Technical Regulations

for the

2014 Event

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This document should be read in conjunction with the Challenge Regulations

Acknowledgment

We want to say thank you to Chris Selwood and the World Solar Challenge for their great cooperation. They shared their hard work and brilliant establishment with the European Solar Challenge and they enabled us to base the following technical regulations on those of the World Solar Challenge. This collaboration stands for joint work and mutual interest in creating a well-functioning and fair event for each participating team.

Section 1 – Administration

Event Organiser

Green Technology Events VZW
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Technical Committee:

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If there are questions to the Technical Regulations, feel free to contact Yago Elbrecht (yago.elbrecht@europeansolarchallenge.eu).

Cancellation of Event

The Organiser reserves the right to cancel or abandon the event for any reason. The Organiser's liability for costs incurred by an entrant are limited to the amount of the Entry Fee received.

In the case that the teams are not able to come to the event although they have signed up and already paid the application fee the application fee is not refunded.

In the case that the ESC Organizers have to cancel the event there is no refund of the application or shipping fee for the teams.

Insurance

All team members have to be medically and property insured themselves.

Please also note that the drives in the event participate at their own risk and are not insured via the event organisers.

Compulsory Third Party Injury

The Organiser will arrange for Third Party Bodily Injury insurance required to operate the Solar EV on public roads, a fee for which may be payable by the owner of the vehicle.

Third Party Property Damage

Cover has been arranged for any claims on the Organiser for damage done by your Solar EV during the event. The cost is the responsibility of the entrant.

Section 2 - Technical Regulations for the Solar EV

Explanatory notes are displayed in shaded boxes, such as this one.

A. Vehicle Classes

A.1 Challenge Class:

Vehicles conforming to the Challenge Class specifications defined in these technical regulations.

A.2 Cruiser Class:

Solar EVs are designed primarily for practicality. They are designed to carry two or more occupants, each facing forwards. They will be judged on external energy use, the time taken to complete the course, payload carried, and practicality.

B. Physical Specifications

B.1 Dimensions

B.1.1 When in motion, the maximum size of the vehicle is 5000 mm in length and 1800 mm in width.

B.1.2 When seated ‘road ready’ (helmet on, hatch closed), minimum height for driver's eye is 700 mm above the road.

B.2 Construction

B.2.1 All vehicles shall be constructed or adapted to protect, as far as is reasonably possible, the occupant(s) in the event of collision or vehicle roll-over. Steps should be taken to ensure that vehicle components, accessories or other components do not impinge on the occupant space.

B.2.2 All sharp edges, chains and sprockets must be covered when in use, and internal components or cargo must be secured.

B.2.3 Adequate ventilation must be provided to all occupants.

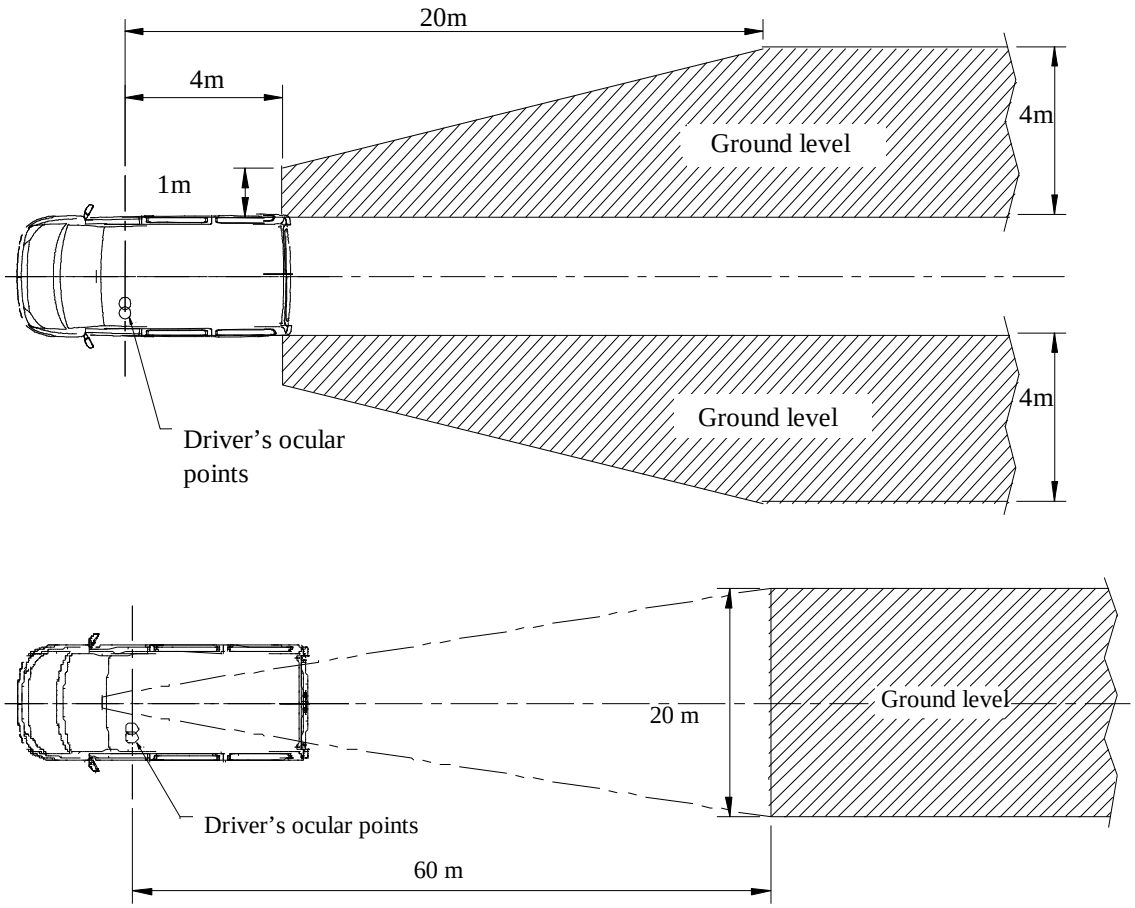
B.2.4 The design and construction of the vehicle must be such that, in the event of a front-end collision, any part of the vehicle structure (especially the solar array) will be deflected away from the driver/passenger compartment.

B.2.5 Drivers of Challenger Class Solar EVs must be enclosed in a safety cage capable of protecting the driver from an impact of 5 G from any direction.

B.2.6 Cruiser Class Solar EVs must be fitted with roll bars or roll cages which meet or exceed the intent of Appendix A of the Technical Regulations.

B.3 Vision

B.3.2 The driver must be able to see the shaded areas shown in the following diagram using the rear vision system (UNECE Regulation 46, Section 15)



B.3.1 Rear vision may be electronic and/or mirror. Electronic rear- vision systems must operate whenever the vehicle is in motion under its own power.

B.4 Windows and Windscreens

B.4.1 All windows must be made of a material that is highly resistant to breaking or major damage. Windows that are necessary to ensure the driver's vision must be made of glass or similar transparent material that does not distort vision.

B.4.2 The window may not be tinted or coloured to the extent that the condition of the driver cannot be easily observed from outside the vehicle.

B.4.3 Windows must have an optical transmittance not less than 75%
(UNECE Regulation 43)

B.5 Seats

B.5.1 Each occupant must be provided with an appropriately constructed seat consisting of a base (squab) and backrest.

B.5.2 Challenge Class vehicles: The angle of the (driver's) seat must not be greater than

27°. Drivers must demonstrate the ability to sit, road ready (helmet on, hatch closed), with their back flush against the seating elements measured in accordance with the provisions of Appendix B of the Technical Regulations.

Seatbelts must be compliant with UNECE Regulation 16 or US FMVSS 571.209 and have an (E..) or equivalent compliance marking.

Operating a vehicle in an extremely inclined position induces fatigue, prevents the driver from securing sufficient visibility, and may interfere with the effective functioning of the seatbelt in the event of collision.

B.5.3 Cruiser Class Solar EVs must have two or more seats, each facing forwards.

B.6 Doors and Openings

B.6.1 Challenge Class vehicles must be designed to allow occupants to enter and exit the vehicle without assistance. The doors must be able to be secured and released from both inside and outside the vehicle. Teams will be required to demonstrate that occupants can enter and exit the vehicle unassisted in no more than 15 seconds for each action.

Defining the time of entry is to encourage practicality in the chosen design.

B.6.2 Cruiser Class Solar EVs must be designed to allow occupants to enter and exit the Solar EV without assistance. Doors must be able to be secured and released from both inside and outside the Solar EV. Entrants will be required to demonstrate that all occupants (one per seat) can enter and exit the Solar EV unassisted in no more than 15 seconds for each action.

B.6.3 Emergency opening points must be clearly indicated on the exterior of the vehicle.

B.6.4 Securing of any egress route, canopy or hatch with adhesive tape is not permitted.

B.7 Emergency Recovery

EV must be equipped with towing eyes mounted as close as practicable to the front and rear extremities of the vehicle, each of which, together with their mountings, must hold sufficient strength to enable the vehicle to be recovered or moved from an inoperable or dangerous situation.

The minimum inner diameter of the towing eye shall be 50 mm. Towing eyes must be painted yellow, orange or red. Covers may be used provided they are removable without the use of tools; are the same colour as the towing eye; and endorsed either with the legend ‘Recovery Point’ or a graphic representation of a ‘hook’. The words or graphic must be in a contrasting colour to their background

It is unlikely that the ‘roll bar’ would meet these requirements.

B.8 Brakes

B.8.1 The vehicle must have a balanced, dual-braking system so that if one system should fail, the vehicle can still be stopped. Mechanical (i.e. not regenerative) braking effort must be applied to at least two of the wheels.

B.8.2 The vehicle must be able to stop with an average deceleration of $3.8\ m/s^2$ from any speed that the vehicle is capable of travelling. The vehicle must demonstrate the ability to stop in $25\ m$ from $50\ km/h$ and in $12.5\ m$ from $35\ km/h$.

B.8.3 Cruiser Class vehicles must be equipped with parking brakes capable of holding the vehicle (including driver) on an incline of 18°.

The braking systems for the vehicle should be designed and modelled in accordance with sound automotive engineering practice. Experience has shown that, in general, bicycle type brakes are inappropriate to the application and are unlikely to pass scrutineering. Note that regenerative braking does not contribute to the requirement of a dual-braking system.

B.9 Steering

B.9.1 For EV's, the steering system must be controlled by a steering wheel which has a continuous circumference/perimeter (q.v. Appendix C of the Technical Regulations).

B.9.2 Hip lever type steering systems are not permitted in any vehicle.

B.9.3 The vehicle must be able to make a U-turn in either direction within a 16 m lane (kerb to kerb).

B.10 Tyres

B.10.1 Tyres must be suitably designed and rated to withstand the loads and forces imposed by the vehicle mass, speed capability, and braking.

B.10.2 Tyres must have a tread pattern across the section width that normally comes into contact with the road, at least 1.5 mm deep in a band that runs continuously around the circumference of the tyre, and must be free of any apparent defect.

B.10.3 Tyres must, at all times, be used in accordance with their respective manufacturer's recommendations.

B.11 Lights and Indicators

Rear brake lamps, front and rear turn indicators, and front and rear hazard lamps are required. These must be visible in sunlight by other road users at a distance of 30 m.

B.12 Horn

An audible warning device (horn, hooter, klaxon, etc.) must be permanently fitted to the vehicle and demonstrated to the satisfaction of the scrutineer.

B.13 Compulsory Signs

B.13.1 The Organiser shall supply signs that carry Event and Event sponsor logos.

B.13.2 Unbroken, rectangular spaces, 200 mm in height x 500 mm in width must be provided on the right and left sides of the competing vehicle, clearly visible to a person standing 5 m from the vehicle.

B.13.4 Unbroken space 200 mm x 200 mm must be provided on the right and left sides of the competing vehicle for the purpose of competition number, clearly visible to a person standing 5m from the vehicle.

These are a mandatory requirements. If, in the opinion of the Chief Scrutineer, no suitable place is provided, the vehicle will not qualify for the Event.

C. Electrical

C.1.1 All electrical equipment must be well constructed according to sound engineering practice. Where the system voltage exceeds 32 V, the vehicle must be constructed in such a way that it is impossible for any occupant of the vehicle to touch live wires or terminals, or for any person working on the vehicle to touch live wires or terminals without having first removed a protective cover.

C.1.2 'High Voltage' warning signs must be fitted throughout the vehicle adjacent to all covers which, when removed, expose live wires or terminals where a potential of more than 32 V may be present.

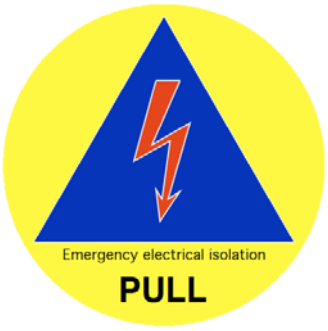
(UNECE Regulation 100, Section 5)

C.2.1 The driver must be able to electrically isolate the solar panel from the rest of the vehicle while seated in a driving position and without releasing the seat belt. Soft (e.g., MOSFET) switching is permissible.

C.2.2 The driver must be able to isolate electrically the battery from the rest of the vehicle while seated in a driving position and without releasing the seat belt. Soft switches are not permitted; the isolator switch must be a circuit- breaker, contactor, or other mechanical type. The isolator switch must be internal to the battery pack (as defined in Section F of the Technical Regulations). If two battery packs are employed, a separate isolator is required in each battery pack.

C.3.1 For emergency use, a means of electrically isolating both the solar panel and the battery from each other and from the rest of the vehicle must be provided on the exterior of the vehicle. The activation device must be able to be operated instantly and without hesitation by someone unfamiliar with the vehicle, and without removing any panels or tape. Soft (e.g., MOSFET) switching is permissible for the solar panel. Battery isolation must be effected through the use of a mechanical device internal to the battery pack(s) (as defined in Section F of the Technical Regulations).

C.3.2 The activation position of the emergency isolation device must be placed within a yellow disc (minimum 180 mm diameter) clearly marked with a blue equilateral triangle containing a red flash (minimum side length 150 mm), with the legend 'Emergency Electrical Isolation'. In addition, there must be a clear instruction on how to operate the device (e.g., 'PULL' or `PRESS'). The isolation device must be located within 50 mm of the lower edge of the windscreen on the left side of the Solar EV.



C.3.3 When the battery isolator switch is 'open', the only live wires permitted to emerge from the battery packs(s) are control and sensing wires that are short-circuit protected and incapable of delivering more than 5 mA under any reasonably foreseeable fault condition.

The purpose of sections C2 and C3 is to minimise the risk of electrical shock and fire, both during normal operation and in the Event of an emergency.

D. Energy Sources

D.1 Natural solar irradiation received directly by the vehicle is the only external energy source that may be used by the vehicle. (exceptions see Challenge Regulation)

D.2 Energy recovered from the motion of the vehicle may be used.

D.3 Auxiliary panels that are deployed only when the vehicle is stationary, are not permitted.

D.4 EV's Array Area

For Challenger Class and Cruiser Class Solar EVs, if the solar collector uses photovoltaic cells then the allowable area of photovoltaic cells is:

D.4.1 not more than 6.000 square metres for Solar EVs using only silicon photovoltaic cells

D.4.2 not more than 3.000 square metres for Solar EVs using only GaAs photovoltaic cells.

Challenger Class and Cruiser Class Teams wishing to use other types of photovoltaic cells, a mix of photovoltaic cell types, or other types of solar collector, must contact the Organiser.

The area of the array will be determined by summing the exposed surface area of the component cells. Entrants must supply sufficient information to enable the scrutineers to determine compliance with this regulation. The minimum requirement is documentation showing the size and number of the component cells; the calculations summing the total area; a map, with dimensions, of the cells as fitted to the vehicle and a written declaration by a licensed professional in the country of origin (e.g., professional consulting engineer) that the array complies with the regulation.

E. Energy Storage

The following electrochemical terminology is used within both the General and the Technical Regulations of the 2014 European Solar Challenge.

***Cell:** A device that converts chemical energy into electrical energy by passing a current (a reverse flow of electrons) between a positive and a negative electrode, through an ionically-conducting electrolyte medium.*

***Module:** A number of cells assembled as the basic unit of a battery pack.*

***Pack:** A number of cells or modules connected together to provide the required power and energy for a given application. (No more than two packs are permitted.)*

***Traction Battery:** The total number of cells, modules or packs connected in series or parallel.*

E.1 Any energy storage device may be used. The total stored energy of these devices must meet the approval of the Chief Energy Scientist.

E.2 Temporary storage devices other than batteries (e.g., supercapacitors) must be shown to be in a fully-discharged state at the Start Line.

E.3 For Challenger Class EVs, if the energy storage system is a secondary electrochemical battery then the sum of the nominal cell masses, as specified by the cell manufacturer, may not exceed the following limits:

Li-ion	21.0 kg
Li-polymer	22.0 kg
LiFePO4	40.0 kg
Ag-Zn	40.0 kg
Ni-MH	70.0 kg
Ni-Zn	75.0 kg
Ni-Fe	100.0 kg
Pb-acid	125.0 kg

Ni-Cd batteries, other than those in used in devices with internal batteries approved by the manufacturer, are not permitted.

E.4 For Cruiser Class EVs, if the energy storage system is a secondary electrochemical battery then the sum of the nominal cell masses, as specified by the cell manufacturer, may not exceed the following limits:

Li-ion	63.0 kg
Li-polymer	66.0 kg
LiFePO4	120.0 kg
Ag-Zn	120.0 kg
Ni-MH	210.0 kg
Ni-Zn	225.0 kg
Ni-Fe	300.0 kg
Pb-acid	375.0 kg

E.5 If the energy storage system is not made from commercially-available secondary cells, the allowable configuration and mass will be determined by the Chief Energy Scientist.

E.6 Commercially-available instruments, computers and digital multimeters may use ancillary batteries provided that the battery is internal to the instrument and complies with the specifications set by the manufacturer of the given instrument. No external connection is allowed to ant such instrument battery.

E.7 Batteries powering vehicle systems and ancillary devices (including computers, telemetry equipment, and non-commercial instrumentation) are considered to be part of the overall energy storage system and will be subject to Technical Regulation E.3.

Entrants considering mixing dissimilar batteries should contact the Organiser.

F. Battery Installation

For the purposes of the Event, battery packs are defined as the outer container (box) holding a complement of cells/modules, associated internal control equipment, and safety isolator described in Technical Regulation C.2.2

F.1.1 Battery packs must be housed in boxes with lids (preferably transparent).
The boxes must be removable from the vehicle in which they are installed.

F.1.2 Battery packs must be constructed in such manner that tamper-evident devices and seals can be applied to ensure that no cell or battery can be removed without breaking the seal.

F.1.3 The designed of the battery box described in Technical Regulation F.1.3 must facilitate the application seals by the provision of 3 mm holes through which strings can be passed across the top of the cells within the box. (an example of how this may be achieved is shown in the photograph in Appendix D of the Technical Regulations).

If the design of the box is such that, once sealed, the lid cannot be opened without breakage of the seals, then cell/battery monitoring must be conducted by an internal or a remote battery-management system.

F.1.4 Battery packs must be securely fixed to the vehicle.

Fixing by the use of cable ties is unlikely to meet this requirement.

F.1.5 Chemical spill-proof barrier(s) must exist between the vehicle occupants and each battery pack.

F.1.6 Battery packs shall be provided with adequate airflow vented to the exterior of the vehicle.

F.2 The traction battery must not exceed two packs.

Appendix A

International Solarcar Federation
Roll Bar Specifications

All vehicles must be equipped with the first and second roll bars (as shown in the specifications below) to prevent direct damage to the driver and serious cockpit deformation in the Event of a collision or of a vehicle turning over.

The first and second roll bars form the basic element of the rollover structure. These structures must be made of steel tubes or other material of sufficient strength to protect the occupant from a force of 4w (w = weight of vehicle). The structure must be bolted, welded or otherwise structurally incorporated to the vehicle according to sound engineering practice. For vehicles whose bodywork fulfils the function as the first and second roll bars, the installation of additional roll bars is not necessary.

Roll bars shall meet the following dimensional criteria.

- The line extended from the top of the first roll bar to the top of the second roll bar must be above the driver's helmet when he/she is seated normally in the vehicle.
- The top of the first roll bar must be higher than the top of the steering device.
- The first roll bar must cover the steering device with steered wheel(s) in the straight position ahead when the vehicle is viewed from the front.
- The second roll bar must cover the driver’s shoulder when the vehicle is viewed from the front. In a case where the bodywork of the vehicle covers the driver's shoulder, the second roll bar may cover only the driver's head.
- The second roll bar must have sufficient strength for lifting or towing with the driver on-board.

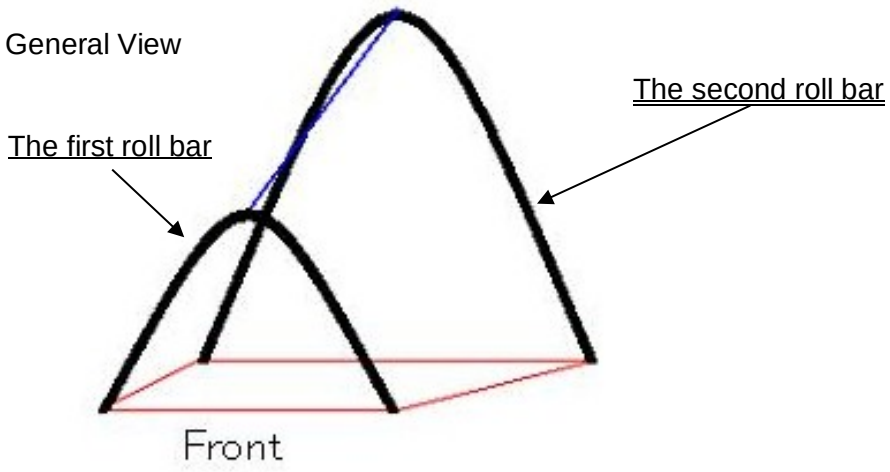
General Descriptions

Roll bars must be designed and constructed so that, when correctly installed, they minimize the risk of injury to the occupant.

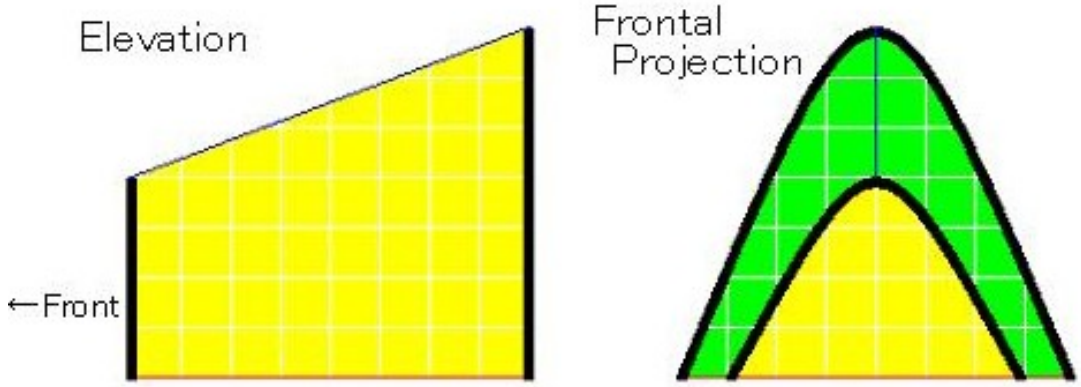
The responsibility to secure the necessary strength rests with participants.

No part of the roll bars must hamper the entry/exit of the occupant or take up the space designed for the occupant.

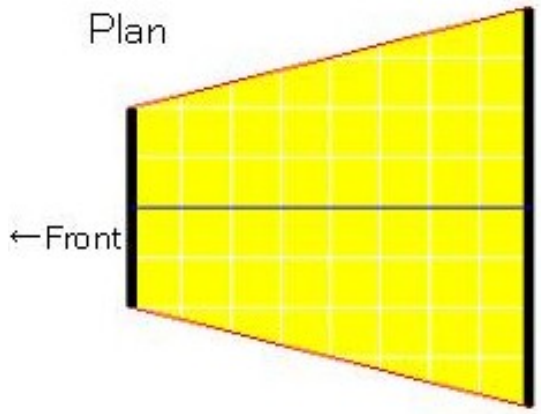
Basic roll bar configuration



The driver's helmet must, when seated normally, be contained within the defined area



All driving controls must be capable of being accessed and operated within the defined area



All parts of the driver's body (including any protective clothing and equipment, must, when seated normally, be contained within the defined area

Appendix B

International Solarcar Federation
Standard Measurement of Seating Angle

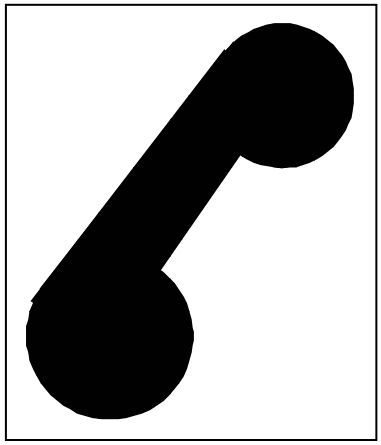
The seating angle must not exceed 27^{o} from the vertical plane.

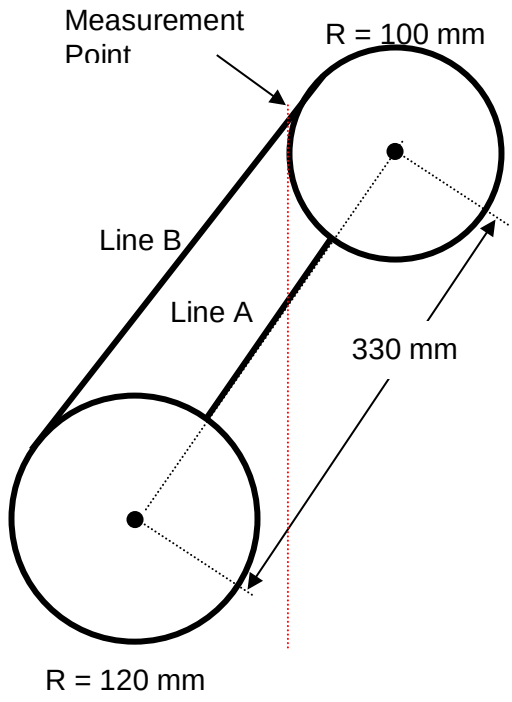
The concept of determining the seating angle is based on the measurement of torso angle in accordance with ISO/JIS Standards.

- JIS D4607 is the standard that shows the three-dimensional seated human model for measurement of automotive body interiors.

- JIS D0024 establishes the H points (hip point: rotational centre of body and thigh in the three-dimensional human model) and indicates measurement methods including the torso angle based on D4607.

For ISF scrutineering purposes, measurement is effected by using a template based on the hip and shoulders of a two-dimensional form derived from the JIS D0024 standard.





Making a Template

- Draw a circle with a radius of 120 mm.
- At a point 330 mm from the centre of the circle, draw another circle with a radius of 100 mm.
- Draw a line connecting the centre of the two circles (Line A).
- Draw a tangent to connect the circumferences of two circles (Line B).
- Cut the shape using suitable material.
- Attach a plumb line to the measurement point.
- The angle is measured between line A and the perpendicular.

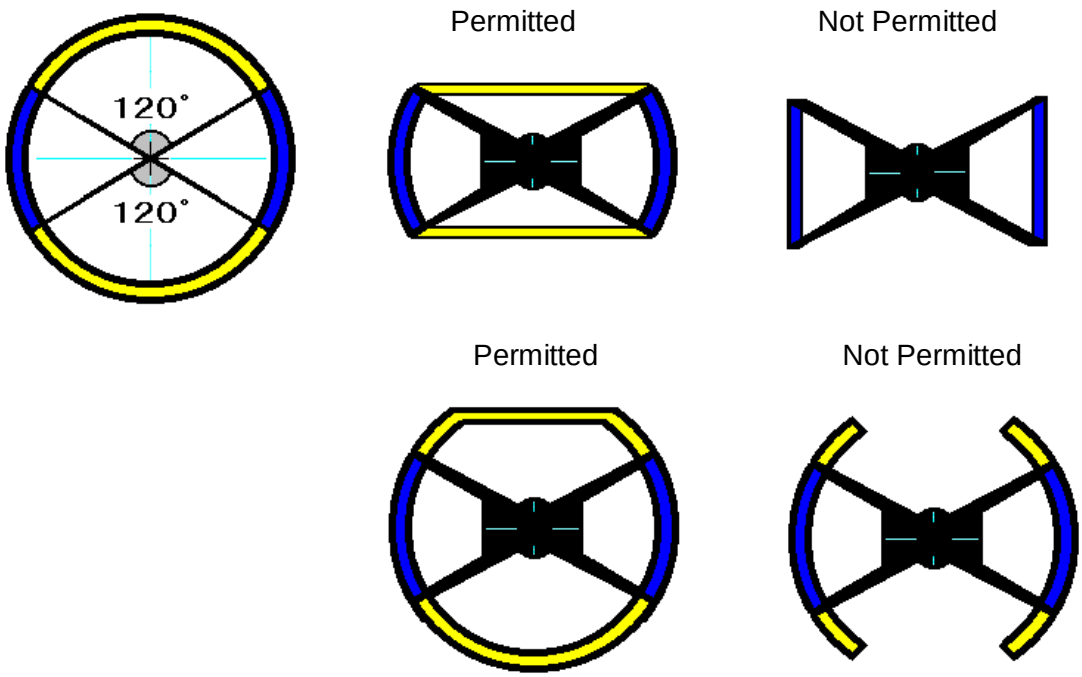
Appendix C

International Solarcar Federation
Steering Wheel Specifications

Steering Wheel

To reduce the possibilities of driver injury in the event of collision and to minimise impediments to emergency egress, the steering system must be controlled by a steering wheel that has a continuous perimeter.

A circular shape is preferred, but the upper part above two-thirds and/or the lower part below two-thirds of the circumference of the steering wheel may be flat as depicted in the diagram below).



Appendix D

Battery Seals (see Technical Regulation F.1.3)

Once the battery has been passed by the Scrutineers, tamper evident seals will be applied to the battery pack(s) to ensure that no cell or module can be removed without breaking the seal. To facilitate this process, the battery box should be pre-drilled with 3 mm diameter holes to allow seals (e.g., string/ties) to be passed across the top of the cells/battery within the box, ***as shown in the example below****.*

Please note that should the pre-drilled holes be unsuitable, the Scrutineer will need to drill the battery box(es) and this could considerably extending the time spent in spent in scrutineering.