

AUSTRALIAN-INTERNATIONAL

MODEL SOLAR CAR

CHALLENGE

2010

REGULATIONS

Section 8

Car Specification

12 February 2010

Section 8 (this document) covers the car specifications
Sections 1 to 7 (a separate document) cover the administration of the event
N.B. All eight sections must be read as a single document.
Details of the design for a suitable light box are also available.
Details of the seeding procedure and the Plate winner re-entry are also available.

Section 8. Car Specification

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8. CAR SPECIFICATION

8.1 Test criteria.

Unless otherwise specified all references to car behaviour and measurements will assume that the car is on a flat, straight section of the track, and in full racing configuration.

8.2 No commercially built cars

Cars may not use any part of the chassis or body of any commercially available model car. This only refers to the structural frame, not to the drive train components such as gears, shafts, wheels, tyres, or to suspension and steering components. Unless specified elsewhere in this document, other external body covering is at the discretion of the entrants.

8.3 Size limit

When the car is racing in a straight line, the overall length of the car shall be no more than 550mm, the height of the car shall be no more than 180mm and the width of the car, wheels, axles and suspension included, shall be no more than 320mm, and no part of the car may extend more than 180mm from the centre of the guide rail. So that it will not encroach on the other lane, at no time whatsoever may any part of the car extend more than 190mm from the centre of the guide rail.

8.4 Source of power

The car is to be powered only by photovoltaic cells as approved by the AIMSCC Executive. Approved photovoltaic cells will be commercially available silicon cells (mono-crystalline, poly-crystalline or amorphous). Amorphous cells currently available are not recommended however, because of their low power to weight ratio. High output cells such as Gallium Arsenide cells, as determined by the high voltage output of such cells (>0.8V per cell), will not be allowed.

8.5 Solar array and support structure

The solar cells connected together to provide the power which drives the car will be referred to as the array. The complete unit on which the photovoltaic cells (the array) are mounted is the array support structure. This structure may form part of the car body, but must not form a part of the chassis, cabin or side panels as defined in 8.22, 8.28, and 8.24. When in place on the car no part of the array or array support structure other than the flexible electrical connection cables may extend below the top level of the cargo space required in 8.23. The structure must be robust enough to enable handling by the scrutineers and officials. The organizers will accept no responsibility for any damage to the solar cells or the solar array due to normal scrutineering procedures. NB. Bare silicon cells are highly prone to breakage and are therefore discouraged.

8.6 Array structure removal

The array and its support structure must be easily removable from the car for testing and weighing and the car must still be capable of free and stable movement with it removed.

8.7 Non planar arrays

Curved, stepped or multi-planed arrays should be able to be re-configured to within 20mm of a single plane for the purposes of power measurement. The scrutineers will calculate a maximum power value for non conforming panels.

8.8 Solar array wiring.

All wiring on the solar array must be visible. All panels must be presented for scrutineering with a pair of connections marked +ve and -ve and able to directly attach to the alligator clips on the power measuring equipment. Teams using panels of their own construction or modified commercial panels must provide a wiring diagram. Where the panel has multiple outputs, teams

must supply pairs of connections as described above for each section of the panel. The power of each section will be measured and the values obtained added together. All wiring must be carried out with standard copper or tinned copper conductors.

8.9 No devices on the array

All mechanical, electrical or electronic devices including the ON/OFF switch and any devices for changing the panel voltage must be separate from the array support structure and supported by the chassis.

8.10 Power measurement

The power delivered by the solar array will be assessed by the scrutineers using a light box. Solar panels presented for testing may produce no more than 25 volts open circuit or 2.0 amps short circuit when tested at 1 Sun (nominal AM 1.5), otherwise they will be assigned the value:

$$\text{Power} = (\text{open circuit voltage}) \times (\text{short circuit amps}) \times 0.8 \text{ watts.}$$

It has come to the attention of the scrutineers that some of the modules used by teams to construct solar arrays have a lower than normally expected Fill Factor (FF). The FF of these modules is considerably below the accepted commercial standard and will result in a much lower than expected power output when tested at 1 Sun. It can be shown that cars using larger panels made from these modules may have a quite significant power to weight advantage at lower light levels relative to cars using solar modules with a more usual FF. In the interests of a fairer and more even competition the scrutineers will measure the power output of all panels at 50% Sun and then double the figure attained. This figure will then be used for all further calculations. It is also possible to artificially lower the FF of any panel in a manner that can be difficult but not impossible to detect. All panels will be closely scrutinised and any panels found to have an intentionally lowered FF will not be allowed in the event.

8.11 Temperature correction

As the power output of a silicon solar cell is affected by temperature, the scrutineers will scan all panels with a non-contact thermometer immediately after power testing. The maximum panel temperature recorded will then be used to standardise the power output to the power expected at a temperature of 25°C using the following formula.

$$P_{\text{standardised}} = P_{\text{measured}} + P_{\text{measured}} \times 0.004 \times (T - 25)$$

Where P = power in watts and T = maximum panel temperature in degrees Celsius.

Any ballast required will then be calculated using this standardised power rating.

8.12 Power limit

Panels should register a total power of less than 12 watts. If an array built up from individual modules exceeds 12 watts, cells will have to be completely removed from the array until the panel generates a power of less than 12 watts. If a team wishes to modify a panel to produce a lower power for any reason then cells must be completely removed from the array. Simply bypassing or masking off cells will not be permitted under any circumstances. Due to advances in solar cells, some standard commercial panels may exceed their nominal ratings. The scrutineers reserve the right to allow the use of any commercial panel with a nominal rating 12 watts or less provided the power rating obtained above does not exceed 14 watts. However, an additional weight penalty will be imposed on panels exceeding 12 watts. Evidence of the manufacturers' nominal rating must be provided to the scrutineers.

8.13 Array and array support structure weight.

The combined solar array and ballast weight will be calculated using the formula:

$$W (\text{solar array and ballast}) [\text{grams}] = 200 \times (\text{Standardised Panel Power} [\text{watts}] - 6) + 500$$

This equation has been derived on the basis of extensive simulation data to make for a more even competition. It is based on the standardised power output using the light box as determined

above. Any panel registering less than 6 watts will still need to have the minimum weight of 500gm. Any panel registering over 12 watts will be required to have the weight calculated above plus additional weight calculated by the formula:

$$\text{Additional weight [grams]} = 100 \times (\text{Standardised Panel Power [watts]} - 12)$$

The Committee will provide scales to determine array and support structure weights, measured accurate to +/-5gm. This means that a panel with an output measured at 8.3watts would be required to weigh between 955 and 965gm.

8.14 Use of electronic devices.

Teams may elect to use electronic circuitry for such purposes as solar panel regulation or motor control. They may decide before each individual race whether to use such devices or not. For teams that do not use such electronic devices, the combined solar array and ballast weight as determined in 8.13 above will be decreased by 30%. That is, the 8.3watt solar panel above would now be required to weigh between 667 and 677gm. The minimum array weight for a car with a 6 watt or less panel would be between 345 and 355gm. The scrutineers will record both weights on the car and all cars may be check weighed before or after each race. Any car found to be incorrectly ballasted will forfeit that race. A repeated offence may result in exclusion.

8.15 Ballast

Any additional weight required by 8.13 or 8.14 is to be carried as ballast whenever the car is on the track. Teams should have approximately the correct amount of ballast when presenting for scrutineering. Ballast will not be provided by the scrutineers. Suitable ballast includes such things as sand and fine gravel, nails, etc. Ballast must be suitably contained to prevent possible spillage onto the track. Note, any item or material used as ballast must not perform any function on the car when racing other than acting as the ballast.

8.16 No energy storage systems

No energy storage system, whether electrical, mechanical or chemical, which assists in the performance of the car, will be permitted. Capacitors of less than 0.2F and inductors less than 1mH are allowed as part of the electrical system.

8.17 ON/OFF switch

Each car must be fitted with an 'ON/OFF' switch to minimize car set-up time whilst at the starting gate. The switch must have the ON and OFF positions clearly marked and the switch must be in a location easily visible by the official starter when the car is on the start line (i.e. left hand side or on the top). This switch must not be on the solar array or attached to the array wiring. It must be a commercially available switch which will electrically disconnect the solar array from the motor. Alligator clips or plug and socket connections, while allowed as part of the electrical circuit, must not be used as the ON/OFF switch.

8.18 Car wiring

Where possible all electrical wiring and electronic modules in the car must be reasonably visible. Teams will be required to explain any wiring going into sealed body areas. A simple block wiring diagram will be required.

8.19 Motors

There is no restriction to the type, size, or number of motors that may be fitted to the car. However, the motor manufacturer and/or part number must be made available to the scrutineer for data base information.

8.20 Wheels

There is no limit as to the number, location, or the diameter of wheels. To reduce damage to the track, knife-edge wheels are not allowed. Each wheel must be at least 1mm wide or have a radius of 0.6mm on the running surface.

8.21 Steering

Each car must incorporate a means of steering around the track. The guide rails as described in 4.3 are approximately 16mm wide and 13mm high. The steering mechanism must be designed to operate on the outside of the guide rail. Use of an active (moving) steering system will be viewed favourably when choosing quality engineering design awards

8.22 Chassis

The car must have a rigid chassis independent of the solar array and its support. The car must have all components, such as the driver's cabin, wheels, guides, motors, On/Off switch, tap changing switches, electronic modules, side panels and cargo area, etc, attached to the chassis. The driver's cabin, side panels, cargo area and any other bodywork may form part of the chassis.

8.23 Cargo space

The car must have a fully enclosed cargo space, complete with a floor and all sides, attached to or as part of the chassis. The space must be located behind the driver's cabin. There must be no holes, gaps or cut outs whatsoever in the floor or the enclosing sides. The solar array structure may form the top but no other part of the enclosure. The front and rear boundaries of the space must be flat rigid fixed transverse bulkheads separated by at least 200mm. One bulkhead must have an area at least 200 sq cm bounded by four straight edges, and the other bulkhead must have an area of at least 100 sq cm, also bounded by four straight edges. Teams will be required to demonstrate these areas to the scrutineers. It must be possible to fit a cargo block 100mm x 100mm x 50mm high weighing 2kg inside the cargo space with the solar array in place. The bulkheads may be any shape beyond the four straight lines and the enclosed space may be larger if desired but the entire enclosure must meet the conditions outlined above and no items other than simple car wiring or any required ballast may be carried in the enclosed space. With the solar array structure removed from the car, the designated cargo space floor must be capable of supporting the cargo block standing on any part of that floor, and the car must be capable of free and stable movement with that block in place.

8.24 Side Panels

The car must have two side panels capable of retaining their shape at all times for attaching numbers and sponsors logos. These must be easily seen by spectators while the car is racing. They will be located one on each side of the car. Each side panel must be capable of supporting a sticker 100mm long and 50mm high. The maximum curvature allowed will be 20mm vertically and 15mm horizontally.

8.25 Solar panel cover.

All teams should provide a suitable opaque cover which will completely shade the active area of their solar array for use at the starting position. The use of the cover is to assist the officials detect and eliminate any hidden illegal storage devices. The cover must be a flat sheet of rigid material capable of supporting sponsors logos. The use of soft items such as clothing, towels or similar will not be accepted. If teams do not provide a suitable cover, the organizers will provide a cover of their choosing. The organizers will not be responsible for any problems created by the use of this cover.

8.26 School and Car Name

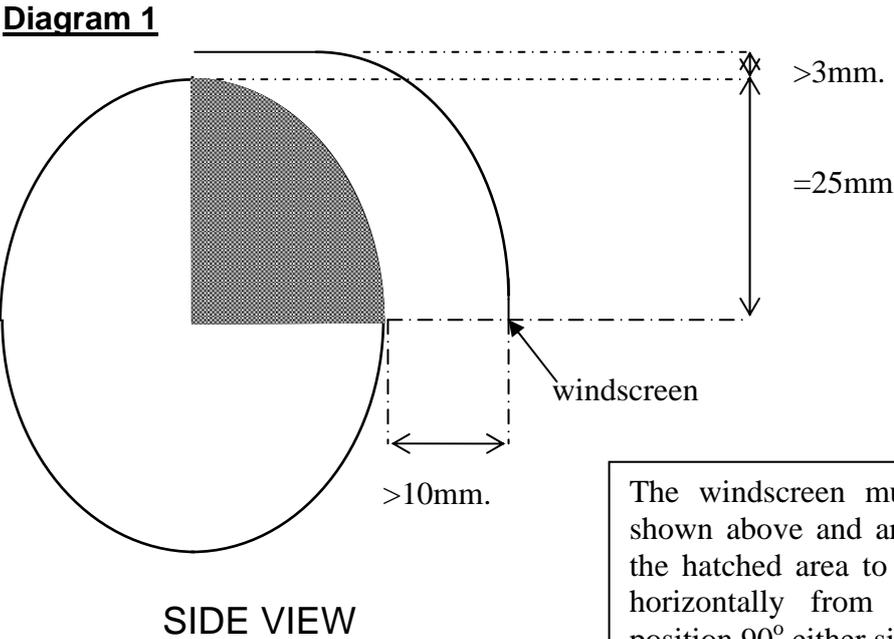
Each entry must have its school name (possibly abbreviated) and car name shown on the car in letters at least 10mm high and visible when racing. These can be attached to any part of the body, other than that area designated as the side panels described above.

8.27 Occupants

To ensure that the cars guarantee occupant safety, the driver and passenger of the car will each be a large (60g) fresh egg supplied by the Committee. In any race, a cracked, broken or dislodged egg will mean that the driver or passenger is injured, so the car will concede that race to its opponent. If an egg is damaged in one heat of a best of three or best of five final, a replacement egg will be provided for the remaining races. The eggs must not be covered in a film or painted so as to increase their strength. The use of any form of adhesive (blue tack, sticky tape, etc.) on the eggs is prohibited. Also, our eggs both have a severe medical condition and are unable to wear a seat belt of any style or have any form of physical restraint above the waistline. This means all the way around above a line 25mm down from the top. Teams may elect to replace one of the eggs with a video camera but the camera must be weighted to at least 60gm. No allowance will be made for overweight cameras.

8.28 Drivers Cabin

Each car must have a fully enclosed cabin at the front of the car in which the eggs sit side by side and vertically (see diagram 1). The cabin must be fully sealed when racing so that if an egg breaks nothing is spilt onto the track or into the cargo area (such sealing may be adhesive tape). The cabin must also include a transparent (not translucent) windscreen conforming to details in diagram 1. Two frame members up to 4mm wide may be incorporated into the windscreen. To allow the driver to operate the controls there must be at least 10mm clear space between the occupants and the windscreen over the 180° arc of visibility specified and 3mm head room (see diagram 1). NB this means that nothing but air may be between the egg and screen over this area. To avoid unnecessary delays it must be possible to install or remove both eggs with the solar array in place on the car and in less than two minutes. N.B. Diagram 1 refers to each egg as if it were in the cabin alone.



The windscreen must have the clearances shown above and around the egg and allow the hatched area to be visible when viewed horizontally from straight ahead to any position 90° either side of the centre line.