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Technical Rules

1.1 Vehicle Types

1.1.1 Adventure Class:

The purpose of this segment of solar electric cars is to provide single seated, **close cockpit environment to the driver**. The fabricated car should be light-weight, nimble to ride. Hence the whole cruising experience in an eco-friendly and economic package to end user.

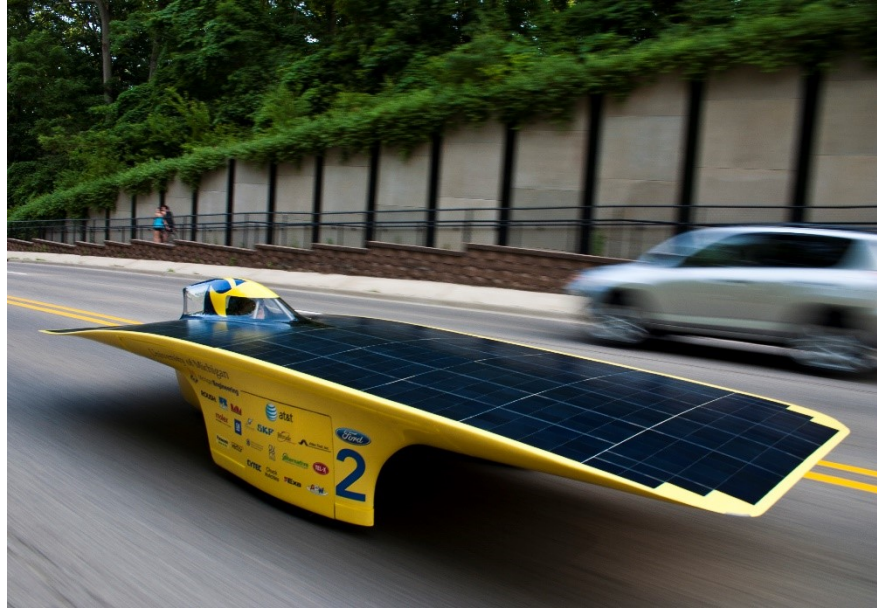


Figure 1 Adventure class vehicle (Single seated)

1.1.2 Professional Class:

This class of multi-seater solar powered vehicle requires good aesthetic design along with the performance that can help the society to incline towards the e-mobility on a commercial level.

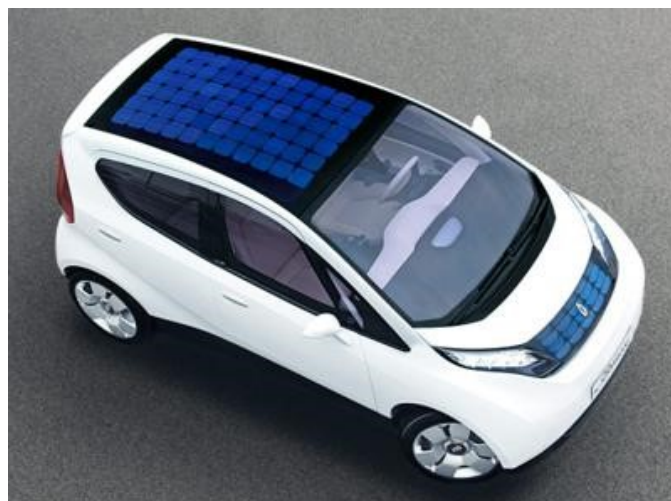


Figure 2 Professional Class Vehicle

1.2 Design Restrictions:

1.2.1 Dimension:

In a straight line, the solar vehicle must fit inside a **cuboid of 5000 mm long, 2200 mm wide and 1600 mm high**, with the base coincident to the ground.

1.2.2 Penalty on the extension in dimensions:

Teams will be penalized as below if they exceed the dimensions–

- x Points penalty count on per square inch deviation.
- x If solar panel dimension exceeds more than 5-inches, team will attract 30 points penalty.
- x If it exceeds up to 10 inches, there will be 75-point penalty in solar performance round.
- x Any team exceeding the solar panel dimensions by 10 inches, would not be allowed in any dynamic activities.

1.2.3 Ground Clearance:

The fully-laden solar car must have a minimum of 7inch of ground clearance which will be measured between the ground and the lowermost part of the vehicle other than tyre.

1.2.4 Weight Test:

- x For Adventure class the weight of the vehicle should not exceed the limit of 300 kg, without the driver.
- x For Professional class, the weight of the vehicle should not exceed the limit of 350 kg, without the driver/passenger.

1.2.5 Wheels and Tyres dimension:

- x Wheel Size: The wheel diameter should be minimum of 10 inch or maximum of 14 inch.
- x Tyre Size:

Tread Width: Maximum 6.5 inch (165.1 mm) and minimum 3.54 inch (90 mm).

Load rating: Greater than the load on wheel.

Speed rating: Greater than the maximum speed of the vehicle.

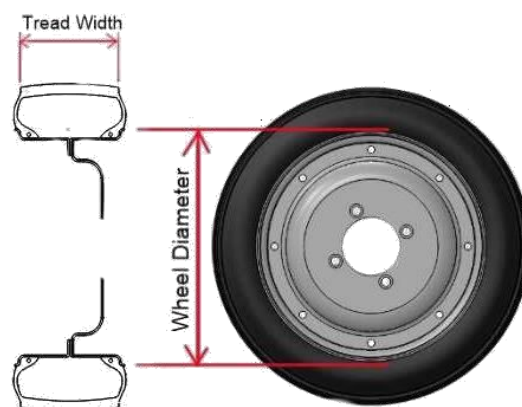


Figure 5 Wheel Diameter and Tyre Width

1.2.6 Vehicle Track-configuration:

1.2.6.1 Wheel Base: Adventure class/ professional class

Minimum wheelbase of **1524 mm** and **Maximum 2570 mm** is allowed to provide to the vehicle.

1.2.6.2 Track Width: Adventure class/ professional class

Smaller track width should be minimum 60 % of the total wheelbase.

1.2.7 Design Category:

Adventure Class: The vehicle has to be equipped with 3 or 4 wheels and open cockpit for adventure class.

Professional Class: The vehicle has to be a closed cockpit 4 wheels car for professional class.

1.2.8 Chassis:

1.2.8.1 Cross section:

- x Teams are supposed to use seamless tubes.
- x Circular cross section tubing is mandatory.
- x Tube Cross section requirement-
- x Minimum outer diameter/dimension –1inch.
- x Maximum outer diameter/dimension –2inch.
- x Minimum wall thickness–1mm.
- x Leaf springs, solid bars, I-bar, rectangular bar or any other shape are prohibited.
- x Rectangular and square tubes could be utilized as support number of automotive system (e.g seat mounting, motor mounting, pedal assembly, battery pack mounting etc). The members should not be used as truss member of the chassis.
- x Also, the team should have at least one open end tube in the frame (This end must be capped)
- x A 3mm drill on main roll hoop should be provided for inspection of wall thickness. The position of drill hole should be such that, Vernier caliper could be used for inspection.

1.2.8.2 Material Specification:

- x Teams can use any material – steel/aluminium/carbon fibre for the tube.
- x In the case of steel minimum, carbon percentage should be 0.1%.
- x Teams need to present material composition and material testing report from certified lab of all the tubes used in frame with the GST invoice.
- x Certificate should have 'Date of testing'. The date of testing should only be after purchasing the tube.
- x The teams using carbon fibre composite material and carbon monocoque chassis required to
- x Prepare separate design report and analysis report. They are required to submit the reports for verification from technical committee before manufacturing.
- x Failing to produce the necessary documents for testing, a team could be penalized or disqualified for the entire event. The decision would be taken by technical inspector and organizing committee.

1.2.8.3 Welding Check Process:

- x Each person who makes any welded joint on any of the vehicle's roll cage elements must personally make two welding samples (defined below), using the same materials and processes as used in the roll cage element welds.
- x All welding samples must be submitted at Technical Inspection.
- x Vehicles for which complete sets of welding samples are not submitted, or for which any of the welding samples are judged inadequate, will not be allowed to compete in dynamic or endurance events.
- x Welding samples must be made from the same tube material, diameter, and thickness as the welds made by each person on the roll cage elements.
- x All weld samples shall be labeled by permanent means such as engraving, etching, or stamping with all of the following information:
- x College Name or College Initials
- x Welder Name or Welder Initials

Sample 1 – Destructive Testing:

A 90-degree joint, the leg length is unrestricted. This joint must be destructively tested causing the joint to fail in the base material (as opposed to the weld metal). The testing method is free either tensile or bending failure may be induced; however, the peak stress must be located at the weld. In the case of bending failure, take care that the largest bending moment is located at the weld.

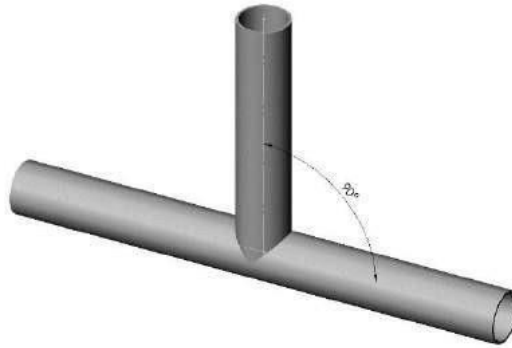


Figure 6 Roll Cage Welding Sample 1

Sample 2 – Destructive Inspection

Two tubes joined at a 30 degree angle with a length of at least 150 mm (5.9 in.) from the center of the joint. The sample must be sectioned along the length of tube to reveal adequate and uniform weld penetration.

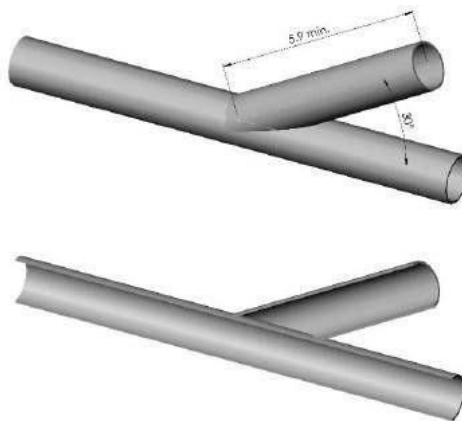


Figure 7 Roll Cage Welding Sample 2

1.2.8.4 Jack Point:

- x There must be two jack points for the vehicle, one at the rear and other at the front. Both jack point must be orange in color.
- x The jack point must be lie horizontally and perpendicular to the centre line of the car.
- x The jack point should be made of a flat steel plate attached to the bottom of chassis.
- x Jack point must be – 12 inch (300 mm) long, 2 inch (50.8 mm) wide and 0.1968inch (5mm) thick.



Figure 8 Jack point

1.2.8.5 Hitch Point:

- x Every vehicle must have two hitch point one at the rear end and other at the frontend.
- x Hitch point will be used to attach push rod.
- x Every team will have to fabricate detachable push rod that should have the capability to push and pull the vehicle.
- x It should be painted in yellow.
- x Hitch point should not be at the bumper. It should be welded and projected from appropriate chassis member.
- x Hitch point should follow the dimensions given in Figure 8.
- x Hitch point would be utilized in case of vehicle breakdown on road and hence would be towed down to the nearest checkpoint for rectification.

| DIMENSIONS | SYMBOL | MINIMUM | MAXIMUM |
|---------------------------|--------|--------------------|--------------------|
| Tab Thickness | None | 3.18mm(0.125 inch) | 9.5mm(0.375 inch) |
| Hole Diameter | D | 25.4mm(1 inch) | 31.75mm(1.25 inch) |
| Hole in tube offset | X | 19.0mm(0.75 inch) | 25.4mm(1 inch) |
| Edge Distance | R | 15.9mm(0.625 inch) | 25.4mm(1 inch) |
| Width at Frame Connection | Y | 76.2mm(3 inch) | unrestricted |

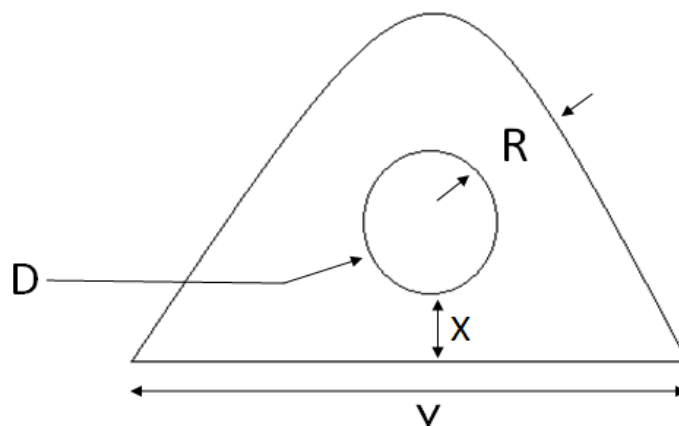


Figure 9 Hitch point & Hitch Point Dimension

Note: Bumper, jack point and hitch point must be separate

1.2.8.6 Push/Pull/Jackbar

- x The detachable push rod is mandatory for all the team. Push rod should have the capability push as well as pull the vehicle.
- x There should be a single rod for both uses.
- x While acting as jack bar, it should be able to lift minimum 100 mm above the ground level.
- x Push/pull bar must have fire extinguisher mount.



Figure 10 Push Rod Example

1.2.8.7 Safety structure (Roll hoops)

A. Main roll hoop:

Adventure class-

- x Teams must provide a roll hoop behind the driver. Separating driver's compartment from the rear of the vehicle.
- x The main hoop must be constructed of a single piece of uncut, continuous, closed section steel tubing
- x The use of aluminium alloys, titanium alloys or composite material requires proper analysis report.
- x 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.
- x 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.
- x Tip of the roll hoop should be at least 6 inches from tip of the helmet. The driver should be at rest while measuring.

Professional class-

- x The roll hoop must cover both the drivers.
- x Tip of the roll hoop should be at least 6 inches from tip of the helmet. The driver should be at rest while measuring.
- x This will be measured by passing 6-inch diameter pipe horizontally from the top point of the helmet to right and left side of helmet.



Figure 11 Distance between Helmet and Roll hoop

B. Front roll hoop:

Adventure class-

- x The front hoop must be constructed of closed section metal tubing
- x 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.

- x With proper gusseting and/or triangulation, it is permissible to fabricate the Front Hoop from more than one piece of tubing.
- x The top-most surface of the front hoop must be no lower than the top of the steering wheel in any angular position.
- x The front hoop must not be more than 250 mm (9.8 inch) forward of the steering wheel. This distance shall be measured horizontally, on the vehicle centreline, 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.

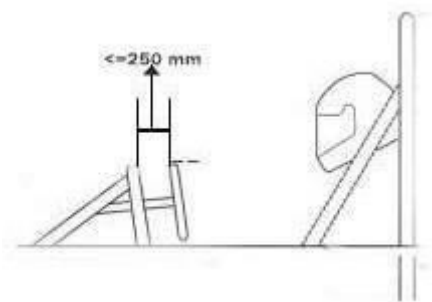


Figure 12 Steering Distance from Front Roll hoop

- x In side view, no part of the front hoop can be inclined at more than twenty degrees (20°) from the vertical.

Professional class-

- x No need of front roll hoop but the main roll hoop must be connected with the front of the car in a cage like manner.

C. Main hoop Bracing:

Adventure class & professional class

- x 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.
- x 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.
- x 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 inch) below the top-most surface of the main hoop. The included angle formed by the main hoop and the main hoop bracing must be at least thirty degrees (30°).

D. Front hoop Bracing:

Adventure class

- x 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.
- x 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.
- x 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 inch) below the top-most surface of the front hoop.

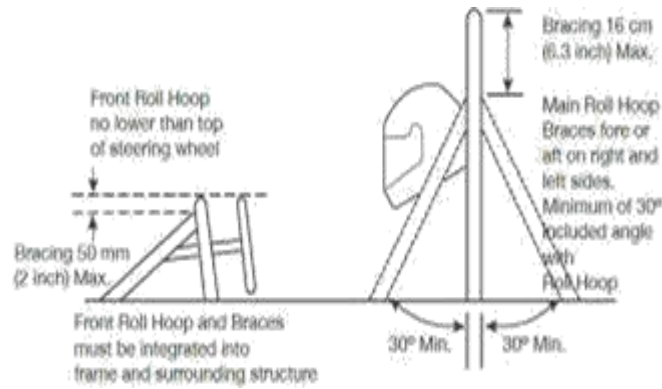


Figure 1 Roll Hoop and Bracing



Figure 4 Adventure Class Chassis



Figure 5 Professional Class Chassis

E. Side Impact Member:

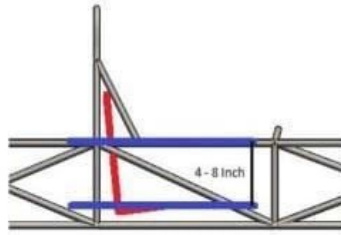


Figure 16 Side Impact Members

- The two side impact members define a horizontal mid plane within the roll cage.
- These members are joined to the rear rolling hoop and extend generally forward.
- The forward ends of the side impact members are joined by a front roll hoop.
- The members must be between 4 inch and 8 inch above the inside seat bottom at all positions.

1.2.8.8 Impact Bumper:

Adventure class/ Professional class

- x There should be impact bumper on front and rear of the vehicle. It should be rigid and strong. Without a bumper, team cannot participate in the dynamic events.
- x Teams can use tubes to act as a bumper.

In case of using metal tubes –

- x The bumper should be cover outer point of the tires kept in zero steering position.
- x The bumper should be rigidly welded to the mainframe.
- x The bumper should also be able to bear front impact load, as well as vertical load up to the 100kg.
- x The bumper must start from the base of the chassis, and it should be in vehicle impact zone
- x i.e. 300mm from the ground.
- x Preferably bumper should be of continuous tube members rigid enough to bear impact load.

Note: Teams are supposed to provide finite element analysis of fully laden vehicle to how the chassis can sustain impact of

- x Frontal impact 5g load
- x Side Impact 5g load
- x Top Impact which includes 5 g load down, 1.5 sideways and 4 g backwards when the chassis is upside down.

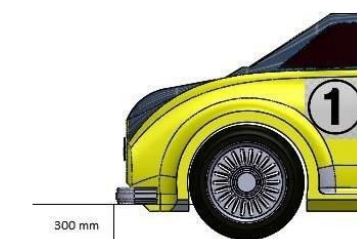


Figure 17 Bumper

1.2.8.9 Node-to-node triangulation

An arrangement of frame members projected onto a plane, where a co-planar, load applied in any direction, at any node, results in only tensile or compressive forces in the, Frame members. This is also what is meant by "Properly triangulated".

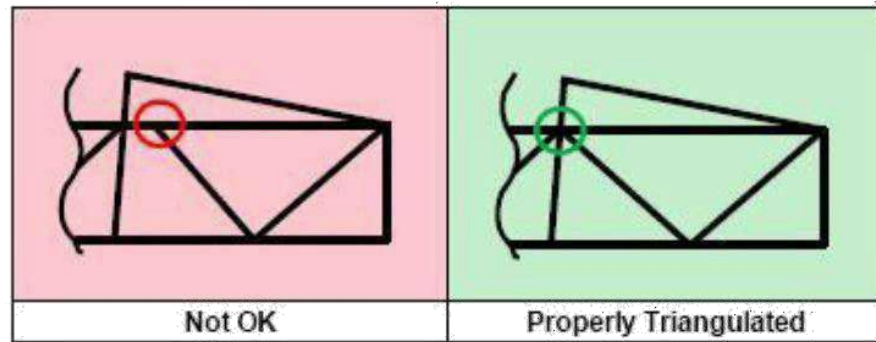


Figure 8 Triangulation of members

1.2.9 Driver's Compartment:

1.2.9.1 Cockpit:

- x Driver's ergonomic ease should be considered in the design. The teams are to provide ergonomics report, in design report, mentioning occupant's packaging.
- x The teams are to provide ergonomics as per SAE 95th percentile male and 5th percentile female rule.
- a. When seated normally and restrained by the driver's restraint system, the helmet of a 95th percentile male and all of the team's drivers must
- b. Be a minimum of 50 mm away from the straight line drawn from the top of the main hoop to the top of the front hoop.
- c. Be a minimum of 50 mm away 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.
- d. Be no further rearwards than the rear surface of the main hoop if the main hoop bracing extends forwards.

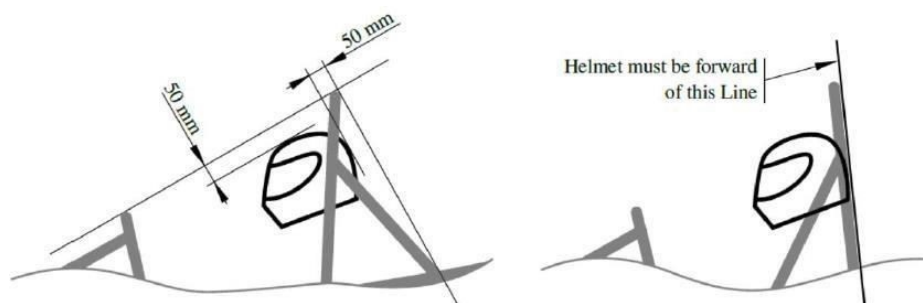


Figure 19 Minimum Helmet Clearance

- x The 95th percentile male is represented by a two-dimensional figure consisting of two circles of 200 mm diameter (one representing the hips and buttocks and one representing the shoulder region) and one circle of 300 mm (representing the head with helmet).
- x The two 200 mm circles are connected by a straight line measuring 490 mm. The 300 mm circle is connected by a straight line measuring 280 mm with the upper 200 mm circle.
- x The figure has to be positioned in the vehicle as follows (see Figure 19):
- x The seat adjusted to the rearmost position
- x The pedals adjusted to the front most position
- The bottom 200 mm circles placed on the seat bottom. The distance between the centre of the circle and

the rearmost actuation face of the pedals must be minimum 915mm.

- x The middle circle positioned on the seatback
- x The upper 300 mm circle positioned 25 mm away from the head restraint.

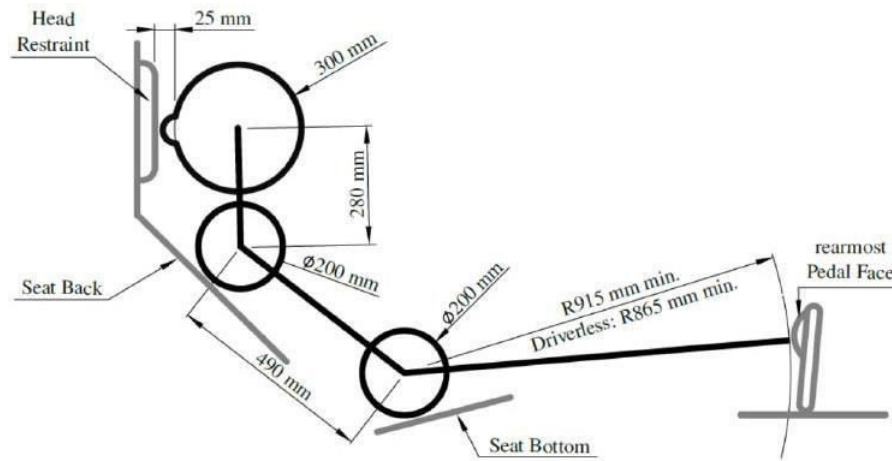


Figure 20 Ergonomic Consideration for Drive

1.2.9.2 Egress:

Driver must be able to get out of the vehicle within 15 seconds (without seeking any outside help).

1.2.9.3 Cooling and hydration (BSVC):

- x The vehicle cockpit has to force ventilated, preferably by fan to prevent the cockpit from overheating.
- x Every car occupant should have 2 liters drinking water at the beginning of the day. This could be replenished at checkpoint during the event.

1.2.9.4 Driver's seat:

- x 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 requirements for side impact tubing, passing underneath the lowest point of the seat.
- x Driver must be provided with a forward-facing seat that consists of a base (squab) and backrest.
- x The distance from the hip point to the top of the head restraint (distance "r" in the diagram below) must be at least 800 mm. (Refer diagram below for H-point approximation.)
- x It is mandatory to use off road bucket seat.
- x Seat should be rigidly mounted and fastening should be attained by locknuts.

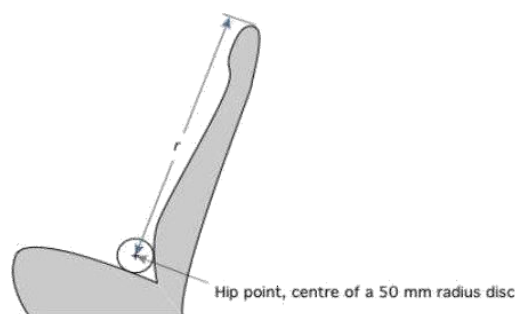


Figure 21 The distance Between Point & Head Rest

1.2.9.5 Seat Belt:

- x All drivers must use a 5-point or 6-point restraint harness meeting the following specifications:
- x All driver restraint systems must meet SFI Specification 16.1, SFI Specification 16.5 or FIA specification 8853/98.
- x The belts must bear the appropriate dated labels.
- x The material of all straps must be in perfect condition.
- x There must be a single metal-to-metal latch type quick release for all straps.
- x All lap belts must incorporate a tilt lock adjuster ('Quick adjuster'). A tilt lock adjuster in each portion of the lap belt is highly recommended. Lap belts with 'Pull-up' adjusters are recommended over 'Pull-down' adjusters.
- x Vehicles with a 'Reclined driving position' must have either anti-submarine belt with tilt lock adjusters ('quick adjusters') or have two sets of anti-submarine belt installed.
- x 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.
- x Tampered seat belts are prohibited.

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

- x The shoulder harness mounting points must be between 178 mm (7 inch) and 229 mm (9 inch) apart.
- x From the driver's shoulders rearwards to the mounting point or structural guide, the shoulder harness must be between 10° above the horizontal and 20° below the horizontal as in Figure20
- x Shoulder harness shouldn't pass through firewall.
- x Anti-Submarine belt should not be rolled over and member, it should be on a mount.
- x Seat belt specification for occupants will be released along with event handbook later close to the event date.

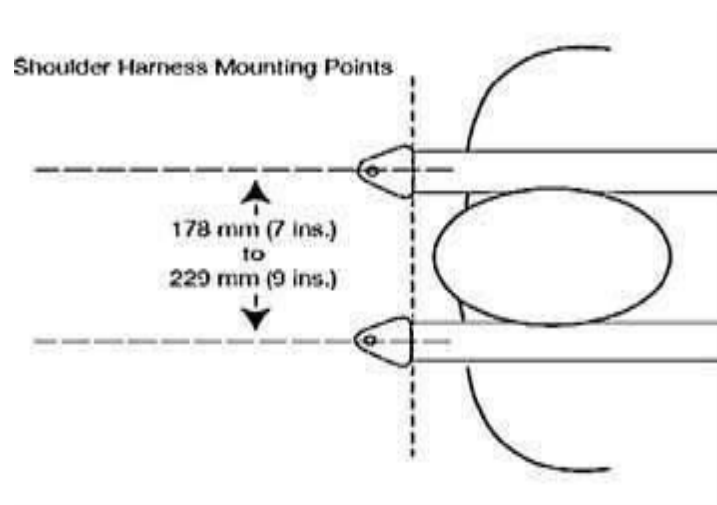


Figure 22 Shoulder Harness Positioning

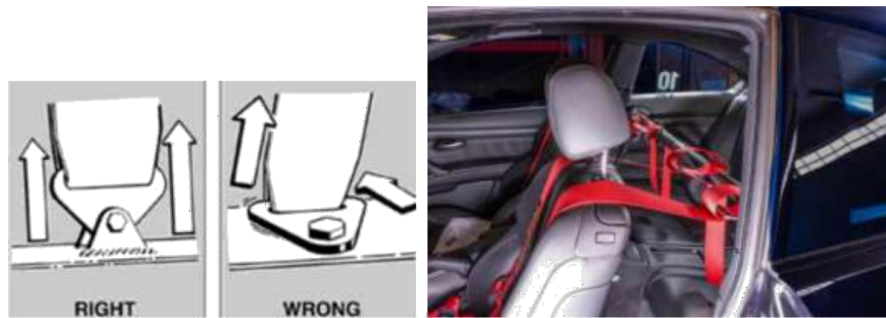


Figure 23 Shoulder Harness/Lap Belt Mounting Method

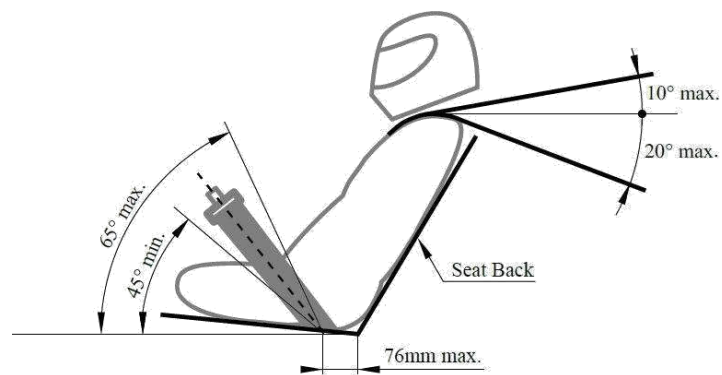


Figure 24 Positioning Point Seat belt Along With Single Quick Release

| LOAD BEFORE FAILURE | VALUE |
|------------------------|------------|
| Shoulder harness | 13 kN |
| Lap belts | 13 kN |
| Anti-submarine harness | 6.5kN |
| Lap + Anti-submarine | 19.5kN |
| ACCEPTED BOLTS | GRADE |
| Shoulder Harness | M10 8.8 |
| Lap Belts | M10 8.8 |
| Anti-submarine harness | M8 8.8 |
| Bracket to chassis | 2 X M6 8.8 |

Note: Bolts of diameters LESS THAN prescribed in table will be allowed ONLY if physically tested with report, must be as a minimum Grade 12.9 and must comply with safety harness manufacturer mounting instructions.

1.2.9.6 Driver's Visibility:

1.2.9.6.1 Front and side visibility:

Driver must have a vision range of 100° (degrees) left and 100° (degrees) right, so a total of 200° (degrees) of vision. This must be provided without any external assistance.

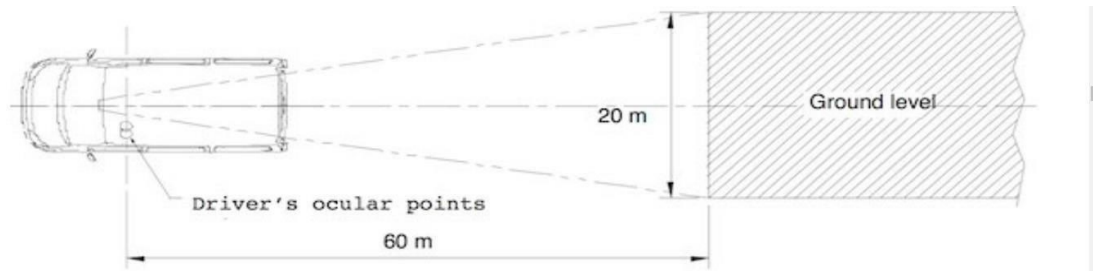


Figure1 Driver's Visibility

1.2.9.6.2 Rear visibility:

- x The solar car must have rear vision systems that enable the driver, when seated in the normal driving position with the safety belt fastened, to see the ground in the shaded areas shown in the diagrams below.
- x Rear vision systems may be electronic, mirrors, or both. Rear vision systems must operate whenever the solar car is in motion under its own power. Rear vision images must be oriented so that objects on the right of the solar car are on the right of the image.

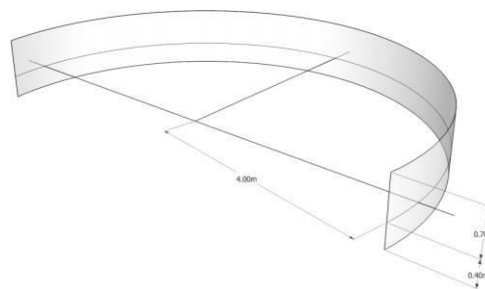


Figure26 RearVisibility

1.2.9.7 Firewall:

- x A firewall must separate the driver compartment from all components of the electrical and electronics and any high voltage system.
- x The firewall must be a non-permeable surface made from a rigid, fire-resistant material.
- x Material for firewall must have fire resistance and electrical resistance property.
- x Multiple panels may be used to form the firewall but there must be no gaps between the joints.
- x Shoulder harness shouldn't pass through Firewall.
- x A firewall can be bolted or riveted using metal brackets welded on the frame.
- x No nylon tie or strap of any kind should be used to fix the floor.
- x Welding of the firewall on the frame is acceptable.
- x Firewall shouldn't be used as mounting member.

1.2.10 Bodyworks:

1.2.10.1 Outer bodywork:

- x Teams have the flexibility of choosing material for bodywork. Some examples are- GFRP, carbon fibre, aluminum etc.
- x Outer body cover must run from front member to rearmost member, without any opening except those required for cockpit opening, cooling venting and kill switches.
- x As the vehicle is of closed wheel design, thus body works should cover the wheels.
- x The wheel should not hit the body during jounce or rebound while riding.
- x There should be no sharp edges/protruding edges on the outer body.
- x The solar panel should be secured so that no damage to the driver is done by it.
- x Bodywork should be detachable at different sections so that battery, transmission, steering, suspension and other components could be easily visible and reached at the time of Technical Inspection or maintenance.
- x Teams are to provide passage/slots for air to get in so that cooling of battery and motor can take place. This can be done by adding slot/opening at the side panel, as shown in the image below. This rule applies to both classes.
- x Bodyworks should be attached to the frame using fasteners and mechanical locks only.
- x Bodyworks should not be attached using nylon ties or any other tie straps.

1.2.10.2 Floor Closeout:

- x All vehicles must have a floor closeout made of one or more panels, which separate the driver from the pavement.
- x If multiple panels are used, gaps between panels should not exceed more than 3mm (1/8inch).
- x The closeout must extend from the foot area to the firewall and prevent track debris from entering the car.
- x The panels must be made of aluminium/steel.
- x Floor closeout should not be attached using nylon ties or any other tie straps.
- x Floor closeout should be attached to the frame using fasteners only.
- x Wooden ply and glass fibre will not be acceptable.

1.2.11 Stickers:

1.2.11.1 Vehicle Identification Number:

Each car will be assigned a number at the time of its entry into a competition. Car numbers must appear on the vehicle as follows:

- x Locations: In three (3) locations: the front and both sides.
- x Height: At least 152.4 mm (6inch) high. x Font: Block numbers (i.e. Sans-Serif characters). Italic, outline is prohibited
- x Stroke Width and Spacing between Numbers: At least 18 mm (3/4inch).
- x Colour: Either white numbers on a black background or black numbers on a white background. No other colour combinations would be approved.
- x Visibility: The numbers must not be obscured by parts of the car, e.g. wheels, side pods, exhaust system etc.
- x Comment: Car numbers must be quickly read by course marshals when your car is moving at speed. Make your numbers easy to see and easy to read.

1.2.11.2 Organization/College Name:

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

- × The organizer name may also appear in non-roman characters, but the roman character version must be uppermost on the sides.
- × It must be displayed on the front of the vehicle below the car number.

1.2.11.3 Title sponsors:

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

1.2.11.4 FMAE Logo:

The FMAE – India logo of length 10inch (254mm) & width of 5inch (127mm) must be displayed on the front of the vehicle in a prominent location. FMAE logo stickers will be provided to the teams on site.

1.2.11.5 BSVC Logo:

The BSVC logo of length 10inch (254mm) & width of 5inch (127mm) must be displayed on the left and right-hand side of the front bodyworks above the car number. BSVC sticker will be provided to the teams on site.

1.2.11.6 Event Sponsor Logo:

This must be displayed on both sides of the vehicle.

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

1.2.12 Number Plate:

- × Each vehicle must have a number plate at the front and rear. FMAE will provide a vehicle number to put on the plate.
- × The background of the plate should be white in colour.
- × The size of the plate should be 600 x 120mm.
- × The numbers should be clearly visible when viewed from far. Stroke width – 14mm, character height – 70 mm, character width – 50mm, space between characters – 11mm.
- × The number plate must be of rigid material like steel or fibre.

1.3 Steering, Brake, and Suspension

1.3.1 Steering:

1.3.1.1 Steering system:

- x The steering wheel must be mechanically connected to the wheels, i.e. “steer-by- wire” or electrically actuated steering is prohibited.
- x Rear wheel steering (if fitted) must not compromise the control of the vehicle under any circumstances, including emergency maneuvers or following failures such as tire blowouts.

1.3.1.2 Steering wheel:

- x The steering wheel must have a continuous perimeter i.e. near circular or near oval; the outer perimeter profile can have some straight sections, but no concave sections.
- x Quick release/disconnect steering hub is mandatory all cars.
- x ‘H’ and ‘8’ figured cut-out steering wheel is not allowed.
- x Steering wheel free play is limited to seven degrees (7°).
- x The steering wheel should have a minimum of 10inch diameter.

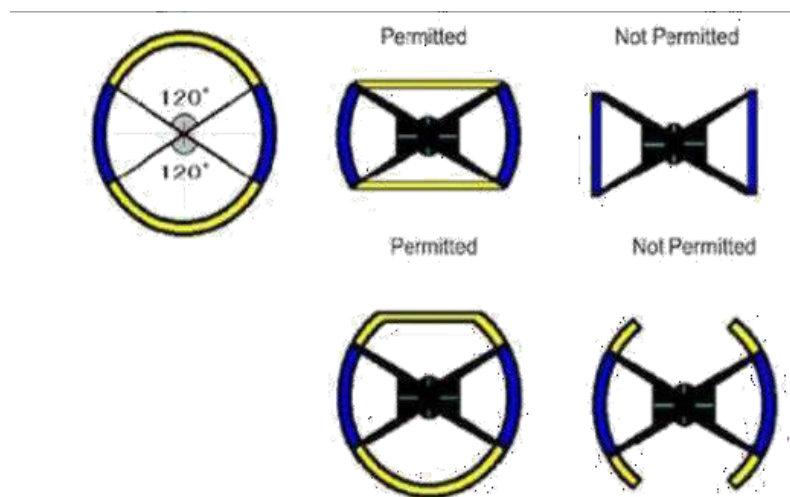


Figure 30 Steering Wheel

1.3.1.3 Steering Wheel Position:

- x Teams must position steering wheel below shoulder line and above abdomen of the driver.
- x The steering wheel should be positioned in such fashion that the risk of a driver getting injured is minimized in the case of impact.
- x The driver should not sense tingling while steering for longer duration.
- x Lock nut is mandatory for all fastening ends.

1.3.1.4 Steering type:

- x Mechanically driven rack and pinion type of steering system is compulsory.

1.3.1.5 Steering positive stop:

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 dynamic events.

1.3.2 Brakes:

A solar car must be equipped **with brakes on all the wheels**, operated by a single control and must be **hydraulic braking system**.

1.3.2.1 Brake types:

- x It must have two independent hydraulic circuits such that in the case of a leak or failure at any point, 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.
- x "Brake-by-wire" system is strictly prohibited.
- x Independent braking systems may share components deemed, not liable to failure" provided that they are amply dimensioned and readily accessible for maintenance.
- x Components, not liable to failure are:
 - x A brake pedal and its bearing.
 - x Brake lever and cam assemblies.
 - x Single brake acting on a limited slip differential is acceptable.
- x The brake system must be capable of locking all 4 wheels simultaneously during the brake test.
- x Braking system must be protected with scatter shield from the failure of the drive train or from minor collisions.
- x 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.
- x Brake must be capable of holding the fully-laden solar car on a 20degree incline or decline.

1.3.2.2 Brake Pedal:

- x The brake pedal should be fabricated from steel, aluminium or titanium only.
- x Braking should be actuated strictly by foot pedal.
- x The pedal over travel should be restricted by positive locking mechanisms.
- x Wobbly brake pedal assembly mounting is prohibited.
- x Teams are advised to use industry manufactured pedal assembly for vehicle. See below figure for reference.



Figure 81 Brake Pedal

1.3.2.3 Brake Over-Travel Switch:

- x A brake pedal over-travel switch must be installed on the car as part of the shutdown system and wired in series with the shutdown buttons.
- x This switch must be installed so that in the event, if brake system fails such that the brake pedals over travels, it will result in the shutdown of the system, which will eventually help to control the system.
- x Break over-travel switch must be a single point, single throw. Only push type of brake over travel switch

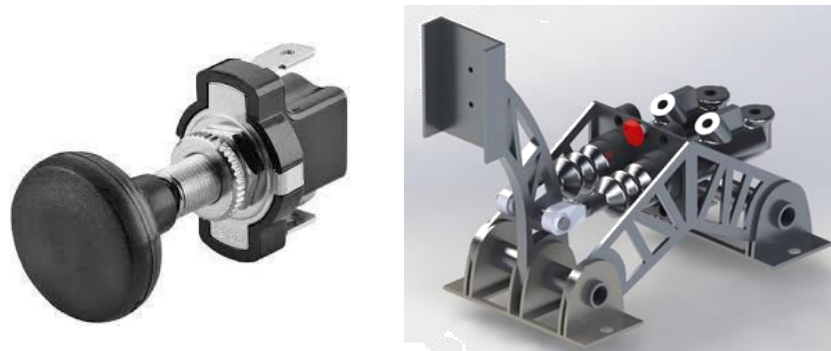


Figure 32 Brake over Travel Switch

as shown in figure is allowed.

- x Repeated actuation of the switch must not restore power to these components, and it must be designed so that the driver cannot reset it.
- x The switch must be implemented with analog components, and not through recourse to the programmable logic controller or similar functioning digital controllers.

1.3.2.4 Brake light:

- x The car must be equipped with red colored brake light; each of them must have minimum 5 inch (127mm) length and 3inch (76 mm) width.
- x The brake light must be rectangular, triangular or near round in shape.
- x Each brake light glowing must be visible from the rear in bright sunlight.
- x Brake light should also function even when vehicle is killed-off.
- x Brake Light must glow continuously when brakes applied.



Figure 33 Brake Lig

1.3.2.5 Brake light position:

The height of the centre of light: Minimum 13.7 inch (350 mm) from the ground.

1.3.3 Suspension:

- x Use of suspension system is mandatory for all wheels.
- x The car must be equipped with a fully operational suspension system with shock absorbers.
- x The judges reserve the right to disqualify cars which do not represent a serious attempt of an operational suspension system or which demonstrate handling inappropriate for a qualifying circuit.
- x All suspension mounting point should be visible at technical inspection, either by direct view or by removing bodywork.
- x Wishbone/ A-Arm should be a seamless tube.
- x The suspension used must have a minimum of 4inch (101.6 mm) of travel, i.e. 2inch (50.8mm) jounce and 2 inch (50.8 mm) rebound.
- x A fastener should be secured by lock nut or safety wire.
- x At least 2 threads should be visible after fastening.

1.4 Electrical System

1.4.1 Drive Train:

1.4.1.1 Basic Definitions:

- x The Accumulator is defined as all the batteries that store the electrical energy to be used by the tractive system.
- x Accumulator Segments are sub-divisions of the accumulator and must respect either a maximum voltage or energy limit. Splitting the accumulator into segments is intended to reduce the risks associated with working on the accumulator.
- x The Tractive System of the car is defined as every part that is electrically connected to the motor(s) and accumulators.
- x The Grounded Low Voltage (GLV) system of the car is defined as every electrical part that is not part of the tractive system (horn, brake light, head lights, innovations etc.)

1.4.1.2 Ground Low Voltage (GLV):

- x The GLV system must be grounded to the chassis.
- x The tractive and GLV system must be galvanically isolated from one another.
- x The border between tractive and GLV systems is the galvanic isolation between both systems.
Therefore, some components, such as the motor controller, may be part of both systems.
- x The tractive system must be completely electrically isolated from the chassis and any other conductive parts of the car.
- x The tractive system motor(s) must be connected to the accumulator through a motor controller.
- x By passing the control system and connecting the tractive system accumulator directly to the

motor(s) is prohibited.

- x The GLV system must be powered up before it is possible to activate the tractive system.

Furthermore, a failure causing the GLV system to shut down must immediately deactivate the tractive system as well.

1.4.1.3 Tractive system Voltage:

- x The maximum permitted operating voltage for the tractive system is 144 VDC for adventure class and 144 VDC for professional class. The maximum operating voltage is defined as the maximum measured accumulator voltage during normal charging conditions.
- x The GLV system must be grounded to the chassis.
- x The tractive system must be completely isolated from the chassis and other conductive parts of the vehicle.
- x The tractive system motor(s) should be connected to the accumulator through motor controller. Bypassing the control system and connecting the tractive system accumulator directly to the motor(s) is strictly prohibited.

1.4.2 Solar Panel:

1.4.2.1 Allowed Solar Cells:

A standard solar collector uses photovoltaic cells without reflectors or concentrators. Teams who want to use reflectors, concentrators or some other form of solar collector must send details of the proposed solar collector to the event organizer for approval.

If the solar collector comprises photovoltaic cells all of the same chemistry, and used without concentrators such as reflectors or lenses, then the total cell area must not exceed the allowable total cell area:

| Class | PV cell chemistry | allowable Total Cell Area (m ²) |
|--------------|--------------------------|---|
| Adventure | Si | 4.000 |
| | Thin film junction | 3.560 |
| | Thin film Multi junction | 3.240 |
| | Multi junction | 2.640 |
| Professional | Si | 5.000 |
| | Thin film junction | 4.440 |
| | Thin film Multi junction | 4.050 |
| | Multi junction | 3.300 |

Cell area calculations must be based on flat, unconnected cells. For cells used without overlapping, cell area is defined as the projected area of the cell in a direction perpendicular to the plane of the cell. For cells that are overlapped, cell area is defined as the exposed surface area of the cell. Cell area includes active material, bus bars, fingers and connection pads.

Example calculation: The area of a SunPower cell with a width of 125 mm and a diagonal diameter of 160 mm is less than 0.015333 m², and so the area of 260 cells is less than 3.9866 m² and the area of 326 cells is less than 4.9986 m².

Teams wanting to use a mixture of photovoltaic cell chemistries must send details to the organizer for approval. If the areas of the different chemistries are area A1 of silicon cells, area A2 of thin film single junction cells, area A3 of thin film multijunction cells and area A4 of multijunction cells then the areas must satisfy

$$A1 / 4.000 + A2 / 3.560 + A3 / 3.240 + A4 / 2.640 \leq 1$$

for adventure solar cars, and

$$A1 / 5.000 + A2 / 4.440 + A3 / 4.050 + A4 / 3.300 \leq 1$$

for professional solar cars.

All devices used for solar charging must be carried in the solar car. This includes stands, supports and cables.

1.4.2.2 The Position of the panels:

For Adventure Class:

- x Teams are not allowed to place panels over the head and the roof of the driver (cockpit).
- x Team are permitted to place solar panels on side of driver provided proper heat and electrical insulation. Position of the panel should not restrict driver's entry and egress.
- x The position of the panel should not be higher than shoulder line of the driver.
- x Panels should be positioned so that they could be detached for easy inspection of automotive system. They could be either completely detachable, hinged at one end to lift.

For Professional Class:

Solar panels could be placed over head of the occupants. There must be 6 inches distance between helmet of the driver and the inner lining of the roof/cockpit.

1.4.3 Tractive System Accumulator:

1.4.3.1 All batteries which store the tractive system energy must be enclosed in an accumulator container(s).

1.4.3.2 If spare accumulators are to be used, then it should be of same size, weight and type of being replaced.

1.4.3.3 Spare accumulator pack should be presented at electrical technical inspection.

1.4.3.4 BSVC Teams are mandatory to have one extra spare battery with same specifications during the event.

1.4.3.5 Battery Specification:

| Class | Maximum Energy Allowed | Maximum Nominal Voltage Allowed |
|--------------|-------------------------------|--|
| Adventure | 7 KWh | 144 VDC |
| Professional | 10 KWh | 144 VDC |

1.4.3.6 Battery Type:

- x Teams are allowed to use Lithium based batteries (Eg. Li-S/ Li-ion/ Li-polymer/ LiFePO4 battery). Teams will not be allowed to change batteries. They need to use the same set of batteries throughout the event.
- x Teams can use Traction battery of max 144 VDC and an Auxiliary battery of max 12 VDC (Lithium or lead acid battery).
- x Teams can use an auxiliary battery for the following function, and the mentioned function must be installed in the vehicle:
 - o Innovations
 - o Horn
 - o Battery level indicator
 - o Brake light
 - o Side indicators
 - o Hazard light

1.4.3.7 Battery Pack (Power pack):

- x The cover material of battery pack must be fire and electric proof and properly insulated.

- x Flexible rubber or plastic sheets are not allowed to be used as covers.
- x Also, the battery cover should be made up of rigid plastic/glass fibre/ sheet metal, with an insulating coating.
- x Use of nylon ties, strings or wire of any kind is prohibited for mounting.
- x The casing of the battery should be fixed/ welded/ fastened (using lock nut) with the chassis.
- x A spill-proof barrier between storage pack and solar car occupants power storage should prevent spilling harmful liquid/gas when damaged.
- x The car should be equipped with easy to assemble and dismantle cover for battery.
- x Forced convection cooling can only be used for cooling accumulators and batteries.
- x Teams can use cooling fans or hoses for this purpose.
- x Self-fabricated or assembled battery pack is not allowed.
- x **Use of battery management system with battery pack is compulsory.**
- x Original GST bills for battery pack should be presented during technical inspection.
- x All batteries declared should be inspected and labelled by technical inspector (Including spare batteries).

Important Note:

- x **Teams can either keep the Spare Battery Pack in the vehicle or they can swap it if required during the run.**
- x **During a rally run, one battery pack would power a motor. After a battery pack is exhausted, terminals can be switched to other battery pack present in the vehicle or a spare battery pack could be swapped if required during a run.**
- x **During the run, charging by grid or external sources is prohibited except Solar Energy, Regenerative Braking and KERS. (For KERS, refer to rule no 1.4.6)**
- x **Charging of batteries by charging station grid allowed only at overnight stays.**

1.4.3.8 Battery Position:

The battery pack can be positioned behind, and adjacent to driver up to plane formed up to pedal assembly.

The battery pack should be positioned in such fashion that, it is easy for teams to detach it when required or in the case of emergency or for repairing, and also easily accessible.

1.4.3.9 Battery State of Charge indicator:

A battery state of charge indicator must be provided in front of the driver on the dashboard. Also, there should be no ocular illusion.

Teams must be able to monitor it during the event. It should completely show the percentage of the battery based on voltage or current. It should also show the temperature of battery and motor.

1.4.4 Battery & Motor Usage:

Old Motor & Battery:

- x If team is using old motor & battery, teams need to show the health certificate of motor & battery from the vendor during report submission round.
- x Teams also required to follow International Electro technical Commission (IEC) 60529 IP67. The motor & battery must be manufactured as per the IEC 60529 IP67. Teams are required to submit the certificate of IEC 60529 IP67 from their vendor.
- x The teams who will not submit the Certification, will be not allowed in any Dynamic Activities.

Important Note:

1. Teams shall submit the ESF (Electrical System Form) with technical specification details for the motor, controller, battery charger electrical safety and the supporting certification documents to the BSVC team for approval. Teams shall use only the components approved by the BSVC team to build their vehicle. Submission details of ESF will be communicated through mail & team account. Also teams shall bring the hard copies of ESF report & certificates for the technical inspection onsite.
2. All electrical components used should be ISI Certified.
3. Teams are also required to submit AIS certificates for Battery (AIS 048) and Motor (AIS 041).
4. All high voltage connections should be labelled with hazard sticker as shown below

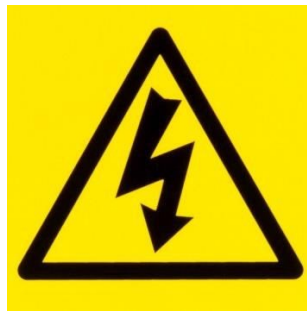


Figure 86 Warning Sticker

1.4.5 Transmission:

1.4.5.1 Motor Type:

- x Teams are allowed to use any type of Motor AC or DC.

1.4.5.2 Permitted Drive Train:

| Permitted Drive Train |
|---|
| Direct drive or Motor with 2/4 speed gearbox |
| Rear wheel hub motor or All wheel/2 Wheel hub motor |
| Motor with open differential |
| Motor with LSD |
| CVT |
| 4WD |

1.4.5.3 atter shield and its position:

Exposed high-speed final drive train equipment such as Continuously Variable Transmission (CVT), sprocket, gear, pulley, torque converter, clutch, belt drive and clutch drive, must be fitted with scatter shields as a fail-proof system. Chain cover should be rigidly mounted.

Teams are suggested to use fibre sheet of minimum 2mm thickness or GV sheet for scatter shield.



Figure 87 Scattering Shield

1.4.5.4 Electrical accelerator:



Figure 88 Throttle Pedal with Positive Stop

The accelerator pedal must be a **right-foot-operated** foot pedal. The foot pedal must return to its original, rearward position when released. The foot pedal must have positive and negative stops at both ends of its travel respectively, preventing its sensors from being damaged or overstressed.

1.4.5.5 Kill switch:

- x There should be 3 kill switches in the vehicle.
- x Only Push-Twist Button kill switch is permitted.
- x The kill switch should be easily reachable to the driver in cockpit.
- x Kill switches placed outside should be easily be actuated in case of an emergency.
- x Kill switches should be clearly visible through long distance bearing a bright red color.



Figure 89 Kill Switch

1.4.5.6 Kill Switch Mounting:

- x Mounting the kill switch with plastic/metallic ties or wires is strictly prohibited.
- x The kill switch can be mounted on bodywork, provided the same bodywork (could be a small part) is rigidly mounted to frame. The frame, bodywork and kill switch has to be insulated electrically.

1.4.5.7 Fusing:

Tractive system must be appropriately fused with electrical rating.

1.4.5.8 Horn:

An audible warning device should be permanently fitted to the solar vehicle. It should continuously emit 105 dB sound measured 2 m behind the source

Note: All buttons should be labelled according to their function.

1.4.6 Kinetic Energy Recovers System (KERS):

- x Teams are free to use energy recovery system at their will. The energy should be stored in batteries only. Use of flywheel or spring to store energy is restricted.
- x The system should be stable and team has to explain every parameter used in the KERS system.
- x A separate switch should isolate and turn off the KERS the system from other electrical systems for safety purpose.

1.4.7 Dashboard:



Figure 40 Interior and Dashboard

- x The dashboard must contain different indicators in front of the driver.
- x It should contain:
 - Battery State of charge indicator.
 - Speedometer.
 - Battery health monitoring indicator (Include temperature sensor and smoke sensor on battery system) power withdrawn from accumulator must be cut-off if readings from temperature sensor and smoke sensor exceed safe value as per data sheet provided by manufacturer.
 - Start button.
 - Reverse drive switch
 - Kill switch.
 - Horn.
 - Temperature level indicator of motor condition.
 - Turn indicator (Left and right)
 - Hazard light

1.4.8 Inertia Switch:

The car should be rigidly mounted with inertia switch (crash sensor)

The device must trigger due to an omni directional peak acceleration of ≤ 8 g for a half sine test pulse of ≥ 50 ms length and ≤ 13 g for a half sine test pulse of ≥ 20 ms length. The “Sensata Resettable Crash Sensor” should meet those requirements.

1.4.9 Master Switch

- x Complete wiring harness should be switched off by rotating key master switch. Master switch should be rigidly mounted on rear right hand side of driver.
- x It should be mounted on fixed bodywork part on chassis.



Figure 41 Master Switch

1.4.10 Turn Indicators

- × Solar vehicle should be equipped with left and right indicators placed in front, side and rear of vehicle.
- × The lights should be placed symmetrically and 0.7 m above ground level.

1.5 General Safety Instructions:

- 1.5.1 Live wires, contacts, PCB etc. of the electrical system has to be electrically isolated by non-conductive material.
- 1.5.2 Use of electrical tape to isolate a joint is prohibited.
- 1.5.3 Teams are supposed to provide double layer insulation, which can be done by reinforced insulation of single layered insulation wires inside the reinforced insulation bundle of wires
- 1.5.4 All wires, connectors and electronic modules (such as MPPTs) which remain at high voltage are to be double insulated.
- 1.5.5 Wires cannot be routed beneath the base frame of vehicle.
- 1.5.6 Motor, suspension, wheels and steering should be secured by a locknut.
- 1.5.7 All batteries must be rigidly mounted to the frame.
- 1.5.8 No electrical connections should be connected to the chassis other than ground.
- 1.5.9 Traction system and GLV circuits must be electrically and physically isolated
- 1.5.10 All parts belonging to the tractive system including conduit, cables and wiring must be contained within the surface envelope of the vehicle to protect in case of a crash or roll-over.
- 1.5.11 Team should regularly check their electrical breakdown between either side of the energy storage system.
- 1.5.12 Fire extinguisher cylinder with pressure gauge should show dial between recharge and overcharge region. Team should present bill of purchased fire extinguisher. The fire extinguisher is liable to invalid if it has passed the expiry date as mentioned on body.
- 1.5.13 Team must be equipped with 2 ABC type fire extinguisher each of 1 kg. At least one must be rigidly mounted in driver sitting compartment and other on push/pull bar during every static and dynamic test.
- 1.5.14 The fire extinguisher should be mounted structural stable mount on the primary member. It should be in cockpit only in such a way that it is easy to access by the person nearby at emergency.
- 1.5.15 Pull-knob type of mounting for fire extinguisher as shown in the figure below is advisable and orientation of knob must be such that sufficient open space is provided for operation.



Figure 42 Fire Extinguisher Mounting



Figure 43 Fire Extinguisher Mounting Bracket

- 1.5.16 If the fire extinguisher is refilled, the team needs to show the original bill of refilling during the technical inspection.
- 1.5.17 Wiring harness should be mounted considering it to interfering with any moving component. Routing of harness should not entangle with driver's movement during drive
- 1.5.18 Wires should be properly covered using external hoses, wiring of electric and electronic system and tractive system can be done separately.
- 1.5.19 Proper automotive grade wiring connector must be used for all types of wiring in vehicle. Wire joint covered with tape is strictly prohibited.



Figure 44 Automotive Grade Wiring Connectors

2 Driver's Requirement

2.1 Driver's Documents:

Every team must have minimum two drivers.

2.1.1 Driver's License:

A valid government issued driving license is must for all drivers.

2.1.2 Driver Restrictions:

Representing driver of the teams must be a member of the participating team.

2.1.3 Accidental Insurance:

Individual Accidental insurance coverage for both drivers is must. Valid hard copy of insurance paper must be submitted at the time of technical inspection.

2.2 Driver's Equipment:

2.2.1 Drivers Safety Gear:

- x The following driver safety equipment specified below is the minimum safety requirement and must be worn by driver during all dynamic condition of the vehicle.
- x Using authentic driver's equipment with valid safety ratings as mentioned in rulebook will be prime responsibility of the team.
- x Date/Year of manufacturing of equipment must be on all critical safety equipment.

2.2.2 Driver's Suit:

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. 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.



SFI 3-2A/5 (or higher)



NORME 1986/ 1986 STANDARD



FIA Standard 8856-2000

Figure 5 Driver Suit & Required Ra

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.

2.2.3 Underclothing:

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. This fire-resistant underclothing (SFI/ FIA rated) should be made from an acceptable fire-resistant material as listed in 2.9 and that should cover the driver's body completely from neck down to ankles and also the wrists



Figure 6 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.

2.2.4 Helmet:

A well- fitting closed face helmet that meets one of the following certifications and is labelled as such- Snell K2000, K2005, K2010, M2000, M2005, M2010, SA2005, SA2010, SAH2010, SA2015 SFI 31.2A, SFI31.1/2005, SFI 31.2/2005, 31.2/2010, 31.2/2015, 41.2/2005, 41.2/2010, 41.2/2015 FIA 8860-2004, FIA 8860-2010, FIA 8859-2015

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 stickered. The organizer reserves the right to impound all non-approved helmets until the end of the competition.



Figure 27 Closed Face Helmet Along with Snell/FIA/SFI Rating

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

2.2.5 Balaclava:

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



Figure 28 SFI Rated Balaclava

2.2.6 Neck Support:

The neck support 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 29 Neck Support Allowed



Figure 50 Prohibited Neck Support

Note: - 360-degree continuous perimeter neck support along with required rating is allowed; Neck support with slots is not allowed

2.2.7 Gloves:

Fire resistant gloves 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 51 SFI Rated Gloves

Note: - Damaged or torn out gloves are not allowed.

2.2.8 Shoes:

Fire resistant shoes made of acceptable fire resistant material, shoes must be certified to the standard and labelled as such: SFI 3.3/ FIA 8856-2000.



Figure 52 SFI Rated Shoes

Note: - Sports shoes/Canvas shoes/Leather shoes/Industrial safety shoes are not allowed at any point of the event.

2.2.9 Socks:

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: Carbon X, Indura, Nomex, Polybenzimidazole (commonly known as PBI) and Proban.

2.2.10 Fire Resistance material:

For the purpose of this section some, but not all, of the approved fire-resistant materials are:

Carbon X, Indura, Nomex, Polybenzimidazole (commonly known as PBI) and Proban.

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

Note: Expired driving equipment's are not allowed, Team must ensure that the expiry date of their driving equipment's is beyond the date of event.