



Swinburne Engineering

**VICTORIAN MODEL SOLAR VEHICLE
CHALLENGE**

***2011 Regulations for:
Model Solar Car***

**To be held at Scienceworks on
October 22nd and 23rd 2011**

*For further assistance, information and resources, please go to:
www.modelsolar-vic.net
or contact the Secretary of the Challenge Organizing Committee
Email: contact@modelsolar-vic.net*

MISSION STATEMENT.

To promote and develop interest and expertise in using solar and renewable energies by school students via an engineering design project using an active learning process. By so doing, it is hoped that the citizens, scientists and engineers of the future will be more likely to participate in developing a more environmentally aware approach to energy usage, both by more efficient use of old technologies and appropriate introduction of renewable energy sources.

OVERVIEW

This is a race for model solar cars built by school age students which compete over a 100 metre figure "8" circuit. Two cars race at a time guided by parallel guides attached to the track surface. A "round robin" will begin the competition. Results from the "round robin" races will be used to "seed" the cars, i.e. allocate them to groups in such a way that the faster cars should not compete against each other in the earlier rounds of the subsequent elimination competition in which cars will only be eliminated after 2 losses. Final rounds may consist of a number of "heats" in which each car may win one or more heats. However, the winner will be the car which wins the most heats. Winning cars will be invited to represent Victoria at the national competition.

CONTENTS.

1.	INTRODUCTION	5
1.1	Event name	5
1.2	Committee	5
1.3	Aim	5
1.4	Spirit of Intent	5
1.5	Verification of learning	5
1.6	Competitors	5
1.7	Statement of involvement	5
1.8	Correspondence	6
1.9	Resources	6
2	INTERPRETATION OF THE REGULATIONS	6
2.1	VMSVC decisions	6
2.2	Use of AIMSCC regulations	6
2.3	Unfair practices	6
3	ENTRIES	6
3.1	Team representation	6
3.2	Original work	7
3.3	Posters required	7
3.4	Interviews	7
3.5	Registration and entry	8
3.6	Victorian entries in AIMSCC event	9
4	TRACK	9
4.1	Size and shape	9
4.2	Slope	9
4.3	Construction	9
4.4	Starting position	9
4.5	Finish position	10
4.6	Race format	10
5	SCRUTINEERING	10
5.1	Race ready	10
5.2	Failure	10
5.3	Panel power output	10
5.4	Check weighing	10
6	SERVICING	10
6.1	Service area	10
6.2	Modifications	11
6.3	Faulty and damaged solar panels	11
6.4	Restricted areas	11
6.5	Hazardous substances	11

CONTENTS (ctd).

7	COMPETITION	11
7.1	Time trial	11
7.2	Structure of races	11
7.3	Timing	12
7.4	Starting procedure	12
7.5	Stopping procedure	12
7.6	Stability	12
7.7	Poor light / adverse weather conditions	12
7.8	Protests	12
7.9	Practice and testing	13
7.10	Results and prizes	13
8	CAR SPECIFICATION	15

The detailed index for the car specification is provided on page 15 in order to allow the Car Specification section to be more easily used as a “stand alone” document by competitors.

1. INTRODUCTION

1.1 Event name

The event shall be known as the "Victorian Model Solar Car Challenge" (VMSCC) and is conducted annually. This, along with boat races, the Sheridan Kit Car Event and the Mars Rover Event, will form a part of the Victorian Model Solar Vehicle Challenge.

1.2 Committee

The Executive Committee of the Victorian Model Solar Vehicle Challenge (VMSVC) is a voluntary committee consisting of sponsors representatives, teachers, students and other invited interested persons, referred to herein as the Committee. The roles of the Committee include establishing the regulations for the year, promoting and organizing the Victorian event.

1.3 Aim

The aim of the event is to encourage student teamwork, enterprise and learning, using an action based learning model, as students work together to research science and engineering principles relating to solar energy, photovoltaic cells and optimization of energy efficiency, by designing, constructing, testing and racing model solar cars.

1.4 Spirit of Intent

The design and manufacture must be predominantly that of students. Teachers, parents, or other adult advisers, are encouraged to teach the students the appropriate scientific and technical principles. Some components may need to be made for the car using equipment unavailable to the students, but they must understand the working of their car and must be able to make all necessary adjustments or repairs on the weekend of the race.

So that the competition remains financially accessible to as many schools as possible, the Committee has framed these regulations so the power to weight ratio of the photovoltaic panel is similar for all entries.

1.5 Verification of learning

To promote student learning, a number of discretionary prizes are awarded. To assist in determining which teams (if any) should receive these, teams are assessed on their posters (discussed in 3.6), an interview by a judging panel (discussed in 3.7) and their cars performance. The interviews will evaluate the level of the whole team's understanding of the design, manufacture and testing of their car. The poster and interview also require the students to exhibit understanding of the relevance of solar energy to reducing greenhouse gas emissions.

1.6 Competitors

The competition is open to Victorian schools or other organizations for school aged students to secondary level, approved by the Committee. All teams entering this event will need to meet the regulations.

1.7 Statement of involvement

Cars entered in any given year should be substantially the work of students in that year. Forms confirming that the work is that of students and not teachers or parents will need to be signed by the students and coordinators and submitted to the organizers prior to the start of the event.

1.8 Correspondence

General correspondence should be addressed to:
The Secretary of the Organizing Committee
Email: contact@modelsolar-vic.net

Mail: The Victorian Model Solar Vehicle Challenge
PO Box 108 Darling 3145

1.9 Resources

“Solar Car Competition & Boat” .- Video by the students of Footscray Secondary College of the 2002 event.

The price of these guides and video are available on application.

Go to www.modelsolar.org.au for **Design Guide** a document written by Ian Gardner for the committee it gives basic details of car design and testing together with an overview of components typically used. Included with the Design Guide is **A Mathematical Simulation of a model solar car** which will predict car performance and allow you to evaluate the expected performance as changes are made to the car. Car photographs are also posted on this site.

2. INTERPRETATION OF THE REGULATIONS

2.1 VMSVC decisions

The VMSVC event officials are empowered to make a decision on any case not covered or clarified by these regulations. In the case of dissent from a VMSVC official's ruling, the dissenting team may be excluded from the competition.

2.2 Use of AIMSCC regulations

These rules are based upon those agreed by the Australian-International Model Solar Car Challenge Committee (AIMSCC), which will be the regulations governing the entry of all Victorian cars, invited to the AIMSCC finals to be held in November 2011 in Hobart. Exact time and venue TBA. (refer to web site)

The AIMSCC Regulations and updates are available on www.modelsolaraustralia.org

2.3 Unfair practices

If VMSVC officials discover that an entrant or crew has deliberately violated these regulations to gain unfair advantage over other entries, or has departed from the spirit of the event, that team will be disqualified from the competition.

3 ENTRIES

3.1 Team representation

Each entrant must represent his or her school or other organization accepted by the Committee. If multiple cars are entered from the same school, the seeding process will be implemented in such a way that they will compete against each other before or during the semi-finals, ensuring that no school can win all the major prizes.

3.2 Original work

All teams must be able to provide evidence to the scrutineers that the car is the original work of the team members in both design and construction, performed in the current year, and not simply a restyling of a previous existing car. This will include both the chassis and the body of the car. Solar panels, motors, drive systems, wheels, suspension, guide systems and other similar components will not be included and may be reused.

If any school has more than one car entered, the cars must be significantly different in both chassis and body to indicate to the scrutineers that the cars are the work of different teams.

3.3 Posters required

All entries will be required to present to the organizers prior to scrutineering a laminated or contact coated A2 Poster (size 420mm x 594mm – may be 2 A3 posters taped together) documenting the design and development of their car. This record should document experiments and or calculations, which were used in the design of the Model Solar Car. Some discussion of the benefits or use of solar power for minimizing greenhouse gas emissions is required. Graphs and design drawings will be marked favourably. The poster will be assessed as follows:

Item	Marks
Headings readable from 5 metres	1
Writing readable from 2 metres	1
Summary of test results	5
Construction details	5
Presentation – photos, drawings,	4
Greenhouse relevance	3
What you have learnt	5
References, acknowledgements	1
Total	25

Selected posters will become the property of the organizers and will be used for promotion of the event. Others can be collected at the end of the competition.

3.4 Interviews.

A panel will interview all team members about the design, construction and testing of their car and its component parts. Each team will be allocated a time slot for their interview so as to minimize time wasted by queuing. Each student should be able to contribute to the answers.

Questions could relate to a number of the following:

Wheel and bearing selection and rolling resistance
Effect of weight and tyres on rolling resistance
Design of steering mechanism
Design of chassis
Design of cockpit
Effect of cloud on solar intensity
Effect of solar intensity on panel performance
Explain how solar cells work
Explain how gear ratios and panel wiring can be changed to suit the weather conditions (if not using electronics)
Explain the function of any electronic controls on their car
Discuss your team's organization and decision making

3.5 Registration and Entry

Please note that registration and entry are two separate activities.

GST is not applicable to any of the fees detailed below.

Cheques should be made payable to **Victorian Model Solar Vehicle Challenge**

Registration

Anyone planning to enter should visit the website www.modelsolar.org.au register online then mail your payment of \$50.00 to the address below by September 1st.

The Victorian Model Solar Vehicle Challenge
PO Box 108 Darling 3145

Registration will be available on the website by mid July. Please note this registration fee includes the entry fee for the first car, **an entry form is still required for this first car.**

Entry

Entry forms should be downloaded from the website shown above filled in and together with any additional payment required mailed back to

The Victorian Model Solar Vehicle Challenge
PO Box 108 Darling 3145

by September 17th. Entries received by this date will cost a further \$25.00 for each additional car after the first car which is covered in the registration fee. Late entries that is after 17th September will incur a cost penalty of \$15.00 per entry bringing the entry cost to \$40.00 per car. Entry forms will be posted on the website listed above by early August.

Please note an entry form is required even if only one car is being entered.

All entries must be received by October 8th.

A SUMMARY OF ENTRY AND REGISTRATION DATES AND FEES IS SHOWN IN THE TABLE BELOW

Registration and Entry Information and Fees	Fees No GST
School registration form. The \$50 fee covers registration and includes the entry fee for the first car.	\$50 due by September 1st
Entry form for each car including the first Entry fee for each car excluding the first which is covered in the registration fee. That is each extra entry after the first requires a \$25.00 entry fee.	\$25.00 per extra entry by 17th of September and \$40 per late entry after 17/9 and by 8/10

3.6 Victorian Entries in The Australian – International Model Solar Car Challenge (AIMSC)

The VMSVC Committee shall recommend to the AIMSCC Committee the four teams that should be issued invitations, along with any wildcards as allowed by the AIMSC committee, to the Australian International event, which is to be held in November 2011 in Hobart the exact date and venue to be announced, See section 2.2.

Entrants must confirm their participation with the Chairman of the Victorian Challenge Organising Committee Mr. Paul Wellington at the address given in 1.8 and the, Australian International Model Solar Car Challenge coordinator whose address is below, within three days of receiving their invitation.

Entry information for the 2011 National competition should be addressed to:

2011 Event Coordinator
Mr Marc Iseli
2 Sanfrancisco St.
Midway Point TAS. 7171
Email msvnationals@gmail.com

4. TRACK

4.1 Size and Shape

The track used in this event will be in a 'figure 8' configuration with a low bridge at the crossover point as shown in Attachment B. The corners will feature curves with an approximate minimum radius of five metres. The track length is approximately 86 metres. The finish position is approximately 14 metres past the start point giving an approximate race distance of 100 metres.

4.2 Slope

The uphill and downhill sections of the track at the crossover point will have a minimum clearance between tracks of 300mm. The slopes will range between 1:16 to approximately 1:8.

4.3 Construction

The track will have a smooth surface with two parallel guides of PVC channel screwed to the plywood base. As the track is assembled in sections, minor transverse misalignments of the guide channel will exist, these will be minimized by inserting joiners between adjacent channel ends. The Committee will endeavor to ensure minimal vertical misalignment between track sections. If in the Committee's opinion, a car is inhibited in any race as a result of a serious track imperfection, that race shall be rerun as soon as possible. Entrants must realize that as the track is made in sections of light weight materials, there will be some undulation in the track. This should be considered in the design process.

4.4 Starting Position

All races will start near the top of the downhill section of the track. Cars will be started by resting against the start gate which will be rotated away from the cars by a person appointed by the Committee. (See 7.4 Starting Procedure.)

4.5 Finish Position

All races will finish at a point on the straight flat section of track after the corner which follows the finish line timing position. NOTE: Even though timing has been completed, the race will not be complete and a winner declared until the car has been safely removed from the track within the designated stopping area. See (7.5 Stopping Procedure)

4.6 Race Format

Unless varied at the Committee's discretion, time trials, round robin races and initial elimination races will be held from the starting position and cover a single full lap of the track plus the distance to the finishing position, a total distance of approximately 100 metres. Again at the committee's discretion based on weather and available time, later stages of the knockout races may be staged over two laps.

5. SCRUTINEERING

5.1 Race Ready

All competing teams shall be required to register upon arrival at the venue by a time to be announced when the invitations are issued. Cars must be in a condition ready to race when presented for scrutineering. Scrutineers have the right to examine each car at any time to ensure it conforms to these regulations

5.2 Failure

Any car failing to pass scrutineering by the end of time allowed may not be permitted to start the event, or may be required to carry additional ballast as a penalty. The scrutineers will make allowances for circumstances beyond the control of the students such as damage in transit.

5.3 Panel power output.

Solar panels will have their output power measured by the scrutineers using a light box with a controlled output. Panels must be presented in their ready to race form. For further details of determining panel performance see Section 8: Car Specifications. Each team must bring for testing the one panel that they intend to use for all time trials and races, and that panel alone will be measured by the scrutineers. The team must then use this panel, unmodified, for all time trials and races. See also 6.3 regarding damaged panels. The scrutineers reserve the right to retest any panel at any time.

5.4 Check weighing.

During scrutineering, the weight of the solar array, any ballast, and the total weight of the car will be recorded. Immediately prior to or after each race, all cars may be re-weighed by the scrutineers. If the car weight varies from the recorded weight by more than +/-10gm the team will be required to explain the reason for the variation.

6. SERVICING

6.1 Service area

During the final series of races an official service area will be set aside for student team members to carry out repairs or modifications. Students capable of representing Victoria at the national level will be expected to be capable of operating

independently of teacher or parent support and hence only students are to conduct car adjustment and maintenance on race day.

6.2 Modifications

Students may modify cars during practice and between races, but the scrutineers may reassess cars at any time. However, cars as passed at scrutineering immediately prior to the commencement of the knockout rounds must be used in that configuration for all subsequent races. Tune up procedures such as changing driving wheels, gears, motors, steering mechanisms and panel voltage will be permitted between races. Electronics units with the appropriate ballast may be inserted or removed between rounds see 8.14 and 8.15.

Modifications specifically prohibited include the changing of the solar panel, the car body and the chassis irrespective of light conditions. Repairs to these major components are allowed. Modifications to solar panels are specifically prohibited and any repairs to solar panels must be reassessed by the scrutineers.

6.3 Faulty and damaged solar panels

After scrutineering, teams will only be allowed to change or modify the car's solar panel if the original panel is damaged or becomes faulty. Any and all panel changes must be first approved by the scrutineers, and repaired or replacement panels will be required to undergo the same examination, testing and ballasting routine as the original panel.

6.4 Restricted areas

No person other than those nominated shall be allowed in the restricted area without permission of a VMSVC official and must be accompanied by that official at all times whilst inside that area.

6.5 Hazardous substances

Due to health and safety requirements, the use of bulk solvents, (other than water) and liquefied gases of any sort, for any purpose whatsoever, is **STRICTLY PROHIBITED** at all times and in all areas of the competition. This will not include small quantities of commonly available solvents and spray cans for the purposes of cleaning or lubricating bearings, etc. This means cooling solar panels with anything other than water ice will not be allowed at any time.

7. COMPETITION

7.1 Time trial

Following scrutineering each car will be timed over a single lap of the course for the purpose of seeding the car for the main races.

7.2 Structure of the races.

The event shall be conducted with pairs of cars competing against each other over equal courses in a series of round robin and/or elimination races to be announced in the official schedule of events. Where more than one car is entered from the same school, the seeding process will be implemented in such a way that they will not race each other during the first elimination round. However, if successful, they will be

required to race against each other before or during the semi finals to ensure that one school does not take more than two of the top four places.

7.3 Timing

Each car will be timed over the course. The winning car will be determined by an electronic timing device initiated by a light/infra-red beam. The Adjudication Sub Committee will adjudicate on any dispute as to the finishing position of any car and there can be no appeal against that decision.

7.4 Starting procedure

Cars will be presented at the start line within two minutes following the call for cars on the public address system. In the case of best of three or best of five heat races, cars will alternate between tracks. If the final race is needed (in best of three or five heat races) to determine the winner, the final race lanes shall be determined by a coin toss.

7.5 Stopping procedure.

The race will not be finished until both cars have stopped and been safely removed from the track. There will be a rigid barrier 120mm high placed centrally between the two guide rails on the first three straight sections of track after the corner following the timing equipment. Teams may only stop their car on these three sections of track. The car must be stopped before the end of these three sections of track, otherwise the race will be forfeit. If both cars fail to stop then this condition will not apply. At the discretion of the race organisers any stopping procedure may be used, provided there is no interference with the car in the other lane.

7.6 Stability

If the car comes off the track it shall be deemed unstable and will not be re-started in that race unless the officials are satisfied that the problem was caused by a deficiency of the track. There shall be no handling of cars during the race other than by officials or by people nominated by officials. If both cars come off, the race will be awarded to the car which travelled the furthest before coming off. If one car comes off and obstructs the other lane, the other car shall be awarded the race if it reaches that point and collides with the car which first dislodged. If one car or team, in the opinion of the officials, causes damage to the other car likely to affect its performance, then the offending car will forfeit that round. The damaged car team will be granted extra time and assistance to effect repairs.

7.7 Poor light / adverse weather conditions

At the discretion of the Committee, races may still be run in virtually any weather conditions. If light conditions do not enable the cars to complete the course, the car that travels the furthest, or, if two cars travel the same distance, the car which reaches that point first, within one minute of the start of the race will be judged the winner. Note, due to the geometry of the track, the car that appears to be in front may not actually have travelled the furthest distance. When both cars have come to a halt short of the finish line the race will be deemed to have finished if neither car has moved, for 30 seconds. If a car stops for any reason, that car may be restarted under the marshal's discretion from any point on the track behind the stopping position, but the car must not be pushed to restart.

7.8 Protests

In the event that a team believes that their car has been negatively affected by the actions of an official, another team, another vehicle or by a significant problem with

the track, a protest may be lodged with the Adjudication Sub Committee immediately after that race is completed. The team captain, with the support of the team coordinator, will need to make a clear statement as to what they believe the negative effect was and how they believe it was caused. The Adjudication Sub Committee will discuss the protest with other race officials as they deem necessary and will deliver a decision within five minutes of the protest being lodged. Due to time pressures to reach a conclusion for the event, there may be no further challenge to this decision.

7.9 Practice and testing

Practice on the track will be allowed at any feasible time that marshals are in attendance.

7.10 Prizes

Final results will be decided after the provisional first four place winners have been re-scrutineered and passed by the officials.

Prizes will be presented to First, Second, Third and Fourth place getters. The presentation of prizes will be held as soon as possible after the completion of the event. Additional prizes for best poster, best team effort, best looking car, best web page, best engineered car & overall best team performance based on aggregate points (car success, poster and interview) will be presented to teams deemed worthy. These prizes will be awarded at the prize ceremony at the completion of the event.

Section 8. Car Specification

A synopsis of the Car Specifications is given on page 21. It is essential that you refer to the full specifications in the DETAILED CONTENTS for complete details.

DETAILED CONTENTS.

8	CAR SPECIFICATION	15
8.1	Test criteria	15
8.2	No commercially built cars	15
8.3	Size limit	15
8.4	Source of power	15
8.5	Solar array and support structure	15
8.6	Array structure removal	15
8.7	Non planar arrays	15
8.8	Solar array wiring	15
8.9	No devices on the array	16
8.10	Power measurement	16
8.11	Temperature correction	16
8.12	Power limit	16
8.13	Array and array support structure weight	16
8.14	Use of electronic devices	17
8.15	Ballast	17
8.16	No energy storage systems	17
8.17	ON/OFF switch	17
8.18	Car wiring	17
8.19	Motors	17
8.20	Wheels	18
8.21	Steering	18
8.22	Drag Plate	18
8.23	Body / Chassis	18
8.24	Side panels	18
8.25	Solar panel cover	18
8.26	School and car name	18
8.27	Definition of key terms	19
8.28	Track drawings	20
	Synopsis of car specifications	21

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 must not use any part of the chassis or body of any commercially available model car. This only refers to the structural frame and body, not to the drive train components such as gears, shafts, wheels, tyres, or to suspension and steering components.

8.3 Size limit

Maximum car size allowed is 550mm long, 180mm high and 320mm wide and at no time may any part of the car extend sideways more than 190mm from the centre of the guide rail.

8.4 Source of power

Only commercially available silicon photovoltaic cells are 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. The thickness of the array and its support structure must not exceed 30 mm. The structure must be robust enough to enable handling by the scrutineers and officials. The organisers will accept no responsibility for any damage to the solar cells or the solar array.

8.6 Array structure removal

The array and its support structure must be easily and quickly (less than two minutes) removable from the car for testing and ballasting purposes. And when removed the car must be capable of free and stable movement.

8.7 Non planar arrays

Curved, stepped or multi-planed arrays must be able to be re-configured such that when placed on the flat light box measuring surface, no part of any cell is more than 30 mm away from that surface. 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 for connection 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 individual sections to allow for series and parallel connection, 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. A plug, socket or terminal block to allow connection of the panel wiring to the car wiring is allowed.

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 must 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:

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

Scrutineers will measure the power output of all panels at a Sun level expected to be the average over the duration of the event. The power figure obtained will be used to ratio up to the power expected at full Sun. This full Sun figure will then be used for all further calculations. Artificial manipulation of Fill Factor is prohibited and will result in disqualification of the team involved. See 8.27 for explanation of Fill Factor.

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 must register a total power of less than 10 watts. Any panel recording a power above 10 watts will have tape applied by the scrutineers covering portion of each cell in the array. Tape will be applied in integral widths of 19 +/- 1 mm until the power is below 10 watts. Fine tuning of final power will not be allowed. Removal of this tape except by the scrutineers is prohibited. Racing without the appropriate tape in place will result in forfeiture of the race and depending on circumstances disqualification.

8.13 Array and array support structure weight.

The minimum required combined weight of the solar array, its support structure and ballast for cars using electronics systems will be calculated using the formula:

$$W (\text{solar array and ballast}) [\text{grams}] = 250 \times (\text{Standardised Panel Power} [\text{watts}]) - 900$$

The minimum required combined weight of the solar array, its support structure and ballast for cars not using electronics systems will be calculated using the formula:

$$W (\text{solar array and ballast}) [\text{grams}] = 150 \times (\text{Standardised Panel Power} [\text{watts}]) - 650$$

The Committee will provide scales to determine array and support structure and ballast weights, measured accurate to +/-5gm.

8.14 Use of electronic devices.

Teams may elect to use electronic circuitry for such purposes as solar panel regulation or motor control. During the time trials (usually held on Saturday) they may decide before each individual race whether to use such devices or not. However they must decide before each round of knockout races whether they will run with or without electronic devices for all races to be held in that particular round. During the final, where the best of five races determines the winner, teams may change to electronics or not after the second heat, but must then stick with this configuration for all remaining races.

At scrutineering teams will be required to indicate their intention to run either exclusively with or without electronics or their intention to select between electronics or not during the course of the competition. The scrutineers will record the appropriate weight/s on the car and all cars may be check weighed before or after each race. It will be the team's responsibility to ensure their car is correctly ballasted at all times. Any car found to be incorrectly ballasted will forfeit that race. A repeated offence will result in exclusion.

8.15 Ballast

Any additional weight required by 8.13 to bring the weight of the solar array and its support structure up to the required minimum is defined as ballast, and must be carried on board the car whenever the car is on the track. Teams should have approximately the correct amount of ballast when presenting for scrutineering. Suitable ballast might include such things as sand and fine gravel, nails, etc. Ballast will not be provided by the scrutineers. 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. Capacitors above 0.047F must be discharged immediately before the race.

8.17 ON/OFF switch

Each car must be fitted with a commercial 'ON/OFF' switch, the ON and OFF positions must be clearly marked and the switch must be in a location easily visible by the official starter when the car is on the start line. Note: the starter is on the left hand side, so typically the switch would be mounted on the left hand side or on the top.

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 if this condition is not met.

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 scrutineers 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.

8.22 Removable Drag Plate

The car must include a fixed, flat, rigid, transverse, vertical, rectangular plate of minimum area 200 square cm. and minimum thickness 2 mm. This plate must be easily and quickly removed for measuring during scrutineering. The plate must be one piece and not have any holes or cut outs whatsoever inside the designated area when in place on the car. A drawing of the plate and calculations proving the minimum area must be presented at scrutineering.

8.23 Body/ Chassis

A car body is completely optional. Any bodywork must not form part of the solar array or array support structure. The body may however form all or part of the chassis. The car must have a chassis or frame with sufficient structural integrity to allow free and stable movement with the ballast and solar array removed.

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. Allowed curvature of the side panels is 20 mm vertically and 15 mm 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 energy storage devices. The cover must be a flat sheet of rigid material capable of supporting sponsors logos. The use of flexible items such as clothing, towels or similar will not be accepted. If teams do not provide a suitable cover, the organisers 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 car, other than the side panels.

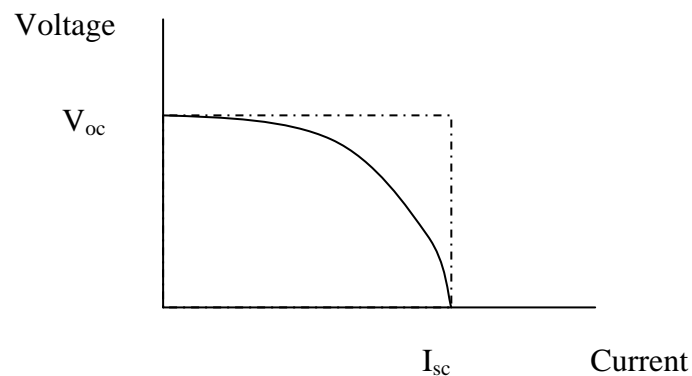
8. 27 Definition of key terms.

Two terms have been used in the regulations which may be new to competitors. These are air mass AM1.5 which is commonly used by manufacturers to test panel output under **Standard Test Conditions** and **Fill Factor**.

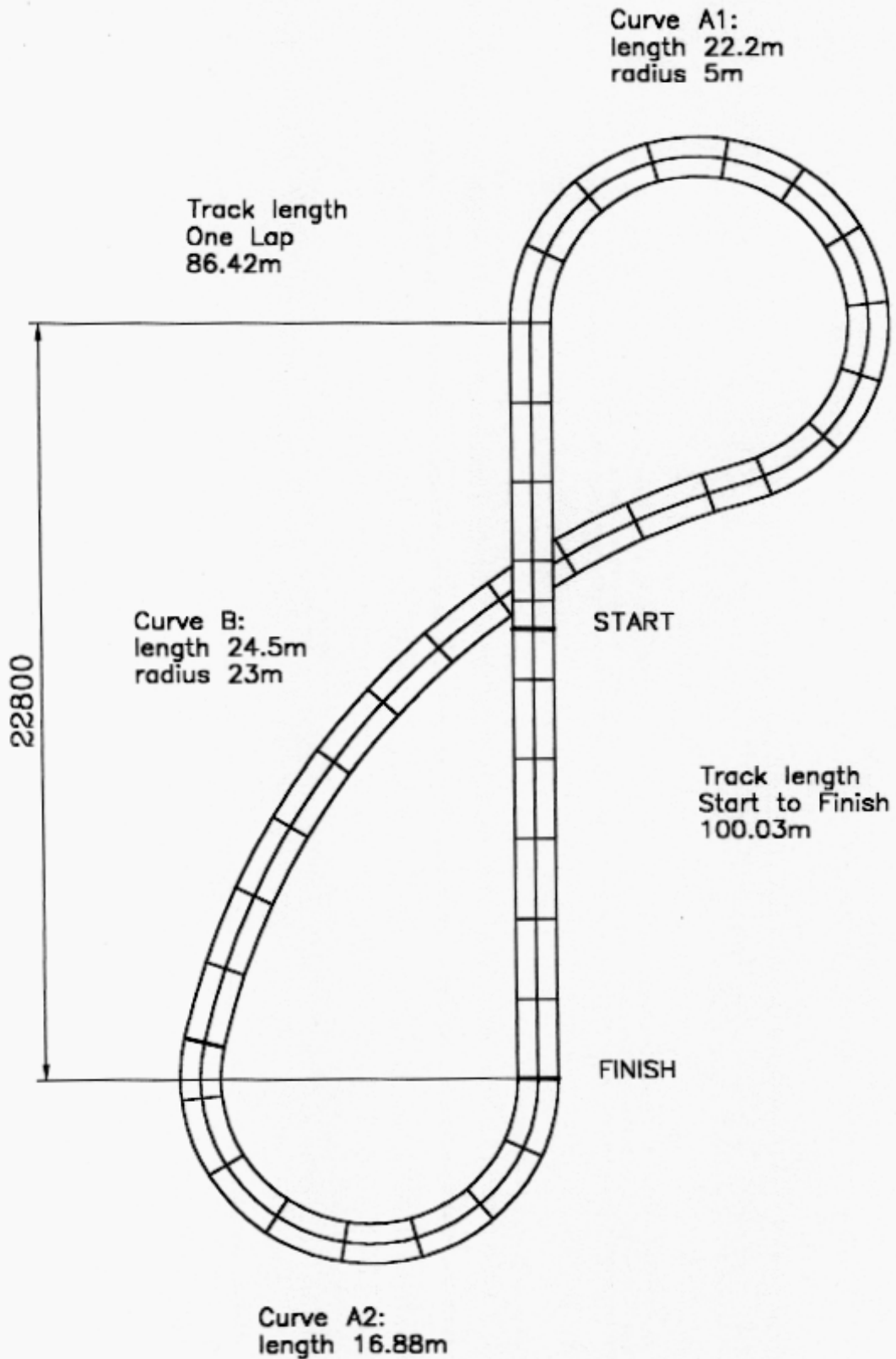
Standard test conditions (STC): The testing conditions to measure photovoltaic cells or modules nominal output power. Irradiance level is 1,000 W/m², with the reference air mass 1.5 solar spectral irradiance distribution and cell or module junction temperature of 25°C. (<http://www.ia-pvps.org/pv/glossary.htm>)

NB. Testing in past events has assumed air mass AM 1; hence panel output readings will now read lower than power levels measured before 2010.

Fill Factor is the ratio of area under the Voltage vs Current curve as a fraction of the area under the rectangle bounded by the extrapolated lines for Short Circuit Current and Open Circuit Voltage. Viz.



Attachment B Outdoor Dual Lane Track Specifications



FULL TRACK TOP VIEW

Scale: 1:200

2011 MODEL SOLAR CAR CHALLENGE

SYNOPSIS OF CAR SPECIFICATIONS

The following is intended to be used as a quick reference guide only. It contains the important basics but does not cover all the detail. YOU MUST REFER TO THE COMPLETE REGULATIONS FOR FULL DETAILS.

- **Maximum body dimensions:** 550 mm long, 320 mm wide, 180 mm high and less than 190 mm from centre line of guide rail at all times.
- **Wheels:** minimum width 1mm or 0.6 mm radius at contact point with track.
- **Guiding:** must be on the outside of the guide rail
- **Side panels:** one each side, minimum 100 mm long by 50 mm wide.
- **Drag Plate:** a fixed, flat, rigid, transverse, vertical rectangular plate of minimum area 200 sq. cm. and 2 mm thickness. Plate to be easily removable for scrutineering.
- **School & Car name:** visible when racing, letters minimum 10 mm high not on the side panels.
- **Solar array:** fully removable from car, silicon technology only and no devices mounted on panel.
- **Wiring:** all wiring and electronics must be visible, otherwise circuit diagram required.
- **ON-OFF switch:** commercial switch required easily visible to the starter, on and off clearly marked.
- **Energy storage:** not allowed, except capacitors up to 0.2 farad provided they are discharged immediately prior to race starting. Inductors up to 1 mH allowed.
- **Panel power:** maximum allowed power is 10 watts. Panels producing greater than 10 watts will be masked by scrutineers to produce less than 10 watts. There is no lower power limit.
- **Electronics:** teams must elect to either use or not use electronics systems before each round of knockout races and then stick by this decision during that round. The total required minimum weight of the solar array, its support structure and ballast will be reduced significantly for cars not using electronics.
- **Array and array support structure weight:** will be calculated using the formulas:

$$\text{Total weight with Electronics} = 250P - 900 \text{ [grams]}$$

or

$$\text{Total weight without Electronics} = 150P - 650 \text{ [grams]}$$

Where P is the panel power in Watts

- **Ballast:** If the solar array and its support structure weigh less than the total minimum required by the appropriate formula above, additional weight in the form of ballast is required to be carried in order to bring the weight up to the required level.