



Ministry of Energy, Mines,  
Water and Environment



# TECHNICAL RULES

## Technical rules : Moroccan Solar Race Challenge

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## Technical rules : Moroccan Solar Race Challenge

### **Article 1 : General instructions**

#### **1.1 Compliance with rules**

Each participant shall show the organizing committees of the competition that the vehicle complies, at all times during the competition, with all the provisions of the present Rules regulating the competition.

#### **1.2 Minimum weight**

All liquid tanks (of lubrication, of braking), shall be at the normal level provided by the manufacturer. Vehicles shall weigh at least the weight indicated on the Technical sheet (a document with all vehicles technical details to stay with the driver) (net weight) presented during the competition. Minimum net weight: 100 kg.

#### **1.3 Dimensions**

The dimensions of the vehicles shall not exceed the following values:

- Length: 5m
- Width: 1.8m
- Height: 1.6m

#### **1.4 Total Gross Vehicle Weight (GVW)**

The total gross vehicle weight of the vehicle is open.

#### **1.5 Size of solar panels**

The maximum allowable solar cells surface (outer surface, not the active surface) is 6m. A maximum of three different sizes are permitted for the outer surfaces of the solar cells in a solar panel. If more than three different sizes are needed to manufacture the solar panel, the participant shall submit a request to the organizer of the competition no less than one month (excluding accidents) in advance. This request must indicate the reasons (availability, cell defects, accident, breakdown ...) for which more than three different sizes of solar cells are used in the panel.

The size of the solar panel will be measured using the flat surface (not the active surface) of a solar cell multiplied by the number of cells of the corresponding type. If more than one cell size is used in the panel, the method of measurement and calculation shall be repeated for each size of solar cells. The total surface of the calculated cells gives the total size of the solar panel. The participant shall prove the size (outer surface, not the active surface) of the different solar cells used to make the solar panel using technical sheets provided by the manufacturer or the company that cut cells.

The cells used must be commercially available, regardless of their types.

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### **1.6 Doors**

**Closed vehicles:** The vehicle shall be equipped with one or more doors allowing the driver to go into and out the vehicle without assistance.

### **1.7 Chassis**

The chassis frame is mostly the main load-bearing element of the vehicle and serves as a rigid connection of the corresponding parts of the chassis. It should be strong enough to withstand the loads produced when the solar vehicle is running. It gives the solar vehicle the necessary resistance to potential forces occurring when in use. Forces are transmitted from the track to the chassis frame only through the tires.

### **1.8 Bodywork**

The bodywork should cover the driver and all the mechanical parts. All parts of the bodywork should be manufactured and finished with full attention. Temporary solutions are not allowed.

Any moving parts or electrical wire near the driver must be adequately covered to avoid contact.

### **1.9 Cockpit**

The cockpit shall be designed so that even long distances can be covered without causing fatigue to the driver. The main equipment required to drive the vehicle shall be designed so that it does not require significant movements of the body or remove safety belts when in use. The cockpit shall be equipped with a means allowing an adequate amount of fresh air to get in. It should be possible to sit down and get out of the cockpit without the help of a third person, in less than 15 seconds.

### **1.10 Wheels and tires**

Tires' width shall be at least 57 mm (nominal size). Scooter or other comparable tires are highly recommended as reinforced tires for solar vehicles are not readily available to all teams. If a central safety system is used, wheels should have a safety system such as pinned or self-locking nuts.

Pressure in the tires may never, at any time, exceed the maximum pressure specified by the manufacturer on the casing of these tires. In case this information is not specified on the texture of the tire, the maximum pressure shall never exceed 5 bars.

### **1.11 Protective surfaces**

The car shall be capable of withstanding a 3 m/s front or rear impact without significant damage to the car (This point will not be checked but the safety of your vehicle and driver in the race depends on it).

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### 1.12 Race number and identification

A square of 14 cm x 17 cm side, free of any cell and any other equipment, shall be allowed on top/front and rear of the vehicle to affix the vehicle's race number. On two sides of the vehicle, a 15 cm high and 1 m wide space shall also be reserved for the organizer's and sponsors logos. Anywhere on the vehicle, an area of 40 cm<sup>2</sup> minimum shall include the name of the school (or the name of the club), and another 40 cm<sup>2</sup> also for the name of the project. That makes 5 mandatory placeholders.

### 1.13 Energy

All the energy of the vehicle shall be exclusively solar. The accumulator(s), whatever their types are, shall be completely empty at the start of the competition. The only allowed energy storage devices are the supercapacitors or accumulators (all types). All energy storage devices shall be presented at the start of the race, disconnected from the vehicle. (It is imperative to think up easy mounting and dismantling systems for the embedded device). Vehicles not having any energy storage system are exempted from this point. For supercapacitors, the value in Farads is unrestricted but shall be checked in short-circuit. For batteries, a member of the organizing committee of the race will check batteries' discharge with a suitable test bench and will place a seal on the battery. Batteries with seals considered empty. Identical recharge time can be allocated to all competitors before the start of the race to allow normal running, in the early laps if the weather is not perfect. Recharge time will not exceed, in any case, 30 minutes.

Any attempt to recharge the battery by any other means than the solar panel installed on the vehicle or the recovery of kinetic energy of the vehicle in race, will result in immediate exclusion.

### 1.14 Kill Switch

The vehicle shall be equipped with a kill switch that completely disconnects power from the solar panel and energy storage devices, easily accessible with a clear indication of the off position.

### 1.15 Replacement of parts

During the racing, all vehicle parts can be replaced if they are broken or worn, except the battery or the storage capacitor. If their replacement is unavoidable, it should be done by the organizing committee of the competition, by a controlled spare battery empty at the mounting. The committee shall place a seal on the new battery.

### 1.16 Radio

The vehicles may be equipped with telemetry and radio link to communicate with the team and shall be powered by its own source of energy.

**Commented [ISF-RC1]:** This rule should be revisited because it limits the power of the vehicles. Many teams had issues with acceleration and grades last year.

**Commented [ISF-RC2]:** What constitutes an empty battery? 10% SOC, 20% SOC? Too low could damage the battery.

**Commented [ISF-RC3]:** When is this done? The morning of the race? Do they then disconnect the panel and reconnect them at the start of the race?

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### 1.17 Other equipment

All solar vehicles, prototypes participating in the competition shall always be in compliance with the following provisions:

- Presence of two stop lamps visible in direct sunlight from a distance of 10m.
- Presence of an approved audible warning device capable of generating a continuous sound of 90 dB / A (Horn)
- Presence a speedometer that shall be within sight of the driver. The speed indicated shall not be less than the actual vehicle speed.
- Presence of mirrors with adequate rear and adjacent visibility on both sides.

## Article 2 : Electrical equipment

### 2.1 Battery/ Accumulator

To simplify batteries' checking, the next energy-mass equivalence table will be used, for 3 kWh and 500 Wh the following respective weights (will be used) depending on the technology:

- Pb/Acide : (40 Wh/kg) 75 kg 12,5 kg
- NiMH : (71 Wh/kg) 42 kg 7,0 kg
- Ag/Zn : (125 Wh/kg) 24 kg 4,0 kg
- Ni/Zn : (66 Wh/kg) 46 kg 7,6 kg
- Ni/Fe : (50 Wh/kg) 60 kg 10,0 kg
- Ni/Cd : (55 Wh/kg) 54 kg 9,1 kg
- Li-Ion : (140 Wh/kg) 21 kg 3,6 kg
- Li Polymer : (165 Wh/kg) 18 kg 3,0 kg

### 2.2 Solar cells

All types of solar cells are allowed.

### 2.3 Solar generator

During the entire competition, the size of the solar generator shall be neither increased nor reduced. In case of breakdown, the modules may individually be replaced under the supervision of a Technical Officer. The solar generator should be firmly fixed to the competition vehicle, in a way that its position in the vehicle cannot be change when the latter is in motion.

### 2.4 Charging the battery

Vehicle's batteries may only be loaded at times and places determined by the race organizer.

### 2.5 Energy recovery

It is allowed to recover the energy produced by the kinetic energy of the vehicle. It is not allowed to store energy in this type of device before the start of the competition.

**Commented [ISF-RC4]:** Are the 3 kWh maximum allowable values? Why is there a limit when they start with empty batteries the charge for only 30 minutes? Max energy they can possibly store is about 750 Whr

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### **2.6 Use of foreign energy**

The use of any other source of energy in any form whatsoever in order to increase the performance of the vehicle is strictly prohibited.

## **Article 3 : Safety equipment**

### **3.1 General safety**

#### **3.1.1 Dangerous constructions**

Solar vehicles are only allowed to run if they are in a state that meets safety standards and if they comply with the Rules. They must be designed and maintained so that to ensure compliance with the Rules and be safe for the driver and the other participants. All solar vehicles that could be dangerous can be excluded.

#### **3.1.2 Fire extinguishers, extinguishing systems**

All vehicles shall be equipped with a 1kg dry manual fire extinguisher against ABC fire. The extinguisher shall be pressurized to 8 bars minimum and 13.5 bars maximum. The following information should be clearly visible on each extinguisher: capacity, type of extinguishing product, weight or volume of the extinguishing product, verification date of the extinguisher, which shall not be more than two years after the date of filling or after the last verification.

All extinguishers shall be adequately protected and strongly fixed.

### **3.2 Seatbelts**

#### **3.2.1 Belts**

Safety belts meeting at least four requirements are mandatory; two shoulder straps and a lap belt; fixing points on the hull: two for the lap belt, two or one symmetrical to the seat for the shoulder straps.

Shoulder straps shall be directed downwardly backwards and shall not be mounted so as to create an angle of more than 45 ° relative to the horizontal, from the upper edge of the backrest, and it is advisable not to exceed 10 °.

The maximum angles relative to the axis of the seat are of 20 ° divergent or convergent.

Fixing Points creating a higher angle relative to the horizontal shall not be used.

For a 4-points harness, the shoulder straps shall be mounted so as to symmetrically intersect relative to the axis of the front seat.

A safety harness shall not be installed on a seat without head restraints. Abdominal and crotch straps should not go over the sides of the seat, but should pass through the seat to wrap and hold the pelvic area over the largest possible surface.

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The lap straps shall tightly fit in the bend between the pelvic crest and the upper thigh. They should not focus on the abdominal area. It should be ensured that the straps cannot be worn by being rubbed against sharp edges.

Fixing points should be installed on the hull or the chassis frame, as close as possible to the axis of the rear wheels for the shoulder straps.

#### 3.2.2 Principles of fixing on the chassis / monohull

- 1) General fixing system: see Figure 1
- 2) Shoulder straps fixing system: see Figure 2
- 3) Crotch straps fixing system: see Figure 3

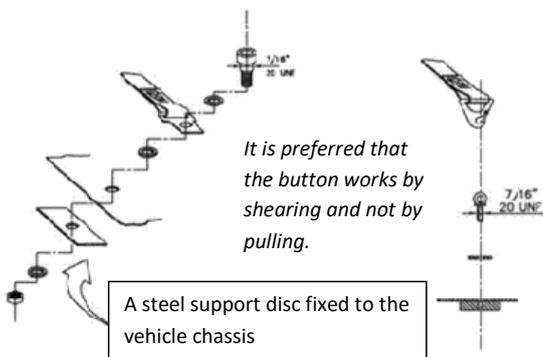


Figure 1 - General fixing system

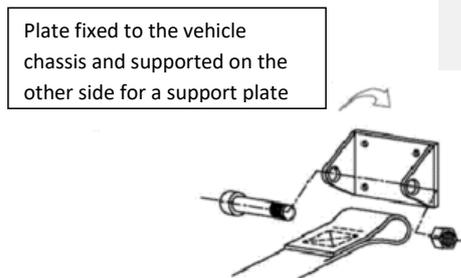


Figure 2 - Shoulder straps fixing system

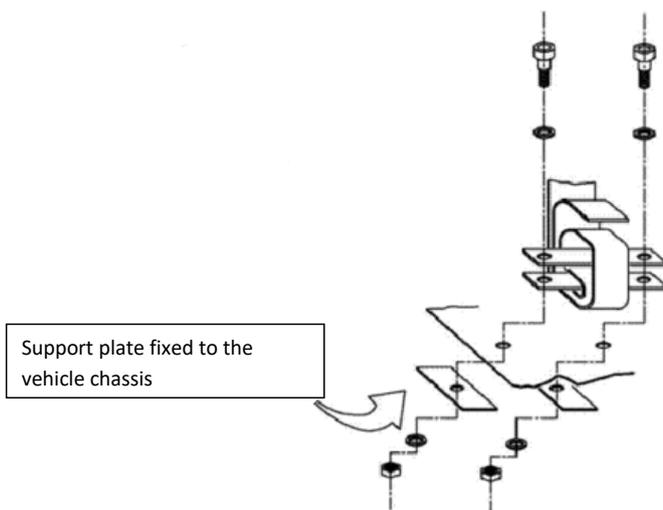


Figure 3 - Crotch straps fixing system

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### **3.2.3 Use**

A safety harness should be used in its configuration approval without modification or removal of parts, and in accordance with the manufacturer's instructions. The efficiency and lifetime of safety belts are directly related to how they are installed, used and maintained. Belts shall be replaced after every severe collision and if they are cut, frayed or if the straps are weakened by sunlight or chemicals effect. They shall also be replaced if the metal parts or the buckles are bent or rusted. Any harness that does not work perfectly shall be replaced.

### **3.3 Seat**

The seat shall be installed in the vehicle so that the angle of the flat surface of the backrest defined in Appendix 2 is less than 27 degrees when measured in accordance with Appendix 2.

### **3.4 Driver's equipment**

- Wearing long sleeve tops and full length trousers for drivers,
- Wearing a helmet with international standards is mandatory for all drivers.

### **3.5 Steering wheel**

To reduce the possibility of injury for drivers in case of collision and to ensure that the driver will not stuck at his exit, the steering system must be controlled by a steering wheel having a completely circular shape (sharp anglers are prohibited).

### **3.6 Accelerator**

The motor's throttle should be activated using a foot pedal or a hand accelerator and must be a manual device. The pedal's surface shall be designed so that the foot of the driver controlling the accelerator may not slip (skid-proof coating).

### **3.7 Brakes**

The braking system should be a main hydraulic braking system activated by a brake pedal. The pedal should activate the brakes on all wheels. A double circuit braking system is required so that the pedal acts at least on two wheels in case of brake fluid leakage or any failure of the braking system.

The carbon brake discs are prohibited.

The surface of the pedal should be designed so that the foot of the driver controlling the accelerator may not slip (skid-proof coating).

Braking must bring the vehicle to a complete stop in less than 10m when the vehicle initial speed is 20km/h.

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### **3.8 Glass panes and windscreen**

All glass panes should be installed the front of the driver and made of a material that does not cause serious injury in case they are broken.

The glass panes required for the driver's view should enable a clear view, not cause distortion and allow 70% of the light.

### **3.9 Cables, electric equipment and piping**

Brake piping, cables and electrical equipment should be protected against any risk of deterioration (stones, corrosion, mechanical breakdown, etc.) if they are attached to the outside of the vehicle; and against the risk of fire if they are attached to the inside of the bodywork.

### **3.10 Reducing the risk of injury**

Elements sticking out the vehicle's interior shall be avoided. Sharp or cutting edges are prohibited and should be adequately padded. The bodywork surrounding the solar panel should not have sharp edges lower than 30 mm radius.

### **3.11 Electric cables**

Each electrical cable shall be adjusted to an amount of electrical currents that will be loaded into the circuit concerned and be properly insulated. All electric cable inside the vehicle should be protected by means of calibrated overvoltage circuits according to the diameter of the individual conductors.