Regulations for the 2022 Event

March 8, 2022

Document Control

Release version 1.0 issued 8th of March 2022

IMPORTANT This printed version may not contain all updates and bulletins. The organizer reserves the right to modify these regulations at any time.

For the latest information please refer to the website of the iLumen European Solar Challenge (https://www.europeansolarchallenge.eu/).

Contents

2022 iLumen European Solar Challenge Regulations

The organizer reserves the right to modify these regulations at any time.

Main changes

The biggest change for 2022 includes:

- Dynamic scrutineering will consist of a dynamic handling parkour onto the race track.

The information contained in this document is for the purposes of conducting the 2022 European Solar Challenge and must not be regarded as constituting definitive instructions as to how a solar car should be constructed or operated.

This document is organised as far as practical into the following sections:

- Administration
- Solar car technical regulations
- Race organization
- Achievement and celebration.

Additional information or clarification of the intent of regulations is included in a grey background.

Acknowledgement

We would like to thank Chris Selwood and the World Solar Challenge for their great cooperation. They shared their hard work and brilliant expertise with the European Solar Challenge, as well as enabling us to found 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 every participating team. As a consequence, every solar car eligible for any of the editions of the World Solar Challenge so far will, in the same road-ready condition, automatically be allowed to compete in the European Solar Challenge.

Also, we would like to keep Laurenz Holthoff in memory, who was in the organizer team in previous events but sadly is no longer with us. He did outstanding work until preparations for the European Solar Challenge 2018.

1 Administration

1.1 Correspondence

1.1.1 All correspondence shall be conducted in English, the official language of the event.

1.2 Eligibility

1.2.1 Solar cars must be powered by solar irradiance collected by the solar car.

1.3 Entrant obligation

1.3.1 By submitting an application, entrants declare that they know and understand the regulations of the event and agree that participation will constitute their full acceptance.

1.3.2 Each entrant will appoint an individual to act as the **'Team Manager'**. The Team Manager will be responsible for regulatory compliance, the actions of team members, and any other individuals associated with the team. Once appointed, the Team Manager may only be replaced with the approval of the organiser.

1.3.3 Entrants are expected to act fairly and in good faith in accordance with the regulations.

1.3.4 Penalties (which may include exclusion) will be applied to any team deemed to have departed from the spirit of the event by deliberately acting to gain an unfair advantage over others, or by conduct that could bring the event into disrepute.

1.4 Event organiser

Green Technology Events VZW

Ambachtstraat 18 BE-3980
Tessenderlo
E-mail: info@europeansolarchallenge.eu
Web: www.europeansolarchallenge.eu

1.5 Organising committee

1.5.1 The organising committee is:

- To be announced later
- such other members the organiser may appoint.

1.5.2 Scientific Faculty:

- To be announced later
- such other members the organiser may appoint.

1.5.3 Operational advisory group:

- To be announced later
- such other members the organiser may appoint.

1.6 Officials of the event

Event Director	To be announced later
Event Operations Manager	To be announced later
Participant Liaison Officer	To be announced later
Clerk of the Course	To be announced later
Chief Steward	To be announced later
Chief Scrutineer	To be announced later
Chief Scientist	To be announced later
Chief Energy Scientist	To be announced later
Chief Safety Officer	To be announced later
Chair of Scientific Faculty	To be announced later
Cruiser Class Manager	To be announced later
Such other officials the organiser may appoint.	

1.7 Stewards of the event

1.7.1 The organiser will appoint independent stewards.

1.7.2 The stewards of the event are the only authority empowered to determine the interpretation of these regulations.

1.8 Schedule

The schedule that follows is only meant as indication. The exact schedule and timings will be made available on the website of the iESC (www.europeansolarchallenge.eu).

8 March 2022	Event dates announced 2022 Event Regulations published Applications for Entry open Volunteer Registrations open
1 July 2022	Standard Applications of Entry close

29 August 2022	Volunteer Registrations close
01 September 2022	Entry list published
14 September 2022	Official event period commences Arrival and opening campsite
14 September 2022	Team Managers briefing
15 September 2022	Static scrutineering commences on zone 5
15 September 2022	Official Team Welcome Drink and speech Chairman
16 September 2022	Free practise Transponder test
16 September 2022	Dynamic scrutineering commences: parcours
16 September 2022	Free night practise
17 September 2022	Team manager and drivers briefing
17 September 2022	Line-up in pitlane
17 September 2022	Ceremonial Start 24h
18 September 2022	Finish 24h
18 September 2022	Parade
18 September 2022	Award Ceremony
18 September 2022	Closing of pit boxes Return of keys

1.9 Entering the event

Applications for entry are invited from any entrant prepared to meet the standards and obligations of the competition.

1.9.1 Applications may be made from the time these regulations are published, until noon 31th of August 2022 (CET), or such other time as the event organiser may determine.

1.9.2 Applications for entry must be made via mail to the official iESC organization, info@europeansolarchallenge.eu.

1.9.3 Entry requests will only be considered on payment of the application fee.

1.9.4 The granting of a place in the event will become void if the entry fees have not been received by the due date.

1.9.5 Entrants who do not satisfy the Chief Scrutineer that they will achieve compliance with the regulations (through documentary submission) may fail to qualify for the event.

1.9.6 The organiser reserves the right to accept or reject any application without explanation.

1.10 Entry fees

1.10.1 An application fee of EUR € 500 has to be paid in advance before July 1st, 2022. Payment of this fee will be via credit card as part of the entry process via mail. An official tax receipt will be provided via email. Application fees cover participants' usage of the camping grounds as well as the usage of sanitary facilities.

1.10.2 The application fee, which forms part of the total entry fee, is non-refundable.

Entrants will be provided with an invoice for the remaining entry fee within one month of receipt of their completed official entry form and application fee. Acceptable methods for payment of entry fees will be detailed in the invoice document.

1.10.3 International banking charges are the responsibility of the entrant.

1.10.4 The Standard Entry fee will apply to applications received before 23:59 (CET) on Friday 1st of July 2022.

1.10.5 All entry fees are payable in full by noon (CET Sunday 31st of July 2022; failure to pay by the due date will void the application. Any refund will be subject to the terms outlined under Regulation 1.11.

1.10.6 The entry fees are:

Class	Standard Entry fee
All	EUR € 3,500 excl. 6% taxes

This price is conditional on 15 teams participating in the iESC 2022. If this is not the case, the price will increase proportional to the number of participating teams. Application fees

cover up to 20 team members. For every additional team member, teams will be charged EUR € 20.

1.10.7 The organiser reserves the right to accept late entries. Entry requests granted after the close of entries will attract a 10% late fee.

All enquiries regarding fees or payments should be directed to the Participant Liaison Officer via email (info@europeansolarchallenge.eu) during business hours, 09:00–16:30, Brussels time, Monday-Friday.

1.11 Refunds

1.11.1 In case that teams are unable to participate in the event despite signing up and already having paid the entry fee, the organizers will decide on a possible refund of the entry fee.

**The application fee and bank charges are not refundable.*

1.12 Cancellation of the event

1.12.1 The organizer reserves the right to cancel or abandon the event for any given reason. The organizer's liability for costs sustained by an entrant is limited to the amount of the entry fee received. In the event that teams are unable to compete in the event despite signing up and already having paid the entry fee the application fee will not be refunded.

1.12.2 Should the organizers of the European Solar Challenge have to cancel the event, any application, entry or shipping fees will not be refunded.

1.12.3 In case the 24 hours iLumen European Solar Challenge is cancelled by the organizers themselves, the entry fee will be refunded.

1.12.4 If another party obligates the organizers to cancel the iESC, the organization will decide whether or not to refund the entry fee.

1.13 Insurance

1.13.1 All team members need to be personally insured for any physiological or property damage that may arise. Comprehensive insurance for personal effects, tools, equipment, solar cars and other vehicles is the responsibility of the entrant. Please also note that all drivers participate at their own risk and are not insured via the organizers of the European Solar Challenge.

Participants are advised that a personal travel insurance policy in respect of theft, loss, sickness and accidents is highly recommended.

1.13.2 Third Party Property Damage: Cover has been arranged for any claims against the organizer for damage done by your solar car during the event. All arising costs are responsibility of the entrant.

1.14 Pit Box Key

1.14.1 Preparation facilities, or pit boxes; will be available at Circuit Zolder in accordance with the dates listed in the schedule. Teams have to leave an EUR € 200 cash deposit for the key to lock their designated pit box on their own. The deposit will be returned on Sunday when the team hands their key back to the event organizers. For deposit return the pit box has to be clean and empty.

1.15 Team members

1.15.1 Each team must include (but not be limited to):

- a team manager
- a safety officer, responsible for the safety of the team
- a battery officer, responsible for the solar car battery
- an interpreter if the team manager is not proficient in English
- at least three and at most six solar car drivers
- at most eight registered solar car passengers (for Cruiser class).

In case a cruiser team would like to have more than eight passengers a request should be made to the event organizer.

1.15.2 Each team member will be required to register and be physically present at team registration. All team members must be registered by 10:00 on Saturday 17th of September 2022.

1.15.3 A person holding the position of team manager, safety officer or battery officer may not hold any other of these roles.

1.15.4 The person holding the position of safety officer may not be a solar car driver.

1.15.5 Each solar car driver must hold an appropriate motor vehicle driver's licence recognised by Belgian authorities and valid for the total period of the event.

Driving licences will be inspected and verified by scrutineers as part of the scrutineering process. Acceptable driving licences must include a photograph of the holder, the class of vehicle for which the licence applies and the expiry date. If these details are not in English, either the licence must be accompanied by a certified translation, or a valid International Driving Licence is required.

1.16 Team identification

1.16.1 Team, team manager and solar car details will be taken from the entry form via mail.

1.16.2 Requests to change entry details will only be considered when submitted, by the team manager, by email.

1.16.3 Once an entry has been accepted, any request to change entry details will be subject to the approval of the organiser.

1.16.4 Each team will be allocated a team number on acceptance of entry.

1.16.5 Teams may make a special request for the use of a particular team number. Requested numbers should contain two digits.

1.16.6 Allocation of any number is at the sole discretion of the event organiser.

1.17 Permits

1.17.1 Import permit arrangements for vehicles (including road trailers) are the responsibility of the entrant.

1.17.2 There are no vehicles allowed on the campground other than: Solar cars during pre-scrutineering, support vehicles during build-up and teardown, campervans (as long as their footprint is in proportion to the number of people sleeping inside). Teams who need a support vehicle on the campground should contact the organizers in advance. Keep in mind that the campground might be very crowded. Vehicles may not leave or enter the campground during the main event.

1.17.3 Anyone on the campground must have a fire extinguisher or other method to extinguish a fire nearby.

1.18 Copyright and Intellectual Property

1.18.1 The correct title of the event is the *iLumen European Solar Challenge*. The correct title is the *Word Mark* of the event. Entrants and their sponsors **must** use the correct title in all references to the event.

1.19 Unmanned Aerial Vehicles (Drones)

1.19.1 Unmanned Aerial Vehicle (UAV/drone) operations may be conducted only with the approval of Circuit Zolder. The organization will allow permits granted by Circuit Zolder. Application for these permits is the sole responsibility of the team.

1.20 Compulsory documentation

1.20.1 Each team must submit documentation during static scrutineering. All submissions must be made by the end of dynamic scrutineering, which date is stated in the event schedule. An exception is Group C, this has to be sent via mail (info@europeansolarchallenge.eu) before the 4th of September 2022.

Group A

- General Specification
- Electrical System Specification
- Solar Collector Specification

- Energy Storage System Specification.

Group B

- Battery Incident Plan
- Team Safety Plan
- Publication-quality information and photographs of the team and solar car.

Group C

- Logistics schedule
- Travel and arrival information.

Group D

- Two printed A4 copies of a diagram of the solar car in plain view, with the front of the solar car depicted at the top of the diagram, and clearly showing how emergency isolation is to be activated
- A simplified wiring diagram, printed on A4 paper, showing how the main functional blocks (PV array, energy storage packs, electronics modules, etc.) are connected together, together with circuit breakers, contactors and fuses.

1.20.2 Any requests to make changes to items described in the compulsory documentation, after the submission deadline, must be sent to the event organiser in writing by the team manager. If granted, any document submitted by a team will supersede all previous versions. No guarantee is provided that changes will be reflected in event publicity or documentation.

2 Solar car technical regulations

Legend:

Explanatory notes are displayed in shaded boxes.

Notes added 6 weeks prior to the start of the event will be displayed in orange boxes.

2.1 Vehicle Classes

2.1.1 The 2022 European Solar Challenge will have two classes of solar car:

- **Challenger class** is for single-seat solar cars designed to be fast
- **Cruiser class** is for efficient, practical solar cars with two or more seats

2.1.2 Every vehicle belonging to the cruiser class must be occupied by no less than one person and no more than five people at all times throughout the race.

The following Regulations are compulsory for all participating vehicles, no matter which class they compete in.

2.2 Dimensions

2.2.1 When driving in a straight line, the solar car must fit inside a right rectangle 5000 mm long and 2200 mm wide.

2.2.2 When seated 'road ready' (helmet on, hatch closed), minimum height for driver's eyes is 700mm above the road.

2.2.3 The fully-laden solar car must be able to drive off a road with a 50mm vertical edge drop without any part of the solar car, other that the tyres, touching the ground.

2.3 Wheels

2.3.1 Challenger and Cruiser solar cars must be supported by three or more wheels. Points of contact between the tyres and the road must be symmetrical about the longitudinal centreline of the solar car.

Teams wanting to use another layout must send details via mail to the organiser for approval.

2.3.2 For Challenger and Cruiser solar cars, the distance between the front tyre centres and the distance between the rear tyre centres must each be more than half the width of the solar car.

2.4 Solar collector

2.4.1 A standard solar collector uses photovoltaic cells without reflectors or concentrators. Teams wanting to use reflectors, concentrators or some other form of solar collector must send details of the proposed solar collector to the event organiser for approval. Natural solar irradiation received directly by the vehicle is the only external energy source that may be used by the vehicle. Energy recovered from the motion of the vehicle may be used.

The power generated by a proposed non-standard solar collector should be equivalent to the power generated from a standard solar collector.

2.4.2 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)**
Challenger	Si	6.000
	thin film single junction	3.560
	thin film multijunction	3.240
	multijunction	2.640
Cruiser	Si	6.000
	thin film single junction	4.440
	thin film multijunction	4.050
	multijunction	3.300

2.4.3 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 (shingled), cell area is defined as the exposed surface area of the cell. Cell area includes active material, busbars, fingers and connection pads. 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.

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 m^2, and so the area of 260 cells is less than 3.9866 m^2 and the area of 326 cells is less than 4.9986 m^2.

2.4.4 Teams wanting to use a mixture of photovoltaic cell chemistries must send details to the organiser for approval. If the areas of the different chemistries are area A_1 of silicon cells, area A_2 of thin film single junction cells, area A_3 of thin film multijunction cells and area A_4 of multijunction cells then the areas must satisfy

$$A_1 / 6.000 + A_2 / 3.560 + A_3 / 3.240 + A_4 / 2.640 \leq 1$$

for Challenger solar cars, and

$$A_1 / 6.000 + A_2 / 4.440 + A_3 / 4.050 + A_4 / 3.300 \leq 1$$

for Cruiser solar cars.

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

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

2.5 Energy storage

2.5.1 A solar car may store energy. A standard energy storage system uses rechargeable electrochemical cells. Teams wanting to use some other form of energy storage must send details of the proposed energy storage system to the event organiser for approval. Any energy storage device may be used but the total stored energy of these devices must meet the approval of the Chief Energy Scientist.

2.5.2 If the energy storage system comprises rechargeable electrochemical cells all with the same chemistry, then the allowable total cell mass for Challenger solar cars is:

Electrochemical cell chemistry	Allowable total cell mass (kg)
Li-S	15.00
Li-ion	20.00
Li-polymer	20.00
$LiFePO_4$	40.00

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

2.5.3 Teams wanting to use other cell chemistries or a mix of cell chemistries must send details of their proposed energy storage system to the event organiser for approval. The Chief Energy Scientist will determine allowable configurations.

2.5.4 Li-ion cells with size designator ‘18650’ are deemed to have a cell mass of 47.6 g. The maximum number of 18650 cells allowed for Challenger and Adventure solar cars is 420. For all other cell sizes and types, the cell mass will be deemed to be the nominal or maximum cell mass specified in detailed cell model specifications provided by the manufacturer.

2.5.5 Specifications from third party suppliers or found on the internet might not match those endorsed by manufacturers. If the event organiser receives conflicting or unclear specifications of cell mass for a particular cell model, the Chief Energy Scientist will determine the nominal cell mass for cells of that model.

2.5.6 The sum of nominal cell masses (i.e., summed over all cells) must be not more than the allowable total cell mass.

2.5.7 The energy storage system must be contained within at most two packs.

Entrants with a traction battery that consists of more than two packs shall contact the organizer via mail prior to the event.

2.5.8 Electrochemical cells must not, at any time, be operated outside of the operating ranges for voltage, current and temperature specified by the manufacturer. Teams must provide manufacturer's specifications (datasheets) that include:

- minimum operating cell voltage
- maximum operating cell voltage
- maximum discharge current
- maximum charge current
- maximum temperature while discharging
- minimum temperature while charging
- maximum temperature while charging.

2.5.9 Teams must provide documentation that describes how they will monitor their electrochemical cells, and what the team and the solar car will do if any cell goes outside specified operating limits. Teams must obtain endorsement by their certifying engineer that an adequate and effective monitoring regime has been designed and implemented, and fault conditions will be managed safely.

2.5.10 Batteries used only to

- power a real-time clock when the solar car is turned off; or
- retain data when the solar car is turned off;
- or power wireless tyre pressure monitors

are not considered to be part of the energy storage system, provided that the total energy capacity does not exceed 2.0 Wh.

2.5.11 Batteries or cells inside devices such as handheld radios, cameras, mobile telephones or wristwatches that are carried by the driver or passengers are not considered to be part of the energy storage system, provided that they are not electrically connected to the solar car, its instrumentation or control systems.

2.5.12 Capacitors are not considered to be part of the energy storage system if their total energy storage capacity is less than 10.0 Wh. Such capacitors must be automatically discharged to less than 60 V within five seconds of the solar car being placed in safe state (see Regulation 2.29). It must be shown these capacitors are in a fully discharged state at the Start Line.

An external battery is not necessary to start a solar car. Possible alternatives include:

- *Use a small galvanically isolated dc/dc converter inside an energy storage pack to supply voltage to a remote start switch. You can use a separate switch on the energy storage pack to turn off this dc/dc converter if it is not going to be used for an extended period.*
- *If the driver can reach the energy storage pack, put the start switch on the energy storage pack.*
- *Use an air switch inside an energy storage pack, with an airline to a remote start button.*

For the purpose of the event, battery packs are defined as the outer container (box) holding a complement of cells / modules, associated internal control equipment, and safety isolation described in these regulations.

2.5.13 Energy storage packs must be mounted in the solar car so that they will be restrained in a 20g acceleration.

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

2.5.14 If an energy storage pack is capable of spilling dangerous liquids when damaged then there must be a spill-proof barrier between that energy storage pack and the solar car occupants.

2.5.15 If an energy storage pack is capable of emitting dangerous gases when damaged then the solar car must be designed so that any gases from a damaged pack will be vented to the exterior of the solar car behind any occupant ventilation intake.

2.5.16 Removable energy storage packs enable teams to work on their solar car while their energy storage packs are impounded. If energy storage packs are removable then:

- each energy storage pack must remain in safe state while not connected to the solar car
- each energy storage pack must meet the electrical safety requirements of Section 2.29 while outside of the solar car
- the team must provide a lockable box for storing energy storage packs while they are impounded.

2.5.17 Energy storage packs must be constructed so that each pack can be sealed using tamper-evident plastic seals, similar to 3 × 100 mm plastic cable ties. With seals fitted, it must not be possible to remove any cell from a pack without breaking the seal. Seals will be provided by, and fitted by, the event organiser at scrutineering.

2.5.18 The design of the battery box must facilitate the application of seals by the provision of holes through which strings can be passed across the top of the cells within the box.

2.5.19 Energy storage packs must be designed and constructed so that scrutineers can verify the cell models being used and the number of cells of each model. Battery packs must be housed in boxes with lids (preferably transparent). The boxes must be removable from the vehicle in which they are installed.

2.5.20 Any charging system that is used to recharge the energy storage system (when allowed) must meet the following requirements:

- the charger must be used with a 30mA residual current device (RCD)
- the charger must be either permanently connected to the energy storage system, or connect to the energy storage system using an appropriate connector
- the output of the charger must be electrically isolated from any ac input
- the charger must stop charging automatically when the energy storage system is full, if a fault occurs or as soon as a single cell is above its maximum voltage (e.g., 2V).
- A battery monitoring system has to monitor all cell- / module-voltages and temperatures and provide a human readable interface.
- The battery monitoring system must be in operating status while charging.

2.5.21 Cruiser charging will be metered by the organiser. Cruiser solar cars are advised to be equipped with an on-board ac charger with a VDE-AR-E 2623-2-2 ('Type 2') charging inlet, and be capable of charging from a single-phase ac supply. The ac current draw must not exceed the limit indicated by the SAE J1772 pilot signal generated by the organiser's Electric Vehicle Supply Equipment (EVSE), which will allow charging rates up to 30 A but may reduce the limit to as low as 6 A. The EVSE may disconnect the car if the indicated current limit is exceeded for more than 5 seconds.

The charger itself could be used outside the car and be carried to the charging bay but a permanent proper connector inside the car is required.

Older cruiser cars, which previously completed scrutineering in a BWSC or ESC, having a 3-phase charging inlet, will also be allowed in this edition of the ESC.

2.5.22 Cell / battery monitoring must be conducted by an internal or a remote battery management system.

2.6 Signage

2.6.1 Unbroken rectangular spaces 200 mm high and 500 mm wide must be provided on both the left and the right sides of the solar car for event signage.

Event signage will be provided by the organiser at scrutineering. Artwork and a style guide will be available on request. Incorrect use of artwork will result in a sticker being applied.

2.6.2 Teams must display their team number on the left and the right sides of the solar car, in digits that are more than 200 mm high and that are clearly visible from a distance of 5 m perpendicular to the side of the solar car.

2.6.3 Event signage and team numbers must be completely visible from a distance of 5 m perpendicular to the side of the solar car and at a viewing height of 1.8 m above the ground.

2.6.4 Solar cars must have an unbroken front signage area on the solar car body forward of the windscreen. The projection of a 600 mm × 150 mm rectangle onto the solar car body, perpendicular to the plane of the rectangle (see the diagram below), must fit entirely within the front signage area. The entire front signage area must be visible in plain view and in front elevation view, and must not overlap with the solar collector. A 150 × 150 mm event logo must be placed within the projection of the rectangle, with part of the event logo further forward than every part of the solar collector. Artwork or a sticker for the event logo will be provided by the event organiser. The front signage area should also include the name of the team or the name of the car.

2.6.5 The national flag of the country of entry must be displayed on the solar car, adjacent to the windscreen. Minimum size is 70 mm × 40 mm. The flag must not be broken.

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

2.7 Ballast

2.7.1 Each solar car occupant will be assigned ballast so that the combined mass of the driver and their ballast is at least 80 kg. The combined mass of a passenger and its ballast must be at least 60 kg.

2.7.2 The solar car must have means of securing each occupant's ballast within 300 mm of their hip point.

2.7.3 Ballast bags are not provided by the organiser but will be weighted before departure of the solar car.

2.8 Timing Transponder

2.8.1 A timing transponder for tracking the race event will be provided by the organizer.

2.8.2 The transponder is advised to be fixed below the solar car, at most in 30 cm height above the ground. It must not be subject to falling off while driving, however it has to be removed easily after the race event. It is sufficient if its signal is detected through the car. The timing transponder is used to count the track rounds driven so it's in the main interest of each team to make sure this transponder is operating correctly and properly fixated onto the solar car.

See the official website for more clarifications. The position of the timing transponder will be validated during test-driving before start of the 24hr.

2.8.3 The timing transponder must be returned to the organiser at the conclusion of the event.

Exact details where the transponder needs to get mounted will be announced before the event.

2.9 Safety

2.9.1 Teams are responsible for the safety and roadworthiness of their solar cars. Compliance with the regulations and passing scrutineering does not mean that a solar car is safe, roadworthy, and fit for purpose.

2.9.2 Each team must engage a professionally qualified engineer, responsible for inspecting and certifying that the solar car is designed and constructed using sound engineering practice, meets the design parameters where stated, and is roadworthy and fit for the purpose of being driven 24h on a circuit.

2.9.3 The event organisers may, at any stage, remove a solar car from the event if they consider the solar car or the behaviour of the team to be unsafe.

2.10 Occupant cell

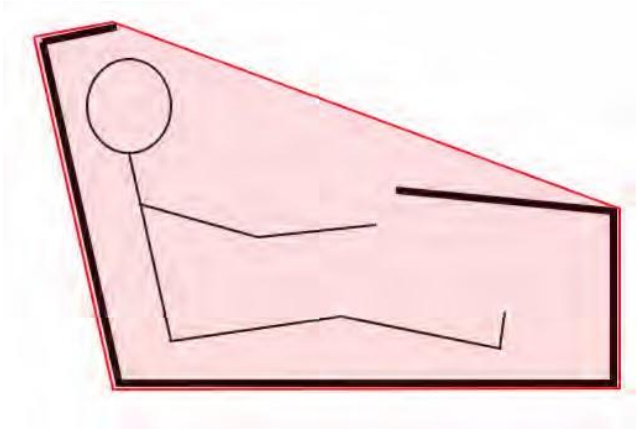
2.10.1 Solar car occupants must be enclosed in an occupant cell designed to protect them from injury. All vehicles shall be constructed or adapted to protect, as far as is reasonably possible, the occupant(s) in the event of collision or vehicle roll-over.

2.10.2 Teams must provide documentation that specifies which parts of their solar car constitute the occupant cell.

2.10.3 When occupants are seated normally, with safety-belts and helmets on, no part of any occupant or their helmet may intersect with the convex hull of the occupant cell.

2.10.4 No point of any occupant's helmet may lie within 50 mm of the convex hull.

Imagine stretching a rubber skin around the occupant cell; no part of any occupant may touch the skin, and helmets must be more than 50 mm from the skin.



2.10.5 Each team must provide a description of how the occupant cell will protect the occupants from frontal impacts, side impacts and rollover impacts. This description must be endorsed by the team's certifying engineer.

For teams wishing to do finite element analysis of the occupant cell, the minimum test loads are:

- *frontal impact: a 5 g load, opposing the direction of travel, applied to the front of the occupant cell in an area less than 250 mm high and less than 600 mm wide*
- *side impact: a 5 g load into the side of the occupant cell, applied adjacent to the driver's torso in an area less than 250 mm high and less than 600 mm wide*
- *top impact: a load with components 5 g down, 1.5 g sideways and 4 g backwards, applied at each possible area of contact between the occupant cell and the ground when the occupant cell is upside down; the contact area for each test load must have a diameter less than 150 mm.*

Loads are based on the fully-laden mass of the solar car. Teams must be able to show that the occupant cell structure will not fail with these test loads, and that any deformations will not impinge on the occupants.

To reduce the risk of injury from impacts, the interior of the occupant cell adjacent to each occupant's pelvis, abdomen, thorax and shoulder should be covered with energy absorbing material at least 50 mm thick and with a compressive strength of 500–1000 kPa.

2.10.6 Cruiser class solar cars must be fitted with roll bars or roll cages which meet or exceed the intent of the Technical Regulations. All rollbars have to withstand a 5G impact from any direction.

2.10.7 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. In general, the solar car should be designed so that parts cannot detach and injure occupants.

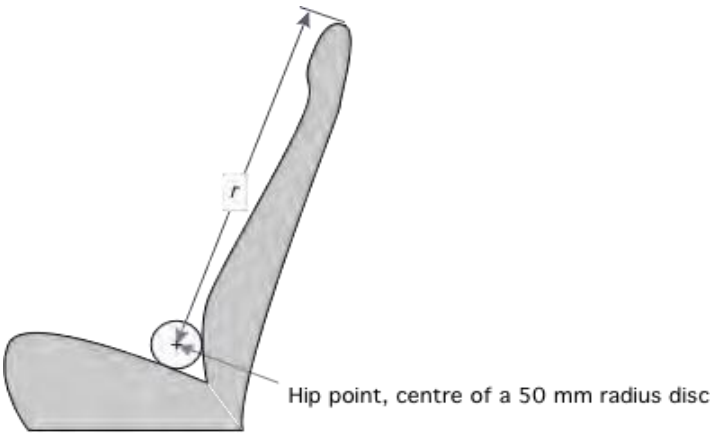
2.10.8 All sharp edges, chains and sprockets must be covered when in use, and internal components or cargo must be secured.

2.11 Seats

2.11.1 Cruiser solar cars must be designed to carry more than one occupant.

2.11.2 Each solar car occupant must have a seat that faces forward at an angle less than 27°, about a vertical axis, from the forward direction of travel. Drivers must demonstrate the ability to sit, road ready (helmet on, hatch closed), with their back flush against the seating elements.

2.11.3 Each seat must have a back and a head restraint. Each head restraint must be entirely behind the occupant's head. The distance from the hip point to the top of the head restraint must be at least 800 mm for front seats and at least 750 mm for rear seats (UNECE Regulations 17 and 25). The hip point may be approximated as shown in the diagram below.



2.11.4 Each occupant's heels must be below their hip point.

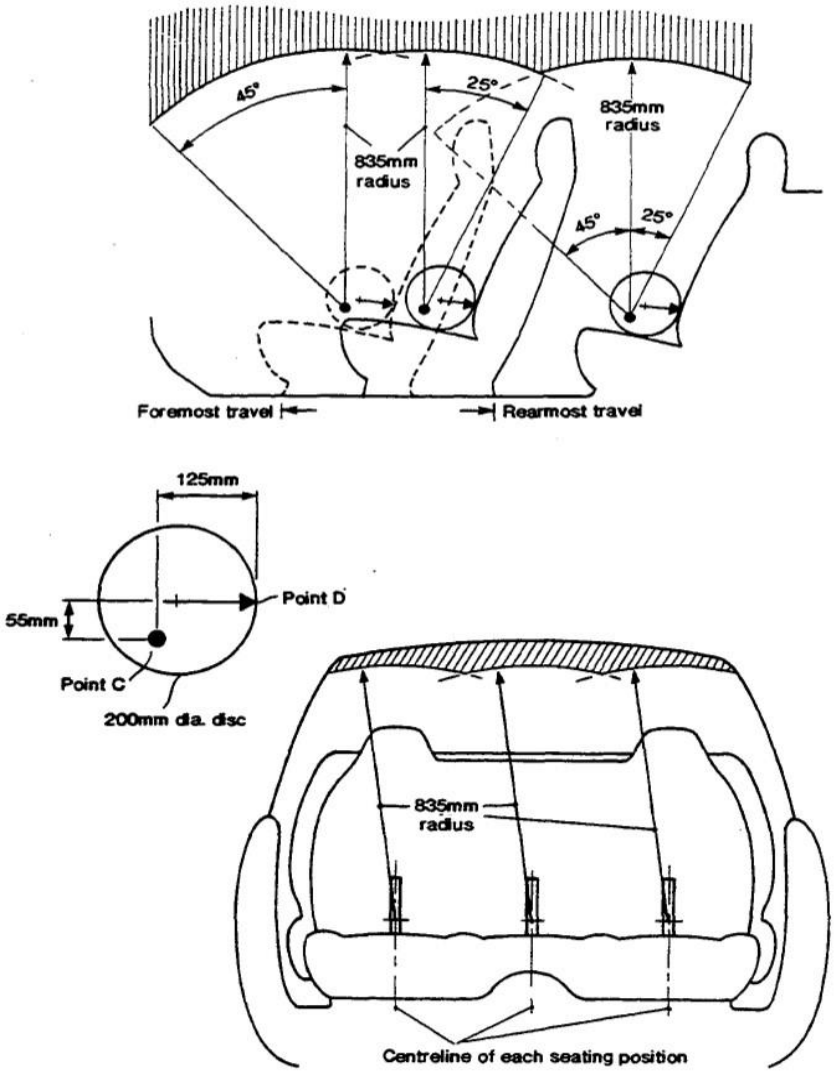
2.11.5 The angle between each occupant's shoulders, hips and knees must be more than 90°.

2.11.6 No more than five solar car seats may be occupied while driving.

2.12 Occupant space

2.12.1 Occupant space for each seat must comply with Section LK of the Australian National Code of Practice for Light Vehicle Construction and Modification, as shown in the following diagram. The 835mm radius arm must be able to move 45° forwards, 25° backwards and 7° either side of vertical. The solar car structure, including the windscreen, must lie wholly outside the occupant space. The steering wheel, mirrors, seat backs and head restraints may be inside the occupant space, but must be designed to minimise the risk of injury in a crash.

This minimum occupant space requirement is based on a 50-percentile male and does not allow for a helmet. Taller team members may need more occupant space.



2.13 Safety-belts

2.13.1 Safety-belts must be fitted for each seating position. Safety-belts must be compliant with at least one of the following standards: UNECE Regulation 16, US FMVSS 571.209, SFI 16.1, SFI 16.5, FAI 8853/98, FAI 8854/98 and have an E or equivalent marking.

The occupant cell will provide the greatest protection when occupants are secured into the cell with four-point or five-point harnesses. Also, three-point harnesses will be allowed but it should be noted that they are considered to be less safe.

2.13.2 Safety-belts must be fitted and used according to the manufacturer's instructions.

2.13.3 Safety-belt anchorages must meet the intent of UNECE Regulation 14. In particular:

- upper anchorages for each seat must withstand a force of 13.5 kN applied to the upper safety-belt straps
- lower anchorages for each seat must withstand a force of 13.5 kN applied to the lower safety-belt straps

- the location of anchor points must comply with the instructions of the safety-belt manufacturer, or with UNECE Regulation 14 Annex 3.

2.13.4 Compliance must be confirmed by the team's certifying engineer.

2.14 Egress

2.14.1 Teams must demonstrate that all occupants can enter and exit the solar car in less than 15 seconds for each action, without assistance. Cruiser solar cars with more than four seats will be tested with four occupants.

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

Passengers of cruiser class vehicles are not allowed to help each other when exiting the solar car.

2.14.2 Doors and canopies must be capable of being secured and released from inside the solar car and from outside the solar car.

2.14.3 Emergency openings, and the methods of opening, must be clearly indicated on the exterior of the solar car, and be visible to an emergency services first responder.

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

2.14.5 Except in an emergency, occupants must exit the solar car without assistance during the event.

2.15 Emergency recovery

2.15.1 Solar cars 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 means of fixation of these towing eyes and validation of the strength of the fixation is the sole choice and responsibility of the team.

2.15.2 The minimum inner diameter of the towing eye shall be 50mm. Towing eyes must be painted yellow, orange or red. Covers may be used, provided they are removable without the use of tools; 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.

2.16 Cooling and hydration

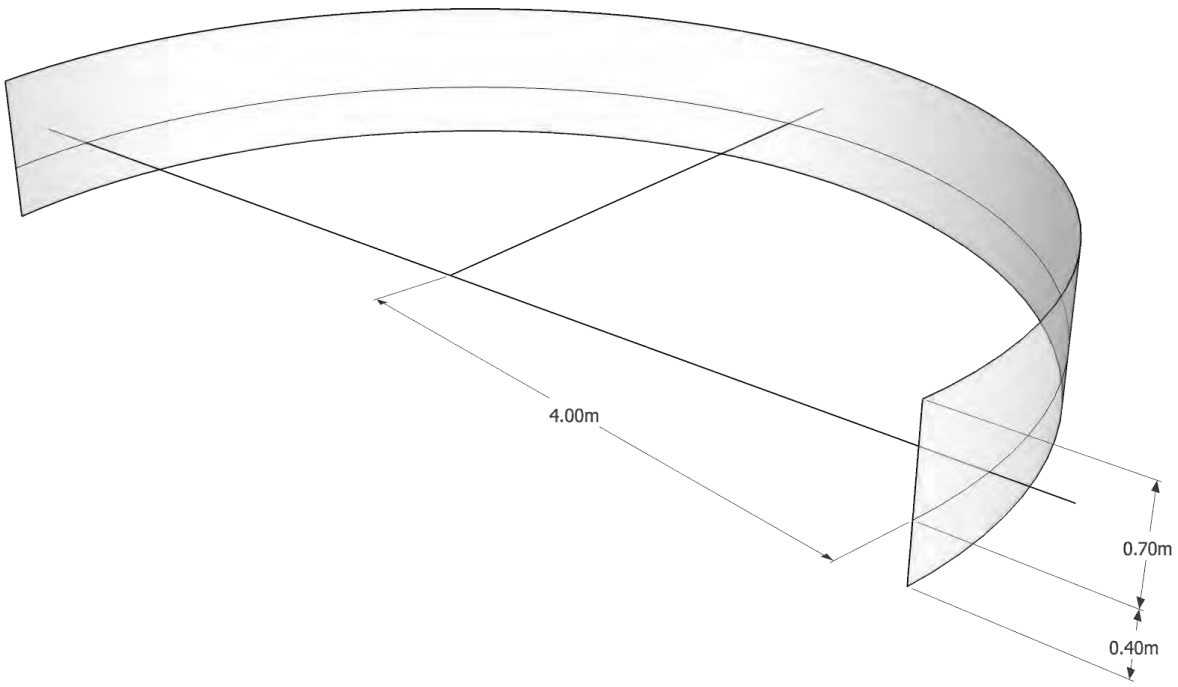
2.16.1 Each solar car occupant must be provided with ventilation or cooling sufficient to ensure that they will not overheat. The team must describe the system and have it approved by their certifying engineer.

2.16.2 Each solar car occupant must have at least two litres of drinking water in the solar car at the beginning of the 24h and when departing each pit stop after a pilot change.

2.17 Forward and sideward vision

2.17.1 Each driver, when seated in the normal driving position with safety-belt and helmet on, must be able to identify 75 mm high letters at every point of forward travel that is:

- 4m from the driver's eyes, and
- between 0.4m below eye level and 0.7m above eye level, and
- between 100° left and 100° right of the direction of travel.



2.17.2 Forward and sideward vision must be achieved without the aid of mirrors, lenses or electronic vision systems.

2.17.3 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.

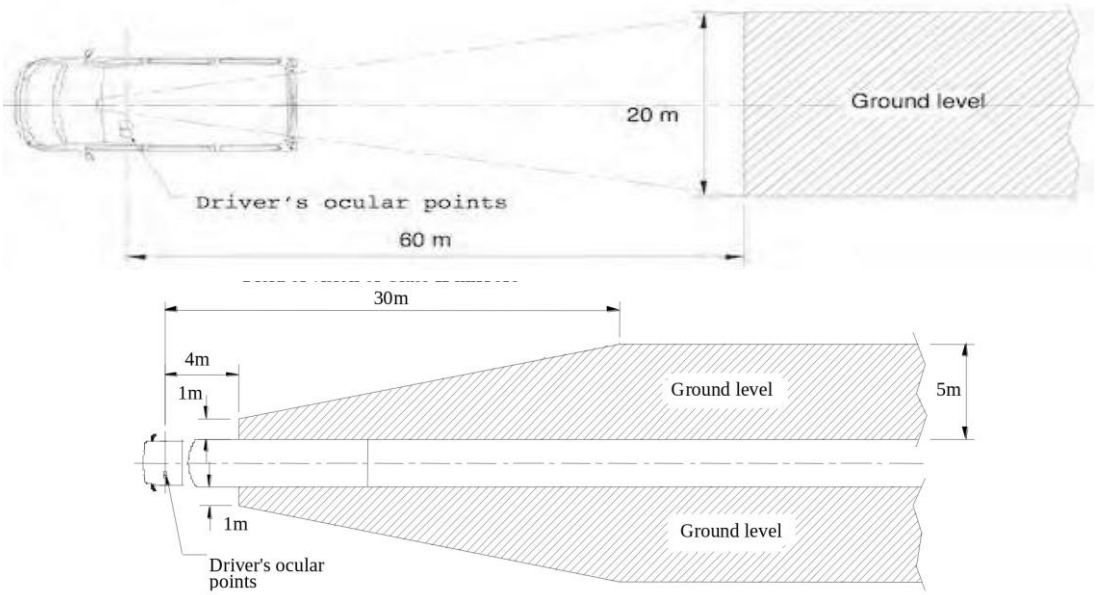
2.17.4 The window may not be tinted or coloured to the extent that the condition of the driver cannot be easily observed from outside the vehicle.

2.17.5 The windscreen that is used for forward and sidewards vision must have an optical transmittance more than 75% (UNECE Regulation 43).

2.17.6 Traffic light colours must be discernible through the windscreen.

2.18 Rear vision

2.18.1 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 (UNECE Regulation 46, Section 15, online accessible at https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2013/R046r5e.pdf).



2.18.2 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 or about to be driven. Rear vision images must be oriented so that objects on the right of the solar car are on the right of the image.

2.19 Steering

2.19.1 Steering must be controlled by a steering wheel which has a continuous circumference / perimeter designed so that it cannot catch on clothing while driving or when the driver exits the solar car.

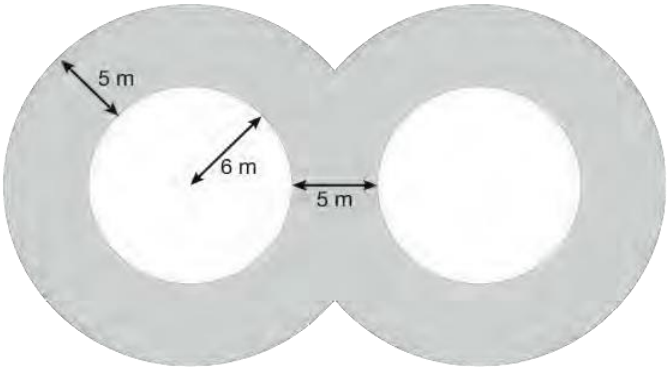
2.19.2 Hip lever type steering systems are not permitted in any vehicle.

2.19.3 Failure of any non-mechanical component of the steering system must not prevent effective steering of the solar car.

2.19.4 Steering shafts must be designed to reduce the risk of injury to the driver in a crash. A collapsible boss is an acceptable method to reduce steering wheel impacts.

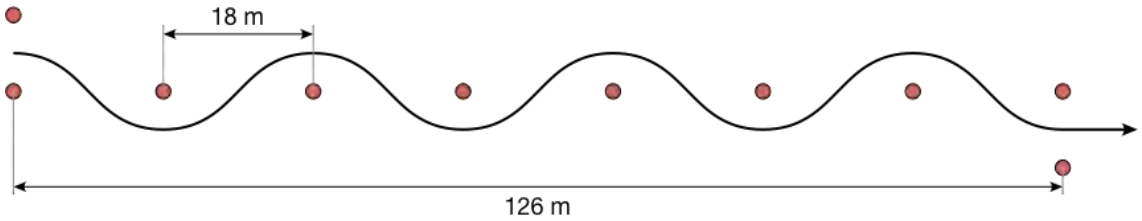
2.20 Stability

2.20.1 Solar cars must be able to negotiate a Figure-8 course in less than 9 seconds per side and less than 18 seconds overall.



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

2.20.3 Solar cars must be able to negotiate a slalom course in less than 11.5 seconds.



2.20.4 The solar car must be stable at all achievable speeds and in crosswinds.

2.21 Brakes

Braking requirements are based on UNECE Regulation 13-H.

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 ring. Note that regenerative braking does not contribute to the requirement of a dual-braking system.

2.21.1 The braking system must be approved by the team's certifying engineer.

2.21.2 The solar car must be equipped with balanced independent service and secondary braking systems, so that if the service system fails the secondary system can still stop the solar car. The service and secondary braking systems must each apply mechanical braking effort to the road wheels.

Conventional cars have a brake pedal that operates two hydraulic master cylinders or one dual-chamber master cylinder. Each master cylinder operates callipers on a pair of wheels: either the front pair and the rear pair, or diagonal pairs. These arrangements meet the requirements for independent service and secondary braking systems—the service system is all four wheels, and the secondary system is one pair of wheels.

2.21.3 Independent braking systems may share components deemed ‘not liable to failure’ provided that they are amply dimensioned and readily accessible for maintenance. Components ‘not liable to failure’ are:

- a brake pedal and its bearing
- hydraulic cylinders and their pistons
- hydraulic control valves
- brake cylinders and their pistons
- brake lever and cam assemblies.

2.21.4 Hydraulic brake hoses and lines are regarded as liable to failure.

2.21.5 For Challenger and Cruiser class vehicles, the service braking system must apply mechanical braking effort to at least two of the wheels.

2.21.6 Braking must not cause the solar car to yaw. This requirement applies to both the service braking system and the secondary braking system.

2.21.7 For solar cars without anti-lock brakes, the front wheels must lock up before the rear wheels.

2.21.8 The service braking system must be able to stop the fully laden solar car within distance

$$0.1\,v + 0.0060\,v^2$$

metres from any speed v, in km/h, that the solar car can achieve.
This is equal to an average deceleration of 3.8m/s² from any speed that the vehicle is capable of travelling. The vehicle must demonstrate the ability to stop in 25m from 50km/h and in 12.5m from 35km/h.

2.21.9 If the service braking system fails, the secondary braking system must be able stop the fully laden solar car within distance

$$0.1\,v + 0.0158\,v^2$$

metres from any speed v, in km/h, that the solar car can achieve.

2.21.10 Solar cars must be equipped with a parking brake that can be operated by the driver from the normal driving position. The parking brake must be capable of holding the fully-laden solar car (including driver and maximum three passengers, if applicable) on a 18% incline or decline.

2.22 Tyres

2.22.1 Tyres must be suitable for circuit use and used in accordance with their manufacturer’s recommendations at all times.

2.22.2 Solar cars must be fitted with tyres that are:

- compliant with UNECE Regulation 30, UNECE Regulation 75 or US FMVSS 571.109, as indicated by an E or DOT approval marking on the tyre; or
- otherwise approved by the event organiser.

Experimental or prototype tyres must be approved by the event organiser who will administer this process, which requires the tyre manufacturer to submit a sample tyre and written technical specifications to the event organiser's office not later than 04 July 2021. A positive outcome to the approval process, which may take up to three months, is not guaranteed. Solar tyres provided by Bridgestone and Michelin allowed for the Bridgestone World Solar Challenge will automatically be allowed for the European Solar Challenge as well.

2.22.3 The speed rating of the tyres must be more than the maximum speed of the solar car. The load rating of each tyre must be more than the maximum static load imposed on it by the fully-laden solar car, especially for highway use.

2.22.4 Tyres must be approved by the certifying engineer.

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

2.22.6 Under rain or generally wet conditions, appropriate tyres must be used. If the road condition and tyre combination is too slippery, accidents can happen more easily. The organizer has the rights to demand the usage of tyres suitable for the specific weather condition. Excessive rain will be announced by the organizer and requests all teams to change to rain tyres in the next 10 minutes, equivalent with at least one full race lap.

2.22.7 Rain tyres must provide a minimum depth of 3mm. Motorcycle tyres likely meet this condition. It has to be ensured that the rain tyres are designed for wet road use and provide enough grip on wet surface.

2.22.8 The organizer has the rights to pause the race due to extreme weather including excessive rain and thick fog. During such a pause all teams are required to drive into the pitlane. No charging may occur nor can any technical work be done on the solar cars. This situation will be indicated by a so-called red flag.

2.23 Reversing

2.23.1 Solar cars must be able to be driven backwards under their own power with the driver seated in the normal position.

2.24 Lighting

2.24.1 Solar cars must be fitted with:

- two rear stop lamps
- one central stop lamp
- left and right front direction indicator and hazard lamps
- left and right-side direction indicator lamps
- left and right rear direction indicator and hazard lamps.

These must be visible in sunlight by other road users at a distance of 30m.

Physically, turn indicators and hazard lights can be implemented to use the same lamps. The modes (turn indicator and hazard lights) are required to be turned on independently from each other, as known from other vehicles.

2.24.2 Solar cars without appropriate head- or taillights are not allowed to drive during night time.

It is insufficient to use hazard lights as head- or taillights.

2.24.3 Lamps must be chosen in a way the car is visible independently of the given light conditions. Headlights also need to provide a good vision for the driver. In case lamps are decided to not be bright enough by observers, the car can be denied to drive until suitable lamps are installed.

2.24.4 Stop lamps must emit red light. Direction indicator lamps must emit amber light.

2.24.5 Lamps must be compliant with UNECE Regulations 6, 7 and 37, or the SAE/DOT equivalents. Teams must demonstrate compliance by either:

- the presence of compliance markings on the lamps (e.g., an approved upper-case E with respective number inside a full circle), or
- detailed documentation that demonstrates compliance with the photometric requirements of the UNECE or SAE/DOT regulations, especially the brightness in lumen or lux, confirmed by the certifying engineer.

Lamps approved for motorcycles may not meet these requirements.

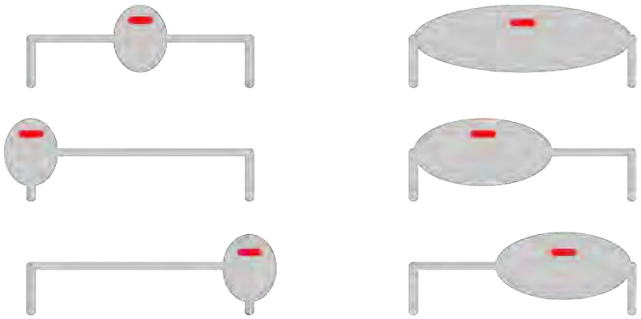
It is extremely dangerous to drive without appropriate light during the night. Especially during the 24 hours race it is expected to be dark on the track for about ten hours. The track is not well enough illuminated to cope with the darkness of the night thoroughly.

2.24.6 Solar cars must have the correct type of lamp in each position. For example, side marker lamps may not be used as stop lamps. Lamps must be mounted with the correct orientation so that the photometric requirements of UNECE Regulations 6, 7 and 37, or the SAE/DOT equivalents, are met.

Lamp position and visibility requirements are based on UNECE Regulation 48.

2.24.7 Rear stop lamps must be within 400 mm of the extreme outer edge of the solar car on each side, at least 600 mm apart (at least 400 mm apart if the solar car is less than 1300 mm wide), and at least 350 mm above the ground. They must be visible 15° up, 5° down and 45° to the left and right.

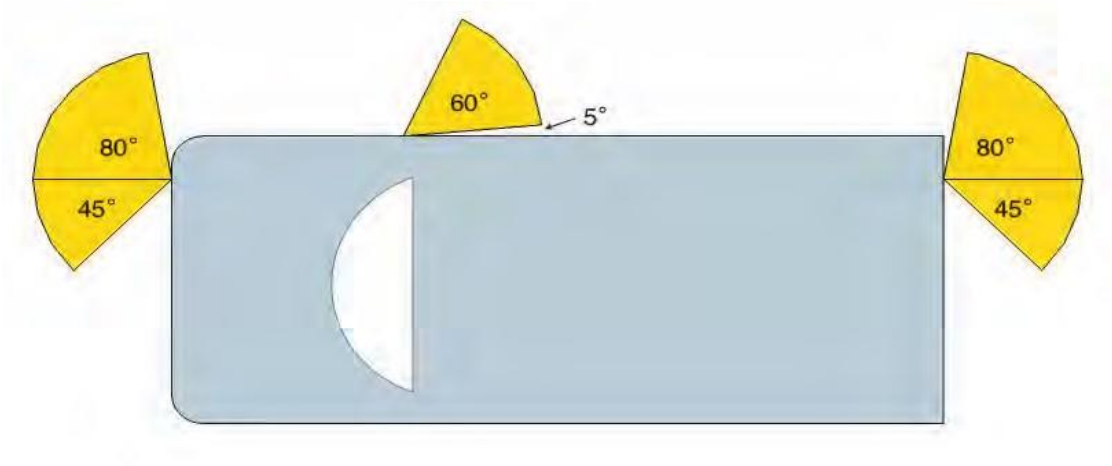
2.24.8 A central stop lamp is required. Viewed from behind the solar car, the lateral position of the lamp must coincide with the visual centre of the solar car (see the examples in the following diagram). The lamp must be higher than a point 150 mm below the rear windscreen or canopy. The lamp must be visible 10° up, 5° down and 10° to the left and right.



2.24.9 Front and rear direction indicator lamps must be within 400 mm of the extreme outer edge of the solar car on each side, at least 600 mm apart (at least 400 mm apart if the solar car is less than 1300 mm wide), and at least 350 mm above the ground.

2.24.10 Side direction indicator lamps must be less than 1800 mm behind the front most part of the solar car.

2.24.11 Direction indicator lamps must be visible 15° up and 5° down. Minimum horizontal visibility requirements of the right direction indicator lamps are shown in the following diagram.



2.24.12 Direction indicators must flash at 90±30 flashes per minute.

2.24.13 It must be possible to flash the left and right direction indicator lamps simultaneously, as a hazard warning signal.

2.25 Audible warning device

2.25.1 An audible warning device (horn, hooter, klaxon, or the like) complying with the intent of UNECE Regulation 28 must be permanently fitted to the solar car. It should be demonstrated to the satisfaction of the scrutineer.

2.25.2 Sound pressure level must be more than L_A = 105 dB measured 2 m from the horn.

The horn should be mounted so that solar car occupants are not subjected to excessive sound pressure levels.

2.25.3 The device must emit a continuous and uniform sound.

2.26 Instrumentation

2.26.1 The following information must be provided to the driver at all times while driving:

- the speed of the solar car
- whether the direction indicators are operating
- whether the hazard lights are operating
- energy storage system warnings
- electronic rear vision images (if fitted).

2.26.2 This instrumentation must be powered from the energy storage system, and not from separate batteries.

2.27 Automatic functions

2.27.1 Any cruise control function must automatically deactivate when the brake is operated or the car is turned off.

2.27.2 Any automatic driving function must immediately deactivate on manual input or when the car is turned off.

2.28 Electrical safety

Electrical safety requirements are based on Section 5 of UNECE Regulation 100. The term 'high voltage' means more than 60 V dc or more than 30 V rms ac.

2.28.1 Protection against direct contact with high-voltage parts, including conductors, must be achieved using double insulation, enclosures or barriers. It must not be possible to remove protection without the use of tools. Example: A motor controller contains high voltage parts, so these parts must be protected by an enclosure or cover. If it is possible to access the motor controller enclosure without using tools (e.g., by opening the boot or tilting the solar collector) then the motor controller enclosure must have a high-voltage symbol on it.

2.28.2 Protection against direct contact with high-voltage parts inside the driver, passenger and luggage compartments must be designed to exclude objects larger than 1 mm diameter (Ingress Protection rating IPXXD).

2.28.3 Protection against direct contact with high-voltage parts inside areas other than the driver, passenger and luggage compartments must be designed to exclude fingers (Ingress protection rating IPXXB).

2.28.4 Double insulation must meet the AS 3001/IEEE 100 definition: comprising both basic insulation and independent supplementary insulation that provides protection equivalent to that of the basic insulation. A single layer of reinforced insulation is also acceptable if it provides protection equivalent to double insulation.

Electrical tape is unlikely to meet the requirements of supplementary insulation. The front surface of a photovoltaic cell is deemed to be double-insulated if properly encapsulated.

2.28.5 High-voltage energy storage packs must be marked with the high-voltage symbol shown in the following diagram. Similar symbols are permissible.

2.28.6 The high-voltage symbol must also be visible on any enclosure or barrier that can be accessed without using tools, if removing the enclosure or barrier exposes high-voltage parts.

Example: A motor controller contains high voltage parts, so these parts must be protected by an enclosure or barrier that requires tools to remove (Regulation 2.28.1). If it is possible to access the motor controller enclosure without using tools (e.g., by opening the boot or tilting the solar collector) then the motor controller enclosure must have a high-voltage symbol on it.

2.28.7 The resistance between any exposed conductive part and each terminal of the energy storage system must exceed 100 *V* ohms, where *V* is the nominal voltage of the energy storage system.

This is equivalent to a maximum leakage current of 10 mA.

2.28.8 The resistance between any exposed conductive part and each terminal of every solar cell must exceed 100 *V* ohms, where *V* is the maximum circuit voltage of the solar collector.

2.28.9 Exposed carbon fibre is considered to be an exposed conductive part and so must be isolated from the energy storage system and from the solar collector.

2.28.10 Each energy storage pack must be protected by a fuse or circuit-breaker rated to interrupt the short-circuit fault current of the pack. This fuse or circuit-breaker must be mounted in or on the energy storage pack.

2.29 Electrical safe state

2.29.1 The solar car must have a ‘safe state’ which, in an emergency, minimises the risk of electrical fire and electric shock to occupants, team members, emergency response personnel, and bystanders. When in the safe state:

- every conductor emerging from each energy storage pack must be galvanically isolated from every energy storage cell.

  Soft switches are not permitted; the isolation switch must be a circuit- breaker, contactor, or other mechanical type. Solid state switches or software could be used to realize battery isolation during emergency cut-off but teams have to be able to demonstrate that the probability that the realized mechanism fails is less than that of a system with mechanical contacts and switches.

- voltage exceeding 15 V must not be present across any pair of conductors emerging from energy storage packs or the solar collector, and no pair of conductors shall be capable of delivering more than 50 mA.

Soft switching (i.e., solid- state relays or MOSFETs in general) is permissible.

2.29.2 When the battery isolation switch is ‘open’, the only live wires permitted to emerge from the battery pack(s) are low voltage control and sensing wires that are short-circuit protected under any reasonably foreseeable fault condition.

2.29.3 Any conductor that is more than 200 mm from the nearest PV cell or from an associated electronics module such as a maximum power point tracker is considered to be outside of the solar collector.

2.29.4 All mechanisms for placing the solar car into safe state and maintaining safe state must be fail-safe; if an electrical activation mechanism fails, the solar car must automatically and immediately place itself into safe state, and must remain in safe state indefinitely.

A simple design might use normally-open contactors in the energy storage packs, and have these contactors energised via a series loop of mechanical switches, all of which must be closed for normal solar car operation. If the loop breaks or any switch opens, the contactors will open and the vehicle will enter safe state.

2.29.5 The driver must be able to place the solar car into safe state while seated in the normal driving position and without releasing the safety-belt.

2.29.6 For emergency use, an activation device that immediately places the solar car into safe state must be provided on the exterior of the car. The activation device must be placed within a yellow disc with a minimum diameter of 180 mm. Also in the yellow disk must be a blue equilateral triangle (minimum side length 150 mm) that contains a red flash, 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 yellow isolation disc and the activation mechanism must be clearly visible to an emergency services first responder approaching the driver, and must be within 100 mm of the base of that part of the windscreen used to meet the forward vision requirement, and adjacent to the driver egress opening or left side of the solar car. 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.

2.30 Auxiliary Battery

2.30.1 Each solar car needs to be able to provide power to mandatory systems such as emergency lights, even in case of a battery cut-off.

2.30.2 Thus, it is demanded to carry a separate auxiliary battery pack, which cannot be used as traction battery (this has to be ensured) but may be connected with the lighting system and should be charged from the main battery.

2.30.3 The auxiliary battery pack needs to last at least for 60 minutes provided there is no charging of the battery (like in an emergency case). Main consumer should be the lights of the cars, therefor the battery must at least be as large as 10Wh, however at a maximum voltage of 48V.

2.30.4 Solar cars have to prove that the head-, tail-, and emergency lights still work for at least 60 minutes.

2.30.5 Additionally, solar cars have to provide an in daylight visible green light on top or behind the canopy. It has to be at minimum as bright as 20 lumens, which is comparable to a smart phone flashlight.

2.30.6 This green light has to be flashing whenever the car is in a safe to touch state, i.e., the main battery is cut off safely. This can help rescue teams to decide whether the car can be touched without any precaution in case of an accident or other emergency.

3 Race Organization

3.1 Supervision

3.1.1 The Clerk of the Course is responsible for supervising on-track activities.

3.1.2 Official announcements (e.g., race commission meetings) can be found at the info desk whiteboard throughout the event and general announcements will also be announced via a communication channel over the internet via a designated “Slack” or “WhatsApp” chat in which all team leaders will be part of. More important (e.g., emergency) notifications however will still be announced via radio.

3.1.3 Every team is required to check for new announcements once per hour.

3.2 Race Commission

3.2.1 Each team needs to pick one member each to join the race commission. As detailed below, the commission will consist of one member from each team and at least one event organizer at all times.

3.2.2 Decisions put before the race commission will be decided by majority vote, whereas the race control always holds exactly one vote.

3.2.3 One race control member will organize and lead the race commission, but not participate in any voting.

3.2.4 Failure to provide a team member to the race commission may result in a team’s immediate disqualification.

3.2.5 The task of the race commission is to clarify discrepancies regarding the regulations.

3.2.6 Furthermore, the race commission will make all decisions concerning unpredictable influences on the race, such as its termination or interruption due to unfavourable weather conditions.

3.2.7 Each team may call for a meeting of the race commission no more than once during the event. For every further summoning, the concerning team will be charged a fee of EUR € 500 each.

3.2.8 The only exception to the above mentioned requires all participating teams to voice the same objection. For an official application form see the official website.

3.3 Race Control

3.3.1 The task of the race control is the event's surveillance.

3.3.2 Therefore, all communication channels used during the event are required to include the race control. The race control is also in charge of decisions concerning the status of the race track, status of the flags, time penalties, and whether or not a safety car is to be present on the track at any given time.

3.3.3 If discrepancies arise teams may contest time penalties through the race control.

3.3.4 If the race control decides in favour of the team the existing penalty will be adjusted or withdrawn. Once again, the issue will be examined together.

3.3.5 The race control may summon the race commission at all times.

Informal complaints not concerning the Race Commission might be directly forwarded to the Race Control. These complaints need to be submitted in written form. A special letterbox for submitting will be made available at the info desk.

3.4 Safety Vehicles

3.4.1 Safety vehicles will be driven by the official event organizers of the European Solar Challenge or by employees of the race track themselves (ambulance).

3.4.2 If a safety car is required it will drive on the track's 'slow side'. No two race contestants may overtake one another or the safety car on the track until the safety car reopens the track and returns to the pit lane. In the case of the yellow flag being displayed, overtaking is also not allowed.

3.5 Safety

3.5.1 The team manager must appoint a safety officer to be responsible for the general safety of the team.

3.5.2 The team manager must appoint a battery officer to be responsible for the safe operation of batteries and for supervising response to any battery emergency.

3.5.3 Battery incident response kits must be readily available to the solar car and any other vehicle carrying solar car batteries.

3.5.4 During the event, all battery parameters must be within the limits specified by the manufacturer.

3.5.5 The vehicle's power supply has to meet the electrical safety guidelines of the team's home country.

3.5.6 During the 24h-race each team has to inform the race control hourly about the following values of their traction battery:

- highest cell temperature
- lowest cell temperature
- highest cell voltage
- lowest cell voltage

3.5.7 Each team must have at least one member with a recognised first-aid certificate, current for the duration of the event.

3.5.8 All solar cars are operated and driven at the team's own risk.

3.5.9 The Clerk of the Course may exclude any team from the event at any time if any team member operates a solar car in an unsafe manner.

3.5.10 Teams must look after the health and safety of their team members.

3.5.11 During the entire event, drivers, team members and officials are to be drug free and maintain a blood alcohol level less than 0.01% whilst engaged in any duties associated with the event. Consumption of drugs or alcohol by participants during the time of the main event is not allowed.

Smoking is permitted on the balcony behind the doors of the pit boxes and on the way to and on the camp ground, but never on the track or inside the pit boxes, as well as the charging areas.

3.6 Safety-belts

3.6.1 The use of safety-belts is mandatory for all occupants of motor vehicles in Belgium, including solar cars.

3.7 Helmets

3.7.1 Each occupant of a solar car must wear an approved motorcycle helmet at any time inside the car. The helmet should be securely fitted and fastened in accordance with the manufacturer's instructions.

3.7.2 A motorcycle helmet must have a mark certifying compliance with an approved standard:

- Australian/New Zealand Standard AS/NZS 1698:2006
- United Nations Economic Commission for Europe Regulation No 22 (UNECE 22.05)
- an equivalent JIS or DOT standard.

3.7.3 Helmets must not be modified, have unauthorised attachments, or be used in any way contrary to the manufacturer's instructions.

3.8 Safety equipment

3.8.1 Suitable and appropriate safety equipment must be present at all times. The minimum safety equipment that must be provided is:

- a first-aid kit
- safety glasses and gloves for handling batteries
- at least two hazard warning cones
- ABC fire extinguisher (10 kg or more)
- fire blankets
- sand (or similar material) for extinguishing fires
- a spade
- suitable container for damaged electrochemical cells
- reflective vests for all team members
- battery datasheet
- safety procedure to extinguish a battery fire

3.8.2 The solar car's battery has to fit into the battery safety container. The container has to be fireproof.

3.8.3 The battery safety container and first-aid-box have to be ready for use in the pit lane. Every team member is required to wear a reflective vest when inside the pit lane or on the race track.

3.9 Communication

3.9.1 Each team has to provide two-way channelled radios, which allow communication between the pit lane and the solar car throughout the race track.

3.9.2 Additionally, teams have to rent two handheld radios from the event organizers (cost is approximately EUR € 100, however details on the pricing are announced later). These have to be used in each solar car as well as in the pit box for communication between the race control and the team. Note, that these differ from the ones specified in regulation 3.9.1.

3.9.3 All drivers should understand English sufficiently to understand essential radio commands.

Should a driver's skills in English not be sufficient for the above, the driver's team should contact the organizers prior to the event.

Due to the racetrack's topography, normal consumer radio hardware will unlikely be able to cover the entire track.

3.10 Entering the Race Track

3.10.1 Without permission from the race control no support vehicles are allowed on the race track.

3.10.2 Team members are prohibited from entering the track unless access is explicitly granted by the race control.

3.10.3 Everyone entering the race track is required to wear a reflective vest at all times. Drivers and passengers are exempt from wearing reflective vests for safety reasons as these tend to be easily inflammable. Shortly before entering and after leaving the car they however are also required to wear reflective vests.

When in danger, driver or passengers are allowed to leave the car immediately.

3.11 Pushing

3.11.1 Manually moving the solar car by either pushing or pulling after placing it on its starting position is not allowed. Manual movement is allowed only in the area between the pit boxes and the red line dividing the pit lane.

3.11.2 In case of an emergency situation, technical failure, or vehicle damage, the concerning vehicle has to be removed from the racetrack as soon as possible. In this case, teams may manually move their vehicle for the purpose of removing it from the track.

Again, teams are not allowed to enter the track without a permission. In most cases the vehicle will be removed using a tow truck provided by the Organizers of the European Solar Challenge, while assisting team members might get picked up and go together with the tow truck.

3.12 Preparation and testing

3.12.1 The event organiser will provide facilities for team preparation and track testing of solar cars at circuit Zolder in accordance with the dates listed in the schedule. Also, nightly testing will be possible.

3.12.2 The event organiser will appoint a paddock manager to supervise the preparation and test facility. The directions of the paddock manager must be followed.

3.12.3 The Clerk of the Course may impose event penalties for breaches of speed limits or other rules at circuit Zolder.

3.12.4 No test driving is to be conducted in the paddock, car park or access roads.

3.12.5 The track must not be accessed without clearance from the track controller.

3.12.6 The event organiser reserves the right to request a security deposit against damage, rubbish removal or cleaning beyond reasonable expectations.

3.13 Damage and Vehicle Failure

3.13.1 If a solar car becomes unable to continue the race, either by breaking down on the track or encountering any mechanical or electrical issues, it has to be removed from the race track as soon as possible. Any necessary repairs can only take place inside the team's pit box.

3.13.2 Each solar car has to carry a towrope at all times, so it may be towed by a safety car in case of it breaking down.

3.13.3 Every vehicle which is towed off the race track has to be reinspected before entering the race track.

3.13.4 If a car stops on the track, the currently unfinished lap will not be counted.

3.14 Modifications or changes after scrutineering

3.14.1 Once a solar car and its drivers have passed static scrutineering, no changes to the design or configuration of the solar car (that is, to any items described in the compulsory documentation) or changes to drivers will be permitted.

3.14.2 Once a solar car has passed dynamic scrutineering, and until released from the start line, component exchange, modification or repair of the solar car is not permitted without the approval of the Chief Scrutineer.

3.15 Charging With an External Power Supply

3.15.1 During the 24-hour race each team may charge their car from mains three times. Each charging stop has to last no less than 30 minutes. Cruiser class cars are also allowed to charge three times; however, this will influence the total energy score as described in the cruiser class scoring. The event organizers will provide a red 3 Phase 16A CEE Power Outlet (IEC 60309, 230-400Vac, +10%, −6%, 5-pole) for each team.

In case, for instance, an IEC 62196-2 Type 2 socket for charging is required and no possibility can be found to be able to function on IEC 60309 three-phase 16A CEE sockets, the organizers should be contacted by the team at least one month prior to the event.

3.15.2 While charging, it is not allowed to fix technical problems or to modify the car.

3.15.3 While charging, a solar car's battery containers must remain closed. All High Voltage parts must be protected from physical contact.

3.15.4 All single cell voltage and temperature values measured while charging need to be visible to the present observer. Teams may actively cool their vehicle's batteries only after proving the measured temperature to be the highest of all cells.

During scrutineering teams have to prove that an airflow won't interfere with the temperature measurements in such a manner that a temperature sensor might read a lower temperature than the actual cell temperature.

3.15.5 Teams have to hand in a technical documentation of the battery that is going to be cooled including the following information:

- cell type and manufacturer
- cell configuration (number of cells in parallel and series)
- number and type of temperature sensors
- technical drawing or photo of the battery pack
- technical drawing of a module (including temperature sensors)

3.15.6 All parts that are used to cool the battery have to be fixed to the vehicle and have to stay inside during the entire event.

3.15.7 Teams are required to provide their battery safety equipment (including a fire extinguisher).

3.15.8 No more than three team members may be present while charging the team's car.

Compliance with the regulations concerning cooling the batteries will be ensured during the scrutineering process.

Charging time is measured from the time at which the vehicle stops in the designated spot until the car leaves the charging area again.

3.16 Solar Charging

3.16.1 Teams may charge their vehicle's batteries using solar power at any time. Any alignment of the panels is only allowed in the designated charging area. The charging area's location will be announced during the event.

3.16.2 Charging with supplementary or auxiliary solar collectors is not allowed. This means that only the solar cells permanently connected to the solar car may be used for solar charging.

3.17 Driver Changes

3.17.1 Changing a vehicle's drivers has to last no less than 5 minutes.

3.17.2 Within this time an observer is allowed to check the function of the vehicle's horn and lights.

3.17.3 Teams shall report their driver changes to the observers one lap in advance.

3.17.4 No more than four teams may switch their vehicles' drivers at a time.

3.17.5 Once a team announces a driver change to the observers, one of the four existing changing slots is immediately reserved for that team.

3.17.6 Once a team announces a driver change to the observers, the team's solar car may not cross the finish line once more but has to enter the pit lane in that lap.

3.17.7 Teams are themselves responsible for avoiding delays caused by all changing slots being occupied.

3.17.8 Teams are furthermore responsible for appropriately scheduling their driver changes, ensuring no driver will drive for more than two hours in a single stint.

The 2h driving solely includes track time so time spent in the pitlane is not counted.

3.17.9 Teams may extend two of their stints by a maximum of 15 minutes each or instead one stint may be extended by 30 minutes.

3.17.10 Cooling of the solar array is not allowed during a driver change.

Spoilage of water could result in dangerous and slippery conditions on the driver change lane.

3.18 Visitors

3.18.1 We're always trying to keep the European Solar Challenge an event with lots of room for socializing and exchange of knowledge or expertise. However, private visitors may only enter the pit boxes or pit lanes when registered with the organizers. Furthermore, they are required to wear reflective vests in this area.

3.18.2 Additionally, all media correspondents need to register with the organizers in advance. They need to check in at the info desk on arrival.

3.18.3 Visitor passes will be available at the info desk for free.

Again, teams are not allowed to give unregistered persons access to the pit lane.

3.19 Pit Lane Safety

3.19.1 The area limited by the pit boxes on one side and the red line on the opposite side is mainly reserved for repairs and modifications, and should be kept clear by private visitors.

3.19.2 The area beyond the red line should be kept clear at all times.

3.19.3 No tables, chairs, or other temporary constructions may be placed directly alongside the wall dividing racetrack and pit lane.

3.19.4 All private visitors to the pit lane are to stay inside the designated pedestrian area.

3.19.5 Any vehicle driving on the pit lane must not exceed the maximum speed of 30km/h. This will be measured at all times during the event.

3.20 Clothing

3.20.1 Every person entering the pit lane has to wear high visibility reflective clothing.

3.20.2 Wearing solid shoes will be mandatory inside the pit lane at all times.

In case drivers have more control over the car while driving without shoes, this will be allowed but socks should be worn. Bare-foot driving will not be accepted.

3.20.3 Drivers are especially requested to comply with this rule. The driver's clothing should cover the entire body.

3.20.4 Clothing should be made of natural fibres and cover the occupants' legs, arms and upper body. Natural fibres are flame-retardant by themselves whereas synthetic fibres can melt and cause dangerous burns on the skin when catching fire.

Overalls or racing suits are highly recommended for drivers.

3.20.5 Each car has to provide reflective vests, one per seat (with a maximum of four), to be worn by occupants when leaving the car in a breakdown or similar situation after getting out of the car.

3.21 Team registration and scrutineering

3.21.1 All participants are required to attend with their team to complete the registration process, and present their solar car for the scrutineering process. The scrutineering process is divided into static and dynamic operations.

3.21.2 Team registration and static scrutineering will take place at circuit Zolder at the time and date described in the schedule.

3.21.3 Teams must attend registration and static scrutineering with:

- the team manager, and an interpreter if required
- all solar car drivers, with their driving licences
- any waiver documents required for participants under the age of 18
- original signed copy of the indemnity form
- all solar car passengers
- the team safety officer
- the team battery officer
- the solar car, in road-ready configuration
- tools and personnel required to facilitate inspection of the solar car, e.g., of structural components
- compulsory documentation

- a spare solar car tyre of each type, at least 1 for normal conditions and 1 for rain
- a sample energy storage cell (if cells inside the energy storage packs are not clearly visible)
- the lockable box in which energy storage packs can be impounded where required.

3.21.4 The team manager must attend all registration and scrutineering stations. A team manager not proficient in English must provide an interpreter to accompany them at all times during this process.

3.21.5 All team members must complete their online registration by signing in at registration.

3.22 Static scrutineering

3.22.1 Static scrutineering will check for compliance with the regulations.

3.22.2 Qualification must be achieved in road-ready condition. ***Teams that do not present their vehicle at the designated time in road-ready condition may fail to qualify.***

Teams who fail scrutineering due to a non-safety aspect may possibly participate in the event out of competition. The decision will be taken by the official organizers.

3.22.3 Up to seven members of a team (including an interpreter and any team media personnel) may accompany the solar car on the scrutineering floor. Team members may be substituted between inspection stations.

3.22.4 Some dismantling (such as removal of the solar collector or top shell) may be required to facilitate inspection of the following components:

- mechanical systems (including seats, tyres, brakes and steering)
- electrical systems
- energy storage system.

3.22.5 Dismantling and reassembly of the solar car when required to facilitate inspection of the solar car must be conducted (in the sole opinion of the Chief Scrutineer) in a reasonable time.

3.22.6 Checks and inspections with the solar car in a road-ready configuration will include, but not be limited to:

- signage
- solar car dimensions
- solar collector type and size
- egress—all solar car drivers and passengers are required
- vision—shortest and tallest solar car drivers are required

- lights, indicators and horn
- electrical compliance
- ability to tow the car
- braking capability.

3.22.7 All energy storage devices must be declared at static scrutineering. Failure to declare any energy storage device may lead to disqualification.

3.22.8 The mass of each solar car driver or passenger, with helmet, driving clothes and shoes, will be determined at scrutineering. If the mass of a driver is less than 80 kg or mass of a passenger is less than 60 kg, ballast provided by the team will be added to make up the difference. No credit will be given if a driver or passenger weighs more.

Deliberate consumption of excessive food and drink prior to weigh-in is not in keeping with the spirit of the event and may be hazardous to the health of the individual.

Solar car occupants must wear similar clothes (including shoes) while driving as when they weigh in.

3.22.9 Teams are responsible for providing additional penalty weights should one or more of their drivers weigh less than 80 kg (respectively 60 kg for passengers).

3.22.10 These penalty weights should be presented inside a container which can easily be sealed by the organizers.

Penalty weights could for instance be made of water-bottles filled with sand. There will be a scale provided in the driver change area to verify the driver's weight before changing the driver.

3.22.11 Drivers and passengers may be re-weighed at any time during the event. Changes in weight considered unreasonable by the Chief Medical Officer will be referred to the Clerk of the Course.

3.22.12 Non-compliance penalties may be imposed at the absolute discretion of the Chief Scrutineer, and may include failure to qualify.

3.23 Dynamic scrutineering

3.23.1 Dynamic scrutineering exercises will test the speed, stability and braking capability of the solar car in form of a car handling parcour.

3.23.2 Dynamic scrutineering will be held on Friday the 16th of September 2022. Attendance of team managers and drivers at 11:00 roll call is mandatory.

3.23.3 No solar car may be submitted for dynamic scrutineering without having first passed static scrutineering.

3.23.4 Solar cars must complete dynamic scrutineering in road-ready condition and with occupants and ballast in place.

3.23.5 Cruiser solar cars must complete dynamic scrutineering with at least one occupant seat occupied.

3.23.6 No solar car will be given permission to start the event until it has passed dynamic scrutineering. Any solar car failing dynamic scrutineering will only be permitted to represent at the absolute discretion of the Chief Scrutineer. Dynamic scrutineering will close at 17:00 on Friday the 16th of September 2022.

3.23.7 Dynamic scrutineering will be organized on the race track and will consist of a handling parcour.

3.23.8 For cruiser solar cars it is also important how practical the car is as the amount and speed of packing will influence the scoring during these dynamical tests. Some objects will be made available and packing and transporting these items will also conclude in bonus seconds. More details will be shared later.

3.23.9 In this year's event, the dynamic parcour will be a high-speed handling parkour. The parkour will contain but will not be limited to:

- A slalom
- Some tight corners
- Drivers and passengers getting into the car.
- …

A more accurate lay-out and details of this parcour can be found in Appendix.

3.23.10 With some of the challenges, bonus seconds can be obtained.

3.24 Briefings

3.24.1 A compulsory briefing for team managers and team safety officers will be held on Saturday the 17th of September 2022 at a time and place to be advised. Team managers not proficient in English must request permission to be accompanied by an interpreter.

3.24.2 A compulsory safety and procedural briefing will be held on Wednesday the 14th of September 2022. All team managers must attend.

3.25 Observers

3.25.1 The observer's responsibilities are:

- to record the times that teams start and stop
- to record the number of Cruiser occupants travelling between pit stops
- to check that ballast is correct for each driver or passenger change
- to notify the Clerk of the Course at the earliest opportunity if any breach of regulation is suspected, energy storage cells or modules have been changed or an energy storage system seal broken, or if they have any concerns about the actions of the team.

3.25.2 Observers are not permitted to interpret regulations or to give advice or directions to teams. Advice or directions from observers do not supersede regulations. The only exception is if an observer asks a team to stop because they think its unsafe—the team must stop.

3.25.3 Each team's responsibilities to the observer are:

- to assist the observer in their duties at all times
- if requested by the observer, to send for assistance from the event organiser or transmit information to Race Control
- to not make any demands of the observer to assist team operations.

3.26 Start line and grid

3.26.1 The ceremonial start of the event will be held at 13:00 on Saturday 17th of September 2022.

3.26.2 Starting position will be determined by performance during dynamic scrutineering.

3.26.3 All solar cars must be in their starting grid position by the appointed time for final inspections. Any solar car not present will have their starting position amended.

3.26.4 Teams must not work on their solar cars on the start grid.

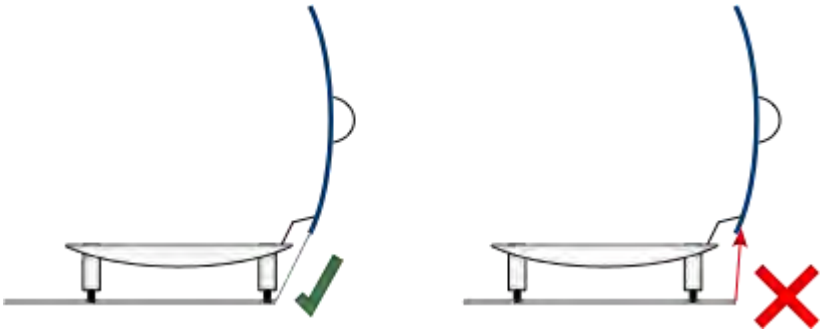
3.27 Energy collection and storage

3.27.1 Charging the energy storage system or powering the solar car from an unauthorised source will lead to exclusion from the event.

3.27.2 External devices intended to increase the irradiance on the solar collector or increase the efficiency of the solar collector must not be used at any time.

Spraying of water from external sources is not allowed.

Ground sheets must not be placed in any position where it is possible to draw a straight line from any part of the ground sheet to any part of the solar collector.



3.27.3 Damaged energy storage cells may be bypassed, but must not be removed from the energy storage system unless it would be unsafe to leave them in. Cells removed must be replaced by ballast with mass greater than the mass of the removed cells.

3.27.4 If a solar car is unable to continue because too many energy storage cells have been damaged, the team may, with the event organiser's permission, replace cells and continue. The final ranking of the team will be based on the distance achieved before replacing cells.

3.28 Timing

3.28.1 The official start time on Day 1 will be 13:00 for all teams.

3.28.2 The official finish time on Day 2 is 13:00.

3.29 Tracking

3.29.1 Each solar car must carry a data logging and tracking device provided by the event organiser. The specifications of the tracking device are described in Regulation 2.8.

3.29.2 Information concerning progress and operation of solar cars may be published during the event.

3.30 Solar car drivers and passengers

3.30.1 Only registered solar car drivers may drive the solar car during event hours.

3.30.2 When driving, ballast must be carried in accordance with the provisions of Regulation 2.7.

3.31 Driving conduct

3.31.1 Each team must ensure that all vehicles associated with their attendance at the event are driven in a careful and courteous manner at all times.

3.31.2 Overtaking must be done in a safe manner and taken into account prevailing conditions. Overtaking is only allowed on the left side meaning all ‘slow’ cars should drive on the right side of the road (next to the middle) whenever overtaking is possible. Whenever a slow car is going to be overtaken by another car, the slow car should blink its right direction indicator as confirmation that overtaking can be performed safely. Overtaking is not allowed in chicanes or sharp corners.

Overtaking in corners will only be allowed in the 3 consecutive corners in Section 0 and 1 of the race track. See Appendix for a layout of the race track including the designations of its Sections.

3.31.3 The organiser reserves the right to determine if any individual is acting de facto as a part of a team.

3.31.4 Except when pushing a disabled solar car to a place of safety, solar cars must not be pushed along the road. Push starting the solar car is not allowed.

3.31.5 Solar cars may be subject to scrutineering at any time during the event to ensure compliance with the regulations.

3.32 Stopping

3.32.1 No solar car may stop on the road except in an emergency.

3.32.2 Where any activity takes place on the track, attendants must be positioned in a place of safety to warn approaching traffic using yellow flags.

3.33 Obstructing other road users

3.33.1 Vehicles associated with a team must not obstruct other road users, including other teams and the safety car. Infringement of this regulation will incur a penalty for each incident.

3.34 Charging stops

3.34.1 For all cruiser cars a total amount of at least 3 hours in the pits will be mandatory. This time equals all time in the pitlane thus including the normal driver changes and these stop times don't need to be announced on beforehand.

3.34.2 The charging stops must be at least 30 minutes long each time and performed at designated charging stops along the 24 hours.

3.34.3 Challenger cars may charge a maximum of 3 times during maximum 60 minutes long stops.

In case your solar car requires more energy to complete the 24 hours, please inform the event organizer and an exception will be granted.

Challengers have no mandatory minimal pit time.

3.34.4 Charging stops may succeed one another. During these stops cars can be charged but this is not required. If the car will not be charged during this stop it may be parked at your own pit box. Repairs, tire changes, etc. will be allowed during this time in the pit box.

3.34.5 All vehicles must obey a pitstop speed limit of 30 km/h.

3.34.6 Teams must obey all directions given by the pitstop manager.

2.34.7 Teams must park in the spaces designated by pitstop officials. Teams may not modify the parking space in any way. Ground sheets may not be used. No team members other than arriving occupants may touch the solar car once it is in the parking space. As a result, only charging is allowed at the charging area. Modifying the solar car here will not be allowed.

2.34.8 Occupants must get out of the solar car without assistance from other team members, bringing their ballast with them. Occupants may help each other get out of the car.

3.34.9 Once all occupants are out of the car, the arriving driver, together with 2 others, may reconfigure the car for charging before pitstop timing commences.

3.34.10 All cooling aids used for charging should be carried inside the car during the full 24hr.

3.34.11 A driver change is required after charging the solar car. In this case, the driver change may take 5 min or less and may be performed within the charging bay. This time is included in the charging time and will immediately indicate the end time of charging.

3.34.12 After charging the car one cannot return via the pitlane to the pit box. When the car is able to, it should drive on the circuit and enter the pit-lane again.

3.34.13 The departing car must not leave until the ballast and drinking water is in place, seat belts are fastened, helmets are secured and the solar car is ready for the track.

3.35 Trailering

The term 'trailering' applies to any means of transport used to carry the solar car including towing.

3.35.1 The solar car must be in safe state at all times while being transported.

3.36 Withdrawal

3.36.1 A team may withdraw by forwarding a completed race commission application form (available in the Appendix) with subject "*Withdrawal*" to the Clerk of the Course.

3.37 Penalties

3.37.1 The race commission may contest any arising penalties.

3.37.2 Penalties range from official warnings to disqualification from the event.

3.37.3 All penalty times listed are suggested minimums.

3.37.4 Driving conduct may double with each subsequent infraction.

3.37.5 The Clerk of the Course may impose demerit points on any team that breaches a regulation.

3.37.6 Each demerit point given to a Challenger team will also incur a time penalty of 30 minutes, to be served at the following pitstop. All Challenger time penalties must be served before arriving at the finish line.

3.37.7 Each demerit point given to a Cruiser team will reduce the team's final score by 1%.

3.37.8 A team accruing three or more demerit points will be excluded from the remainder of the event.

3.37.9 The Clerk of the Course may impose operational restrictions (such as speed restrictions) on any team.

3.37.10 At any time during the event, the Clerk of the Course may issue a penalty of one demerit point in response to any of the following behaviours noted by an observer or reported by an official:

- obstructing other road users
- poor safety protocols
- deliberately violating regulations for strategic advantage
- driving without effective rear vision.

3.37.11 The Clerk of the Course will determine penalties for offences including:

- improper language
- failure to observe a request by event officials
- wilful damage or interference to property
- failure to stop at a designated pitstop
- driving without adequate rain tyres in case of rain
- night's rest: During the main event, all participants are to keep quiet on and around the campsite. In addition, all participants are required to respect a period of rest every day of the event between 11 p.m. and 7 a.m. During these hours, no noise disturbing the other participants will be tolerated on and around the campsite.

The main event begins at Wednesday, 10 a.m. and ends at Sunday, 5 p.m.

The European Solar Challenge takes place during a low noise weekend at Circuit Zolder. Participants are required to keep excessive noise which may disturb the neighbourhood to a minimum.

Pushing A penalty of one lap will be given to every team who pushes a solar car while on the track. (Except in an emergency).

Improper Ballast A five lap penalty may be assessed each time a team operates their solar car with ballast not matching the one assigned to the car's driver or their passengers.

Unauthorized Drivers Any solar car driven by an unauthorized driver will be required to return to the pit lane and drive with an authorized driver. Unauthorized driving will not be counted.

Disturbing Official Battery Seals Solar car batteries will be marked with an official seal. Disturbing these seals in a manner that prevents proper identification by an observer may be penalized as though all of the battery cells affected had been replaced as handled in the following penalty regulation.

Replacement of Batteries Decisions to exchange all or part of a battery must be communicated formally to the team's observer. The penalty will be computed as follows:

- Cruiser cars: The energy score's battery capacity is incremented by two times the replaced capacity.
- Challenger cars: One lap penalty for each $3600\mathrm{mAh}$ of replaced capacity.

Exceeding Size Specifications Oversize solar arrays will be penalized one lap per exceeded square centimetre beyond the allowed size specification.

Restriction on Overtaking On the track there are three dangerous turns. The restriction on overtaking will be marked with red tire stacks (details will be announced in the team meeting). Dangerous overtaking in these curves will be penalized with a penalty of three laps.
Shortcut curves on the green areas beside the track will be penalized with one lap penalty.

Stopping Stopping on the racetrack will result in a penalty of one lap. Obstructing other teams will increase this penalty. An exception are unforeseen car breakdowns.

Slow Vehicles Slow vehicles not driving on the slow side of the track will be penalized with at least one lap. Obstructing other teams will increase this penalty.

Blocking Cars The blocking or hindering of other vehicles out of deliberation or negligence will be penalized with one lap.

Further Penalties The Race Control may enforce further penalties during the event. Further penalties will commonly be enforced in accordance with a Race Commission.

3.37.12 The Clerk of the Course may exclude any team from the event for wilful disregard of any regulation or of the spirit of the event. These offences include but are not limited to:

- misrepresentation
- use of alcohol or illegal substances
- wilful obstruction, or aggressive or unsafe driving including speeding in the pit lane and driving without properly fitted safety belt
- cheating including distracting race control
- violation of traffic rules around the racetrack
- charging of the energy storage system from any unapproved source
- accumulation of three or more demerit points.

Drugs and Alcohol Consuming any drugs or alcohol inside the pit lane may result in disqualification of the concerning team member or team.
People participating in the event must not be under the influence of alcohol at any time.

Teams are responsible for the conduct of all persons associated with the team, whether or not they are officially registered.

3.38 Protests and appeals

3.38.1 A team manager may appeal any decision of the Chief Scrutineer or the Clerk of the Course to the race commission by lodging a written Notice of Appeal with the Clerk of the Course within one hour of the notification of the decision. The Notice of Appeal must detail the grounds for the appeal.

3.38.2 A team manager may lodge a written protest with the Clerk of the Course. Protests must be lodged before 14:00 on Sunday. Protests hereafter will not be accepted. The protest shall specify the details of the incident.

3.38.3 The Chief Steward may convene the race commission to consider any protest or appeal requiring final resolution. The race commission may take advice from any party with regard to the incident giving rise to the decision being appealed. The decision of the race commission is final and binding.

3.38.4 The decision of the race commission must be conveyed to the team manager lodging the appeal within one hour of reaching the decision, and confirmed in writing to all parties to the appeal including the Clerk of Course.

4 Achievement and Celebration

4.1 Event results

4.1.1 Results published throughout the duration of the event are provisional. Results will not be final until after the determination of any outstanding protests and appeals.

4.2 Completing the 24h

4.2.1 To complete the course, the solar car must cross the finish line at least once, in accordance with the regulations.

4.3 Challenger class

4.3.1 The goal for the Challenger class is to complete the most laps in 24h, in accordance with the regulations.

4.3.2 The Challenger Cup will be awarded to the Challenger team that completes the 24hr with the most race laps.

4.3.3 Challenger teams that complete the 24hr and cross the finish line after 24hr will be ranked by total score. This score is divided in 75 % for the 24h race lap score, 5 % for the fastest lap and 20 % for the dynamic tests performed during dynamic scrutineering. A detailed scoring can be found in Appendix.

4.3.4 Challenger teams that do not complete the challenge will be ranked behind Challenger teams that complete it. They will be ranked by total score mainly influenced by the number of race laps completed.

4.4 Cruiser class

4.4.1 The goal for Cruiser teams is to design and build a practical solar car, and transport people. Cruiser teams will be scored on energy efficiency, the time taken to complete the course, payload carried and practicality.

4.4.2 Cruiser solar cars may be recharged from Electric Vehicle Supply Equipment (EVSE) at the charging stop only. No other charging from external sources is allowed. The external energy used to recharge the solar car will be measured by the organisers.

4.4.3 Each Cruiser solar car completing the 24h will be given an energy score calculated by

$$S = D / E \times 0.99^{d}$$

where

- D is the number of points related to number of occupants. For every lap the driver and first occupant will score 1 point. A second and third occupant also count for 0.5 points.
  Resulting in following calculated scoring per lap:

Only driver	0.5 points
Driver + 1 passenger	1.0 points
Driver + 2 passengers	1.5 points
Driver + 3 passengers	2.0 points
Driver + 4 passengers	2.5 points

- *E* is the nominal external energy use of the solar car, in kilowatt-hours. Defined as follows: starting battery capacity + (energy charge 1 + energy charge 2 + energy charge 3). The minimal used total energy will be 40 kWh. When a team uses less energy, their score will be divided with this amount of 40 kWh.

The nominal energy capacity of a rechargeable electrochemical battery is the sum of the nominal cell masses in kilograms multiplied by:

- 330 Wh kg-1 for Li-S cells
- 250 Wh kg-1 for Li-ion cells
- 250 Wh kg-1 for Li-polymer cells
- 125 Wh kg^{-1} for $LiFePO_4$ cells.

In case of unforeseen circumstances like bad weather or race incidents, the organisation can change this number of 40 kWh.

- *d* is the number of demerit points received by the team.

4.4.4 The Cruiser Cup will be awarded to the Cruiser team that receives the highest total score. This score is divided in 45 % for the 24h race lap score, 40 % for practicality, 5 % for the fastest lap and 10 % for the dynamic tests performed during dynamic scrutineering. A detailed scoring can be found in Appendix.

4.4.5 Cruiser teams will be ranked in the following groups:

- teams that complete the entire 24h, ranked by score
- all remaining teams behind Cruiser teams that complete it.

4.4.6 The nominal energy capacity of other types of energy storage system will be determined by the Chief Energy Scientist.

4.5 24-Hour race

4.5.1 The 24-hour race starts on Saturday, September 17, 2022 at 13:00 (1 p.m.), and concludes on Sunday, September 18, 2022 at 13:00 (1 p.m.).

4.5.2 The race begins with a Le Mans-style start.

4.5.3 In order to line up for the start, teams are allowed to drive backwards through the pit lane. The line-up will be overseen by the observers.

4.5.4 At the start, every team may assign one team member to aid the driver while entering the solar car.

4.5.5 Every team needs to take their position in the line-up no later than 15 minutes before the official starting time of the race.

4.5.6 Teams failing to arrive in time for the line-up will start from the pit lane and will be penalized.

4.5.7 Depending on strategy, all teams may decide for themselves when their solar car exits and enters the track during the duration of the race.

4.5.8 During the duration of the race, all repairs or modifications conducted on participating vehicles need to comply with the regulations of the European Solar Challenge. This will permanently be verified by technical inspectors.

The Open track or night test driving will be on Friday evening after finishing dynamic scrutineering. Every team able to scrutineer its solar car will be able to participate in the Open Track.

4.6 Fastest Lap

4.6.1 The fastest lap challenge will take place as a part of the 24-hour race.

4.6.2 After the race has ended, the fastest lap for each team will be detected. The team with the fastest lap wins this challenge.

4.7 Awards

4.7.1 An awards ceremony will be held on the afternoon of Sunday 18 September 2022.

4.7.2 The winner of the Challenger class will receive the Challenger Cup; the winner of the Cruiser class will receive the Cruiser Cup.

4.7.3 The event organiser reserves the right not to present an award in any given category.

4.7.4 Each team will receive a participation award.

4.7.5 All winning teams must make themselves available for an official media call if required.

4.8 Pack-down facilities

4.8.1 Open-air facilities will be made available for repacking solar cars for shipment. All vehicles, containers and equipment must be removed by 12:00 on Monday the 19th of September 2022. Any remaining items will be removed for storage at the entrant's expense.

Glossary

Battery	Electrochemical cells wired in series or parallel and housed in a single container.
CB	Citizen's Band radio.
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.
certifying engineer	A professional engineer engaged by a team to report on compliance with regulations and roadworthiness requirements.
Clerk of the Course	The person responsible for coordinating Dynamic Scrutineering and the on-road portion of the event.
DOT	United States Department of Transport.
Energy storage pack	A self-contained box containing components of the energy storage system, such as electrochemical cells and a battery management system.
Energy storage system	The solar car subsystem used to store energy. It is typically a rechargeable electrochemical battery, but other types of energy storage system are possible.
Entrant	The legal entity that completes the Participation Agreement and requests a place in the event for one or more teams. An entrant is typically a registered institution, organisation or commercial entity.
EVSE	Electric Vehicle Supply Equipment.
FAI	Federation Internationale de l'Automobile.
FMVSS	United States Federal Motor Vehicle Safety Standards.
High voltage	More than 60 V dc or more than 30 V rms ac.
ISF	International Solarcar Federation.
Judge	A person invited to make subjective comment on Cruiser Class attributes.
Judge of Fact	A person recognised by the organiser as able to determine whether a particular event occurred (e.g., whether a team obstructed traffic).
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.)

Participant	A person who has registered to participate in the event as a member of a team.
PV	Photovoltaic.
Red-Shirt	A senior event official (wearing a red shirt) responsible for overseeing the conduct of the event.
Road-ready	Ready to drive on the road.
Scrutineering	The process of checking the solar car and other team vehicles for compliance with the regulations.
SFI	The SFI Foundation issues standards for motor sports equipment.
Solar collector	The solar car subsystem used to collect solar energy. It is typically an array of photovoltaic cells, with or without concentrators or reflectors, but other types of solar collector are possible.
Steward	An event official responsible for ensuring regulations are applied correctly and fairly.
Team	A group of people registered by the entrant to participate in the event. An entrant may have more than one team participating in the event.
Team manager	The person in charge of, and responsible for, the actions of a team.
Traction battery	The total number of cells, modules or packs connected in series or parallel.
UHF	Ultra High Frequency. Commonly refers to Australian two-way radio operating on the Citizens Band.
UNECE	United Nations Economic Commission for Europe, responsible for regulations for motor vehicles.
UTC	Coordinated Universal Time.
VIN	Vehicle Identification Number.

Appendix

1 ISF 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 car 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 tensile 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 case that 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 enough 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 competitors. No part of roll bars must hamper the entry/exit of the occupant or take up the space designed for the occupant.

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

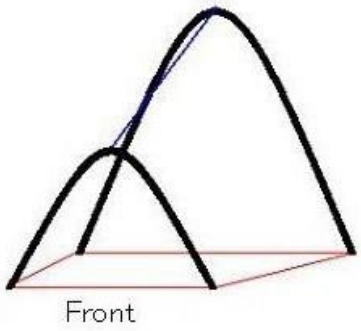


Figure 8: Rollbar: general view

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

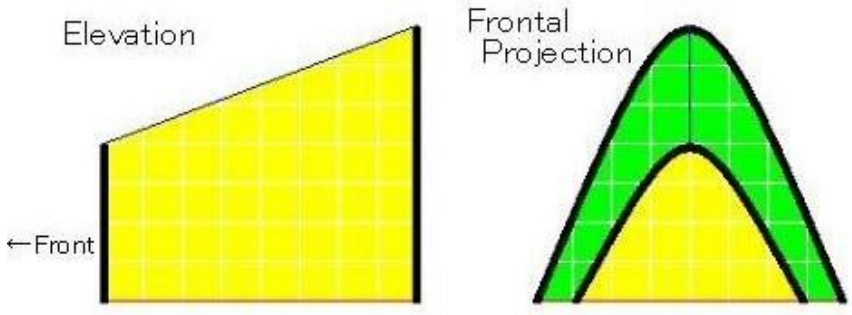


Figure 9: Rollbar: side view

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

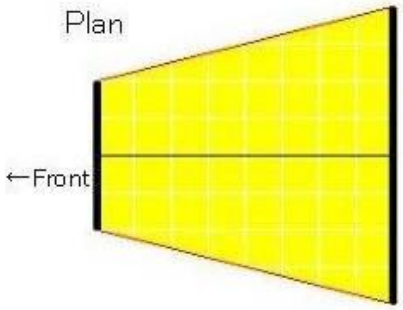


Figure 10: Rollbar: plan

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

2 ISF Standard Measurement of Seating Angle

- The seating angle must not exceed 27 degrees.
- 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 performed by using a template based on the hip and shoulders of a two-dimensional form derived from the JIS D0024 standard.

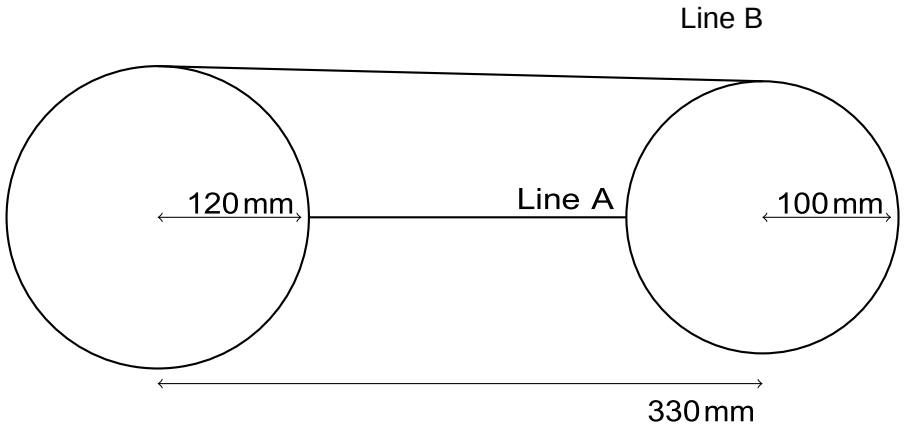


Figure 11: Measurement Template

Making a Template

- Draw a circle with a radius of 120mm.
- At a point 330mm from the centre of the circle, draw another circle with a radius of 100mm
- 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.

3 ISF Steering Wheel Specifications

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 which has a continuous perimeter.

A circular shape is preferred, however the upper part above 2/3 and/or the lower part below 2/3 of the circumference of the steering wheel may be flat as depicted in the diagram below). Permitted.

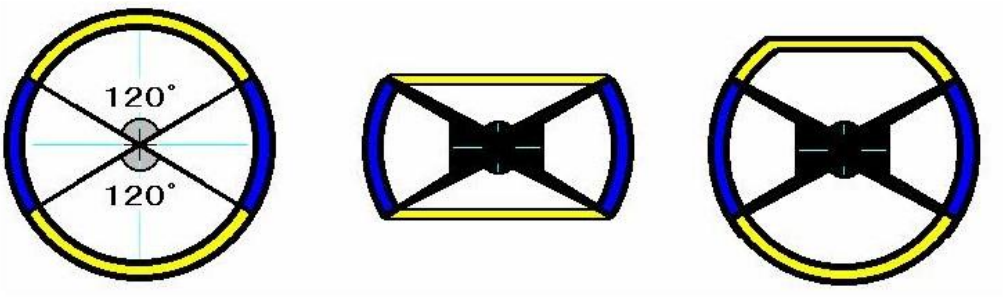


Figure 12: Examples of permitted steering-wheels

Not permitted:

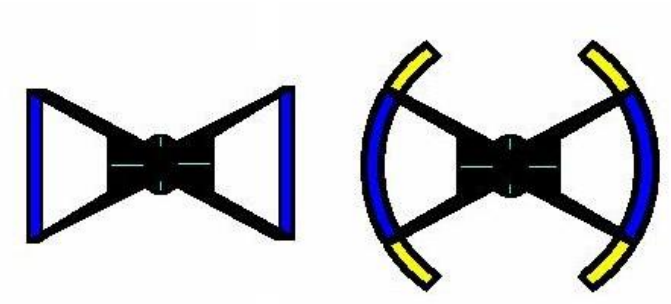


Figure 13: Examples of prohibited steering-wheels

4 Handling parcour

The parcour that follows is only meant as indication and may be changed. The exact schedule and challenges will be made available by the event organizer later on.

1. Warming-up round starting from the pitboxes.
2. Hot lap starting from the finish line. (**Start time at the finish line**)
3. Cooling-down round when the solar car passes the finish line again. (**Stop time at the finish line**)
4. At the end of the cooling-down round the car must enter the pitlane.
5. Perform a pitstop and change 1 tyre of choice. (**Start time when entering pit**)
   Not more than 4 people may help in any way for this challenge. All occupants should remain seated and may not help.
6. Drive outside the pitlane.
   Be aware that a max speed limit of 30 km/h is obliged inside the pitlane.
7. Complete one final round and drive inside the pitlane.
   This marks the end of the parcour and the overall time will be stopped when entering the pit.

Several challenges will be available on the race track:

- Section 2, after the finishline: Slalom
- Section 0: Chicane 1
- Section 1: Funnel towards a narrow lane ending in a chicane on Section 2
- Section 3, before finishline: Chicane 2

Each missed obstacle will account for a penalty of 30 seconds.
Each obstacle will be stationed by a marshall.

5 Detailed Scoring

Challengers

Rank	Dynamics	Fastest lap	24hr
1	20	5	75
2	13	4	47
3	8	3	31
4	6	2	21
5	4	1	13
6	2	0	7

Cruiser (With practicality)

Rank	Dynamics	Fastest lap	24hr	Practicality
1	10	5	45	40
2	6	4	28	25
3	4	3	18	16
4	3	2	12	11
5	2	1	8	7
6	1	0	4	4

6 Race Commission Application Form

Team:

Subject:

Additional Information:

Time of Submission:

Hand this form to an Official of the European Solar Challenge at the Race Control.

Person handing in this Document:

Signature:

Team Manager:

Signature: