authenticity

The rules and other information related to events is valid to till completion of the event schedule as per decided by ISIEINDIA. Rule of other may be different.

A4.3 Rules compliance

A4.3.1 By entering through registration in an ISIEINDIA competition, the team members, team advisors and other personnel of the entering university agree to comply with, and be bound by, the rules and all rules interpretations or procedure issued or announced by ISIEINDIA Organizing Committee.

A4.3.2 All team members, team advisors and other university/college/industry representatives are required to cooperate with, and follow all instructions from competition organizers, officials and judges.

A4.4 Understanding the rules

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

A4.5 Participation in the competition

Teams, team members as individuals, faculty advisors and other representatives of a registered university/industry who are present on-site at a competition are considered to be "participating in the

competition" from the time they arrive at the site until they depart the site at the conclusion of the competition or earlier by withdrawing.

A4.6 Right to Impound

During the event any registered team can be called for technical inspection and examination at any point of time and stage and can be questioned for any technical element related to the Vehicle during the event to any team member.

A4.7 Restriction of vehicle use

Teams are cautioned that the vehicles designed by the team are restricted to operate at the event place. It is operated at the time of dynamic competition only on permission of technical inspector.

A4.8 Behavior

All the members of each and every team must follow the rules laid by ISIEINDIA, during or before the competition. Any member's failure to follow the rules will result in 20 % point reduction or elimination from the event. Arguments with officials may also result in the team being eliminated from event.

- **Smoking and Illegal Material**: Alcohol, illegal drugs, weapons or other illegal material are strictly not allowed on the event site during the competition. This rule will be in effect during the entire competition.
- **Unsportsmanlike Conduct**: In the event of unsportsmanlike conduct, the team will receive a warning from an official. A second violation will result in expulsion of the team from the competition.
- **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. There should not be directly involvement of faculties of Industrial in Designing and manufacturing of the Vehicle.
- **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.
- **Parties:** Disruptive parties either on or off-site should be prevented by the Team Advisor.
- **Safety of tools:** Teams will be responsible for all their tools, equipments and components. ISIEINDIA will not be responsible for any kind of losses or damage.
- **Trash Clean-up**: 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.

A4.9 Violation Intent

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

A4.10 Competition Objective – A Reminder

A4.10.1 The FORMULA IMPERIAL-HVC event being organized by ISIEINDIA is a design engineering and manufacturing competition that requires performance demonstration of Hybrid and Electric Vehicles and is NOT a race. Engineering ethics will apply.

A4.10.2 It is recognized that lots of hard work has been put in by the teams for an entry into FORMULA IMPERIAL –HVC Event.

A4.10.3 It is also recognized that this event is an "innovation enhancement experience" but that it often times becomes confused with a high stakes race. In the heat of competition, emotions peak and disputes arise.

A4.10.4 The officials of ISIEINDIA are trained volunteers and maximum effort will be put in to settle the disputes an equitable, professional manner.

A4.11 General Authority

ISIEINDIA and the competition organizing bodies reserves 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 FORMULA IMPERIAL-HVC series as a whole.

PART T GENERAL TECHNICAL REQUIREMENTS

T1: GENERAL DESIGN REQUIREMENTS

T1.1 Vehicle Configuration

T1.1.1 The vehicle must be open-wheeled, single seat and open cockpit (a formula style body) with four wheels that are not in a straight line.

T1.1.2 Definition of "Open Wheel" – Open wheel vehicles must satisfy all of the following criteria:

a. The top 180 degrees of the wheels/tires must be unobstructed when viewed from vertically above the wheel.
b. The wheels/tires must be unobstructed when viewed from the side.
c. No part of the vehicle may enter a keep-out-zone defined by two lines extending vertically from positions 75 mm in front of and 75 mm behind the outer diameter of the front and rear tires in the side view of the vehicle, with tires steered straight ahead. This keep-out zone extends laterally from the outside plane of the wheel/tire to the inboard plane of the wheel/tire. See Figure 1(below).

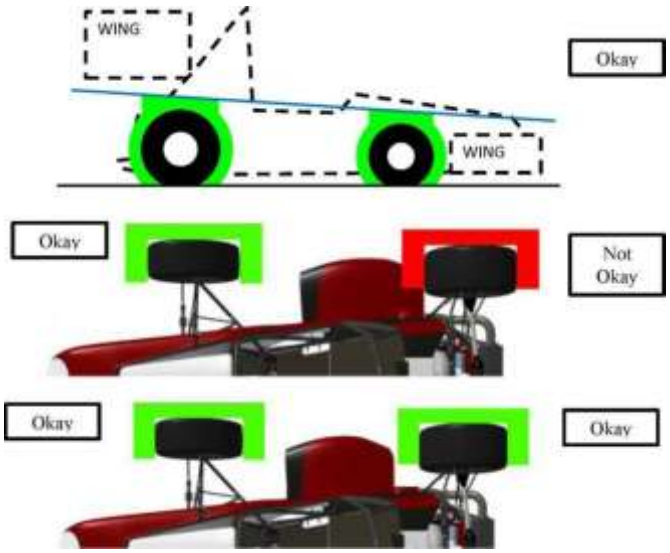

Figure 1 Open wheeled vehicle definition

T1.2 Bodywork

T1.2.1 There must be no openings through the bodywork into the driver compartment from the front of the vehicle 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.

T1.2.2 All edges of the bodywork that could come into contact with a pedestrian must have a minimum radius of 1 mm. The bodywork in front of the front wheels must have a radius of at least 38 mm extending at least 45° relative to the forward direction, along the top, sides and bottom of all affected edges.

T1.2.3 Sharp edges on the forward facing bodywork or other protruding components are prohibited.

Figure 2 Bodyworks

T1.2.4 Enclosed chassis structures and structures between the chassis and the ground must have two venting holes of at least 25 mm diameter in the lowest part of the structure to prevent accumulation of flammable liquids. Additional holes are required when multiple local lowest parts exist in the structure.

T1.3 Wheelbase

The vehicle 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.

T1.4 Track width

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

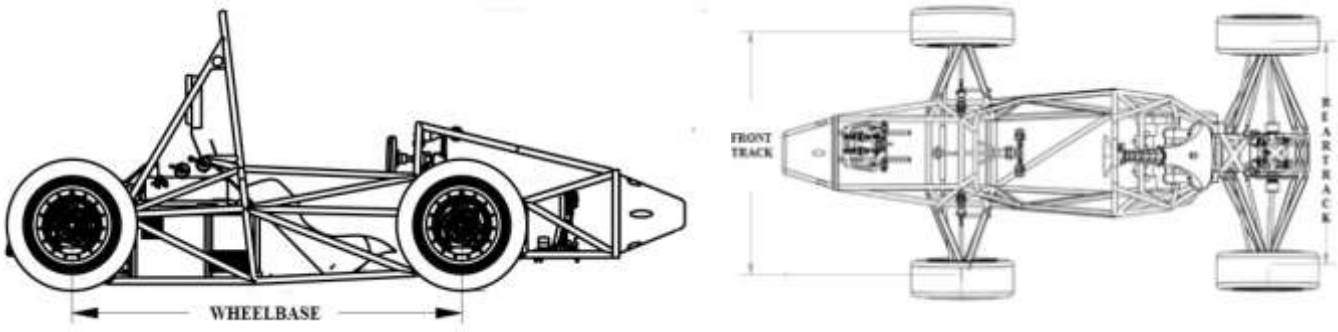

Figure 3 Wheelbase & Track width

T1.5 Ground clearance

The minimum static ground clearance of any portion of the vehicle, other than the tires, including a driver, must be a minimum of 30 mm.

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.*

T1.6 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.

T1.7 Weight of the vehicle

The weight of the vehicle should not be exceeding more than 250 kg (Excluding the weight of the driver).

T2 GENERAL CHASSIS DESIGN

T2.1 Definitions

T2.1.1 The following definitions apply throughout the Rules document:

Chassis/Frame - The "Chassis" 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.

Chassis/Frame member - A minimum representative single piece of uncut, continuous tubing or equivalent structure.

Tube frame - A chassis made of metal tubes.

Monocoque - A chassis made of composite material.

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 Hoop - 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).

Primary Structure - The Primary Structure is comprised of the following Frame components:

- Main Hoop
- Front Hoop
- Roll Hoop Braces and Supports,
- Side Impact Structure,
- Front Bulkhead,
- Front Bulkhead Support System
- All Chassis Members, guides and supports that transfer load from the Driver's Restraint System into the above mentioned components of the primary structure.

Major Structure of the Frame – This is 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 provides protection for the driver's feet.

Impact Attenuator - A deformable, energy absorbing device located forward of the Front Bulkhead.

Side Impact Zone – This is the area of the side of the vehicle 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.

Rollover protection envelope - Envelope of the primary structure and any additional structures fixed to the primary structure which meet the minimum specification defined in Table 1 or equivalent.

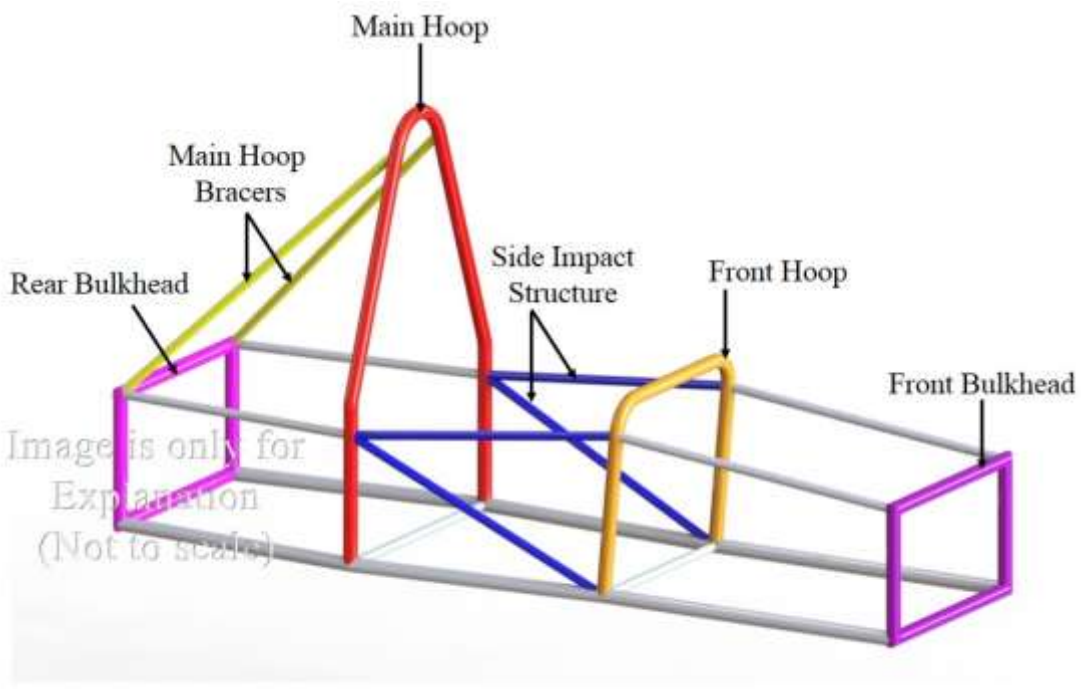

Figure 4 Formula chassis description

Node-to-node triangulation - An arrangement of chassis 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 chassis members as shown in Figure 5.

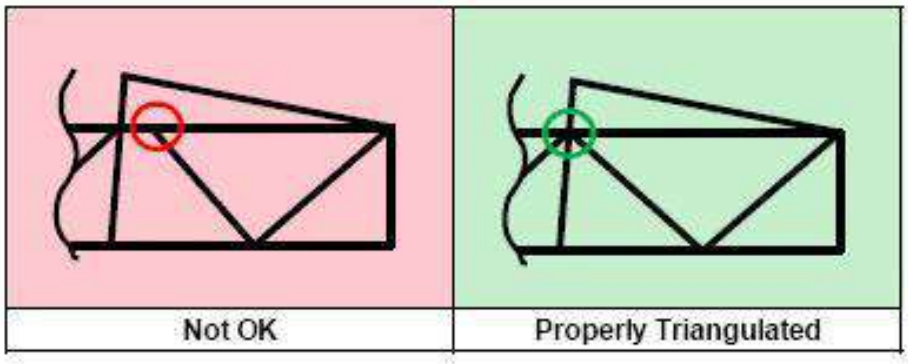

Figure 5 Node to node triangulation of chassis members

T2.2 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.

T2.3 Minimum Material Requirements

T2.3.1 Teams are allowed to use Seamless pipe, it should be a circular cross section of outer diameter in the range of 0.8 to 2 inches.

T2.3.2 The Primary Structure of the vehicle must be constructed of either round, mild or alloy, steel tubing (minimum 0.1% vehiclebon).

T2.3.3 Table 3 shows the minimum requirements for the members of the primary structure if made from steel tubing.

Item or Application	Minimum wall thickness
Front and Main Roll Hoops, Shoulder Harness Mounting Bar	2.0 mm
Roll Hoop Bracing, Roll Hoop Bracing Supports, Side Impact Structure, Front Bulkhead, Front Bulkhead, Support Driver's Harness Attachment (Except for Shoulder Harness Mounting Bar - above) Protection of accumulators Protection of TSV components	1.2 mm

Table 3 - Steel Tubing Minimum wall thickness

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.*

T2.3.4 If a bent tube 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. The support tube must terminate at a node of the chassis. It should not be angled no more than 30° from the plane of the supported tube(s).

T2.4 Aluminum Tubing Requirements

T2.4.1 Minimum Wall Thickness of Aluminium Tubing is 3.0 mm.

T2.4.2 The equivalent yield strength must be considered in the "as-welded" condition, (Reference: *WELDING ALUMINUM* (latest Edition) by the Aluminium 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.

T2.4.3 Aluminium tubing should be solution heat-treated and age hardened to increase its strength after welding; the team must supply sufficient documentation as to how the process was performed. This includes, but is not limited to, the heat-treating facility used, the process applied, and the fixturing used.

T2.5 Alternative Tubing and Material – General

T2.5.1 Alternative materials may be used for all parts of the primary structure and the tractive system accumulator container with the following exceptions:

- The main hoop and the main hoop bracing must be steel
- The front hoop must be metal
- Any welded structures of the primary structure must be steel
- However, the front hoop may be an aluminum welded structure

T2.5.2 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.

T2.5.3 If any other materials than steel tubing are used in the primary structure or the tractive system accumulator container, physical testing is required to show equivalency to the minimum material properties for steel in T2.3.3.

T2.5.4 To be considered as a structural tube in the MFSES Submission (**T2.7**) tubing cannot have an outside dimension less than 25 mm or a wall thickness less than that listed in **Table 3**

T2.6 Composite Materials

T2.6.1 Composite materials are not allowed for the Main Hoop or the Front Hoop.

T2.6.2 If composite structures are used in the primary structure or the tractive system accumulator container, the Flexural Rigidity (EI) of that structure must be calculated as the EI of a flat panel about its neutral axis. This panel must have the same composition as the structure used in the chassis. The curvature of the panel and geometric cross section of the monocoque must be ignored for these calculations.

T2.6.3 If composite materials are used in the primary structure or the tractive system accumulator container the SES must include:

a. Material type(s)
b. Cloth weights
c. Resin type
d. Fiber orientation
e. Number of layers
f. Core material
g. Lay-up technique
h. 3-point-bend test and shear test data

T2.6.4 The team must submit calculations demonstrating equivalence of their composite structure to one of similar geometry made to the minimum requirements found in Section **T2.3.3**. 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 **T2.7**

***Note**: Some composite materials present unique electrical shock hazards, and may require additional engineering and fabrication effort to minimize those hazards.*

T2.7 Structural Documentation – MFSES Submission

T2.7.1 All teams must submit a Main Frame Structural Equivalency Spreadsheet (MFSES) before starting the fabrication in which teams have to present their CAD design of the frame for approval.

T2.7.2 The CAD design of the frame must show the steel tubing that matches the minimum tubing requirement as per the **Table T3**

T2.7.3 The tubing used in the CAD design must be color coded showing the different tubing used for different structural parts (Roll hoops, Side Impact Structures, Roll Hoop Harness, Front Bulkhead and all the Supporting tubing with proper triangulation)

T2.7.4 The Main Frame Structural Equivalency Sheet form can be downloaded from the formula Imperial website (www.formulaimperial.com). (Teams can take the reference from the example of MFSES provided on the FORMULA IMPERIAL website).

T2.7.5 The submission of the MFSES will be done through the mail before the provided dead line.

T2.7.6 Vehicles completed under an approved MFSES must be fabricated in accordance with the materials and processes described in the MFSES.

T2.7.7 Teams must bring a copy of the approved MFSES with them to Technical Inspection.

Do not resubmit MFSES's unless instructed to do so.

T2.8 Main and Front Roll Hoops – General Requirements

T2.8.1 The driver's head and hands must not contact the ground in any rollover attitude.

T2.8.2 The Frame must include both a Main Hoop and a Front Hoop.

T2.8.3 When seated normally and restrained by the Driver's Restraint System, the helmet of a 95th percentile male (anthropometrical data; See **Table 4** and **Figure 6**) 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 6a**).

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 6b**).

c. Be no further rearwards than the rear surface of the main hoop if the main hoop bracing extends forwards. (**Figure 6c**).

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

- A circle of diameter 200 mm will represent the hips and buttocks.
- A circle of diameter 200 mm will represent the shoulder/cervical region.
- A circle of diameter 300 mm will represent the head (with helmet).
- A straight line measuring 490 mm will connect the centers of the two 200 mm circles.
- A straight line measuring 280 mm will connect the centers of the upper 200 mm circle and the 300 mm head circle.
- The upper 300 mm circle will be positioned no more than 25.4 mm away from the head restraint (i.e. where the driver's helmet would normally be located while driving).

Table 4: 95th Percentile Male Template Dimensions

Figure: 6(a)

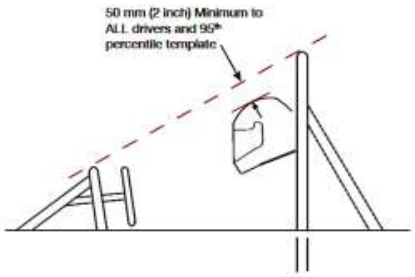

Figure: 6(b)

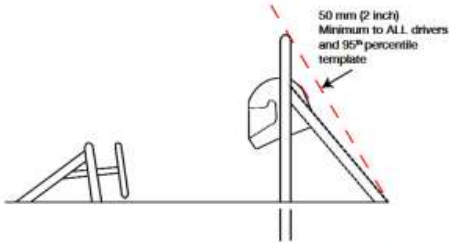

Figure: 6(c)

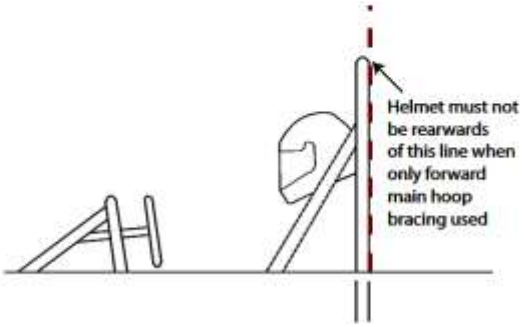

Figure 6 Roll Hoops and Helmet Clearance

T2.8.4 The 95th percentile male template will be positioned as follows: (See Figure 7.)

- 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).

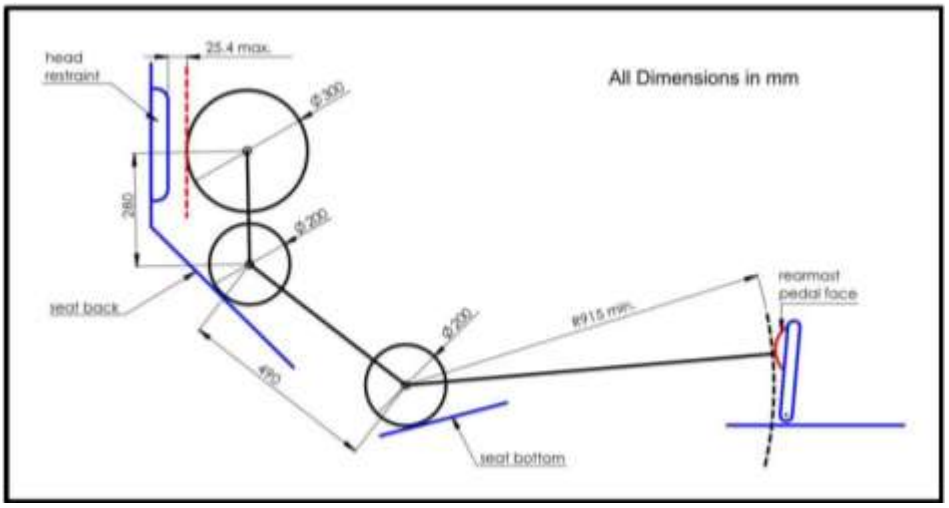

Figure 7(a)

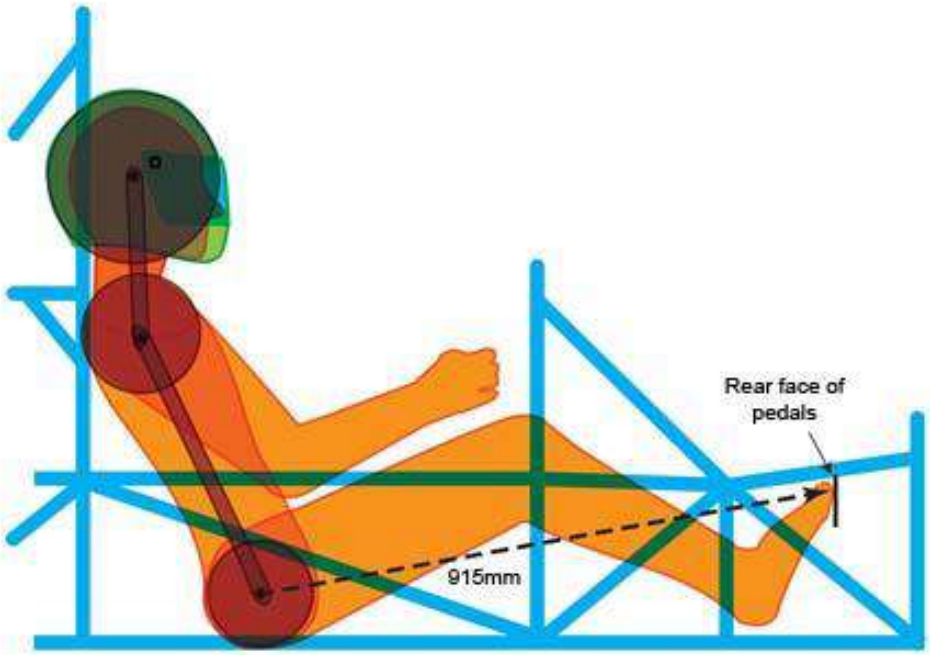

Figure 7(b)

Figure 7 Percy -- 95th Percentile Male with Helmet

T2.8.5 If the requirements of T2.8.4 are not met with the 95th percentile male template, the vehicle will not receive a Technical Inspection Sticker and will not be allowed to compete in the dynamic events.

T2.8.6 Drivers who do not meet the helmet clearance requirements of T2.8.3 will not be allowed to drive in the competition.

T2.8.7 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.

T2.8.8 The Main Hoop and Front Hoop must be securely integrated into the Primary Structure using gussets and/or tube triangulation.

T2.9 Main Hoop

T.2.9.1 The Main Hoop must be constructed of a single piece of uncut, continuous, closed section steel tubing as per rule T2.3.3.

T2.9.2 The use of aluminum alloys, titanium alloys or composite materials for the Main Hoop is prohibited.

T2.9.3 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.

T2.9.4 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.

T2.9.5 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.

T2.9.6 In the side view any portion lower than the upper attachment point to the side impact structure must be inclined either forward or not more than 10° rearward.

T2.9.7 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.

T2.10 Front Hoop

T2.10.1 The Front Hoop must be constructed of closed section metal tubing as per the rule T2.3.3

T2.10.2 The Front 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.

T2.10.3 With proper gusseting and/or triangulation, it is permissible to fabricate the Front Hoop from more than one piece of tubing.

T2.10.4 The top-most surface of the Front Hoop must be no lower than the top of the steering wheel in any angular position.

T2.10.5 The Front Hoop must not be 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.

T2.10.6 Inside view, no part of the Front Hoop can be inclined at more than twenty degrees (20°) from the vertical.

T2.11 Main Hoop Bracing

T2.11.1 Main Hoop braces must be constructed of closed section steel tubing as per the rule T2.3.3

T2.11.2 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.

T2.11.3 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.

T2.11.4 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 inches) 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 8.

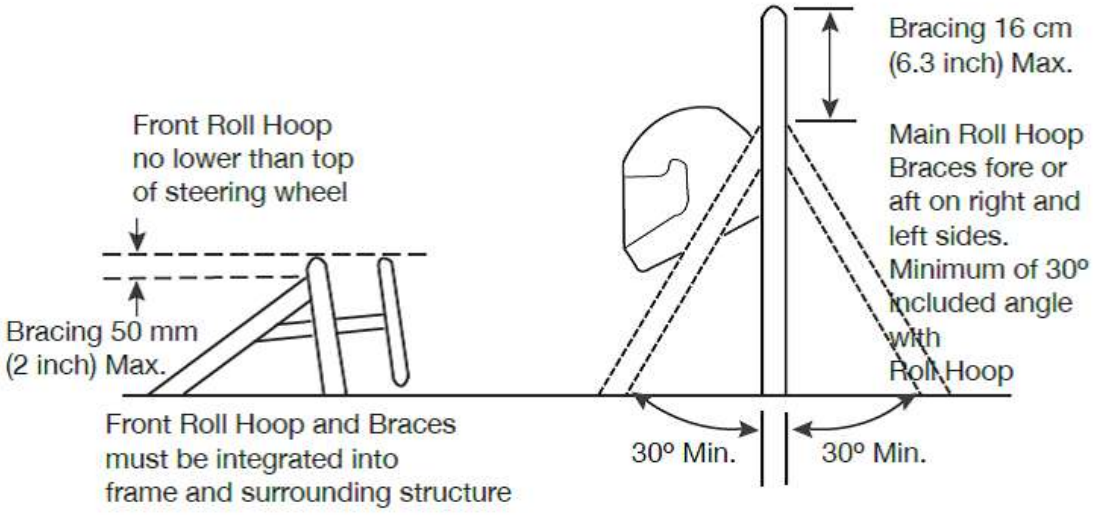

Figure 8 Main and Front Hoop Bracing

T2.11.5 The Main Hoop braces must be straight, i.e. without any bends.

T2.11.6 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. Bracing loads must not be fed solely into the engine, transmission or differential, or through suspension components.

T2.11.7 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.

T2.12 Front Hoop Bracing

T2.12.1 Front Hoop braces must be constructed of material per Rule T2.3.3

T2.12.2 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.

T2.12.3 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.

T2.12.4 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 inches) below the top-most surface of the Front Hoop. See Figure 8
.
T2.12.5 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 (see Table 3)

T2.12.6 The front hoop braces must be straight.

T2.13 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 or stronger, bolts. Mounting plates welded to the Roll Hoop braces must be at least 2.0 mm (0.080 in) thick steel.

T2.14 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.

T2.15 Mechanically Attached Roll Hoop Bracing

T2.15.1 Roll Hoop bracing may be mechanically attached.

T2.15.2 Any non-permanent joint at either end must be either a double-lug joint (see Figure 9), or a sleeved butt joint (see Figure 10).

T2.15.3 The threaded fasteners used to secure non-permanent joints are considered critical fasteners and must comply with Rule No. T8.

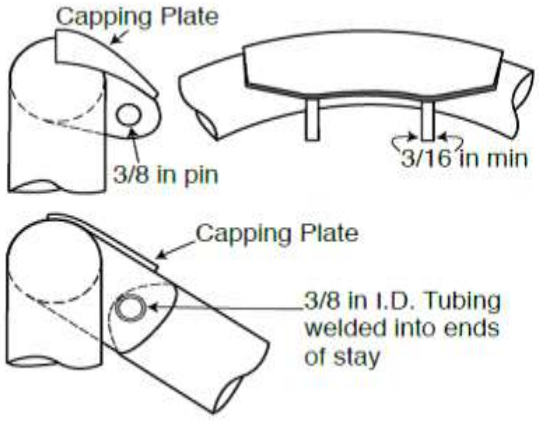

Figure 9(a)

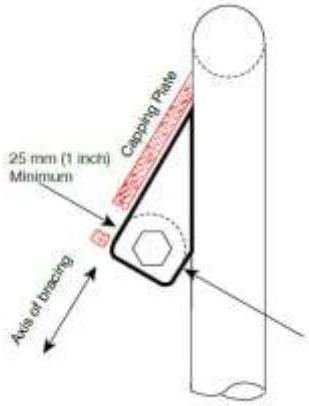

Figure 9(b)

Figure 9 Double lug joint

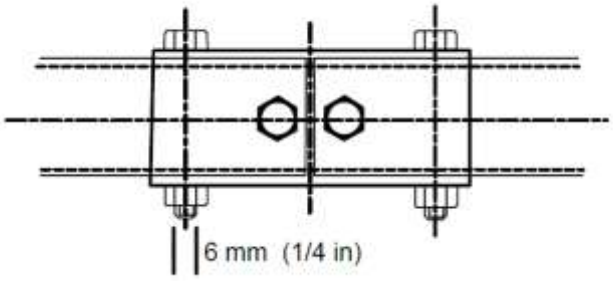

Figure 10 Sleeved Butt Joint

T2.15.4 No spherical rod ends are allowed.

T2.15.5 For double-lug joints, each lug must be at least 4.5 mm (0.177 inch) thick steel, measure 25 mm (1.0 inch) minimum perpendicular to the axis of the bracing and be as short as practical along the axis of the bracing.

T2.15.6 All double-lug joints, whether fitted at the top or bottom of the tube, must include a capping arrangement (Figure 9).

T2.15.7 In a double-lug joint the pin or bolt must be 10 mm Metric Grade 8.8 minimum. The attachment holes in the lugs and in the attached bracing must be a close fit with the pin or bolt.

T2.15.8 For sleeved butt joints (Figure 10), the sleeve must have a minimum length of 76 mm (38 mm 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 8 minimum. The holes in the sleeves and tubes must be a close-fit with the bolts.

T2.16 Frontal Impact Structure

T2.16.1 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.

T2.16.2 Forward of the Front Bulkhead must be an energy-absorbing Impact Attenuator.

T2.17 Front Bulkhead

T2.17.1 The Front Bulkhead must be constructed of closed section tubing as per the rule no. T2.3.3

T2.17.2 The Front Bulkhead must be located forward of all non-crushable objects, e.g. batteries, master cylinders, hydraulic reservoirs.

T2.17.3 If the front bulkhead is part of a composite structure and is modeled as an "L" shape, the Flexural Rigidity of the front bulkhead about the vertical and lateral axes must be equivalent to a steel tube meeting the requirements for the front bulkhead. The length of the section perpendicular to the bulkhead may be a maximum of 25 mm measured from the rearmost face of the bulkhead

T2.17.4 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.

T2.18 Front Bulkhead Support

T2.18.1 The Front Bulkhead must be securely integrated into the Frame.

T2.18.2 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 of its top-most surface), one (1) at the bottom, and one (1) as a diagonal brace to provide triangulation.

T2.18.3 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.

T2.18.4 All the Frame Members of the Front Bulkhead Support system listed above must be constructed of closed section tubing as per the rule no. T2.3.3

T2.19 Inspection Holes

T2.19.1 allow the verification of tubing wall thicknesses, 3 mm inspection holes must be drilled in a non-critical location of both the Main Hoop and the Front Hoop.

T2.19.2 In addition, the Technical Inspectors may check the compliance of other tubes that have minimum dimensions specified in T2.3.3. This may be done by the use of ultra-sonic testing or by the drilling of additional inspection holes at the inspector's request.

T2.19.3 Inspection holes must be located so that the outside diameter can be measured across the inspection hole with a vernier caliper, i.e. there must be access for the vernier caliper to the inspection hole and to the outside of the tube one hundred eighty degrees (180°) from the inspection hole.

T2.20 Impact Attenuator

Figure 12 Intrusion plate mountings

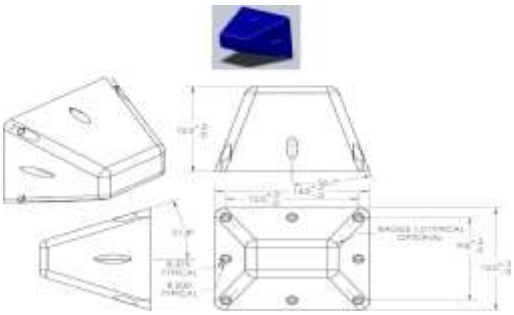

Figure 11 Impact Attenuator

T2.20.1 On all vehicles there must be an Impact Attenuator and an Anti-Intrusion Plate forward of the Front Bulkhead, with the Anti-Intrusion Plate between the Impact Attenuator and the Front Bulkhead.
All methods of attachment of the IA to the Ant-Intrusion Plate and of the Anti-Intrusion Plate to the Front Bulkhead must provide adequate load paths for transverse and vertical loads in the event of off-axis impacts.

T2.20.2 The Impact Attenuator must be:

a. Installed forward of the Front Bulkhead & designed with a closed front section.
b. At least 200 mm (7.8 inches) long, with its length oriented along the fore/aft axis of the Frame.
c. At least 100 mm (3.9 inches) high and 200 mm (7.8 inches) wide for a minimum distance of 200 mm (7.8 inches) forward of the Front Bulkhead.
d. Not able to 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.

T2.20.3 The attachment of the Impact Attenuator to the anti-intrusion plate requires an approved “Main Frame Structural Equivalency Spreadsheet” per **T2.7** that shows equivalency to a minimum of four (4) 8 mm Grade 8.8 or 5/16 inch SAE Grade 5 bolts.

T2.20.4 On all vehicles, a 1.5 mm (0.060 in) solid steel or 4.0 mm (0.157 in) solid aluminum "Anti-Intrusion Plate (AIP)” must be integrated into the Impact Attenuator(IA).

- If the IA & AIP are 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.

T2.20.5 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 bolts must be attached the Impact Attenuator to the Front Bulkhead. . The IA may be attached to the AIP by a minimum of four 8 mm metric grade 8.8 bolts.

T2.21 Impact Attenuator Test Data Report Requirement

T2.21.1 All teams, whether they are using their own design of Impact Attenuator (IA) or the "standard Impact Attenuator, must submit an Impact Attenuator Data Report using the Impact Attenuator Data (IAD) Template found on the FORMULA IMPERIAL website (www.formulaimperial.com).

Note- *for IAD teams can contact their impact attenuator vendors for all required details and certificates*.

T2.21.2 Teams that submit their Impact Attenuator Data Report after the due date will be penalized.

T2.21.3 Impact Attenuator Reports will be evaluated by the organizers and the evaluations will be passed to the Design Event Captain for consideration in the event.

T2.22 Welding required

TIG/MIG welding must be used to weld the main structure along with the mountings.

T2.23 Non-Crushable Objects

T2.23.1 All non-crushable objects (e.g. batteries, master cylinders, hydraulic reservoirs) must be rearward of the rear most plane of the front bulkhead and at least 25 mm behind the AIP, except for environment perception sensors, aerodynamic devices and their mountings.

T2.24 Side Impact Structure for Tube Frame Vehicle

T2.24.1 The Side Impact Structure for tube frame vehicles 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 13.

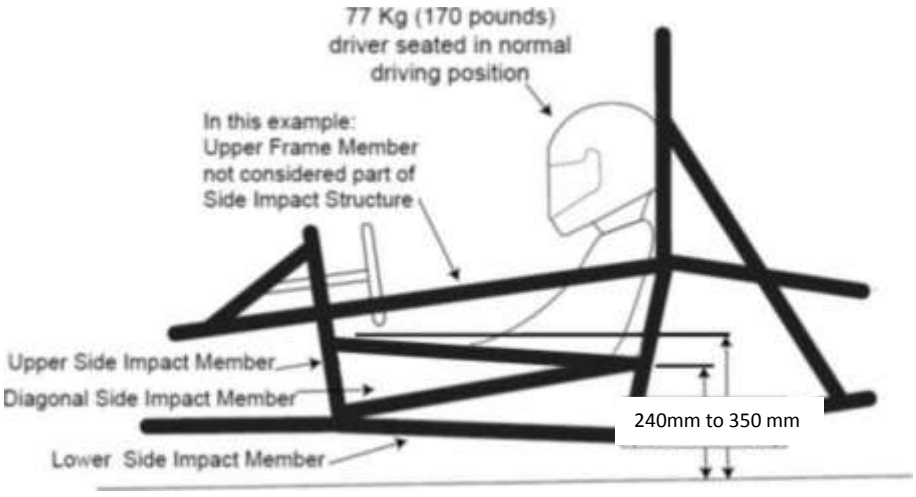

Figure 13 Side impact structure

T2.24.2 The locations for the three (3) required tubular members are as follows:

a) 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 member must be at a height between 240 mm and 350 mm above the lowest inside chassis point between the front and main hoop. The upper frame rail may be used as this member if it meets the height, diameter and thickness requirements.

b) 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.

c) 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.

T2.24.5 With proper gusseting and/or triangulation, it is permissible to fabricate the Side Impact Structural members from more than one piece of tubing.

T3 COCKPIT

T3.1 Cockpit Opening

T3.1.1 The size of the cockpit opening needs to be sufficient for the template shown on the left in Figure 14 to pass vertically from the opening below the top of the side impact structure when held horizontally. The template may be moved fore and aft.

T3.1.2 If the side impact structure is not made of tubes, the template must pass until it is 320 mm above the lowest inside chassis point between the front and main hoop.

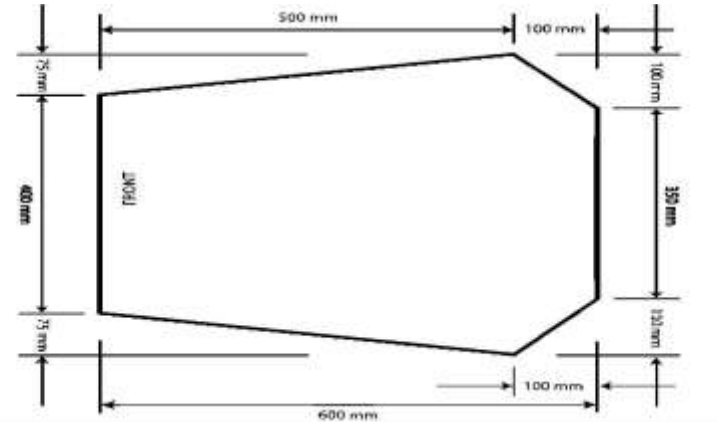

Figure 14 Cockpit opening Template

T3.1.3 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.*

T3.2 Cockpit Internal Cross Section

T3.2.1 A free vertical cross section, which allows the template shown in Figure 15 to be passed horizontally through the cockpit to a point 100 mm 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.

T3.2.2 The template, with maximum thickness of 7 mm, will be held vertically and inserted into the cockpit opening rearward of the rear-most portion of the steering column.

***Note**: At the discretion of the technical inspectors, the internal cross-section template may be moved vertically by small increments during fore and aft travel to clear height deviations in the floor of the vehicle (e.g. those caused by the steering rack, etc.). The template must still fit through the cross-section at the location of vertical deviation.*

T3.2.3 The only items that may be removed for this test are the steering wheel, and any padding required by Rule T9.8 "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.

T3.2.4 Teams whose vehicles do not comply with T3.1 or T3.2 will not be given a Technical Inspection Sticker and will NOT be allowed to compete in the dynamic events.

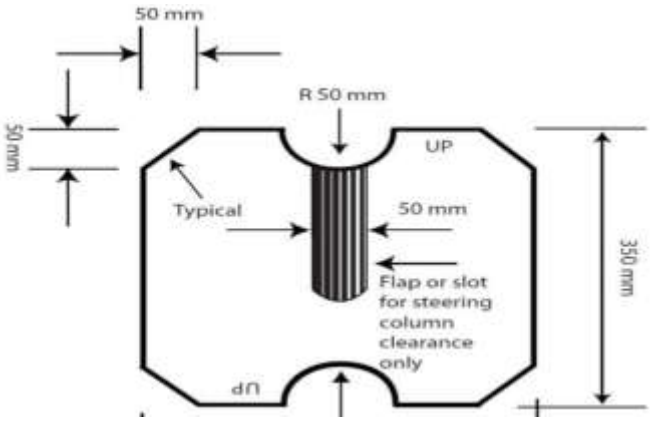

Figure 15 Cockpit Internal Cross Section Template

T3.3 Driver's Seat

T3.3.1 The lowest point of the driver's seat must not be lower than the bottom surface of the lower frame rails or by having a longitudinal tube (or tubes) that meets the material requirements for Side Impact structure (T2.3), passing underneath the lowest point of the seat.

T3.3.2 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.

T3.3.3 Seat must be removable as for inspection.

T3.4 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. The closeout must extend from the foot area to the firewall and prevent track debris from entering the vehicle. The panels must be made of a solid, non-brittle material.

T3.5 Firewall

T3.5.1 Firewall(s) must separate the driver compartment from the following components:
(a) Fuel Tanks.
(b) Accumulators.
(c) BLDC Motor and Controller
(d) Any inbuilt direct charging system / circuits for batteries
(e) All components of the fuel supply.
(f) External engine oil systems including hoses, oil coolers, tanks, etc.
(g) Liquid cooling systems including those for I.C. engine and electrical components.
Lithium-based GLV batteries.
(h) All tractive systems (TS) components
(i) All conductors vehiclerying tractive system voltages (TSV) (Whether contained within conduit or not.)

T3.5.2 The firewall(s) must be a rigid, non-permeable surface made from 1.5 mm or thicker aluminum or proven equivalent.

T3.5.3 The firewall(s) must seal completely against the passage of fluids and hot gasses, including driver's back, left-right sides and the floor of the cockpit as shown in figure 16. There can be no holes in a firewall.

T3.5.4 Mounting of components like seat belt, kill switch, fire extinguisher, brake light etc. are strictly prohibited.

T3.5.5 Pass-through for GLV wiring, cables, etc. are allowable if grommets are used to seal the pass-throughs. Multiple panels may be used to form the firewall but must be mechanically fastened in place and sealed at the joints.

T3.5.6 Height of firewall on main hoop must be at least up to lowest point of tallest driver's helmet when seated on seat.

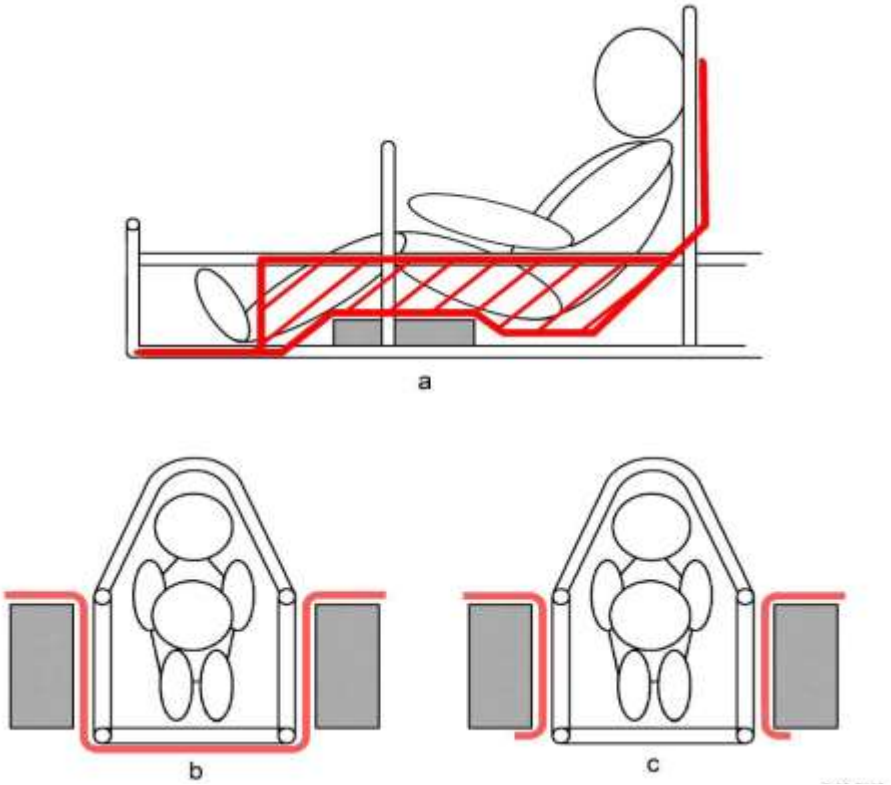

Figure 16 Examples of firewall configurations

The firewalls shown in red in **Figure 16** are examples only and are not meant to imply that a firewall must lie outside the frame rails.

T3.6 Driver Visibility

T3.6.1 The driver must have adequate visibility to the front and sides of the vehicle. 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. See figure 17

T3.6.2 If mirrors are required to meet Rule T3.6.1**,** they must remain in place and adjusted to enable the required visibility throughout all dynamic events.

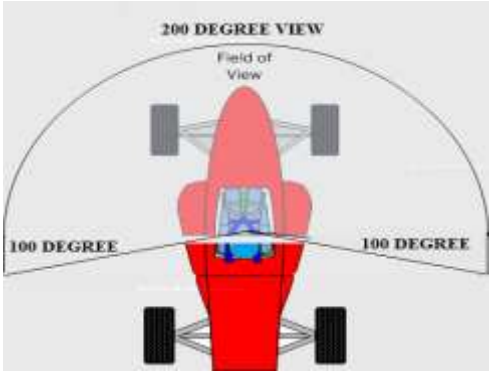

Figure 17 Visibility

T3.7 Driver Egress

All drivers must be able to exit to the side of the vehicle in no more than 5 seconds. Egress time begins with the driver in the fully seated position, hands in driving position on the connected steering wheel and in complete driver equipments (innerwear, suit, gloves, shoes, balaclava, and helmet) and also be wearing proper seat belt. Egress time will stop when the driver has both feet on the ground.

T3.8 Emergency Shut Down Test

With their vision obscured, all drivers must be able to operate the KILL SWITCH in no more than two seconds. Time begins with the driver in the fully seated position, hands in driving position on the connected steering wheel, and wearing the required driver's equipment and also be wearing proper seat belt.

T4 GENERAL CHASSIS RULES

T4.1 Suspension

T4.1.1 The vehicle must be equipped with a fully operational suspension system with shock absorbers, front and rear, with usable wheel travel of at least 50 mm (25 mm jounce and 25mm rebound). The judges reserve the right to disqualify vehicles which do not represent a serious attempt at an operational suspension system or which demonstrate handling inappropriate for an autocross circuit.

T4.1.2 All suspension mounting points must be visible at Technical Inspection, either by direct view or by removing any covers.

T4.2 Wheels

T4.2.1 The wheels of the vehicle must be 203.2 mm (8.0 inches) or more in diameter.

T4.2.2 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.

T4.2.3 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.

T4.2.4 Aluminum wheel nuts may be used, but they must be hard anodized and in pristine condition.

T4.3 Tires

T4.3.1Vehicles must have two types of tires as follows:

a. Dry tires - The tires on the vehicle when it is presented for technical inspection are defined as its "dry tires".

b. Wet tires - Wet 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 or were cut by the tire manufacturer or their appointed agent. Any grooves that have been cut must have documentary proof that it was done in accordance with these rules.

- There is a minimum tread depth of 2.4 mm.

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

T4.3.2 Tires on the same axle must have the same manufacturer, size and compound.

T4.3.4 Special agents that increase traction may not be added to the tires or track surface.

T4.3.5 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.

T4.4 Steering

T4.4.1 The steering wheel must be mechanically connected to the wheels, i.e. "steer-by-wire" is prohibited *or electrically actuated steering, is prohibited.*

T4.4.2 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.

T4.4.3 Allowable steering system free play is limited to seven degrees (7°) total measured at the steering wheel.

T4.4.4 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.

T4.4.5 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.

Figure 18 Steering Wheel

T4.4.6 In any angular position, the top of the steering wheel must be no higher than the top-most surface of the front hoop.

T4.4.7 Joints between all components attaching the steering wheel to the steering rack must be mechanical and visible at technical inspection. Bonded joints without a mechanical backup are not permitted. The mechanical backup must be designed to solely uphold the functionality of the steering system.

T4.4.8 Steering Type- Teams are allowed to use any kind of steering system. There is also no restriction on steering ratio. Teams are free to use any configuration according to their compatibility.

T4.4.9 The steering rack must be mechanically attached to the frame. If fasteners are used they must be compliant with **Rule No. T8**

T4.4.10 Steering systems using cables for actuation are not prohibited by T4.4.1 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 Main frame structural equivalency spreadsheet (MFSES). The report must outline the analysis that was done to show the steering system will function properly, potential failure modes and the effects of each.

T4.4.11 The track and center of gravity of the vehicle must combine to provide adequate rollover stability. 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.

Note: *Those team want to use customized steering system e.g. 7:1, 6:1 and 12:1 they can give their requirement as soon as possible. Delivery and manufacturing will take time, so if your team interested then make order on www.techimperial.in as soon as possible. Tech Imperial will provide this steering on subsidized price.*

T4.5 Jack Point

T4.5.1 A jack point, which is capable of supporting the vehicle's weight and of engaging the organizers' "quick jacks", must be provided at the rear of the vehicle.

T4.5.2 The jacking point is required to be:

a) Visible to a person standing 1 meter (3 feet) behind the vehicle.
b) Painted Bright orange.
c) Oriented horizontally and perpendicular to the centerline of the vehicle
d) Made from round, 25 - 29 mm (1 - 1 1/8 inch) O.D. aluminum or steel tube
e) A minimum of 300 mm (12 inches) long
f) Exposed around the lower 180 degrees (180°) of its circumference over a minimum length of 280 mm (11 in)
g) The height of the tube is required to be such that:

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

T4.5.3 Access from the rear of the tube must be unobstructed for at least 300mm of its length.

Comment on Disabled Vehicles - The organizers and the Rules Committee remind teams that vehicles disabled on course must be removed as quickly as possible. A variety of tools may be used to move disabled vehicles including quick jacks, dollies of different types, tow ropes and occasionally even boards. We expect vehicles to be strong enough to be easily moved without damage. Speed is important in clearing the course and although the course crew exercises due vehiclee, 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, vehiclery or tow the vehicle 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.

T4.6 Hitch point

Every vehicle must have hitch point at the rear end. Hitch point will be used to attach push rod. Every team will have to fabricate detachable push rod that should have the capability to push and pull the vehicle.

T5 BRAKING SYSTEM

T5.1 Brake System - General

T5.1.1 The vehicle must be equipped with a braking system that acts on all four wheels and is operated by a single control.

T5.1.2 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.

T5.1.3 "Brake-by-wire" systems are **prohibited.**

T5.1.4 A single brake acting on a limited slip differential is acceptable.

T5.1.5 Unarmored plastic brake lines are prohibited.

T5.1.6 The brake system must be capable of locking all four (4) wheels during the test specified below.

T5.1.7 Braking systems must be protected with scatter shields from failure of the drive train or from minor collisions.

T5.1.8 The braking systems must be protected from failure of the drive train and from minor collisions.

T5.2 Brake pedal

T5.2.1 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.

T5.2.2 The brake pedal must be fabricated from steel or aluminum or machined from steel, aluminum or titanium.

T5.2.3 Pedal should only be operated from driver's foot and no usage of hand operated levers for braking mechanism is allowed. The pedal travel should be restricted after some distance by some kind of locking mechanisms. See Figure 19.

Figure 19 Brake pedal with positive stop

T5.3 Brake Over-Travel Switch

T5.3.1 A brake pedal over-travel switch must be installed on the vehicle 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 pedals over travels, it will result in the shutdown of the system, which will eventually help controlling the system.

Figure 20 Brake Switch

T5.3.2 Repeated actuation of the switch must not close the shutdown circuit, and it must be designed so that the driver cannot reset it.

T5.3.3 The switch must be implemented with analog components, not incorporating programmable logic controllers, engine control units, or similar functioning digital controllers.

T5.3.4 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). See figure 20.

T5.4 Brake Light

T5.4.1 The vehicle must be equipped with one brake light that meets the following requirements:

- The vehicle must be equipped with a **red** brake light.

- The brake light itself must be rectangular, triangular or near round shape with a minimum shining surface of at least 15 cm sq.
- Each brake light must be clearly visible from the rear in very bright sunlight.
- When LED lights are used without a diffuser, they may not be more than 20 mm apart.
- If a single line of LEDs is used, the minimum length is 150 mm.

T5.4.2 In the side view the brake light must be orientated vertical or near vertical and mounted between the wheel centerline and driver's shoulder level. Viewed from the back it should be positioned approximately at the vehicle's centerline.

Figure 21 Brake light

Figure 22 brake light mounting

T6 POWERTRAIN

T6.1 Transmission and Drive

Any transmission may be used.

T6.2 Drive Train Shields and Guards

T6.2.1 Exposed high-speed final drive train equipment such as Continuously Variable Transmissions (CVTs), sprockets, gears, pulleys, torque converters, clutches, belt drives and clutch drives, must be fitted with scatter shields in case of failure. It must be rigidly mounted with chassis but not with any moving part of vehicle. It can be of metal net but capable to prevent scattering of small parts of transmission system.

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

Figure 23 Scatter Shield

T6.2.2 It must be constructed of non-perforated 2 mm steel or 3 mm aluminum alloy 6061-T6. Perforated material may not be used for the construction of scatter shields.

T6.2.3 Scatter shields for chains and belts must be centered on the centerline of the chain or belt and remain aligned with the chain or belt under all conditions. The minimum width of the scatter shield should be at least three times the width of the chain or belt.

The minimum material requirements are:

a) For metallic chains and belts: 2 mm steel.
b) For non-metallic chains and belts: 3 mm aluminum alloy 6061-T6.

T6.2.4 The guard must be centred on the centre line of the belt and remain aligned with the belt under all conditions.

T6.2.5 Attachment Fasteners - All fasteners attaching scatter shields and guards must be a minimum 6mm Metric Grade 8.8 or 1/4 inch SAE Grade 5 or stronger.

T6.2.6 Finger Guards – Finger guards are required to cover any drive train parts that spin while the vehicle 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 diameter object through the guard.

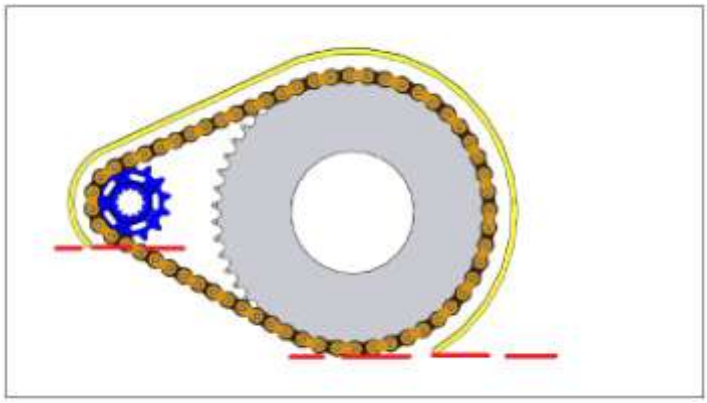

Figure 24 Example of the final drive scattering shield

T7 AERODYNAMIC DEVICES

T7.1 Aero Dynamics and Ground Effects - General

All aerodynamic devices must satisfy the following requirements:

T7.2 Location

In plan view, no part of any aerodynamic device, wing, under tray or splitter can be:
(a) Further forward than 460 mm forward of the fronts of the front tires
(b) No further rearward than the rear of the rear tires.
(c) No wider than the outside of the front tires or rear tires measured at the height of the hubs, whichever is wider.

T7.3 Wing Edges - Minimum Radii

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

T7.4 Other Edge Radii Limitations

All wing edges, end plates, Gurney flaps, wicker bills, splitters undertrays and any other wing accessories must have minimum edge radii of at least 3 mm i.e., this means at least a 6 mm thick edge.

T7.5 Ground Effect Devices

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.

T7.6 Driver Egress Requirements

T7.6.1 Egress from the vehicle within the time set in the rule T3.7 “Driver Egress,” must not require any movement of the wing or wings or their mountings.

T7.6.2 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.

T8 FASTENERS

T8.1 Fastener Grade Requirements:

T8.1.1All 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.

T8.1.2The use of button head cap, pan head, flat head or round head screws or bolts in any location in the following systems is prohibited:

- Driver’s cell structure,
- Impact attenuator attachment
- Driver’s harness attachment
- Steering system
- Brake system
- Suspension system.

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

T8.2 Securing Fasteners

T8.2.1 All critical bolt, 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 are defined as those that:

(a) The Technical Inspectors (and the team members) are able to see that the device/system is in place, i.e. it is visible, **AND**

(b) The "positive locking mechanism" does not rely on the clamping force to apply the "locking" or anti-vibration feature. In other words, if it loosens a bit, it still prevents the nut or bolt coming completely loose.

See Figure 25.

Positive locking mechanisms include:
(a) Correctly installed safety wiring
(b) Cotter pins
(c) Nylon lock nuts
(d) Prevailing torque lock nuts

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

Figure 25 Lock Nuts

T8.2.2 There must be a minimum of two (2) full threads projecting from any lock nut.

T8.2.3 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.

T8.2.4 Adjustable tie-rod ends must be constrained with a jam nut to prevent loosening.

T9 DRIVER RESTRAINT SYSTEM

T9.1 Seat Belts - General

T9.1.1 Definitions

a) 5-point system – consists of two (2) 3 inches lap belts, two (2) 3 inches shoulder straps and a single 2 inch 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. See figure 26
b) 6-point system – consists of two (2) 3 inches lap belt, two (2) 3 inches shoulder straps and two (2) 2 inches leg or anti-submarine straps.
c) 7-point system – system is the same as the 6-point except it has three (3) anti-submarine straps.

***Note**: 6 and 7-point harnesses to FIA specification 8853/98 and SFI Specification 16.5 with 2 inches lap belts are acceptable.*

d) **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 above in figure 7.

e) **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 above in figure 7.

f) **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.

T9.1.2 Harness Requirement
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 latch type.
(e) Vehicles with a "reclined driving position" must have either a 6 point or 7-point harness, and have either an anti-submarine belt with "tilt-lock adjusters" or have two (2) sets of anti-submarine belts installed.
(f) 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.
(g) It is mandatory that the shoulder harness, where it passes over the shoulders, be 3 inches, except as noted below. The shoulder harness straps must be threaded through the three bar adjusters in accordance with manufacturer's instruction.

T9.1.3 **OEM Seat belt is strictly not allowed**. See figure 27.

Figure 26 5-Point system harnessed seat belt

Figure 27 OEM Seat belt

T9.2 Belt, Strap and Harness Installation - General

T9.2.1 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 **T2.8**.

T9.2.2 The tab to which any harness is attached must have:

(a) A minimum cross sectional area of 40 sq. mm of steel to be sheared or failed in tension at any point of the tab,
(b) A minimum thickness of 1.6 mm.
(c) Where lap belts and anti-submarine belts use the same attachment point, a minimum cross sectional area of 90 sq. mm of steel to be sheared if failed in tension at any point of the tab.
d) Where brackets are fastened to the chassis, two fasteners of 6 mm metric grade 8.8 fasteners or stronger must be used.

Note: *Double shear mounting is preferred.*

T9.2.3 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.

T9.2.4 The restraint system installation is subject to approval of the chief technical inspector.

T9.3 Lap Belt Mounting

T9.3.1 The lap belt must pass around the pelvic area below the Anterior Superior Iliac Spines (the hip bones).

T9.3.2 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.

T9.3.3Where the belts or harness pass through a hole in the seat, the seat must be rolled or grommet to prevent chafing of the belts.

T9.3.4 To fit drivers of differing statures correctly, in side 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.

T9.3.5 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 forward of the seat back to seat bottom junction. (See Figure 26)

T9.3.6 With a "reclined driving position", in side view the lap belt must be between an angle of sixty degrees (60°) and eighty degrees (80°) to the horizontal.

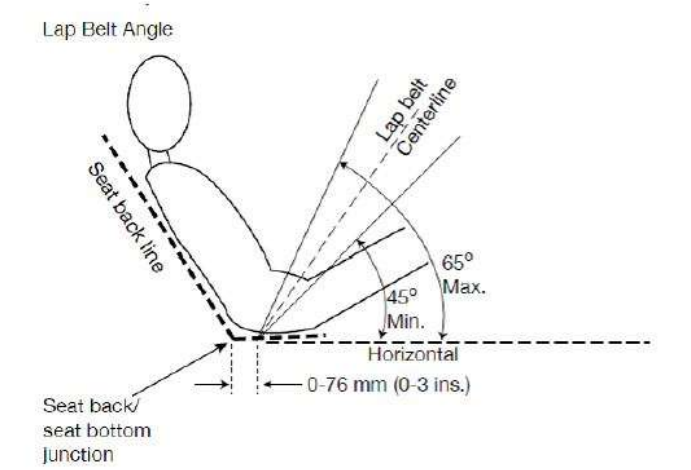

Figure 26 Lap belt angles with upright driver

T9.4 Shoulder Harness

T9.4.1 The shoulder harness must be mounted behind the driver to a structure that meets the requirements of the primary structure. However, it cannot be mounted to the main hoop bracing or attendant structure without additional bracing to prevent loads being transferred into the main hoop bracing.

T9.4.2 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 in side view by gussets or triangulation tubes to prevent torsional rotation of the harness mounting tube.

T9.4.3 The shoulder harness mounting points must be between 178 mm and 230 mm apart. (See Figure 27)

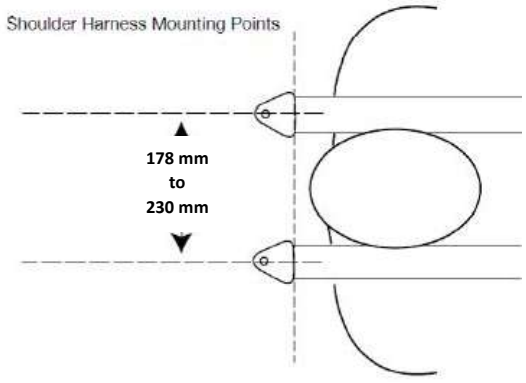

Figure 27 Shoulder Harness Mounting – Top View

T9.4.4 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 28).

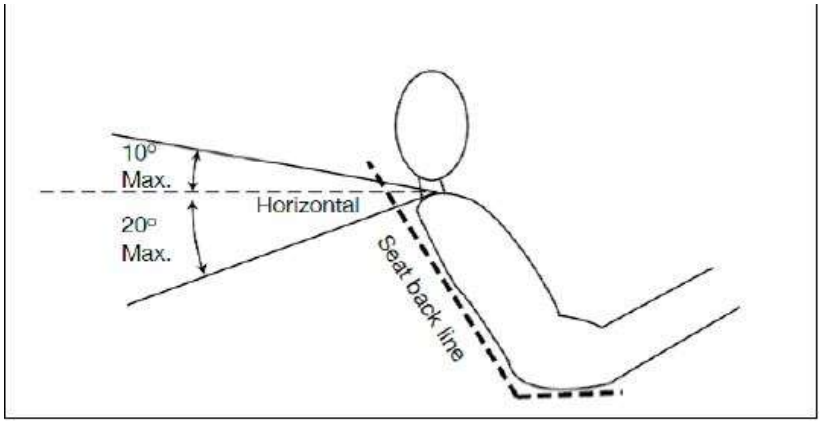

Figure 28 Shoulder Harness Mounting – Side View

T9.5 Anti-Submarine Belt Mounting

T9.5.1 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.

T9.5.2 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 apart.
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.

T9.6 Head Restraint

T9.6.1 A head restraint must be provided on the vehicle to limit the rearward motion of the driver's head.

T9.6.2 The restraint must

a. Be vertical or near vertical in side view.
b. Be padded with an energy absorbing material such as Ethafoam® or Ensolite® with a minimum thickness of 38 mm.
c. Have a minimum width and height of 150 mm and have a minimum height adjustment of 175 mm or,
d. have a minimum width of 150 mm and a minimum height of 280 mm.
e. Be located so that for each driver:

i. The restraint is no more than 25 mm away from the back of the driver's helmet, with the driver in their normal driving position.

ii. The contact point of the back of the driver's helmet on the head restraint is no less than 50 mm from any edge of the head restraint.

T9.6.3 Head restraints must be able to accommodate different drivers.

T9.6.4 Approximately 100 mm 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.

T9.6.5 The restraint, its attachment and mounting must be strong enough to withstand a force of 890 Newton's applied in a rearward direction.

T9.7 Roll Bar Padding

T9.7.1 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 of padding which meets SFI spec 45.1 or FIA 8857-2001.

T9.8 Driver's Leg Protection

T9.8.1 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 rearward of the pedals, must be shielded with a shield made of a 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.

T9.8.2 Covers over suspension and steering components must be removable to allow inspection of the mounting points.

T10 COMPULSARY ADVERTISE

T10.1 Vehicle number

T10.1.1 Each vehicle will be assigned a number at the time of its entry into a competition.
T10.1.2 Vehicle numbers must appear on the vehicle as follows:

- Locations: In three (3) locations: the **front** and both left & right **sides;**
- Height: At least 152.4 mm (6 inch) high;
- Font: Block numbers (i.e. sans-serif characters). Italic, outline, serif, shadow, or cursive numbers are prohibited.

T10.1.3 Stroke Width and Spacing between Numbers: At least 18 mm (3/4 inch).

T10.1.4 Color: Either white numbers on a black background or black numbers on a white background. No other color combinations will be approved.

T10.1.5 Clear: The numbers must not be obscured by parts of the vehicle, e.g. wheels, side pods, exhaust system, etc.

***Comment**: Vehicle numbers must be quickly read by course marshals when your vehicle is moving at speed. Make your numbers easy to see and easy to read.*

T10.2 Organization Name

T10.2.1 Each vehicle must clearly display the organizer name (or initials - if unique and generally recognized) in roman characters at least 50 mm (2 inch) high on both sides of the vehicle.

T10.2.2 The characters must be placed on a high contrast background in an easily visible location.

T10.2.3 The organizer name may also appear in non-roman characters, but the roman character version must be uppermost on the sides.

T10.2.4 It must be displayed on the front of vehicle below the vehicle number.

T10.3 Title sponsor sticker

It must be displayed on the front of the vehicle above the vehicle number and both side of the front bodyworks below the vehicle number.

T10.4 ISIEINDIA Logo

T10.4.1 The ISIEINDIA logo must be displayed on the front of the vehicle in a prominent location.

T10.4.2 ISIEINDIA logo stickers will be provided to the teams on site.

T10.5 FORMULA IMPERIAL Logo

T10.5.1 The FORMULA IMPERIAL logo must be displayed on left and right hand side of the front bodyworks above the vehicle number.

T10.5.2 FORMULA IMPERIAL sticker will be provided to the teams on site.

T10.6 Event Sponsor sticker

This must be displayed on both side of side impact zone.

Note: *There should be sufficient visible space remained for the Technical round and brake test clear sticker in your vehicle.*

Figure 29 Space mentioned for the stickers on font & side

PART D SAFETY REQUIRMENTS

D2 DRIVER'S EQUIPMENT

D2.1 Drivers Safety Gear

D2.1.1 The following are the minimum requirements and restrictions that will be enforced through technical inspection, at any stage of competition.

D2.1.2 Noncompliance if any observed by the inspection/organizing/judging committee members must be corrected and no vehicles without passing the technical inspection would be allowed to participate further in the event. All the parts of Driver's Safety Gear must meet the required rating (specified).

- No driver would be allowed to drive the vehicle without the complete driver's safety gear in any of the dynamic event.
- using authentic driver's equipment with valid safety ratings as prescribed in rulebook
- will be prime responsibility of the team.
- Date/Year of Manufacturing of equipment must be on all critical safety equipment.

D2.2 Driver's Suit

D2.2.1 A fire resistant one piece suit, made from a minimum of 1 layer that covers the body from the neck Down to the ankles and the wrists.

D2.2.2 The suit must be certified to either one of the following standards and be labelled such as SFI 3.2A/1 (or higher) / FIA Standard 1986/ FIA Standard 8856-2000. (see figure 30)

Figure 30 SFI 3-2A/5 (or higher)-Left & FIA Standard 1986- Right

Figure 31 FIA Standard 8856-2000-Left & Driver suit and required rating- Right

Note: - *Damaged suits (with minor cuts or holes) or over stitched suits are not permitted to be*

used. Before purchasing the driver suit, teams must check the suit's safety rating along with the manufacturing dates.

D2.3 Underclothing

D2.3.1 It is mandatory for all drivers to wear fire resistant underclothing of SFI 3.2A/5 / FIA standard 1986 or higher under their approved driving suit.

D2.3.2 This fire resistant underclothing (SFI/ FIA rated) should be made from an acceptable fire resistant material as listed in D2.10 and that should cover the driver's body completely from neck down to ankles and also the wrists.

Figure 32 Innerwear along with rating

Note: *Drivers must have inner wears of required rating, Teams must check the rating and manufacturing details of the innerwear before purchasing*

D2.4 Helmet

D2.4.1 A well- fitting closed face helmet that meets one of the following certifications and is labeled as such- Snell K2000, K2005, K2010, M2000, M2005, M2010, SA2005, SA2010,SAH2010, SA2015, SFI 31.2A, SFI 31.1/2005, SFI 31.2/2005, 31.2/2010, 31.2/2015, 41.2/2005, 41.2/2010, 1.2/2015, FIA 8860-2004, FIA 8860-2010, FIA 8859-2015.

D2.4.2 Open faced helmets are not a permissible. All helmets to be used in the competition must be presented during Technical Inspection where approved helmets will be a stickered. The organizer reserves the right to impound all non-approved helmets until the end of the competition.

Figure 33 Closed face helmet along with Snell/FIA/SFI rating

D2.4.3 Motocross helmets are not allowed, Teams must check the specified rating along with manufacturing details of the helmet before purchasing. -Beware of Chinese helmets.

D2.4.4 Any camera mounting on helmet is prohibited.

D2.5 A balaclava

D2.5.1 A balaclava which covers the driver's head, hair, and neck, made from an acceptable fire resistant material (SFI 3.2A/5 / FIA standard 1986 or higher) as or a full helmet skirt of acceptable fire resistant material.

D2.5.2 The balaclava requirement applies to drivers of either gender, with any hair length.

Figure 34 SFI rated balaclava

D2.6 The neck support

D2.6.1 It must be a full circle (360°) and SFI rated. Horseshoe collars are not allowed. Simpson, RCI, G-Force, Deist or Leaf Racing Products supply neck collars that meet this requirement.

Figure 35 Left: Neck support allowed Right: Neck support not allowed

D2.6.2 A 360 degree continuous perimeter neck support along with required rating is allowed, Neck support with slots is not allowed.

D2.7 Gloves

D2.7.1 Fire resistant gloves made from made from acceptable fire resistant material (SFI/ FIA rated) Gloves of all leather construction or fire resistant gloves constructed using leather palms with no insulating fire resisting material underneath are not acceptable.

Figure 36 SFI rated gloves

D2.7.2 Damaged or torn out gloves are not allowed.

D2.8 Shoes

D2.8.1 Fire resistant shoes made from acceptable fire resistant material shoes must be certified to the standard and labeled as such: SFI 3.3 FIA 8856-2000.

Figure 37 SFI rated shoes

D2.8.2 Sports shoes/Canvas shoes/Leather shoes/Industrial safety shoes are not allowed at any point of the event.

D2.9 Shocks

Fire resistant socks made from acceptable fire resistant material, which covers the bare skin between the driver's suit and the boots or shoes. For the purpose of this section the approved fire resistant materials are: Vehiclebon X, Indura, Nomex, Polybenzimidazole (commonly known as PBI) and Proban.

D2.10 Fire Resistance material

D2.10.1 For the purpose of this section some, but not all, of the approved fire resistant materials are: Vehiclebon X, Indura, Nomex, Polybenzimidazole (commonly known as PBI) and Proban. T-shirts, socks or other

undergarments made from nylon or any other synthetic material which will melt when exposed to high heat are prohibited.

D2.10.2 Expired driving equipment's are not allowed, Team must ensure expiry date of their driving equipment's is beyond the date of event. Individual safety equipment should be available for each driver in a team.

D3 OTHER SAFETY REQUIRMENTS

D3.1 First aid box

Every team must have their own first aid box to be used in emergency during the dynamic round.

D3.2 Goggles

Every team should have their own goggles to use during welding and grinding.

D3.3 Fire Extinguishers

D3.3.1 Each team must have at least two dry chemical/dry powder fire extinguishers with a minimum firefighting agent capacity of 0.9 kg.

D3.3.2 Extinguishers of larger capacity (higher numerical ratings) are acceptable.

D3.3.3Aqueous Film Forming Foam (AFFF) fire extinguishers are prohibited. Halon extinguishers and systems are prohibited.

D3.3.4 All extinguishers must be equipped with a manufacturer installed pressure/charge gauge.

D3.3.5 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.

D3.3.6 At least one must be rigidly mounted in driver sitting compartment and other must be in hand of team member in every static and dynamic test during final event.

Figure 38 Fire extinguisher mounting

Figure 39 Fire extinguisher mounting bracket

D3.4 Pushbar

D3.4.1 Each team must have a removable device (called the pushbar) that attaches to the rear of the vehicle and allows two people to push and pull the vehicle while standing erect behind the vehicle.

D3.4.2 The pushbar must have a red color.

D3.4.3 The pushbar must be presented during technical inspection.

D3.4.4 The pushbar must be capable of slowing and stopping the forward motion of the vehicle and pulling it rearwards.

D3.5 Quick Jack

D3.5.1 Each team must have a removable device (called the quick jack) that lifts up the vehicle, so that all driven wheels are at least 100 mm off the ground and the vehicle is adequately supported.

D3.5.2 The lifting of the vehicle with the quick jack must be possible by one person and not require actions other than positioning and operating the quick jack itself.

D3.5.3 In the lifted position the quick jack must be locked and secured, and function without the support of a person or additional weights.

D3.5.4 The quick jack must have a red color.

D3.5.5 The quick jack must be presented during technical inspection.

PART HV HYBRID VEHICLE CATEGORY

HV1 INTERNAL COMBUSTION ENGINE

HV1.1 Engine limitations

HV1.1.1 Engine must be Internal Combustion, four-stroke piston engine, with a maximum displacement of 710cc. Only one engine is allowed.

HV1.1.2 All waste/rejected heat from the primary heat cycle may be used. The method of conversion is not limited to the four-stroke cycle.

HV1.1.3 Permitted modifications to a stock engine are:

1. Modification or removal of the clutch, primary drive and/or transmission.
2. Changes to fuel mixture, ignition or cam timings.
3. Replacement of camshaft. (Any lobe profile may be used.)
4. Replacement or modification of any exhaust system component.
5. Replacement or modification of any intake system component; i.e., components upstream of (but NOT including) the cylinder head. The addition of forced induction will move the engine into the modified category.
6. Modifications to the engine casings (This does not include the cylinders or cylinder head).
7. Replacement or modification of crankshafts for the purpose of simplifying mechanical connections. (Stroke must remain stock.)

HV1.2 Starter

HV1.2.1 Each vehicle must be equipped with an on-board starter or equivalent, and be able to move without any outside assistance at any time during the competition. Specifically, push starts are not permitted.

HV1.2.2 A hybrid may use the forward motion of the vehicle derived from the electric drive to start the I.C. engine, except that this starting technique may not be used until after the vehicle receives the “green flag” in any event.

HV1.2.3 A manual starting system operable by the driver while belted in is permissible.

HV1.3 Air Intake System

HV1.3.1 All parts of the engine air and fuel control systems (including the throttle and the complete air intake system, including the air filter and any air boxes) must lie within the surface defined by the top of the roll bar and the outside edge of the four tires.

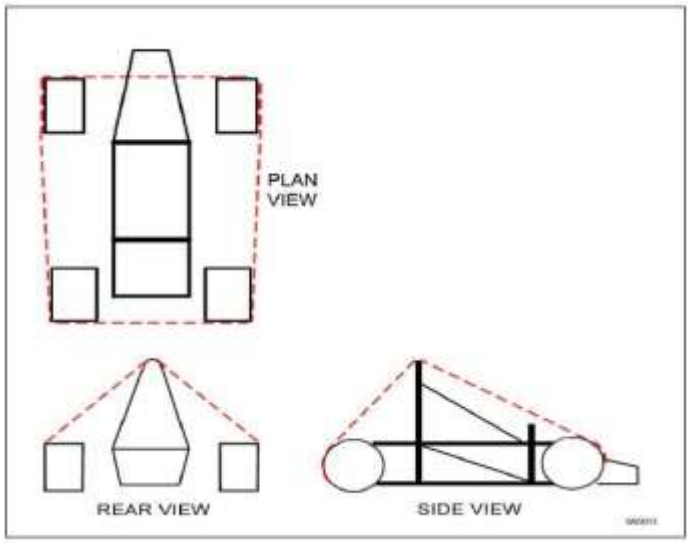

Figure 40 Surface Envelope

HV1.3.2 Any portion of the air intake system that is less than 350 mm above the ground must be shielded from side or rear impact collisions by structure built.

HV1.3.3 Intake Manifold -
If an intake manifold is used, it must be securely attached to the engine crankcase, cylinder, or cylinder head with brackets and mechanical fasteners. This precludes the use of hose clamps, plastic ties, or safety wires.
Original equipment rubber parts that bolt or clamp to the cylinder head and to the throttle body or vehicleburetor are acceptable.

***Note**: These rubber parts are referred to by various names by the engine manufacturers; e.g., "insulators" by Honda, "joints" by Yamaha, and "holders" by Kawasaki.*

HV1.3.4 Other than such original equipment parts the use of rubber hose is not considered a structural attachment. Intake systems with significant mass or cantilever from the cylinder head must be supported to prevent stress to the intake system.
Supports to the engine must be rigid, Supports to the frame or chassis must incorporate some isolation to allow for engine movement and chassis flex.

HV1.3.5 Air boxes and filters- Large air boxes must be securely mounted to the frame or engine and connections between the air box and throttle must be flexible. Small air cleaners designed for mounting to the vehicleburetor or throttle body may be cantilevered from the throttle body.

HV1.4 Accelerator Actuation - General

HV1.4.1 All systems that transmit the driver's control of the speed of the vehicle, commonly called "Accelerator systems", must be designed and constructed as "fail safe" systems, so that the failure of any one component, be it mechanical will not result in an uncontrolled acceleration of the vehicle. This applies to both IC engine and to electric motor that power the vehicle.

HV1.4.2 The Accelerator control must be actuated mechanically i.e. electrical Accelerator control (ETC) or "drive-by-wire" is acceptable.

HV1.4.3 Any Accelerator pedal must have a positive pedal stop incorporated on the Accelerator pedal to prevent over stressing the accelerator cable or any part of the actuation system.

HV1.4.4 The accelerator system mechanism must be protected from debris ingress to prevent jamming.

HV1.5 Mechanical Accelerator Actuation

HV1.5.1 If mechanical accelerator actuation is used, the Accelerator cable or rod must have smooth operation, and must not have the possibility of binding or sticking.

HV1.5.2 The Accelerator actuation system must use at least two (2) return springs located at the accelerator body, so that the failure of any component of the Accelerator system will not prevent the Accelerator returning to the closed position.

Note: *Springs in Throttle Position Sensors (TPS) are NOT acceptable as return springs.*

HV1.5.3 Any Accelerator pedal cable must be protected from being bent or kinked by the driver's foot when it is operated by the driver or when the driver enters or exits the vehicle.

HV1.5.4 If the Accelerator system contains any mechanism that could become jammed, for example a gear mechanism, then this must be covered to prevent ingress of any debris.

HV1.5.5 The use of a push-pull type Accelerator cable with an Accelerator pedal that is capable of forcing the Accelerator closed (e.g. toe strap) is recommended.

HV1.5.6 Any Accelerator pedal must have a positive pedal stop incorporated on the Accelerator pedal to prevent over stressing the accelerator cable or any part of the actuation system.

HV1.6 Intake System Restrictor

HV1.6.1 In order to limit the power capability from the engine, a single circular restrictor must be placed in the intake system between the throttle and the engine and all engine airflow must pass through the restrictor.

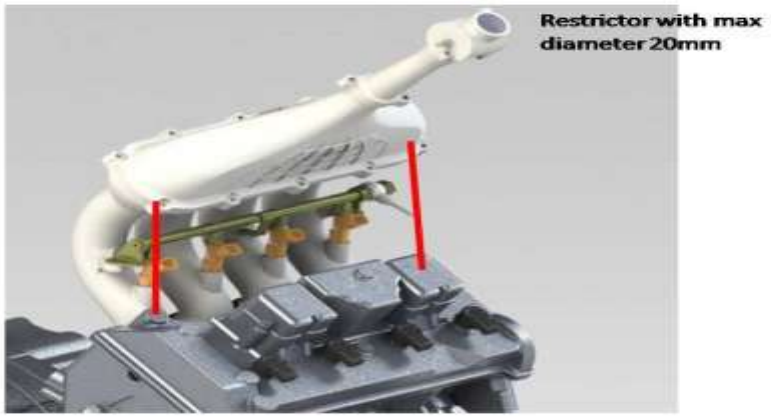

Figure 41 Intake System Restrictor

HV1.6.2 The restrictor must be located to facilitate measurement during the inspection process.

HV1.6.3 The circular restricting cross section may not be movable or flexible in any way, e.g. the restrictor may not be part of the movable portion of a barrel accelerator/throttle body.

HV1.6.4 Any device that has the ability to throttle the engine downstream of the restrictor is prohibited.

HV1.6.6 The restrictor must be circular with a maximum diameter of 20 mm.

HV1.6.7 INTAKE ASSY should rigidly mounted with engine and flexible mount to chassis.

HV1.7 Turbochargers & Superchargers

HV1.7.1 Turbochargers or superchargers are allowed if the competition team designs the application. Engine that have been designed for and originally come equipped with a turbocharger are not allowed to compete with the turbo installed.

HV1.7.2 The restrictor must be placed upstream of the compressor but after the vehicle buretor or throttle valve. Thus, the only sequence allowed is throttle, restrictor, compressor, and engine.

HV1.7.3 The intake air may be cooled with an intercooler (a charge air cooler). Only ambient air may be used to remove heat from the intercooler system. Air-to-air and water-to air intercoolers are permitted.

HV1.8 Crankcase / Engine Lubrication Venting

HV1.8.1 Any crankcase or engine lubrication vent lines routed to the intake system must be connected upstream of the intake system restrictor.

HV1.8.2 Crankcase breathers that pass through the oil catch tank(s) to exhaust systems, or vacuum devices that connect directly to the exhaust system, are prohibited.

HV2 FUEL AND FUEL SYSTEM

HV2.1 Fuel

HV2.1.1 The available fuel types will be unleaded gasoline.

HV2.1.2 To avoid any alterations in the properties of the fuel at the time of race, ISIEINDIA will provide the fuel to all the teams at the standard market rate.

HV2.1.3 No agents other than fuel (gasoline), and air may be induced into the combustion chamber.

HV2.1.4 The temperature of fuel introduced into the fuel system may not be changed with the intent to improve calculated efficiency.

HV2.3 Fuel Tanks

HV2.3.1 The fuel tank is defined as that part of the fuel containment device that is in contact with the fuel. It may be made of a rigid material or a flexible material.

HV2.3.2 Fuel tanks made of a rigid material cannot be used to vehiclery structural loads, e.g. from roll hoops, suspension, engine or gearbox mounts, and must be securely attached to the vehicle structure with mountings that allow some flexibility such that chassis flex cannot unintentionally load the fuel tank.

HV2.3.3 Any fuel tank that is made from a flexible material, for example a bladder fuel cell or a bag tank must be enclosed within a rigid fuel tank container which is securely attached to the vehicle structure.

HV2.3.4 Fuel tank containers (containing a bladder fuel cell or bag tank) may be load vehiclerying.

HV2.3.5 Any size fuel tank may be used but must not exceed 7 liters in volume.

HV2.3.6 The fuel system must have a drain fitting for emptying the fuel tank. The drain must be at the lowest point of the tank and be accessible from under the vehicle. It must not protrude below the lowest plane of the vehicle frame, and must have provision for safety wiring.

HV2.4 Fuel System Location Requirements

HV2.4.1 All parts of the fuel storage and supply system must lie within the surface defined by the top of the roll bar and the outside edge of the four tires.

HV2.4.2 Fuel tank must be shielded from side or rear impact collisions.

HV2.4.3 A firewall must be incorporated to separate the fuel tank from the driver.

HV2.4.4 Any portion of the fuel system that is less than 350 mm above the ground must be within the primary structure.

HV2.4.5 All parts of the fuel storage and supply system must be adequately protected against any heat sources and located at least 50 mm from any exhaust system component.

HV2.4.6 The placement of fuel tank should be such that it maintains a proper distance from the engine and also it should not be above the battery.

HV2.4.7 It must be securely fixed to the chassis and be designed in such a way that neither it nor the fuel pipes (which must be flexible) present any danger of leakage during the event.

HV2.4.8 A quick attachment to the chassis is strongly recommended. It is mandatory to place it between the main tubes of the chassis-frame.

HV2.5 Fuel Tank Filler Neck & Sight Tube

HV2.5.1 All fuel tanks must have a filler neck which is:

(a) With a minimum inside diameter of 38 mm & at least 125mm vertical height above the top level of the tank.
(b) That is vertical (with a horizontal filler cap) or angled at no more than forty-five degrees (45º) from the vertical.

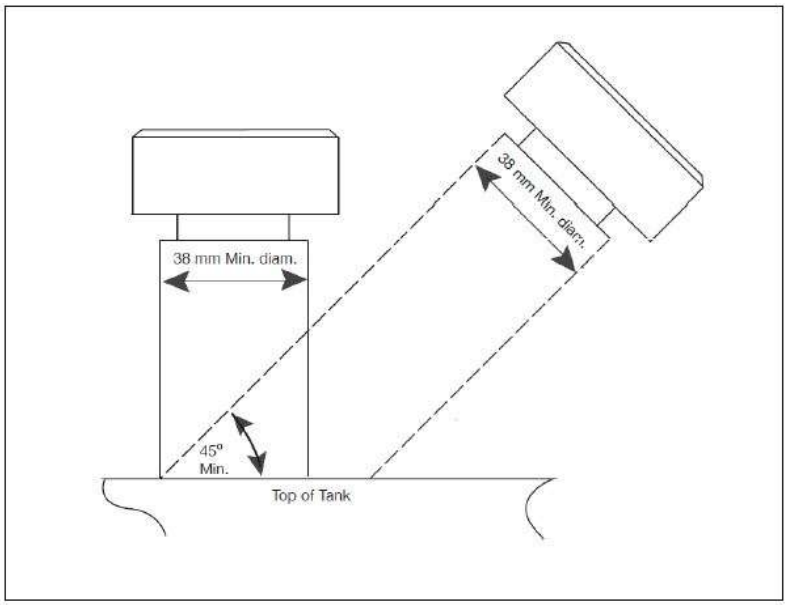

Figure 42 Fuel Tank Filler Neck

HV2.5.2 Any sight tube must not run below the top surface of the fuel tank.

HV2.5.3 Made of material that is rated for temperatures of at least 130ºC.

HV2.5.4 A clear filler neck tube may be used as a sight tube.

HV2.5.5 A permanent, non-moveable, clear and easily visible fuel level line must be located between 12mm and 25mm below the top of the visible portion of the sight tube. This line will be used as the fill line for the tilt test and before and after the endurance test to measure the amount of fuel used during the endurance event.

HV2.5.6 The filler neck opening must be directly accessible without removing any parts of the vehicle except for the fuel filler cap.

HV2.5.7 The filler neck must have a fuel filler cap that can withstand severe vibrations or high pressures such as could occur during a vehicle rollover event.

HV2.7 Tank Filling Requirement

HV2.7.1 The tank must be capable of being filled to capacity without manipulating the tank or vehicle in any way (shaking vehicle, etc.).

HV2.7.2 The fuel system must be designed such that the spillage during refueling cannot contact the driver position, exhaust system, hot engine parts, or the ignition system.

HV2.7.3 Belly pans must be vented to prevent accumulation of fuel.

HV2.8 Venting Systems

HV2.8.1 The fuel tank and vehicleburetor venting systems must be designed such that fuel cannot spill during hard cornering or acceleration.

HV2.8.2 All fuel vent lines must be equipped with a check valve to prevent fuel leakage when the tank is inverted. All fuel vent lines must exit outside the bodywork.

HV3 EXHAUST SYSTEM AND NOISE CONTROL

HV3.1 Muffler and Exhaust

HV3.1.1 ISIEINDIA strongly believe in green future. The teams must keep in mind that they should select the appropriate exhaust system in order to reduce the noise, efficient exhaust silencers are compulsory.

HV3.1.2 The exhaust must be routed so that the driver is not subjected to fumes at any speed considering the draft of the vehicle.

HV3.1.3 Any exhaust components (headers, mufflers, etc.) that protrude from the side of the body in front of the main roll hoop must be shielded to prevent contact by persons approaching the vehicle or a driver exiting the vehicle. The temperature of the outer surface must not be harmful to a person touching it.

HV3.1.4 The exhaust outlet(s) must not extend more than 450 mm behind the centerline of the rear wheels, and shall be no more than 600 mm above the ground.

HV3.1.5 The application of fibrous material, e.g. “header wrap”, to the outside of an exhaust manifold or exhaust system is prohibited.

HV3.2 Coolant Fluid Limitations

HV3.2.1 Water-cooled must use only plain water. Glycol-based antifreeze, “water wetter”, water pump lubricants of any kind, or any other additives are strictly prohibited.

HV3.3 Catch Cans

HV3.3.1 Any vent or cooling or lubrication system must be sealed to prevent leakage. It must employ a catch-can to retain any fluid that is expelled. A separate catch-can is required for each vent.

HV3.3.2 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 whichever is greater.

HV3.3.3 Catch cans must be capable of containing boiling water without deformation, be shielded by a firewall, be below the driver’s shoulder level, and be positively retained, i.e. no tie-wraps or tape as the primary method of retention.

HV3.3.4 Any catch-can for an IC engine cooling system must vent through a hose with a minimum internal diameter of 3 mm down to the bottom levels of the Frame.

PART EV ELECTRICAL POWERTRAINS AND SYSTEMS

EV1 ELECTRIC SYSTEM DEFINITIONS

EV1.1 Grounded Low Voltage System (GLVS) and Tractive System (TS)

EV1.1.1The TS of the vehicle is defined as every part that is electrically connected to the motor and TS accumulators.

EV1.1.2 The GLVS of the vehicle is defined as every electrical part that is not part of the TS.

EV1.2 Motor

EV1.2.1 Only one electric motor is allowed.

EV1.3 Motor Controllers

EV1.3.1 The tractive system motor must be connected to the accumulator through a motor controller.

EV1.3.2 Bypassing the control system and connecting the tractive system accumulator directly to the motor is prohibited.

EV1.3.3 Motor controller inputs that are not galvanically isolated from TS may not be present in the cockpit. This includes accelerator input, forward/reverse, on/off switches etc.

EV2 POWER LIMITATION

EV2.1 Maximum System Voltages: The maximum permitted operating voltage and energy limits are

Formula Hybrid voltage and energy limits	
Maximum operating voltage (TSV)	300 V
Maximum GLV	30 VDC or 25 VAC
Maximum accumulator segment voltage	120 V
Maximum accumulator segment energy	6 MJ

Table 5: Voltage and Energy Limits

EV3 GENERAL REQUIREMENT

EV3.1 Overcurrent Protection

EV3.1.1 All electrical systems must have appropriate overcurrent protection. The continuous current rating of the overcurrent protection must not be greater than the continuous current rating of any electrical component, for example wire, busbar, cell or other conductor that it protects. i.e. if multiple pins of a connector are used to vehiclery currents in parallel, each pin must be appropriately protected.

EV3.1.2 All electrical systems (both tractive system and grounded low voltage system) must be appropriately fused.

EV3.2 Grounding

EV3.2.1 All electrically conductive parts of the vehicle (e.g. parts made of steel, (anodized) aluminum, any other metal parts, etc.) which are within 100 mm of any TS or GLVS component, the driver harness mounting points

and the seat mounting points must have a resistance below 300 mΩ (measured with a current of 1 A) to GLVS ground.

EV3.2.2 All parts of the vehicle which may become electrically conductive (e.g. completely coated metal parts, vehiclebon fiber parts, etc.) which are within 100 mm of any TS or GLVS component, must have a resistance below 5 Ω to GLVS ground.

EV3.3 Grounded Low Voltage System (GLVS)

EV3.3.1 The maximum permitted voltage that may occur between any two electrical connections is 60 V DC or 25 V AC RMS.

EV3.3.2 The GLVS must be grounded to the chassis.

EV3.3.3 The GLVS must not use orange wiring or conduit.

EV3.3.4 All GLV batteries must be attached securely to the frame.

EV3.3.5 The ground wire must run directly from the battery to the nearest frame ground and must be properly secured at both ends.

***Note**: Through-bolting a ring terminal to a gusset plate or dedicated tab welded to the frame is highly recommended.*

EV3.3.6 Any wet-cell battery located in the driver compartment must be enclosed in a nonconductive marine-type container or equivalent and include a layer of 1.5 mm aluminum or equivalent between the container and driver.
EV3.3.7 GLV battery packs based on Lithium Chemistry (other than commercially assembled packs) are not permitted.

EV4 TRACTIVE SYSTEM VOLTAGE ISOLATION

Most Formula Hybrid vehicles contain voltages that could cause injury or death if they came in contact with a human body. In addition, all Formula Hybrid accumulator systems are capable of storing enough energy to cause injury, blindness or death if that energy is released unintentionally.
To minimize these risks, all tractive system components and wiring must at a minimum comply with the following rules.

EV4.1 Isolation Requirements

EV4.1.1 All TS wiring and components must be galvanically (electrically) isolated from GLV by separation and/or insulation.

EV4.1.2 All interaction between TS and GLV must be by means of galvanically isolated devices such as opto-couplers, transformers, digital isolators or isolated dc-dc converters.

EV4.1.3 All connections from external devices such as laptops to a tractive system component must be galvanically isolated, and include a connection between the external device ground and the vehicle frame ground.

EV4.1.4 All isolation devices must be rated for an isolation voltage of at least twice the maximum TS voltage.

EV4.1.5 The entire TS and GLVS must be completely galvanically isolated.

EV4.1.6 TS and GLVS circuits must be physically segregated such that they are not running through the same conduit or connector, except for interlock circuit connections.

EV4.1.7 Components and cables capable of movement must be positively restrained to maintain spacing.

EV4.1.8 If tractive system and GLVS are on the same PCB, they must be on separate well defined areas of the board, each area clearly marked with "TS" or "GLVS". The outline of the area required for spacing must be marked.

EV4.1.9 Teams must be prepared to demonstrate spacing on team-built equipment. For inaccessible circuitry, fully assembled spare boards must be available.

EV4.1.10 All connections to external devices, such as laptops, from a TS component must include galvanic isolation.

EV4.2 General Requirements

EV4.2.1 Tractive system and GLV conductors may not run through the same conduit.

EV4.2.2 Tractive system and GLV wiring may not both be present in one connector.

EV4.2.3 TS wiring must be separated from the driver's compartment by a firewall.

EV4.2.4 TS wiring may not be present behind the instrument panel.

EV4.2.5 All components in the TS must be rated for the maximum TS voltage. Printed Circuit Boards (PCBs) are considered as one component. Every input of a PCB connected to the TS must be rated to the maximum TS voltage.

EV4.2.6 All components must be rated for the maximum possible temperature which may occur during usage.

EV4.3 TS System Enclosures

EV4.3.1 Every housing or enclosure containing parts of the TS system, must be labeled with (a) reasonably sized sticker(s) according to "ISO 7010-W012" (triangle with black lightning bolt on yellow background). The sticker must also contain the text "High Voltage" if the voltage is more than 60 V DC or 25 V AC.

EV4.4 Positioning of Tractive System Parts

EV4.4.1 With the exception of what is permitted according to EV4.4.4, all parts belonging to the TS including cables and wiring must be located within the rollover protection envelope.

EV4.4.2 The transmission to be used in the Vehicles must be of rear wheel drive only. The teams are free to use any sort of designs i.e. the use of differential, through the axle, the wheel mounting hub or by any other means.

EV4.4.3 Any part of the TS that is less than 350 mm above the ground must be shielded from side or rear impact collisions by structure.

EV4.4.4 Outboard wheel motor are allowed even if the motor, attendant cables and wiring are outside of the rollover protection envelope and only if an interlock is added such that the shutdown circuit, see Figure 31, is activated if the wheel assembly is damaged or knocked off the vehicle. The activation of the shutdown circuit must occur before the failure of the TS wiring. TS wiring running outside of the envelope must be reduced to a minimum. The TS wiring must not be able to reach the cockpit opening or the driver regardless of where it breaks.

EV4.4.5 In side or front view any part of the TS must not project below the lower surface of the chassis.

EV4.5 Tractive System Insulation, Wiring and Conduit

EV4.5.1 All parts especially live wires, contacts, etc. of the electrical system need to be isolated by non-conductive material, protected from being touched.

EV4.5.2 Using only insulating tape or rubber-like paint for insulation is prohibited.

EV4.5.3 The minimum acceptable temperature rating for TS wiring, connections and insulation is 90ºC.

EV4.5.4 TS components and containers must be protected from moisture in the form of rain or puddles.

EV4.5.5 Teams must provide **double layered insulation**, it can be done by reinforced insulation of single layered insulation wires. Inside this reinforced insulation, bundles of wire.

EV4.5.6 All wires, connectors and electronics modules which remain at high voltage must be double insulated.

EV4.5.7 Wires must not go under the base frame of the vehicle.

EV4.5.8 There must be no electrical connection between the frame of the Vehicle (or any other conductive surface that might be inadvertently touched by a crew member or spectator), and any part of any traction system circuits except the ground of the vehicle.

EV4.5.9 All parts belonging to the tractive system including conduit, cables, and wiring must be contained within the Surface Envelope of the Vehicle such that they are protected in case of a crash or roll-over situation.

EV4.5.10 Teams should regularly check their electrical breakdown between either sides of the energy storage system.

EV4.5.11 Electrical wiring should be properly done and it should not disturb the ergonomics of the driver or entangle with any parts of the driver.

EV4.5.12 Loosely hanging of wires must be avoided.

EV4.5.13 Wires should be properly covered using external hoses, wiring of electric and electronic system and tractive system can be done separately.

EV4.5.14 Proper automotive grade wiring connector must be used for all types of wirings in vehicle. Avoid using wire joints covered with tapes.

Figure 43 Automotive grade wiring.

EV4.5.15 All TS wiring that runs outside of TS enclosures must:

- Be enclosed in separate orange non-conductive conduit or use an orange shielded cable.
- Be securely anchored at least at each end so that it can withstand a force of 200N without straining the cable end crimp.
- Body work is not sufficient to meet this enclosure requirement.

EV4.5.16 Any shielded cable must have the shield grounded.

EV4.5.17 Every TS connector outside of a housing must include a pilot contact/interlock line which is part of the shutdown circuit. Housings only used to avoid interlocks are prohibited.

EV4.5.18 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.

EV4.6 High Voltage Disconnect (HVD)

EV4.6.1 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 350 mm 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.

EV4.6.2 An untrained person must be able to remove the HVD within 10 seconds when the vehicle is in ready-to-race condition.

EV4.6.3 The HVD must be clearly marked with “HVD”.

EV4.6.4 No tools must be necessary to open the HVD. Therefore, a pilot contact/interlock must open the shutdown circuit when the HVD is removed.

EV4.6.5 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

EV4.7 Discharge Circuit

EV4.7.1 If a discharge circuit is required tomeet EV5.5.3, it must be designed to handle the maximum tractive system voltage permanently.

EV4.7.2 The discharge circuit must be fail-safe. I.e.wired in a way that it is always active whenever the shutdown circuit is open or de-energized.

EV4.7.2 The discharge circuit must be wired in 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.

EV4.7.3 Fusing of the discharge main current path is prohibited.

EV4.8 Electrical accelerator/ Throttle paddle

EV4.8.1 Only foot operated paddle is allowed, hand operated lever will not allowed. It must be a right-foot-operated foot pedal.

EV4.8.2 There should be a positive lock provided with the throttle paddle. It must return to its original, rearward position when released.

EV4.8.3 The pedal must return to its original, rearward position when released. The pedal must have positive stops at both ends of its travel, preventing its sensors from being damaged or overstressed

EV5 TRACTIVE SYSTEM ENERGY STORAGE

EV5.1 Allowed Tractive System Accumulators

EV5.1.1 The TS accumulator is defined as all the battery cells that store the electrical energy to be used by the TS.

EV5.1.2 Accumulator segments are sub-divisions of the accumulator.

EV5.1.3 The energy of a cell is defined by the maximum cell voltage times the nominal capacity of the used cell.

EV5.1.4 The following accumulator devices are acceptable; batteries (e.g. lithium-ion, NiMH, lead acid and similar battery chemistries)

EV5.1.5 capacitors, such as super caps or ultracaps are not allowed.

EV5.1.6 The following accumulator devices are not permitted: Molten salt batteries, Thermal batteries, Fuel cells, Mechanical storage such as flywheels or hydraulic accumulators.

EV5.2 Tractive System Accumulator – General Requirements

EV5.2.1 All cells which store the TS energy will be built into accumulator segments and must be enclosed in (an) accumulator container(s).

EV5.2.2 Each accumulator segment must not exceed a maximum static voltage of 120 V DC and a maximum energy of 6 MJ, see EV2.1

EV5.2.3 If spare accumulators are used, they must be of the same size, weight and type as those that are replaced. Spare accumulator packs must be presented at technical inspection.

EV5.2.4 It must be possible to open the accumulator container for technical inspection.

EV5.2.5 Each accumulator container must be removable from the vehicle while still remaining rules compliant without the need to install extra components.

EV5.2.6 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 20 mm high on the lid of each accumulator container. The characters must be clearly visible and placed on a high contrast background.

EV5.3 Tractive System Accumulator – Electrical Configuration

EV5.3.1 If the container is made from an electrically conductive material, the insulation barrier must be adequately protected against conductive penetrations.

EV5.3.2 Every accumulator container must contain at least one fuse and at least two accumulator isolation relays, see EV5.3.6

EV5.3.3 Each segment must be electrically insulated by the use of suitable material between the segments in the container and on top of the segment to prevent arc flashes caused by inter segment contact or by parts/tools accidentally falling into the container during maintenance. Air is not considered to be a suitable insulation material in this case

EV5.3.4 GLVS must not be included in the accumulator container except where inherently required. Exceptions include the AIRs, HV DC/DC converters, the Battery Management System (BMS), the IMD and cooling fans.

EV5.3.5 Maintenance plugs, additional contactors or similar must allow electrical separation of all internal cell segments, see EV5.3.2. The separation must affect both poles of all segments including first and last segment.

EV5.3.6 It must not be physically possible to electrically connect the maintenance plugs in any way other than the design intent configuration.

EV5.3.7 Maintenance plugs must not require tools to separate the segments. Maintenance plugs must be non-conductive on surfaces that do not provide any electrical connection.

EV5.3.8 It must not be physically possible to electrically connect the maintenance plugs in any way other than the design intent configuration.

EV5.3.9 Every wire used in an accumulator container, regardless of whether it is part of the GLVS or TS, must be rated to the maximum TS voltage.

EV5.3.10 Each accumulator container must have a prominent indicator, a voltmeter or a red LED visible even in bright sunlight that will illuminate whenever a voltage greater than 60 V DC or half the nominal TS voltage, whichever is lower, is present at the vehicle side of the AIRs.

EV5.3.11 The indicator must be clearly visible while disconnecting the accumulator container from the vehicles. The indicator must be clearly marked with "Voltage Indicator"

EV5.3.12 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 GLV system or removed from the vehicle.

EV5.4 Tractive System Accumulator – Mechanical Configuration

EV5.4.1 All accumulator containers must lie within and be attached to the primary structure no higher than the top of the side impact structure.

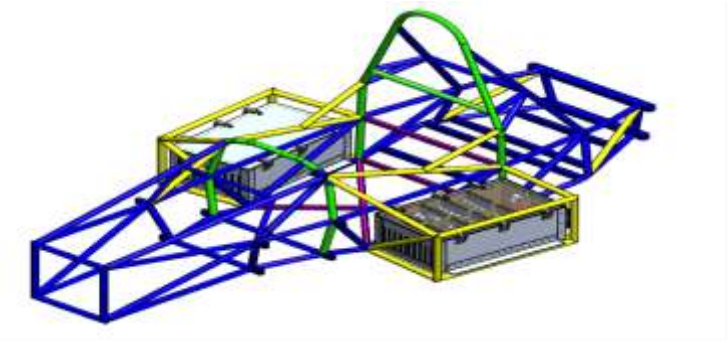

Figure 44 Acumulator container mounting example

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EV5.4.2 All accumulator container materials must be fire resistant according to UL94-V0, FAR25 or equivalent.

EV5.4.3 The accumulator containers must be protected from side or rear impact collisions by structure equivalent to that defined in rule no. T2.3. The container must not be part of this structure.

EV5.4.4 The design of the accumulator must be documented in the SES including materials used, drawings, images, fastener locations, segment weight, cell and segment position.

EV5.4.5 Accumulator containers must be constructed of steel or aluminium. With the following requirements:

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

EV5.4.6 The accumulator segments, see EV5.2.2, must be separated by an electrically insulating and fire resistant barrier according to UL94-V0, FAR25 or equivalent.

EV5.4.7 The floor and walls of the accumulator container must be joined by welds, bonding and/or fasteners.

EV5.4.8 The cells and/or segments must be appropriately secured against loosening inside the container.

EV5.4.9 All fasteners used within or to mount the accumulator container must comply with rule no.A6. Fasteners within the accumulator used for non-structural accumulator parts (e.g. PCBs etc.) do not have to follow rule no.A6 if the fasteners are made of electrically non-conductive material.

EV5.4.10 The AIRs and the main fuse must be separated with an electrically insulated and fireproof material to UL94-V0 from the rest of the accumulator. Air is not considered to be a suitable insulation material in this case.

EV5.4.11 Any brackets used to mount the accumulator container must be made of steel 1.6 mm thick or aluminium 4mm thick and must have gussets to vehiclery bending loads. Each attachment point including brackets, backing plates and inserts, must be able to withstand 20 kN in any direction.

EV5.4.12 Holes, both internal and external, in the container are only allowed for the wiring-harness, ventilation, cooling or fasteners. External holes must be sealed according to EV4.5.

EV5.4.13 A sticker according to "ISO 7010-W012" (triangle with black lightning bolt on yellow background) with triangle side length of at least 100mm and the text "Always Energized" must be applied on every accumulator container. The sticker must also contain the text "High Voltage" if the voltage is more than 60 V DC or 25 V AC.

EV5.4.14 Any accumulators that may vent an explosive gas must have a ventilation system to prevent the vented gas from reaching an explosive concentration.

EV5.4.15 Every accumulator container which is completely sealed must also have a pressure relief valve to prevent high-pressure in the container.

EV5.4.16 Cell tabs must not vehiclery mechanical loads.

EV5.5 Accumulator Isolation Relays (AIRs)

EV5.5.1 At least two AIRs must be fitted inside each accumulator container.

EV5.5.2 The AIRs must open both poles of the accumulator. If the AIRs are open, no TS voltage may be present outside of the accumulator container.

EV5.5.3 When the AIRs are opened, the voltage in the tractive system must drop to under 30 VDC (or 25 VAC RMS) in less than five seconds.

EV5.5.4 The AIRs must be of a "normally open" type.

EV5.5.5 The fuse protecting the accumulator TS circuit must have a rating lower than the maximum switch off current of the AIRs.

EV5.5.6 The AIRs must not contain mercury.

EV5.5.7 The AIRs must be mechanical relays. Solid-state relays are prohibited.

EV5.6 Battery Management System (BMS)

EV5.6.1 Each accumulator must be monitored by an BMS whenever the GLVS is active or the accumulator is connected to a charger.

EV5.6.2 The BMS must continuously measure

a. all cell voltages

b. the accumulator current

c. the temperature of thermally critical cells

d. for lithium based cells: the temperature of at least 30% of the cells equally distributed within the accumulator container(s)

EV6 SHUTDOWN CIRCUIT AND SYSTEMS

EV6.1 Shutdown Circuit

		Controlled Systems				
		Engine Starter (High Current)	GLV Supply to: Instrumentation Data acquisition Computers Telemetry Etc.	I.C. Engine Ignition Fuel pumps Starter solenoid Etc.	AIRs (TS Voltage)	Fail indication extinguishes SSOK lamps
Shutdown Sources	TSMS				OFF	NO
	Cockpit Kill switch			OFF	OFF	NO
	Interlocks*			OFF	OFF	YES
	AMS			OFF	OFF	YES
	IMD			OFF	OFF	YES
	Brake Over-travel			OFF	OFF	YES
	Side mounted Kill Switch		OFF	OFF	OFF	YES
	GLVMS	OFF	OFF	OFF	OFF	YES

*Optional interlocks as required (wheel motors, etc.)

Figure 45 Priority of shutdown sources

EV6.1.1 The shutdown circuit must consist of at least:

a) Grounded Low Voltage Master Switch (GLVMS) See: **EV76.3**
b) Tractive System Master Switch (TSMS) See: **EV6.4**
c) Two side mounted Kill Switches See: **EV6.5**
d) Cockpit-mounted Kill Switch. See: **EV6.5**
e) Brake over-travel switch. See: **T5.3**
f) A normally open (N.O.) relay controlled by the insulation monitoring device (IMD). See: **EV6.9**
g) A normally open (N.O.) relay controlled by the Battery management system (BMS). See: **EV5.6**
h) All required interlocks.

EV6.1.2 Any failure causing the GLV system to shut down must immediately deactivate the tractive system as well.

EV6.1.3 The shutdown circuit must directly vehiclery the current energizing the accumulator isolation relays (AIRs).
All components in the shutdown circuit must be rated for the maximum continuous current in the circuit (i.e. AIR and relay current).

***Note**: A normally-open relay may be used to control AIR coils upon application to the rules committee.*

EV6.1.4 In the event of an AMS, IMD or Brake over-travel fault, it must not be possible for the driver to re-activate the tractive system from within the cockpit. This includes "cycling power" through the use of the cockpit shutdown button.

***Note:** Resetting or re-activating the tractive system by operating controls which cannot be reached by the driver is considered to be working on the vehicle.*

EV6.1.5 Electronic systems that contain internal energy storage must be prevented from feeding power back into the vehicle GLV circuits in the event of GLV shutdown.

EV6.2 Master Switches

EV6.2.1 Each vehicle must have two Master Switches:

a) Grounded Low Voltage Master Switch (GLVMS)
b) Tractive System Master Switch (TSMS).

EV6.2.2 Both master switches must be located on the right side of the vehicle, in proximity to the Main Hoop, at the driver's shoulder height and be easily actuated from outside the vehicle.

EV6.2.3 Both master switches must be of the rotary type, with a red, removable key, similar to the one shown in **Figure 46.**

EV6.2.4 The master switches are not allowed to be easily removable, e.g. mounted onto removable body work.

EV6.2.5 The function of each switch must be clearly marked with "GLV" and "TSV".

EV6.2.6 The "ON" position of both switches must be parallel to the fore-aft axis of the vehicle.

EV6.3 Grounded Low Voltage Master Switch (GLVMS)

EV6.3.1 The GLVMS is the highest priority shutdown and must disable power to all GLV electrical circuits. This includes the alternator, lights, fuel pump(s), I.C. engine ignition and electrical controls.

EV6.3.2 All GLV current must flow through the GLVMS.

EV6.3.3 Vehicles with GLV charging systems such as alternators or DC/DC converters must use a multi-pole switch to isolate the charging source from the GLV.

EV6.4 Tractive System Master Switch (TSMS)

EV6.4.1 The TSMS must open the Tractive System shutdown circuit.

EV6.4.2 The TSMS must be identified with a label with a red lightning bolt in a blue triangle. (See **Figure 47**)

EV6.4.3 The TSMS must be the last switch in the loop vehiclerying the holding current to the AIRs.

Figure 46 Typical Master Switch

Figure 47 International Kill Switch Symbol

EV6.5 Kill switch

EV6.5.1 There must be **three kill switches** in the vehicle.

EV6.5.2 They should be placed in such a way that one can be easily accessed by driver and other should be mounted to the back of roll hoop on both left & right side as shown in figure 48 with yellow circle.

EV6.5.3 Kill switch must be of bright red colors so that it can clearly visible from a long distance.

EV6.5.4 It should be push to off type, it should not be simple push button which retraces after the button is pressed, also home appliance switches should not be used as kill switches.

Kill Switch	
	
ALLOWED KILL SWITCH	**NOT ALLOWED SWITCH**

Figure 48 Kill switch

EV6.6 Kill Switch Mounting

EV6.6.1 The kill switch must be installed properly and rigidly in a case.

EV6.6.2 Mounting the kill switch with plastic/metallic ties or wires is strictly prohibited.

EV6.6.3 Mounting of kill switch on fire wall of roll hoop is strictly prohibited but should be rigidly mounted using the outer cases.

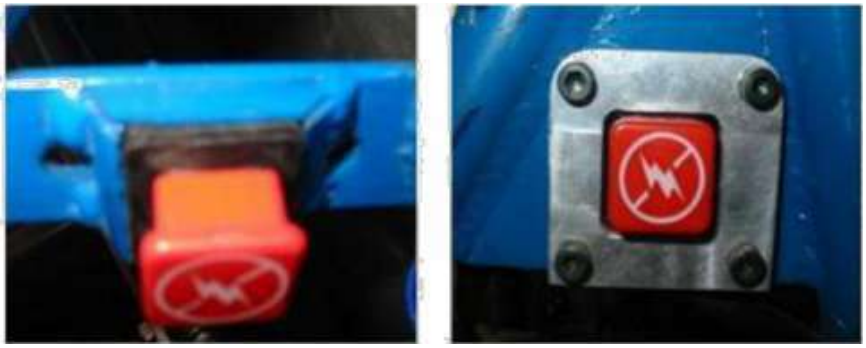

Figure 49 Kill switch mounting

EV6.7 Kill switch sticker

There must be a sticker on which kill switch is written with arrow sign in red color, showing position of kill switch.

Figure 50 Kill switch sticker

EV6.8 Vehicle Start button

EV6.8.1 The GLV system must be powered up before it is possible to activate the tractive system shutdown loop.

EV6.8.2 After enabling the shutdown circuit, at least one action, such as pressing a "start" button must be performed by the driver before the vehicle is "ready to drive". I.e. it will respond to any accelerator input.

EV6.8.3 The "start" action must be configured such that it cannot inadvertently be left in the "on" position after system shutdown.

EV6.9 Insulation Monitoring Device (IMD)

EV6.9.1 Every vehicle must have an insulation monitoring device (IMD) installed in the tractive system.

EV6.9.2 The IMD must be a Bender24 A-ISOMETER ® iso-F1 IR155-3203 or IR155-3204 or equivalent IMD approved for automotive use.
Equivalency may be approved by the rules committee based on the following criteria: robustness to vibration, operating temperature range, availability of a direct output, a self-test facility and must not be powered by the system which is monitored.

EV6.9.3 The response value of the IMD needs to be set to no less than 500 ohm/volt, related to the maximum tractive system operation voltage.

EV6.9.4 In case of an insulation failure or an IMD failure, the IMD must shut down all the electrical systems, open the AIRs and shut down the I.C. drive system. (Some GLV systems such as accumulator cooling pumps and fans, may remain energized – See **Figure 45**).

EV6.9.5 The tractive system must remain disabled until manually reset by a person other than the driver. It must not be possible for the driver to re-activate the tractive system from within the vehicle in case of an IMD-related fault.

EV6.9.6 Latching circuitry added by teams to comply with **EV6.9.6** must be implemented using electro-mechanical relays.

EV6.9.7 The status of the IMD must be displayed to the driver by a red indicator light in the cockpit. (See **EV7.3**)

***Note**: The electrical inspectors will test the IMD by applying a test resistor between tractive system (positive or negative) and GLV system ground. This must deactivate the system. Disconnecting the test resistor may not re-activate the system. I.e. the tractive system must remain inactive until it is manually reset.*

EV6.10 Low Voltage Batteries

EV6.10.1 Teams can also use a separate battery of max 12V, for the low voltage functions.

EV6.10.2 Low voltage batteries are all batteries except tractive system batteries of electric vehicles.

EV6.10.3 Low voltage batteries must be attached securely to the chassis.

EV6.10.4 Low voltage batteries must be located within the rollover protection envelope.

EV6.10.5 Any wet-cell battery located in the driver compartment must be enclosed in a non-conductive, water proof (according to IPX7 or higher, IEC 60529) and acid resistant container.

EV6.10.6 Low voltage batteries must have a rigid and sturdy casing.

EV6.10.7 The hot (ungrounded) terminal must be insulated.

EV6.10.8 Low voltage batteries must be protected for short circuits.

EV7 SYSTEM STATUS INDICATORS

EV7.1 Tractive System Active Lamp (TSAL)

EV7.1.1 The vehicle must be equipped with a TSAL mounted under the highest point of the main roll hoop which must be lit and clearly visible any time the AIR coils are energized.

EV7.1.2 The TSAL must be red.

EV7.1.3 The TSAL must flash continuously with a frequency between 2 Hz and 5 Hz.

EV7.1.4 It must not be possible for the driver's helmet to contact the TSAL.

EV7.1.5 The TSAL must be clearly visible from every horizontal direction, (except for the small angles which are covered by the main roll hoop) even in very bright sunlight.

EV7.1.6 The TSAL must be visible from a person standing up to 3 m away from the TSAL itself. The person's minimum eye height is 1.6 m.

***NOTE**: If any official e.g. track marshal, scrutineer, etc. considers the TSAL to not be easily visible during track operations the team may not be allowed to compete in any dynamic event before the problem is solved.*
It is prohibited to mount other lights in proximity to the TSAL.
EV7.1.7 The TSAL must be lit and clearly visible any time the voltage outside the accumulator containers exceeds 32 V or 1/3 the maximum bus voltage, whichever is higher.

EV7.1.8 The TSAL system must be powered entirely by the tractive system and must be directly controlled by voltage being present at the output of the accumulator (no software control is permitted).

EV7.1.9 TS wiring and/or voltages must not be present at the TSAL lamps themselves.

EV7.2 Safety Systems OK Lamps (SSOK)

EV7.2.1 There must be two SSOK lamps. One mounted on each side of the roll bar in the vicinity of the side-mounted Kill switches (**EV6.5**) that can easily be seen from the sides of the vehicle.

EV7.2.2 They must be Amber, complying with DOT FMVSS 108 for trailer clearance lamps[25]. See **Figure 51**

EV7.2.3 They must be clearly labeled "**SSOK**".

EV7.2.4 They must be illuminated by the logical AND of the following systems:

a) GLV Master Switch
b) Both side-mounted shutdown buttons (BRBs)
c) Brake over-travel switch
d) Accumulator Monitoring System (AMS)
e) Insulation Monitoring Device (IMD)
f) Any additional required interlocks

I.e. if any of the systems listed above indicates a fault, the SSOK indicators must extinguish.

EV7.2.5 The SSOK lamps must not be extinguished by operating either:

a) The cockpit shutdown button **OR**
b) The tractive System Master Switch (TSMS).

Figure 51 Typical SSOK Lamp

EV7.3 Insulation Monitoring Device Indicator

EV7.3.1 The status of the IMD must be shown to the driver by a red indicator light in the cockpit that is easily visible even in bright sunlight. This indicator must light up if the IMD detects an insulation failure or if the IMD detects a failure in its own operation e.g. when it loses reference ground.

EV7.3.2 The IMD indicator light must be clearly marked with the lettering “IMD” or “GFD” (Ground Fault Detector).

EV7.4 Accumulator Voltage Indicator

EV7.4.1 Any removable accumulator container must have a prominent indicator, such as an LED, that is visible through a closed container that will illuminate whenever a voltage greater than 30 VDC is present at the vehicle side of the AIRs.

EV7.4.2 The accumulator voltage indicator must be directly controlled by voltage present at the container connectors using analog electronics. No software control is permitted.

EV8 CHARGERS

EV8.1 Chargers General Requirements

EV8.1.1 TS charging leads must be orange.

EV8.1.2 When charging, the BMS must be live and must be able to turn off the charger in the event that a fault is detected.

EV8.1.3 The charger must include a push type emergency stop button which has a minimum diameter of 24 mm and must be clearly labeled.

EV8.1.4 When charging the accumulator, an IMD as described in C6.6 must be active and 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. An IMD indicator light must be available during charging.

EV9 TRACTIVE SYSTEM PROCEDURES AND TOOLS

EV9.1 Working on the Tractive System

EV9.1.1 Activities on the TS, except for the accumulator must take place in the pit.

EV9.1.2 For activities on the inactive TS, the following procedure must be vehicleried out:

1. Barrier off the vehicle from anyone not involved in the work, by using barrier tape.
2. Make sure the Tractive System Master Switch (TSMS) is switched off.
3. Assure that the TS cannot by restarted, by, at a minimum, using the lockout/tag out of the TSMS.
4. Check for zero-potential.
5. Install a sign that declares the vehicle is electrically safe.

EV9.1.3 In 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:

1. This activity can be done only in the supervision of PIT CONTROL OFFICER (PCO)
2. Make a note of the name of an PIT CONTROL OFFICER (PCO) who is supervising the activities on the sign. This PCO is the only person who may remove the sign and the barrier.
3. Barrier off the vehicle from anyone not involved in the work, by using barrier tape.

4. The vehicle must be jacked up and the driven wheels removed.
5. One team member must be prepared to push a shutdown button at any time.\
6. The TS must only be activated for as long as necessary.
7. Appropriate insulated tools and equipment must be used.
8. Safety glasses with side shields and compliant safety gloves must be worn by all participating team members when parts of the TS are exposed.
9. No other work on the vehicle is permitted when the TS is active.

EV9.1.4 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.

EV9.2 Working on Tractive System Accumulators

EV9.2.1 Opening or working on accumulator containers is only allowed in the provided work places in the charging area, see rule no.EV9.3

EV9.2.2 Whenever the accumulator containers are opened, the cell segments must be separated with the maintenance plugs.

EV9.2.3 Appropriate insulated tools and equipment must be used.

EV9.2.4 Safety glasses with side shields and compliant safety gloves must be worn by all participating team members.

EV9.2.5 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.

EV9.2.6 Additional safety measures may be included in the respective competition handbook.

EV9.3 Charging

EV9.3.1 There will be a separated charging area on the competition site. Charging TS accumulators is only allowed inside this area.

EV9.3.2 Accumulators must be removed from the vehicle and placed on the accumulator container hand vehiclet, see C8.4, for charging.

EV9.3.3 No grinding, drilling, etc. is allowed in the charging area.

EV9.3.4 At least one team member who has knowledge of the charging process must stay with the accumulator(s) during charging.

EV9.3.5 Moving accumulator cells and/or accumulator segment(s) around at the competition site is only permitted if they are inside a completely closed accumulator container.

EV9.4 Accumulator Container Hand Vehiclet

EV9.4.1 The hand vehiclet(s) must be used for transporting the accumulator container(s) around the competition site.

EV9.4.2 The hand vehiclet must have a brake which is always on and only released if someone pushes the handle, or similar.

EV9.4.3 The brake must be capable of stopping the fully loaded accumulator container hand vehiclet.

EV9.4.4 The hand vehiclet must be able to vehiclery the load of the accumulator container(s).

PART F FINAL EVENT

Selected teams from virtual round will participate in the final event with the Vehicle fabricated by them; all teams will undergo TECHNICAL INSPECTION and BRAKE TEST. After passing both the test, team will be permitted to participate in dynamic rounds of the event.

F1 TECHNICAL INSPECTION (TI)

F1.1 General Technical Requirements

F1.1.1 Teams are responsible for confirming that their vehicle and the required equipments satisfy the requirements and restrictions of the rules before presenting it for technical inspection.

F1.1.2 Vehicles must be presented for technical inspection in finished condition, i.e. fully assembled, completed and ready-to-run. Technical inspectors will not inspect any Vehicle presented for inspection in an unfinished state.

F1.1.3 Visible access can be provided by removing body panels or by providing removable access panels to check the various components.

F1.1.4 Each Vehicle must pass all stages of technical inspection and testing before it is permitted to participate in any dynamic event. The exact procedures and instruments employed for inspection and testing are entirely at the discretion of the Chief Technical Inspector.

F1.1.5 TI does not have any points, but it is mandatory for the teams to qualify this round to participate in the another qualifying round Brake Test.

F1.1.6 The technical inspection sheet includes all inspection points and will be provided on the event site. It must always stay with the vehicle.

F1.1.7 The TI sheet must be submitted at control room on every day of final event before site closed.

F1.1.8 The Technical Inspector (s) may inspect other points not mentioned on the technical inspection sheet to ensure compliance with the rules.

F1.1.9 The vehicle must maintain all required specifications throughout the competition.

F1.1.10 Each team must present a quick jack to lift up the vehicle during technical inspection

F1.1.11 A maximum of three team members including tallest driver may enter the inspection area at one time.

F1.2 Modification and repair

F1.2.1 Once the vehicle has been presented for judging in the Design Events, or submitted for Technical Inspection, and until the vehicle is approved to compete in the dynamic events, i.e. all the inspection stickers are awarded, the only modifications permitted to the vehicle are those directed by the Inspector(s) and noted on the Inspection Form.

F1.2.2 Once the vehicle is approved to compete in the dynamic events, the ONLY modifications permitted to the vehicle are:

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 inserts for different drivers
e. Adjustment of mirrors
f. Adjustment of the suspension where no part substitution is required, (except that springs, sway bars and shims may be changed)
g. Adjustment of wing angle (but not the location)
h. Adjustment of tyre pressure
i. Replacement of worn tyres or brake pads
j. Recharging of Grounded Low Voltage (GLV) supplies
k. Recharging of Accumulators.

F1.2.3 The vehicle must maintain all required specifications, e.g., suspension travel, braking capacity, throughout the competition.

F1.2.4 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.

F1.3 Driver's Safety Equipment Inspection

F1.3.1 At this inspection driver's equipment are checked for compliance with the rules.

F1.3.2 The driver's safety inspection sheet includes all inspection points and will be provided on the competition website prior to the competition. The same sheet will be checked during the onsite Pre-Technical Inspection.

F1.3.3 Two drivers or any other two members of a Team with complete safety equipment as mentioned in PART T9 must be present at driver's safety inspection area.

F1.3.4 Team must have two (2) separate set of complete driver's safety equipment as mentioned in PART T9.

F1.3.5 During this inspection, drivers are not required to wear the safety equipment so that Inspector can check any damage or torn part of any safety equipment mentioned in PART T9.

F1.4 Electrical Inspection

F1.4.1 Electrical Inspection Objective- During the electrical inspection, all electrical parts and systems of the vehicle are checked for compliance with the rules.

F1.4.2 Accumulator 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.

F1.4.3 The accumulator charger will be inspected and sealed.

F1.4.4 The following items must be presented at electrical inspection:

- All TS and accumulators mounted on vehicle.
- Accumulator hand vehiclet
- Accumulator charger
- Data sheets for all parts used in the accumulator & the tractive system.
- Quick jack and push bar
- Samples of self designed PCBs that are part of the tractive system
- Data sheets for all parts used in
- Tools needed for the (dis)assembly of parts for electrical inspection

F1.4.5 The following basic tools in good condition must be presented:

- Insulated cable shears
- Insulated screw drivers
- Multimeter with protected probe tips
- Insulated tools, if screwed connections are used in the tractive system
- at least two pairs of HV insulating gloves (not expired)
- Safety glasses with side shields for all team members that might work on the tractive system or accumulator

F1.4.6 All electrical safety items must be rated for at least the maximum tractive system voltage.

F1.5 Mechanical Inspection

F1.5.1 Mechanical Inspection Objective- During the mechanical inspection, all mechanical parts of the vehicle are checked for compliance with the rules.

F1.5.2 The following items must be presented at mechanical inspection:

- The vehicle
- Quick jack and push bar
- The tallest driver of the team
- Copies of any safety structure equivalency forms
- Copies of any impact attenuator data requirement
- Impact attenuator test piece (except for teams with "standard" IA)
- Teams with a monocoque: laminate test specimen(s)
- Only tools needed for the (dis)assembly of parts for mechanical inspection

F1.6 Tilt Test

F1.6.1 Tilt Test Objective- The tilt test is to evaluate the rollover stability of the vehicle and to check for any fluid leaks.

F1.6.2 Tilt Test Procedure

- The tilt test will be conducted with the tallest driver fully strapped in normal driving position.
- The tilt test will be conducted with all vehicle fluids at their maximum fill level.
- The vehicle will be placed upon the tilt table and to an angle of 45°. There must be no fluid leaks.
- If the vehicle passes on angle of 45°, the angle is increased to 60° representing a cornering force of 1.7 g. All wheels must remain in contact with the tilt table surface at this angle.

F1.7 Weight Test

F1.7.1 Weight Test Objective- At the vehicle weighing, the vehicle's official technical inspection weight is determined.

F1.7.2 Procedure-

- All vehicles must be weighed in ready-to-race condition.
- All fluids must be at their maximum fill level for weighing.

F1.7.3 Scoring Formula:
F1.7.4 Those vehicle will exceed the weight limit of 250Kg (excluding driver) will be scored 0 (zero).

F1.8 Corrections and Disqualification

F1.8.1 If a Vehicle is deemed to a concern or does not comply with the rules, then correction must be done to get re-inspected. Only 2 attempts will be given to clear their TI.

F1.8.2 Decisions of the inspectors and the Chief Technical Inspector concerning vehicle compliance are final and are not permitted to be appealed.

F1.9 Questionnaire

F1.9.1 There will be a questionnaire round to any of the team members by the judges. Questions will be related to manufacturing of the Vehicle and other technical aspects of the Vehicle. Engineering practices of the teams is also evaluated here.

F2 BRAKE TEST

F2.1 Objective

F2.1.1 All the electric and hybrid Vehicles have to pass the brake test to participate in any of the dynamic events.

F2.1.2 Hybrid Teams have to run their vehicle on power mode during brake Test.

F2.1.3 On application of brakes, all 4 wheels should lock immediately and hence the Vehicle must stop in a straight line after the brake is applied on the Vehicle.

F2.1.4 Every vehicle will get maximum 3 attempts. (Teams should focus mainly on locking of wheels at the time of application of brake).

F2.1.5 Vehicles having any leakage of brake fluid from any point of braking circuit will not be allowed to appear for brake test.

F2.1.6 Brake test should be attempted by the vehicle at the given speed within that limited distance and full force should be applied by the driver on the brake pedal in order to stop the vehicle.

F2.1.7 Brake Test does not have any points, but it is mandatory for the teams to qualify this round to participate in the dynamic round.

F2.1.8 Speed of the vehicle- During this test teams must maintained at least 30Km/hour speed. If team fail to maintained this much speed, there attempt will be not taken in consideration.

F2.1.9 Procedure- Drivers have to run their vehicle in straight way for 50 Meters. There will be a brake line whenever vehicle touching that line driver required to apply brake at the same. All four wheel must be lock in a straight line.

F2.1.10 Did Not Attempt (DNA)- If the Vehicle did not attempt or if it does not complete the event, then those teams would receive DNA. And after all attempt team will not allow to participate in any dynamic event.

F3 BUSINESS PLAN PRESENTATION EVENT (BPP)

F3.1 Business Plan Presentation Objective

F3.1.1 The objective of the BPP is to evaluate the team's ability to develop and deliver a comprehensive business model which demonstrates their product – a prototype race vehicle – could become a rewarding business opportunity.

F3.1.2 The judges should be treated as if they were potential investors or partners for the presented business model.

F3.1.3 The business plan must relate to the specific prototype race vehicle entered in the competition. The quality of the actual prototype will not be considered as part of the BPP judging.

F 3.2 Business Plan Presentation Procedure

F3.2.1 The BPP must be submitted at control room on first day of final event before the deadline. The same PPT will be displayed during the Team slot for BPP.

F3.2.2 Team can be announced any time during the BPP round, Team members for BPP must be ready.

F3.2.3 Presentations are limited to a maximum of ten minutes. The judges will stop any presentation exceeding ten minutes.

F3.2.4 The presentation will not be interrupted by questions. Immediately following the presentation there will be a question and answer session.

F3.2.5 One or more team members may present the business plan. Maximum 5 members are allowed.

F3.2.6 All team members involved in the BPP must be in the podium area and must be introduced to the judges at the beginning of the presentation. The team members who have been introduced may answer the judges' questions even if they were not actually presenting.

F3.2.7 Data projectors or screens with VGA and HDMI (type A) input connectors will be provided for video signal transmission. Teams planning to use audio or other presentation equipment are responsible for bringing it themselves.

F3.2.8 Teams that fail to make their presentation within their assigned time period will receive zero points for the BPP.

F3.3 Executive Summary

F3.3.1 To convince the potential investors or partners that the team's presentation is worthy of their time, it is required that an executive summary is submitted before the competition. The executive summary should contain a brief description of the team's business plan.

F3.3.2 The executive summary must not exceed one page. The vehicle number and university (or college) name must be written in the top right corner.

F3.3.3 The executive summary must be submitted online via the competition website, not later than the deadline given by mail and published on website.

F3.3.4 If the executive summary is not compliant with the rules, 5 penalty points are deducted from the final BPP score.

F3.4 Business Plan Presentation Scoring

F3.4.1 The BPP will be evaluated on the categories specified in the following table:

Category	Points
Executive Summary	10
Novelty	10
Content	20

Finances	10
Deep Dive Topic	10
Demonstration and Structure	15
Delivery	10
Questions	10
General Impression	5
Total	100

Table 6: B Plan Presentation Scoring

F3.4.2 The judging at the competition will start with an initial judging, where all teams are judged by different judging groups. The top three to five teams are then judged by all business judges in the BPP finals.

F3.4.3 The scoring of the BPP is based on the average of the scores given by each of the judges.

F4 COST AND MANUFACTURING EVENT

F4.1 Cost and Manufacturing Objective

F4.1.1 The objective of the cost and manufacturing event is to evaluate the team's understanding of the manufacturing processes and costs associated with the construction of a prototype race vehicle. This includes trade off decisions between content and cost, make or buy decisions and understanding the differences between prototype and mass production.

F4.2 Cost and Manufacturing Procedure

F4.2.1 Prior to the competition, Cost Report must be submitted to the competition website by the deadline intimated through mail and news on website.

F4.2.2 During the competition, a discussion with the judges will take place, next to the team's vehicle. The discussion is split into two parts:

F4.2.3 Part 1 "Cost Report (CR) Discussion":

A discussion to evaluate the team's ability to prepare an accurate engineering and manufacturing cost for the complete vehicle. The team must prove the following:

- The specification of the vehicle in the CR accurately reflects the vehicle brought to the competition.
- The costs within the Costed Bill of Material mentioned in cost report are correct and realistic.
- The manufacturing feasibility of the vehicle.

F4.2.4 Part 2 "Cost Understanding":

A discussion to evaluate the general cost and manufacturing knowledge of the team. The following topics might be judged:

- Differences between prototype and mass production
- Resource and cost planning
- Financial and production risk management

- Make or buy decisions
- Environmental influence of the vehicle production
- Effectiveness of financial planning

F 4.2.5 Teams are allowed to bring electronic, handwritten, or printed handouts, flip charts or similar to the event, but the space available may be limited.

F4.2.6 If the team takes too long, blocks the bay or does not show up on-time, five penalty points will be deducted from the team's cost event score.

F4.3 Cost Report (CR)

F4.3.1 The CR format will be created online on the competition website. The website tool will provide a printable pdf version of the CR format.

F4.3.2 Team need to share the CR in format given to the mail Id (formulaimperial@imperialsociety.in) within the deadline.

F4.3.3 An addendum for the CR is not possible and changes will not be permitted after the deadline.

F4.3.4 All CR documents must be brought as one hard copy and one digital version, two hard copies or a split table folder of the CR to the event discussion.

F4.3.5The hard copy must be in a ring binder with DIN A4 pages (or similar).

F4.3.6 The hard copy must be identical to the uploaded version, otherwise five penalty points will be deducted from the team's cost event score.

F4.4 Cost and Manufacturing Scoring

F4.4.1 The following maximum scores apply for the cost and manufacturing event:

Category	Points
Format and Accuracy of Documents	5
Knowledge of Documents and Vehicle	5
Content and Completeness of the Cost Report	20
Realism of Cost Report	20
Discussion Part 2 "Cost Understanding"	50
Total	100

Table 7: Cost and Manufacturing Scoring

F5 ENGINEERING DESIGN EVENT

F5.1 Engineering Design Objective

F5.1.1 The concept of the design event is to evaluate the student's engineering process and effort that went into the design of a vehicle, meeting the intent of the competition.

F5.1.2 Proprietary components and systems that are incorporated into the vehicle 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.

F5.2 Design Report (DR)

F5.2.1 The DR should contain a brief description of the overall vehicle with a review and derivation of the team's design objectives. Any information to scope, explain or highlight design features, concepts, methods or objectives to express the value and performance of the vehicle to the judges shall be included at the teams' discretion.

F5.2.2 The DR must not exceed eight pages, consisting of not more than five pages of content (text, which may include pictures and graphs) and three pages of drawings.

F5.2.3 The three DR drawings (no renderings) must show the vehicle from the front, the top and the side. Each drawing must appear on a separate page.

F5.2.4 Any measures to facilitate reviewing the drawings (e.g. measurements, details, colors) may be utilized at the teams' discretion.

F5.2.5 Any portions of the DR that exceed five pages of content and/or three pages of drawings will not be evaluated.

F5.2.6 If included, cover sheets and tables of contents will count as text pages.

F 5.2.7 The DR will be used to sort the teams into appropriate design queues based on the quality of its review.

F 5.2.8 Evidence of information mentioned in the DR should be brought to the competition and be available, on request, for review by the judges.

F5.3 Design Spec Sheet (DSS)

F5.3.1 A completed DSS must be submitted online on the mail id: formulaimperial@imperialsociety.in

F5.4 Engineering Design Procedure

F5.4.1 The design event starts with the submission of the DSS & Design Report (DR) and their review respectively.

F5.4.2 At the competition, teams will present their knowledge and their vehicle to the judges, which will evaluate the teams' performance following the design objectives stated in chapter F5.1.

F5.5 Engineering Design Judging Criteria

F5.5.1 The judges will evaluate the engineering effort based upon the team's design report and responses to questions and an inspection of the vehicle.

F5.5.2 The judges will inspect the vehicle to determine if the design concepts are adequate and appropriate for the application (relative to the objectives set forth in the rules).

F5.5.3 The judges may deduct points if the team cannot adequately explain the engineering and construction of the vehicle.

F5.6 Engineering Design Scoring

F5.6.1 The overall engineering design event maximum scoring is 150 points.

F5.6.2 The maximum scores listed in Table 5 apply for the engineering design event.

Category	Points
Design consideration (Design & Analysis)	25
Vehicle Dynamics Knowledge	25
Aesthetics	25
Safety and Ergonomics	25
Team Knowledge	5
Manufacturing consideration in Design	15
Knowledge of type of transmission system and transmission system used	10
Electrical / Electronic	20
Total	150

Table 8: Maximum scores in engineering design event

F6 INNOVATION ROUND

F6.1 Innovation Round Objective

F6.1.1 ISIEINDIA strongly believe in smart technology and innovation. So, we recommend to all the teams to develop some innovation in their vehicle.

F6.1.2 There is a best innovation award for the team.

F6.2 Innovation Round Procedure

F6.2.1 The Innovation round starts with the submission of the Innovation Report and their review respectively.

F6.2.2 At the competition, teams will present their knowledge and their innovations to the judges, which will evaluate the teams' performance following the innovation objectives.

F6.5.4 Teams may bring any photographs, videos and dummy that they believe are supportive to the innovation round, but the space provided for design judging may be limited.

F6.3 Innovation on Vehicle Condition

F6.3.1 Innovations must be presented for innovation judging in finished condition, fully assembled, mounted on vehicle, complete and in running condition.

F6.3.2 The judges will not evaluate any innovation that is presented in Innovation report, If it is in an unfinished state and Team will award zero points for the entire Innovation Round.

F6.3.4 Covers and/or parts may be removed during the design judging to facilitate access and presentation of components or concepts.

F6.4 Innovation Round Scoring

F6.4.1 The maximum scores listed in Table 6 apply for the engineering design event.

Category	Points
Concept of Innovation & Ideation	10
Scope of Concept	20
Sketching of Innovation to product	10

Developing Process	20
Cost Vs Market Value	20
Contribution to Green Transport	20
Any other (extra mark based on jury)	
Total	100

Table 9: Maximum scores in engineering design event

F7 ACCELERATION TEST

F7.1 Objective

F7.1.1 The acceleration event evaluates the Vehicle's acceleration in a straight line on flat pavement for hybrid as well as electric vehicle.

F7.2 Procedure

F7.2.1 The vehicles will accelerate from a standing start over a distance of 50 m on a flat surface.

F7.2.2 The foremost part of the Vehicle will be staged at exactly behind the starting line. The time taken to accelerate would be measured.

F7.2.3 There will be separate rounds for the acceleration for hybrid and electric Vehicles.

F7.2.4 Best Acceleration Award will be separate for electric and hybrid vehicle.

F7.2.5 Two attempts will be given to each team of Hybrid Vehicle (HV) Category

- First Attempt: Vehicle must be run on power mode.
- Second Attempt: Vehicle must be run on economy mode.

F7.2.6 Both the attempts are compulsory for HV Category mentioned in F7.2.5. Average of both the attempts will be counted.

F7.2.7 For EV Category only one attempt will be given for acceleration test.

F7.3 Scoring

F7.3.1 The acceleration score is based upon the corrected elapsed time. Elapsed time will be measured from the time the vehicle crosses the starting line until it crosses the finish line.

F7.3.2 Scoring formula: 100 × [(T longest – T yours)/ (T longest- T shortest)]

F7.4 Penalty

H1.4.1 Cones Down or Out: 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.

F7.5 Did Not Attempt (DNA)

F7.5.1 If the Vehicle did not attempt or if it does not complete the event, then those teams would receive DNA.

F8 CROSS PAD

F8.1 Objective

F8.1.1 In this round the vehicle should be driven through a track specified by the organizers.

F8.1.2 This round checks the maneuverability of vehicle, to measure the Vehicle's cornering ability on a flat surface while making a constant-radius turn and driver's skill.

F8.2 Cross Pad Layout

F8.2.1 There will be two (2) pairs of concentric circles in a figure of eight pattern.

F8.2.2 The centers of these circles will be 13m apart. The inner circles will be 10m in diameter, and the outer circles will be 16m in diameter.

F8.2.3 The driving path will be the 3m (9.842 feet) path between the inner and outer circles.

F8.2.4 The Vehicles will enter and exit through gates on a 3 m wide path that is tangential to the circles where they meet.

F8.2.5 After completing 8 pattern shapes. It (Vehicle) will pass through a multiple movement on either side path, where cones are placed in such a way that the Vehicle will make sinusoidal wave pattern about cones without touching them.

F8.2.6 There are 6 cones at a distance of 3m each and 1 cone at a center of circle of radius 6 m.

F8.2.7 Tires will be placed as an extreme stopping point at a distance of 10m from exit gate. The path for cross pad is described in the figure given below:

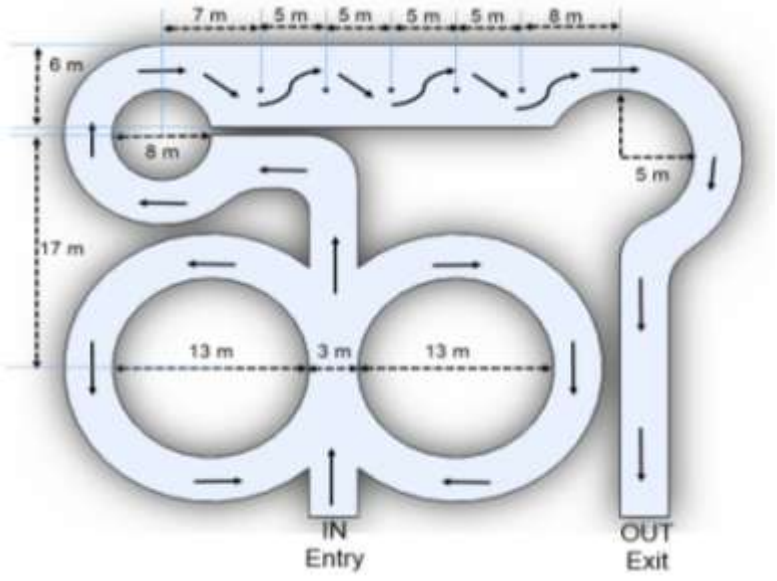

Figure 52 Cross Pad track

F8.3 Procedure

F8.3.1 The track is laid as shown in figure 52 and vehicles will enter the track perpendicular to the figure eight.

F8.3.2 They must take one full lap on the right circle to establish the turn and vehicle must move on to the left circle to complete the lap. This completes one lap.

F8.3.3 After that vehicle have to move for multiple movement on either side path or revolve about center cone. Finally Vehicle will move to the exit gate.

F8.3.4 Driver has to stop his/her vehicle within 10m after exit gate.

F8.3.5 For HV category it is team's choice to run vehicle in any mode of the two (power mode or hybrid mode).

F8.4 Scoring formula

F8.4.1 Scoring formula: 300 × [(T max–T yours)/ (T max- T min)]

F8.4.2 Each team may make only single attempt with any of the driver.

F8.5 Penalties

F8.5.1 Cones Out/touch- A penalty of 1 second will be added to the time for every cone that is knocked out/touch (including gate cones).

F8.5.2 Cone Down- A penalty of 2 seconds will be added to the time for every cone that is knocked down (including gate cones).

F8.5.3 Missing cone- A penalty of 5 seconds will be added for missing a cone during multiple movement on either side path.

F8.5.4 Unfinished- Go-Vehicles that has gone out of the track will continue as long as they have not gone off course will be classified as Unfinished.

F8.5.5 Incorrect Laps- Go-Vehicles that do not follow procedure, i.e. run an incorrect number of laps or run the Laps in the wrong sequence will also be classified as unfinished.

F8.5.6 Tire touch/hit- A penalty of 50 points will be added if driver don't stop the vehicle within 10 m after exit gate.

F8.5.7 Skit-A penalty of 50 points will be added if driver intentionally skits/drift the vehicle after exit gate.

F9 ENDURANCE EVENT

F9.1 Objective

The endurance event is designed to evaluate the Vehicle's overall performance, reliability and efficiency.

F9.2 Endurance Track Layout

F9.2.1 The endurance track layout is a closed lap circuit built to the following guidelines:

(a) **Straights**: No longer than 40.0 m (132 feet) with hairpins at both ends (or) no longer than 35.0 m (115 feet) with wide turns on the ends. There will be passing zones at several locations.
(b) **Constant Turns**: 20.0 m (65.5 feet) to 45.0 m (147.5 feet) diameter.
(c) **Hairpin Turns**: Minimum of 9.0 m (29.5 feet) outside diameter (of the turn).
(d) **Slaloms:** Cones in a straight line with 10.0 m (32.8 feet) to 15.0 m (49.2 feet) spacing.
(e) **Minimum Track width:** The minimum track width will be 4.5 m (14.76 feet).

(f) **Miscellaneous**: The organizers may include various turns or decrease the turns and the other specifications according to the situation.

F9.2.2 The length of one lap of the endurance track is approximately 1 km.

F9.2.3 The length and layout may be differing as per availability of sub track or main track.

F9.3 Procedure& Specifications

F9.3.1 For HV category it is compulsory to run vehicle on Hybrid mode during endurance.

F9.3.2 In general, the team completing the laps in the shortest time will earn the maximum points available for this event. The endurance distance is approximately 20km.

F9.3.3 Driver changes will be made after completion of 10 km (half no. of laps). A driver change must be made during a three minute period at the midpoint of the run.

F9.3.4 Four (4) Wheel to wheel racing is prohibited.

F9.3.5 During the endurance event, overtaking is only permissible in the designated passing zones and under the control of the track marshals.

F9.3.6 Course speeds for vehicles can be estimated by the following course specifications. Average speed should be around 45 km/hr. (28 mph) with top speeds of approximately 80 km/hr. (50 mph).

F9.3.7 Endurance courses will be configured, where possible, in a manner which maximizes the advantage of regenerative braking.

F9.3.8 After leaving the track, the vehicle must be powered down.

F9.4 Endurance Driver Change Procedure

F9.4.1 Two drivers are compulsory for Formula Imperial-HVC 19.

F9.4.2 Each driver will drive half of the no. of laps and then be signaled into the driver change area.

F9.4.3 Only three team members including the driver may enter the driver change area. They may only bring the tools required to adjust the vehicle to accommodate the second driver.

F9.4.4 During the driver change, the team may:

- Perform changes to accommodate the second driver.
- Operate the master switch(es).

No other work may be performed during the driver change.

F9.4.5 Each team is given three minutes to change their driver.

F9.4.6 The driver change time will start once the vehicle is stopped in the driver change area and the first driver has turned off the engine and/or tractive for HV or turned off the tractive system for EVs.

F9.4.7 The first driver will climb out the vehicle and any necessary adjustments will be made to the vehicle to fit the second driver (seat cushions, head restraint, pedal position, etc.). The second driver will then be secured in the vehicle.

F9.4.8 Once the new driver is in place and an official has verified the correct adjustment of the driver restraints and safety equipment, a maximum of two (2) minutes are allowed to re-energize the electrical system, restart the Vehicle drive system and begin moving out of the driver change area.

F9.4.9 When the second driver is fully secured in the vehicle, the vehicle has restarted and is ready-to-drive again, the driver change time is stopped.

F9.4.10 If the driver change takes longer than three minutes, the extra time is included in the final time.

F9.5 Endurance Penalties:

F9.5.1 The penalties in effect during the endurance event are listed below:

- **Cone down or out:** Five (5) seconds per cone. This includes cones before the start line and after the finish line.
- **Off Course (OC):** For an off Course, the driver must re-enter the track at or prior to the missed gate or a twenty (20) second penalty will be assessed.
- **Missed Slalom:** Missing one or more gates of a given slalom will incur a twenty (20) second penalty.
- **Vehicle to Vehicle Contact:** DISQUALIFIED
- **Running Out of Order:** 2 Minutes

F9.6 Endurance Vehicle Restarting:

F9.6.1 The Vehicle must be capable of restarting without external assistance at all times once the Vehicle has begun the event.

F9.6.2 If a Vehicle stops out on the track, two min. will be given and if team is not able to make the Vehicle run in specified time, than some points will be deducted.

F9.6.3 At the end of Driver Change, the Vehicle will be allowed two (2) minutes to reenergize the electrical system and restart the Vehicle drive system.

F9.7 Breakdowns & Stalls:

F9.7.1 If a Vehicle breaks down it will be removed from the course and will not be allowed to re-enter the course.

F9.7.2 If a Vehicle spins, stalls, ingests a cone, etc., it will be allowed to restart and re-enter the course where it went off, but no work may be performed on the Vehicle.

F9.7.3 If a Vehicle stops on track and cannot be restarted without external assistance, the track workers will push the Vehicle clear of the track. At the discretion of event officials, two (2) team members may retrieve the Vehicle under direction of the track workers.

F9.8 Reckless or Aggressive Driving:

F9.8.1 Any reckless or aggressive driving behavior (such as forcing another Vehicle off the track, refusal to allow passing, or close driving that would cause the likelihood of Vehicle contact) will result in a black flag for that driver.

F9.8.2 When a driver receives a black flag signal, he/she must proceed to the penalty box to listen to a reprimand for his/her driving behavior.

F9.8.3 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.

F9.8.4 If it is impossible to impose a penalty by a stop under a black flag, e.g. not enough laps left, the event officials may add an appropriate time penalty to the team's elapsed time.

F9.9 Inexperienced Driver

F9.9.1 The Chief Marshall/Director of Operations may disqualify a driver if the driver is too slow, too aggressive, or driving in a manner that, in the sole opinion of the event officials, demonstrates an inability to properly control their Vehicle. This will result in a Did Not Finish (DNF) for the event.

F9.10 Scoring

F9.10.1 The times for the endurance event will be based upon the sum of the times of each driver in the heat plus penalties.

F9.10.2 The following equation is used to determine the time scores for the event:
If Tyour is < or = to Tmax:

$$\text{ENDURANCE SCORE} = 450 \times \frac{(T\,max/\ Tyour) - 1}{(T\,max/\ T\,min) - 1} + 50$$

If Tyour > Tmax: ENDURANCE SCORE = 0 (ZERO)
Tmin will be the lowest corrected time of the fastest team of the event.
Tyour will be the combined corrected times of both of your team's drivers in the heat. Tmax will be 1.45 times Tmin.
If ENDURANCE SCORE < Laps Comp, then ENDURANCE SCORE = LapsComp
LapsComp is the number of full laps completed by the team.

F9.10.3 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.

F10 EFFICIENCY TEST

F10.1 Objective

F10.1.1

- **For Hybrid Vehicles:** The Efficiency test is based on the average liters per kilometer fuel economy obtained during the endurance round.
- **For Electric Vehicles:** The Efficiency test is based on the average charge used from accumulator during the endurance round.

F10.1.2 The efficiency under racing conditions is important in most forms of racing and also shows how well the Vehicle has been tuned for the challenge.

F10.1.3 This is an event where optimization is needed because the efficiency score and endurance score will be calculated from the same heat. No refueling will be allowed during an endurance.

F10.2 Procedure

F10.2.1 The Vehicle's efficiency will be measured in conjunction with the endurance event.

F10.2.2

- **For Hybrid Vehicle:** Fixed amount or fuel will be given to each team after completion their laps, rest fuel will be measured.
- **For Electric Vehicle:** Potential drop of accumulator will be measured after completion of their laps.

F10.3 Scoring

F10.3.1 For Hybrid Vehicle:

$$EFF.SCORE = 100 \times \left(\frac{(\text{Fuel Efficiency Factor}}{(\text{Fuel Efficiency Factor}} \quad \frac{_{MIN}/\text{ Fuel Efficiency Factor}}{/\text{ Fuel Efficiency Factor}_{MIN}} \quad \frac{_{YOUR})-1}{_{MAX}-1} \right)$$

And

$$EFF.FACTOR = 100 \times \left(\frac{(T_{MIN}/\text{ Laptotal})}{(T_{YOURS}/\text{ Lapyours})} \right) \times \left(\frac{(V_{MIN}/\text{ Laptotal})}{(V_{YOURS}/\text{ Lapyours})} \right)$$

Where:
Vmin is the smallest volume of fuel used by any competitor, whose corrected Endurance time Tyour < 1.45 x **Tmin** on a per lap basis
Vyour is the volume of fuel used by the team being scored.
Tmin will be the lowest corrected Endurance time of the fastest team of the event.
Tyour will be the combined corrected times of the drivers in your heat.
Lapyours will be the number of laps driven by the team being scored.
Laptotal will be the number of laps completed by the teams which set Tmin and Vmin, respectively.

F11 SEMI-AUTONOMOUS ROUND (OPTIONAL)

F11.1 Definition

The specific capabilities and features of each vehicle so-equipped with semi-autonomous functions vary by teams; however, all such examples of semi autonomous vehicle require the driver to be attentive and aware of the surrounding road conditions and traffic.

F11.2 Objective

Autonomous vehicles are already under research & development of some automobile companies. Hence, skill and knowledge of semi autonomous or autonomous vehicles are required in future engineers. This round in Formula Imperial-HVC 19 provides platform for students to showcase their ideas for developing a semi autonomous vehicle.

F11.3 Procedure

F11.3.1 Teams participating in autonomous round have to bring the vehicle to the Tech inspection bay for safety check before entering the autonomous test bay.

F11.3.2 The teams after clearing autonomous technical inspection must line up at the area directed by the organizer.

F11.3.3 For autonomous test, a track is provided over which teams have to run their vehicles without driver.

F11.3.4 The points will be awarded on the basis of the maximum distance covered or the best finishing time, braking efficiency and initial acceleration control.

F11.3.5 Track length will be 50 m, having distance boards after every 10 m and the points will be awarded on the basis of the maximum distance covered in the best time with efficient braking at the finish line.

F11.3.6 If a vehicle stops in between the track or before finishing line, the team will be given maximum one minute to restart their vehicle (without touching the vehicle). If their vehicle fails to restart within one minute the scoring will be according to rule no. F11.4.2

F11.4 Scoring

F11.4.1 Teams which will cover 50m of specified distance
Scoring Formula: {(Tmax-Tyours)/(Tmax-Tmin)}x100

F11.4.2 Teams which will cover certain distance but might not able to reach the finishing line
Scoring Formula: {Distance covered (in m)/50 m}x100

F11.5 Penalties

F11.5.1 The penalty of 5 points will be allotted to the vehicle if the vehicle touches the cones used to set the track boundaries.

F11.5.2 For an off Course, the vehicle will be disqualified from the semi autonomous round and will be marked zero.

F12 FLAGS

There are two types of flags which are command flags & Informational flags. The command flags command the teams and they must obey without any question while the informational flags give us information to guide along the laps.

F12.1 Command Flags

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

- **BROWN FLAG** - Pull into the penalty box for a mechanical inspection of your Vehicle, something has been observed that needs closer inspection.

- **BLUE FLAG** - Pull into the designated passing zone to be passed by a faster competitor or competitors. Obey the course marshal's hand or flag signals at the end of the passing zone to merge into competition.

- **CHECKER FLAG** - Your segment has been completed. Exit the course at the first opportunity after crossing the finish line.

- **GREEN FLAG** - Your segment has started, enter the course under direction of the starter.

***NOTE**: If you are unable to enter the course when directed, await another green flag as the opening in traffic may have closed.*

- **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 course marshal's directions.

- **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 course marshals.

- **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 course marshals.

F12.2 Informational Flags

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

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