

## 1 PURPOSE

The Solar Car Challenge is dedicated to the educational development of science students. On a broader scale, the challenge objectives are to stimulate interest in technical education, promote the use of renewable sources of energy, and raise public awareness of these issues.

## 2 ADMINISTRATION

- 2.1 **Application of Regulations** – The regulations will apply to the Solar Car Challenge (SCC), hereinafter referred to as the “event.”
- 2.2 **Effective Date of Regulations** – The regulations become effective when issued in final form on November 1, 2011.
- 2.3 **Right to Revise Regulations** – The sponsor, as defined in Section 2.5 below, reserves the right to revise these regulations at any time by providing the participant written notice of the revisions in the form of *Rules Updates* on the web site.
- 2.4 **Acceptance of Regulations** – All persons or groups selected to participate in the event are assumed to know the regulations. Their participation in the event will constitute acceptance of all rules, updates, and guidelines promulgated by the event.
- 2.5 **Sponsor** – The primary sponsor of the event is The Solar Car Challenge, 3505 Cassidy, Plano, Texas 75023.
- 2.6 **Selection of Event Officials** – The sponsor will select event officials for this competition. These officials will be instructed in and be responsible for specific duties.
- 2.7 **Authority of Officials** – Solar Car Challenge Officials will have the authority and responsibility to apply these regulations.

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## 3 ENTRIES

- 3.1 **Selection of Entries** – Entries for the event are selected through a proposal system consisting of the evaluation of the application submitted by teams desiring to participate. The sponsor may select up to twenty proposals total from the classic, open, and advanced divisions to participate in the event. The sponsor may also select up to 5 proposals from the demonstration division to participate in the event. The sponsor reserves the right to reject any proposal.
- 3.2 **Teams and Drivers** – Any number of people may act as the team, however, during the event, it is suggested that a manageable core team of approximately twelve members be designated as “the team.”
- 3.3 **Team Provisions** – During each event, special meal opportunities are provided to the teams in the form of Open and Closing Banquets and one meal per day. The event will provide each team with identification tags and meal tickets for up to 12 team members and 2 chaperones per team. Larger teams must make reimbursement arrangements with the sponsor prior to arriving at the event. A special water facility will be provided to the teams at the event start, required stops, impound, and qualifiers. All other water requirements must be supplied by the teams.
- 3.4 **Makeup of Teams** – Teams, including drivers, will consist of high school students in grades 9-12. Twelfth grade includes the summer following the student's last year in high school. Team members must be from the same school district.
- 3.5 **Qualifiers** – Each team must successfully participate in a qualifier before they will be allowed to compete in the main event. Qualifiers will be held preceding the event. The qualifier will hereinafter be referred to as “scrutineering.”

To assist teams in preparing for scrutineering, teams must submit pictures of their solar car to event officials via an online system. A detailed list of required pictures and login information will be provided to each team accepted for participation in the event. Event officials will review the

submitted information and provide feedback to teams before arrival to scrutineering. Teams must submit pictures by June 1st of the year in which they intend to participate.

Teams can be pre-qualified to take part in the event by arranging for the Event Director, or one of his staff, to visit the team to determine if their solar car complies with the essential elements required to pass the scrutineering process. Teams will still have to proceed through the regular scrutineering process, but they are assured that their mechanical and electrical configurations comply with the basic event directives. Travel arrangements must be provided by the requesting team.

- 3.6 **Data Sheets** – Each team must submit data sheets no later than April 1st of the year in which they intend to participate. The sheets must include all vehicle specifications including weight, dimensions, motor type, solar cell type, solar array power output, battery type and capacity, braking systems, and wheel type. All crew members, designated drivers, and faculty advisors must also be listed. The information from the data sheets will provide the basis for selection of event participants, and will appear in the Official Challenge Booklet.

Five additional documents must accompany the Data Sheets:

- (1) Complete, detailed drawing(s) showing the mechanical structure of the vehicle. This should be drawn with a drafting program such as AutoCAD for clarity and is not limited to one page. The drawing(s) must include crush zones, frame structure, and overall dimensions in three views (front, side, top). A final updated drawing must be submitted upon check-in to the event if there has been any design changes since the first drawing was submitted. Drawings that fail to show adequate "360 degree crush zones" will be disqualified.
- (2) A complete, detailed schematic and wiring diagram showing the electrical layout of the vehicle. This schematic must include but does not need to be limited to all the wiring for the propulsion, solar, instrument, and battery systems. A final and current schematic must be submitted upon check-in to the event.
- (3) A team photo, in digital format of at least 1500x2100 pixels and in color. The photo must clearly show the solar car (may be unfinished) and team members.
- (4) Manufacturer's data sheets for the propulsion system batteries, including, but not limited to voltage per battery, capacity per battery, weight of each battery, and its chemistry type (lead-acid, or otherwise)
- (5) Manufacturer's data sheets for the solar cells you intend to use, including, but not limited to the size of each solar cell, the efficiency rating, the number of watts per cell, and the list price of each solar cell.

Teams submitting incomplete data sheets shall not be considered for the event.

**3.6.1 Photo Documentation** – Teams shall upload to a specified web site photos of specific parts of their solar car and its progress during construction. The specific list of parts and account information will be sent to teams upon their submission of the *Intent to Race* form.

- 3.7 **Changing Entry Data Sheets** – Entrants may change the data presented on their Data Sheets [See Section 3.6] up to the scheduled time of scrutineering, however, changes after June 1st may not appear in the Official Challenge Booklet.

- 3.8 **Vehicle Design and Construction** – It is the intent of the event that the solar cars be designed and constructed by high school students. The major components of the vehicle (frame, body, solar array, battery compartment, motor mount, drive system, electrical system, suspension, running gear, and lighting system) must be designed and constructed completely by the students. Off-the-shelf components (e.g., wheel hubs, brake calipers, power trackers, motors, motor controllers, suspension/steering components, wheels, etc.) may be used as long as the selection of these components was made exclusively by the students. Teams can receive contributions of off-the-shelf components from other solar teams.

The students may seek the advice of engineers or other design consultants. Parts may be fabricated by specialty shops (for welding, machining, etc.) as long as the students specify what the specialty shop is to do, through drawings or specification sheets prepared by the students. However, it is the spirit of the event to learn how to build a solar car, and it is recommended that students perform whatever tasks they can to construct the solar car on their own. The drawings and specification sheets must be made available during scrutineering as proof of student design. During scrutineering, judges will strenuously question the students to determine compliance with this rule.

#### 4 OFFICIAL COURSE

The Official Course on alternating years will be either the Texas Motor Speedway or a cross-country course announced on the Solar Car Challenge website <http://www.solarcarchallenge.org>.

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#### 5 SOLAR CAR REGULATIONS

5.1 **Solar Car Dimensions** – All solar cars entered will have the following maximum dimensions: length = 5 meters; height = 1.6 meters; width = 1.8 meters. Minimum height is 1 meter. When turning corners, wheels and wheel fastenings may exceed these dimensions. Fins, antennas, and other aesthetic components may not be used to meet the minimum height requirement. Antennas may extend above the maximum height requirement. Vehicles arriving at the event that exceed the specific car dimensions will be disqualified.

5.2 **Structure** – Safety is the Sponsor's primary concern with regard to the structural development and fabrication of the solar cars.

Insufficient regard for structural safety will result in disqualification from the event during scrutineering. In specific, judges will require teams to show a specific *crush zone* designed to help protect the driver in the event of collision. Teams not being able to demonstrate a specific, adequate crush zone will be disqualified.

Crush zone is defined as an area of the car designed to collapse in an effort to absorb some of the impact from a collision without impacting the driver space. A crush zone must be considered for frontal, side, and rear collisions. Therefore, the driver, when seated, must have a minimum of 15 cm of horizontal distance from any part of the body to the inside of the most exterior structural frame member. The distance is measured at the height of the driver in their normal seating position. Teams must demonstrate at scrutineering that each driver complies with the 15 cm requirement.

5.2.1 **Stability** – To ensure stability under various road conditions, the vehicle must employ either a three or four wheel design. If a three wheel design is used, event officials strongly suggest that the single wheel should be in the rear of the vehicle, with two wheels in front. During scrutineering, cars must demonstrate the stability of the vehicle. Either the front or rear wheel(s) or both may be powered, and either the front or rear wheel(s) may be used to steer the vehicle.

5.2.2 **Body of the Vehicle** – Although windshields are required, solar cars need not have a body or covering unless the event judges determine that the driving of that vehicle would be unsafe and/or create an unreasonable risk of harm to the driver.

5.2.3 **Roll Cage** – All solar cars must be equipped with a roll cage that encompasses the entire driver. The roll cage shall be a fixed, integral part of the solar car structure. The protection provided for the driver in a collision must be documented in the team's mechanical drawings. In addition to providing collision and rollover protection, the roll cage must be designed so as to deflect body/array panels of the car away from the driver in the event of an accident.

5.2.3.1 **Minimum Dimensions** – The roll cage tubing must have a minimum outside diameter of 1.9 cm. There must be at least 5 cm of clearance in all directions between the roll cage and the driver seated in the normal driving position. Teams must demonstrate at scrutineering that each driver complies with the 5 cm clearance.

5.2.3.2 **Waivers** – Teams wanting to use alternate dimensions must submit a waiver request to Event Officials before May 1. Waivers may not be requested at scrutineering. The waiver request must document what materials will be used and how these materials afford equivalent protection for the driver. A detailed mechanical drawing (in three views) must be included, showing the dimensions, material, and location of the roll cage members.

Waiver requests may be electronically submitted to Event Officials, so long as the request is saved in Microsoft Word or Adobe PDF format and the mechanical drawing is saved in AutoCAD, SolidWorks, or Adobe PDF format. Waiver requests may also be submitted by sending four copies of the request and mechanical drawing by mail to Event Officials.

5.2.4 **Roll Bar** – The roll bar is the structural frame member that extends above the driver's head, protecting the driver in the event of a roll-over. The top of the roll bar must extend at least 5 cm vertically from the top of the driver's head or helmet. All solar cars must be equipped with a roll bar that is welded to the frame. The roll bar must also be a welded, integral part of the frame and cannot be removed.

5.2.4.1 **Minimum Dimensions** – The roll bar tubing must have a minimum outside diameter of 5 cm. It must also have a minimum wall thickness of 1.0 mm for chromoly steel, 1.5 mm for carbon steel, and 3.2 mm for aluminum.

5.2.4.2 **Waivers** – Teams wanting to use alternate materials or dimensions must submit a waiver request to Event Officials before May 1. Waivers may not be requested at scrutineering. The waiver request must document what alternate materials will be used and how these materials afford equivalent protection for the driver. A detailed mechanical drawing (in three views) must be included, showing the dimensions, material, and location of the roll bar.

Waiver requests may be electronically submitted to Event Officials, so long as the request is saved in Microsoft Word or Adobe PDF format and the mechanical drawing is saved in AutoCAD, SolidWorks, or Adobe PDF format. Waiver requests may also be submitted by sending four copies of the request and mechanical drawing by mail to Event Officials.

5.3 **Power** – Global solar radiation received by the car directly from the sun is the only power source that will be used for propulsion.

5.3.1 **Solar Cell and Array Size Limitations** – Solar cell types are restricted by division and set out in the provisions of Section 12. For all vehicles, the solar array may be configured in any way, provided that the size of the array fits within the maximum dimensions of the solar car.

When stationary, the solar array may have any orientation. The solar array must remain mounted on the outside of the vehicle, except as provided in Section 5.18; the solar array cannot be dismantled and carried inside the vehicle.

The solar array cannot be reconfigured, without specific written permission of Event Officials. Reconfiguration is defined as changing the position or orientation of any portion of the array. Changing the position or orientation of the entire array, when stationary, is not considered reconfiguration. When stationary, the array may exceed the maximum height of the solar car so long as the array is not reconfigured.

No reflector-type device can be used to enhance the collection capacity of the panel. All leads extending from the solar array must be properly protected to eliminate shock hazards.

5.3.2 **Supplemental Batteries** – All solar cars must be equipped with supplemental batteries to power solar car accessories, such as, but not limited to, radios, electronic speedometers, cameras, memory devices, computers (only if used for data gathering and not to control the vehicle systems), and telemetry transmission, and they must be totally isolated from the propulsion system of the solar car. The main battery pack may not be used to power anything other than propulsion devices.

- 5.3.2.1 **Battery Type** – There are no regulations limiting the type, voltage, or weight of supplemental batteries.
- 5.3.2.2 **Low Battery Warning System** – The supplemental batteries powering the following equipment: (1) lights; (2) horn; and (3) battery box air circulation fans, must be equipped with a low voltage warning system that will aggressively warn the driver when the supplemental battery pack is getting low.
- 5.3.2.3 **Enclosure** – Supplemental batteries must be properly secured to the solar car's frame. If sealed batteries are not used, the supplemental batteries must be enclosed in a battery box that is separate from the main battery pack.

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5.5 **Storage of Solar Radiation** – All solar cars in the event will be allowed to store solar-generated energy.

- 5.5.1 **Battery Type** – In the interest of cost and standardization, only rechargeable, commercial production, lead-acid batteries are permitted (unless otherwise allowed in Section 12). The total battery capacity cannot exceed 5 kilowatt-hours at a 20 hour discharge rate. There is no limit applied to system voltage, number of cells, or modules. [Capacitors can not be used to supplement the 5kwh battery capacity.](#)
- 5.5.2 **Battery System** – The main battery pack must be fully contained in enclosures that can be sealed by event officials (thus sealing the batteries). A hasp latch for the battery enclosure will assist event officials in complying with this section of the rules. Battery enclosures will be equipped with a forced air ventilation system, which must operate whenever the battery system is electrically connected to the solar car. Such ventilation system must exhaust to the exterior of the solar car. The ventilation system must be capable of cycling air within the battery box at least 4 times per minute. All electrical cables must be properly sized to expected system currents. Teams that choose to power their venting fans from a supplemental battery must comply with the requirements set out within Section 5.3.3.

A battery enclosure is defined as a rigid box-like structure that provides protection and stability to the battery system in the event of collision. Battery bag devices are not appropriate. Each battery and the battery enclosure must be secured to the chassis of the vehicle.

- 5.5.3 **Main Fuse** – A separate fuse (not a circuit breaker) shall be placed in series with the main battery. The fuse's voltage rating shall be in DC voltage units matching system voltage, and the fuse's breaking capacity shall not exceed 200% of the maximum expected current draw. All other connections to the main battery shall be separately fused. All fuses must be placed first in series with the battery starting at the positive connection.
- 5.5.4 **Array Disconnect** – The solar charging system will be equipped with a manually operated high current switch to quickly disconnect the solar array from the main battery pack. The array disconnect must directly interrupt the current from the array to the battery and must be capable of carrying and interrupting the peak array current. This device will not operate a separate contact, relay, or solenoid switch.

The switch must be clearly labeled in 10mm-high letters as the "Array Disconnect" and be plainly marked (10mm-high letters) with "ON" and "OFF" positions. Such markings shall be visible from outside the solar car.

The switch must physically be located as near to the battery pack as practical and be operable from outside the solar car. This means that the canopy or motor compartment does not have to be opened first to activate the disconnect.

When both the array disconnect and the motor disconnect are thrown, the solar array, main battery pack, and motor must be disconnected from each other.

- 5.5.5 **Motor Disconnect** – Solar cars must have a “kill” switch wired to disconnect all power to the motor. The motor disconnect must directly interrupt the current through the motor and must be capable of carrying and interrupting the full load motor current. The motor disconnect must be separate from the array disconnect. This device will not operate a separate contact, relay, or solenoid switch.
- The switch must be clearly marked in 10mm-high letters as the “Motor Disconnect,” and be within easy reach from both the driver’s position and from outside the solar car. The switch must be plainly marked (10mm-high letters) with “ON” and “OFF” positions. Such markings shall be visible from outside the solar car.
- In the case where a brushless DC motor is used, the motor disconnect switch may be placed in the main DC current loop supplying power to the motor controller, or alternatively, at least two of the three main leads between the controller and the motor must be interrupted by the motor kill switch.
- Two switches wired directly in series may be used so that one of the switches is within easy reach from the driver’s position and the other switch is within easy reach from the outside of the solar car. If two switches are used, each switch must be able to interrupt full load current.
- When both the array disconnect and the motor disconnect are thrown, the solar array, main battery pack, and motor must be disconnected from each other.
- 5.5.6 **Electrical System Grounding** – The main battery pack or any propulsion system components may not be grounded to the solar car’s frame. The supplemental battery pack may be grounded to the solar car’s frame, but is discouraged by Event Officials.
- 5.5.7 **Assistance Devices** – Any device used to assist the start, stop, or powering of a solar car must be carried on the solar car and must be a permanent part of the electrical system. Once the event has started, teams will not be allowed to plug any devices into the solar car except telemetry equipment and multimeters.
- 5.6 **Seating Position** – Each occupant must be provided with an appropriately constructed seat where the occupant’s head is higher than his or her feet.
- 5.7 **Visibility** – In the normal driving position, each driver’s eyes must be a minimum of 70cm above the ground.
- 5.7.1 **Forward Visibility** – From the normal driving position, all drivers must be able to see, without artificial assistance: (1) a point on the ground 8 meters in front of the solar car; and (2) a minimum of 10 degrees above the horizon on level ground.
- 5.7.2 **Side Visibility** – From the normal driving position, all drivers must be able to see, without artificial assistance, 90 degrees to either side at all times. This must be essentially unobstructed by the solar car structure. The intent is for the driver to see oncoming traffic, left and right.
- 5.7.3 **Rear Visibility** – All solar cars must be equipped with a rear vision system that will allow the driver to see a vehicle 15 meters directly behind the solar car, as well as see vehicles 45 degrees in each direction approaching from the rear. If an electronic rear vision system is used, it must operate whenever the solar car is operating under its own power.
- 5.8 **Braking** – The intent of the Sponsor is to require that solar cars be capable of braking and coming to a safe stop based upon road and traffic conditions. To this end, solar cars will be equipped with two separate, independent braking systems. This means that there must be two separate foot pedals (one for each braking system) and that each is connected to a different actuating device. The two separate foot pedals may be linked together, so long as the pedal assembly engineering is sound and each foot pedal can be independently operated if the linkage fails. Each braking system must apply brakes to the left and right sides of the solar car evenly. Regenerative brakes are not considered a separate, independent braking system for consideration in this rule.
- If the vehicle is equipped with a cruise control system, as allowed by Section 5.12, it must be designed to automatically disengage when the brakes are applied.

During scrutineering, solar cars will be required to demonstrate their braking capability at both 20 mph and at the vehicle's maximum speed.

5.8.1 **Low Speed** – At 20 mph, the driver must be able to bring the vehicle to a safe, controlled stop in no more than 2.5 seconds.

5.8.2 **High Speed** – At the vehicle's maximum speed, the driver must be able to bring the vehicle to a safe, controlled stop without drifting out of the appropriate lane of travel, and within a reasonable time frame based on that vehicle's maximum speed.

5.9 **Steering** - All steering mechanisms must be directly operated by the driver. All components between the driver's steering device (e.g. steering wheel) and wheel turning mechanisms must be connected via direct mechanical linkages. No electrical actuators or controls are allowed.

**5.9.1 Turning Radius** – Solar car wheels must be able to make a U-turn in a 15-meter wide lane.

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## 5.10 Warning Systems

5.10.1 **Lighting** – Solar cars must have stoplights, front and rear turn indicators, and hazard lights visible from 30 meters away. The geometric visibility of each light should be 45 degrees from center and 15 degrees up and down. At the event official's discretion, teams may receive a "moving violation" for each incidence of non-working lights. Once the team is notified by an event official that they have a non-working light, they must safely remove themselves from the official course and make the necessary repairs.

5.10.2 **Audible Warning** – Drivers must be able to give audible warning to pedestrians and other vehicles using a horn producing at least 92 decibels as measured at the source. The horn shall be mounted as far to the front of the vehicle as possible and face forwards. The horn may not be located inside the passenger compartment.

In closed-track events, the horn must be sounded when a solar car attempts to overtake and pass another vehicle. In the event that the horn malfunctions, a driver-operated airhorn may be used to complete the lap before exiting and conducting repairs.

5.11 **Driver Safety** – Teams must take whatever steps necessary to protect the safety and well-being of the drivers. Driver safety measures include, but are not limited to:

5.11.1 **Safety Belts** – Solar cars must be equipped with a minimum of a five-point lap and shoulder belt (harness system). The use of safety belts is mandatory at any time the vehicle is moving. The belts must be attached securely to a structural component or main frame member of the solar car. The harness must be attached with bolts at least grade 8 and 3/8" in diameter.

5.11.2 **Impact Protection** – The driver compartment must be equipped with structural components that help protect the driver from vehicle roll-over, or from front or side impacts, in compliance with Rule 5.2 (above). All sharp objects and frame members within the driver area must be padded to help protect the driver during entry and egress and in case of impact.

5.11.3 **Protection from Vehicle Components** – All equipment housed within the vehicle must be adequately secured to the main frame to prevent the shifting of that equipment during an impact. Special emphasis is placed on securing the batteries due to their weight and potential for environmental damage.

5.11.4 **Windshield** – All solar cars will utilize windshields at all times to protect the driver from road hazards.

5.11.5 **Cockpit Egress** – Each driver must be able to demonstrate that unassisted egress can be achieved in less than 15 seconds in the event of an emergency. The "exit process" will be carefully checked by event officials during scrutineering. Other team members can not assist the driver during this required "exit process."

- 5.11.6 **Fire Extinguishers** – Cockpits must be equipped with a fire extinguisher which can be easily reached by the driver in the event of an emergency. Chase vehicles must also be equipped with a fire extinguisher.
- 5.11.7 **Liquid Container** – Cockpits must be equipped with a plastic liquid container filled with water, which can be easily reached by the driver.
- 5.11.8 **Belly Pan** – The cockpit must be equipped with a full belly pan to isolate the driver from the road.
- 5.11.9 **Ultimate Driver Safety** – Each team must recognize that the ultimate responsibility for driver safety rests with the individual solar teams and not with the Solar Car Challenge, or its officials.
- 5.11.10 **Air Circulation** – Forced air ventilation must be provided for the solar car's driver. This is particularly important for the health and safety of the driver while the vehicle is powered but not in motion. This requirement applies whether or not the driver's compartment is enclosed or open.
- 5.11.11 **Driver Seat** – When the driver is seated in the normal driving position, the driver's seat must provide back and neck support for the driver, such that whiplash will be minimized in case of an accident or sudden stop.
- 5.11.12 **Battery Spill Kit** – A battery spill kit consists of a box of baking soda, to mitigate the effects of battery spills. All teams must carry a battery spill kit in the solar car, within reach of the driver. All teams must also carry a second battery spill kit in their chase vehicle.
- 5.11.13 **Closed-Toe Shoes** – All drivers are required to wear closed-toe shoes while operating the solar car. Event officials strongly recommend team members wear closed-toe shoes throughout the event.
- 5.12 **Throttle** – Accelerator mechanisms on solar cars must be free moving and when released, must return to the zero current position. If the solar car is equipped with cruise control, it must be designed with an automatic shut-off when the brake is activated. Solar cars may only be equipped with a cruise control system during closed-track events. All accelerator mechanisms (manual throttle or cruise control) must be directly operated by the driver.
- 5.13 **Covers and Shields** – The solar car's revolving parts must be suitably covered to prevent accidental contact. All steering linkage must be shielded from the contact of the driver. If a flywheel is used, it must be covered by a National Hot Rod Association-approved shield.
- 5.14 **Electrical Shock Hazards** – All conductors must be properly insulated. All conductors operating at greater than 36 volts must be marked with "High Voltage" warning signs. All solar cells and panels must be marked with "High Voltage" warning signs.
- All leads extending from the solar array must be properly protected to eliminate accidental shock hazards resulting from participants or bystanders coming in contact with these leads.
- Event Officials strongly suggest the following steps to improve safety:
- (1) When working with the battery box, be sure that you only use one hand, and that the other hand is kept behind your back. In the event of an electrical shock, the charge will not pass through the entire body.
  - (2) When working with the battery box, be sure to use rubberized tools to insulate against the possibility of electrical shocks.
  - (3) Students working in the battery box require continuous supervision by teacher/sponsors.
  - (4) When working with the battery box, be sure to wear eye protection (a full face shield is best) to protect against battery explosions caused by sparks or arcing.
- 5.15 **Radios** – Solar cars must be equipped with a two-way radio to allow communication with the chase vehicle. Teams must demonstrate during scrutineering that the transmission from the solar car can be received at a distance of at least 0.5 miles. If a radio system "goes down" during the event, drivers must stop at the earliest opportunity and make repairs before proceeding on the course.
- Judges will make every effort to ensure that a team's radio communications will remain private, unless there is a safety issue involved.

- 5.16 **Fasteners** – All fasteners associated with the vehicle's suspension, steering, brakes, seat belts, battery chassis, and drive train must be equipped with locking nuts, double nuts, or nuts secured with safety wire or cotter pins. *Loctite* may be used in areas of difficult accessibility.
- 5.17 **Graphics**
- 5.17.1 **Inappropriate Graphics** – The event organizer reserves the right to disapprove any graphic it deems offensive.
- 5.17.2 **Sponsored Graphics** – Teams must reserve a space 4 x 8 inches on each side of the solar car for sponsored graphics.
- 5.18 **Umbilical Cord** – To position a solar car's solar array in a favorable position for charging, an umbilical cord may be used. This cord must be carried on the solar car.
- The purpose of the umbilical cord is to provide the racing participant the means to keep the array electrically connected to the vehicle, though physically removed from the vehicle to receive more favorable sunlight. Teams reconfiguring only a portion of the array must request explicit permission for reconfiguration, as required in Rule 5.3.1.

## 6 NATURE OF THE EVENT

In alternating years, the event will consist of either a multi-day closed-track event or a cross-country event. For a closed-track event. Teams will cover the same course each day with the same specific start and finish line at the Texas Motor Speedway. Teams will accumulate full laps around the Texas Motor Speedway (no partial laps will be awarded). The team that completes the most laps during the event will be declared the winner. The team that completes the same number of laps with a lower elapsed time than another team will place higher than the other team. The details of closed-track events will be spelled out in *Rules Updates* for that specific year's event.

For a cross-country event, teams will drive or trailer their solar car on a specified route over the course of several days. The team driving the most miles in their solar car over the course of the event will be declared the winner. The team completing the same number of miles with a shorter elapsed time will place higher than the other team. A tie shall be declared for teams completing the same number of miles and a difference in elapsed time of less than 1%. This allows for judging tolerance for recording time. The details of cross-country events will be spelled out in *Rules Updates* for that specific year's event.

- 6.1 **Elapsed Time** – On each day of the event, a team's elapsed time begins at its allotted time slot (based on starting order). A team's elapsed time ends when it completes the course for the day, or when time has elapsed for the day, whichever is earlier. Time spent at required stops or when teams are required to trailer a particular course segment are deducted from the elapsed time.

## 7 DATES AND LOCATIONS

- 7.1 **Challenge Events** – Teams will be required to take part in all special events and activities, including all scheduled pre-challenge and post-challenge events. Teams will be notified at Team Check-In, which precedes the Opening Banquet. Teams failing to participate in all events and activities may be disqualified from the event.
- 7.2 **Items Provided by the Solar Car Challenge**
- Comprehensive Challenge Booklet
  - Guide to Hotel/Motel/Campsite Accommodations
  - Emergency Medical Personnel
  - Judges Accompanying Each Team
  - On-road police protection (where appropriate)
  - One meal per day from the Opening Banquet to the Closing Banquet (For up to 12 team members and 2 Advisors)
  - Special Texas License Plate (For cross-country events only)
  - *Caution: Solar Car Ahead* Sign
  - Drinking Water (At Scrutineering, Start & Finish Lines, Media Stops, and Vehicle Impound)
  - Security for Solar Cars during nightly impounds

- 7.3 **Items Provided by Entrants** – All items not specifically enumerated in Section 7.2 (above) will be provided by entrants, unless set out in *Rules Updates*. Teams must remember to provide driver's licenses for designated Team Drivers, as well as Proof of Vehicle Liability Insurance.
- 7.4 **Trailing Provisions** – Teams may trailer their solar cars at any point on the cross-country course (unless otherwise restricted by the *Where-to-Be, What-to-Do* document). Teams will not accumulate any miles spent trailing their solar car. Teams must trailer their solar cars when required to do so in the Official Route booklet.

## 8 SCHEDULED TIMES

Central Daylight Time is the "official" time for all events. When a cross-country route moves into another time zone, the time within the zone when the day started will be considered the "official time" for all events conducted in that new time zone on that day.

- 8.1 **Racing** – For cross-country events each team will be released from an official Starting Line at fixed intervals and all racing will stop at a fixed interval after the team's allotted time slot. The detailed schedule for each day will be published on the Solar Car Challenge web site and on the *Where-to-Be, What-to-Do* document. For closed track events, the racing schedule will be published on the Solar Car Challenge web site.
- 8.2 **Charging** – Teams may charge their solar car batteries during daylight hours up to the time for impounding the vehicles. Charging of the main battery pack must be done in the presence of an event official, and can only be charged by direct solar radiation.
- 8.3 **Impound** – All solar cars will be impounded under event security each day. Teams may start removing their solar cars from the Impound when opened by event officials. Once the event has begun, no team will be allowed to remove their vehicle from the Impound without the escort of an event official. The car must remain under the direct supervision of an event official throughout the day until it is again submitted for impound. Teams violating this rule may be disqualified from the event. Specific impound times can be found on the *Where-to-Be, What-to-Do* document.

## 9 SCRUTINEERING

- 9.1 **Time** – Solar cars will be inspected to verify compliance with the regulations at 8:00 AM on the day preceding the event (subject to change). Vehicles not ready to begin scrutineering at this time will be penalized up to 5 miles.
- 9.2 **Inspected Solar Cars** – Solar Cars that pass scrutineering will be allowed to participate in the event. Vehicles that do not pass scrutineering must correct the deficiency in order to be considered for participation in the event. After repairs are made, the team has the responsibility to notify event officials that their vehicle is again ready for scrutineering. Vehicles will continue to be inspected until 12:30 PM. Scrutineering will officially end at this time unless an extension is specifically announced by event officials.
- 9.3 **Safety** – Each team is responsible for the road-worthiness of its solar car. Passing the scrutineering process does not relieve the team of its responsibility, nor impose any liability on the event organizers. Solar cars must be maintained in a safe, road-worthy condition at all times.
- 9.4 **Liability** – Teams will be required to sign a Release of Liability Form prior to admission to the event. Proof of Vehicle Liability Insurance will also be required at the time of scrutineering. On cross-country event years, teams must submit their Proof of Vehicle Liability Insurance no later than June 15th.
- 9.5 **Deleted**
- 9.6 **Braking** – Solar cars will be required to meet the braking guidelines set out in Section 5.8. Failure to meet these guidelines will require the team to make the necessary changes to bring their vehicle into compliance, and then to be re-tested. Any solar car that does not pass the brake test will not be allowed to enter the event.

Teams whose cars are equipped with cruise control systems, as allowed by Section 5.12, will be required to explain how the cruise control system is disengaged when brakes are applied, and to demonstrate its function.

- 9.7 **Handling** – Solar cars will be required to run through a slalom course, weaving in-between at least six cones spaced approximately 40 feet apart, to ensure proper handling when lateral forces are exerted on the frame and wheel assemblies. Each driver must pass the slalom course to qualify to drive in the event.
- 9.8 **Safety Meeting** – Team drivers and advisors will be required to attend a safety meeting scheduled before the start of each racing day.
- 9.9 **Safety Equipment** – Each team must demonstrate during scrutineering that it is prepared to handle emergencies. This includes the designation of a *team safety coordinator*. The following equipment must be easily accessible to the team: fire extinguishers (both on the solar car and the chase vehicles), traffic cones or warning triangles, flags, safety vests, and jack stands. Jack stands must be used whenever the solar car is off the ground for maintenance.
- 9.10 **Post-Event Inspection** – At the conclusion of the event, the event officials may conduct a post-event inspection of the first place team in each division. In addition, event officials will have the discretion to conduct post-event inspections for all other teams. The post-event inspection will confirm that the car complies with event regulations and that the components in the car agree with the final Data Sheets [See Section 3.6] submitted to the event. If a car fails any portion of the post-event inspection, the team will be penalized based on the provisions set out in Section 27.

## 10 REGISTRATION

- 10.1 **Purpose** – The purpose of registration is to identify participants and vehicles taking part in the event.
- 10.2 **Registration Deadline** – Teams must file registration papers no later than April 1st of each event year. To accommodate the publication of the Challenge Booklet, no team will be admitted to the event after May 31st.
- 10.3 **Fees** – Registration for the Solar Car Challenge must be accompanied by a non-refundable \$500 fee.
- 10.4 **License Plates** – No license plates are required on the closed-track events. The SCC will supply a 30-day special Texas License Plate for cross-country events to teams providing proof of solar vehicle liability insurance. [See Section 9.4]
- 10.5 **Participants Registered** – Any person taking part in the event must be registered, and must wear an official SCC Identification Badge around their neck at all times. This includes media, sponsors, officials, guests, and teams. The Identification Badge must be visible at all times.
- 10.6 **Driver Restrictions** – Solar car team drivers must have a valid driver's license. All drivers will be specifically identified at registration. Only registered drivers will be allowed to drive during the event. On each day of the event, solar car drivers must report the name (and function) of any drug that they are using. The report should be made during the drivers' meeting to the Assistant Event Director.
- 10.7 **Driver Weight** – No ballast provisions will be imposed on any team.
- 10.8 **Liability Insurance** – Teams must submit proof of liability insurance on their solar car during the scrutineering process. On cross-country events, teams must submit proof of liability insurance no later than June 15th of the year in which they intend to participate. Teams not complying with this rule will receive an automatic penalty during Scrutineering, and may be disqualified.

## 11 STARTING ORDER

The starting order for the first official day will be determined by a drawing at the Opening Banquet. On all other days, the starting order will be determined by the solar cars' previous day mileage.

The solar cars will be released from an official Starting Line at fixed intervals. If a solar car is not ready for its assigned starting slot, it will be detained until all remaining cars have been released. Time will start for the detained car at its assigned starting slot, not when the detained car is released.

## 12 LEVELS OF PARTICIPATION

- (1) Event participants must choose to participate in one of four divisions of racing:

**CLASSIC DIVISION** – Classic Division retains all the rules and regulations set out in the Official Rules. No hub motors can be used. Solar modules must have a rated efficiency of 18% or below. Prefabricated solar panels are rated per module efficiency. Bare solar cells are rated per cell.

**OPEN DIVISION** – Open Division provides teams the option to implement more expensive technologies in their solar car design. In addition to rules and regulations set out in the Official Rules, teams in the Open Division may use a hub motor and/or solar cells that have a rated efficiency above 18%. The size limitations of the solar array remain the same, however, individual solar cells may be less than 100 square centimeters. The list price for all bare solar cells must be less than \$10/watt; teams may pay extra for cutting, tabbing, or lamination of cells.

**ADVANCED DIVISION** – Advanced Division provides teams an opportunity to explore new and upcoming technology for their solar car. In addition to rules and regulations set out in the Official Rules and technology allowed in the Open Division, teams may use prefabricated solar car molds and/or other battery types. Prefabricated solar car molds are defined as molds designed for solar cars that are not directly constructed by team members (i.e. molds purchased, donated, or otherwise obtained). Batteries may be of any chemistry type, but must have the appropriate protection systems required by that type. Battery capacity remains limited per Official Rules.

**DEMONSTRATION DIVISION** – Demonstration Division provides a way for Solar Car Challenge alumni to participate in this event. Teams entering this division must be composed of high school graduates, and the majority of team members must have previously participated in a Solar Car Challenge event. Vehicles entered into the Demonstration Division are limited to the same rules and regulations as the Classic Division.

- (2) Trophies and Awards will be granted in all divisions other than the Demonstration Division.

- 13 **SCORING** – Official times and distances are the responsibility of event officials. Daily results will be announced prior to the start of the next day's competition.

- 14 **DRIVER MEETING** – Drivers and Team Sponsors must attend a briefing at 8:00 AM each event day (unless otherwise noted). All other team members are encouraged to attend. A major penalty will be imposed on any team not attending this important session.

## 15 OVERNIGHT

15.1 **Impound** – The impound will be a building, tent, or protected parking lot where every solar car will be secured under the direction and supervision of event officials. There will be no vehicle maintenance allowed on the solar cars while in the impound. Solar cars transported to the impound and arriving after 9:00 PM will be impounded immediately upon arrival.

15.2 **Garage** – The garage will be an area for charging and maintaining vehicles before and after the impound. No other vehicles will be permitted in the garage area.

15.3 **Support Vehicle Parking** – All support vehicles must be parked in this area. Maintenance or repair of solar cars requiring close proximity to their support vehicles must be done in the support vehicle parking area.

15.4 **Headquarters** – Event Headquarters will be located near the Impound and Garage area. All official announcements and postings will be at the Headquarters.

15.5 **Accommodations** – Teams are responsible for securing their own accommodations. In Dallas, the official SCC Hotel is the DFW Marriott. On cross-country events, a special list of event hotels will be mailed to teams prior to the event so that timely reservations can be secured. Special team prices are available at all event hotels.

- 16 **MANDATORY STOPS** – Teams are required to make specific stops during the event day. At Team Check-in, teams will receive a detailed list of these stops. These include media opportunities, organized lunch breaks, vehicle inspections. Solar charging, vehicle maintenance, team needs, and driver rotation are allowed during these stops. A list of required trailering segments will also be provided.
- 17 **CHECKPOINTS** – Checkpoints will be established along the course. Failure to pass a checkpoint may result in event disqualification.
- 18 **MAINTENANCE** – Vehicles can be repaired and maintained at any time during the day except when public or media events make it inappropriate, or during the impound. Any component of the solar car may be changed or repaired with the following restrictions.
- 18.1 **Batteries** – Cells, modules, or battery packs may not be replaced nor removed for any reason other than malfunction or accident. Decisions to exchange all or part of a battery system must be communicated first to an event official who will record the exchange and penalty. The judge must observe the breaking of any battery seal, date, and initial the broken seal. The standard penalty for battery replacement is the percentage of modules replaced multiplied by 100 miles. The chief scrutineer has the authority to impose further penalties if a team, in effecting a battery replacement, has gained an unfair advantage over the other teams or has otherwise departed from the spirit of the competition.
- 19 **ACCIDENTS** – All accidents must be reported to an event official immediately. Failure to do so may result in expulsion from the event. In the case of an accident involving personal injury and/or property damage, notification of the appropriate emergency personnel will have priority.
- 19.1 **Re-Inspection** – If a solar car is involved in an accident, it must be re-inspected by event officials. If the safety of any solar car is in question during the event or during the scrutineering process, an event official may require re-inspection prior to that vehicle's resuming the event or resuming the scrutineering process.
- 20 **WITHDRAWALS** – Any team that has agreed to participate must fulfill its obligation unless specifically excused by the event organizer. Any team wishing to withdraw must notify the organizer in writing.
- 21 **PUSHING** – Solar cars may be pushed under the following conditions: (1) Into and out of the required Impound; (2) After the team is off the Race Route at Mandatory Stops; and (3) When the solar car is on the Race Route only if an event official authorizes "pushing" to protect the safety of the team.
- 22 **SUPPORT VEHICLES** – Teams must have all their support vehicles registered and properly marked at the time of scrutineering.
- 22.1 **Cross-Country Support Vehicles** – Teams will be allowed two support vehicles on the course with the solar car: a lead vehicle (driven with lights on) directly in-front of the solar car, and a chase vehicle directly behind the solar car. All support vehicles on the course must have roof-mounted flashing amber lights. The chase vehicle must have its amber light mounted at the rear of the vehicle, and must also carry a rear-mounted sign (supplied by the event organizer) that reads: "Caution! Solar Car Ahead." If the team has a lead vehicle, it must within 3-4 seconds from the solar car at all times to prevent "drafting." The lead vehicle is required whenever the solar car is driven on the highway. The chase vehicle must remain within 3-4 seconds from the solar car at all times, including media stops, rest stops, trailering, repairs, etc. It is suggested that the lead vehicle pull the trailer that stores the solar car. Any other support vehicles must keep a distance away from the lead and chase vehicle to allow traffic to pass.
- Teams must provide space in the chase vehicle for an event judge and telemetry equipment.
- 22.2 **Closed-Track Event** – Teams will be allowed one support vehicle in the event that the solar car stops on the track. This support vehicle must have a roof-mounted flashing amber light. The support vehicle will only carry enough equipment to facilitate the solar car's return to the pit area. No significant repairs will be made on the track itself. In the event that the car must be trailered, teams are required to first get the permission of the Technical Director so that removal of the vehicle from the track can be carried out without undue hazard to the other racing solar cars.

- 22.3 **Accompanying** – At any time the solar car is moving on the open road, it must be accompanied by a designated chase vehicle (with the flashing amber lights and rear-mounted sign). Failure to follow this safety regulation may subject the team to a major penalty.
- 23 **OVERTAKING** – Situations will arise when slower solar cars (and their accompanying support vehicles) will need to pull over when being overtaken by a faster-moving solar car. Failure to pull over, or recklessly pulling out into the path of a passing solar car, will result in a major penalty. In the event that one team is overtaken by another team, the faster team must signal their intention to pass by flashing the lead vehicle's headlights. On a closed-track event, the faster team must signal their intention to pass by sounding their horn. The slower team must then give way by slowing down or pulling over to allow the faster team to pass. Safety is the primary consideration here. Additional provisions for closed-track events will be provided in *Rules Updates*.
- 24 **DRAFTING** – Drafting by a solar car is prohibited. Solar cars must be no closer than 4 vehicle lengths behind the car in front of them; solar cars must be no closer than 3 vehicle lengths to their chase vehicle behind them.
- 25 **HELMETS** – Helmets are not mandatory for solar car drivers during the event, but are highly recommended. The design of the vehicle must provide sufficient protection to the driver's head in the event of a rollover, or collision.
- 26 **JUDGING**
- 26.1 **Team Action** – A significant technique to help teams not incur penalties is for the team to designate a liaison to inform the event official about what the team is going to do before the team does it! This includes how the team will deal with emergencies, intentions to trailer, plans to switch-out drivers, plans to make unspecified stops, etc.
- 26.2 **Judges**
- (1) These rules are in addition to, and do not contradict any existing rule.
  - (2) Each day, judges will be assigned, on a rotating basis, to solar teams. Teams must provide a seat in the chase vehicle with an unobstructed view of the solar car for the Team Judge. A judge (meaning the adult judge or the intern/judge) must remain in close proximity to the solar car at all times.
  - (3) Judges will be required to enforce all rules set out in the Rules or Appendices.
  - (4) Judges are prohibited from supporting or giving any tactical advice to a team during the event. Any judge violating this rule will be immediately removed from the event.
  - (5) Judges will make every effort to ensure that a team's radio communications will remain private, unless there is a safety issue involved.
  - (6) Judges must report their comments and penalties to the headquarters judge at the end of each event day. In addition, judges must report any favoritism shown to any team. A history of "errors" or poor record-keeping may cause a judge to be removed.
  - (7) Any team protest involving a judge must be filed no later than 9:00 PM on the day on which the alleged infraction occurred.
- 26.3 **A Team's Duty to their Judge on Cross-Country Events**
- (1) Provide lunch and water
  - (2) Provide appropriate "pit" stops
  - (3) Provide a seat in the chase vehicle with an unobstructed view of the solar car
  - (4) Provide respect
  - (5) Pick up your judge prior to getting your car out of Impound
  - (6) Provide your judge with information about what you are going to do *before* you do it!
- 26.4 **A Team's Duty to their Judge on Closed-Track Events**
- (1) Provide seat in the chase vehicle in the event that it is necessary to go on to the track.
  - (2) Provide respect.
  - (3) Pick up your judge prior to getting your car out of the impound.
  - (4) Provide your judge with information about what you are going to do before you do it.

## 27 PENALTIES

Any team failing to comply with the regulations will be penalized. Except for the last day of the event, all penalties will be posted at event headquarters by 12:00 PM (noon) the following day. On the last day of the event, penalties will be posted no later than one hour after the finish of the event. Penalties shall be rounded to the nearest complete lap for closed-track events.

- 27.1 **Disturbing Official Battery Seal** – A battery seal broken without official supervision, in a manner that would allow battery access, will result in the assessment of a 60 mile penalty.
- 27.2 **Replacement of Batteries** – Battery replacement will be penalized as provided in Section 18.1 of these regulations.
- 27.3 **Non-Solar Charging of Batteries** – Any team using an alternative means to charge their main solar car batteries during the event (other than utilizing solar energy or regenerative brakes) will be disqualified. Teams charging supplemental batteries are required to have an event official present to avoid any misunderstandings, and to prevent the application of this severe penalty.
- 27.4 **Failure to Comply with Stops** – Failure to comply with the mandatory stops during each day of the event will incur a 15 mile penalty for each infraction. Teams must drive the two miles preceding and following the Starting Line, the Finish Line, Mandatory Stops, and specified cities. In the event that a vehicle is mechanically unable to drive the two miles, and is in the process of being trailered, no penalty will be assessed *so long as the Team Judge feels that this would be in the best interest of safety*. A team failing to make a required stop forfeits any opportunity to receive that day's Daily Trophy.
- 27.5 **Failure to Allow Others to Pass** – Failure to pull over in accordance with Section 23 will incur a major penalty, as determined by the appropriate event official.
- 27.6 **Traffic Violations** – Any team committing a traffic violation will be penalized. All non-moving traffic violations will result in a 2.5 mile penalty. A moving traffic violation will result in a penalty ranging from 5 miles to disqualification. Any driver who commits two moving violations over the course of the event will be disqualified to drive.
- 27.7 **Failure to Attend a Drivers Meeting** – Failure to attend a driver/advisor meeting each day will incur a 5 mile penalty.
- 27.8 **Conduct** – An event official may assess penalties ranging from 2.5 miles to disqualification for improper or un-sportsman-like conduct. Such conduct may include, but is not limited to, disrespect to judges and staff, improper language, gestures, questionable attitude, cheating, and use of tobacco products, alcohol, or controlled substances.
- 27.9 **Failure to Comply with Regulations** – An event official may assess penalties ranging from 2.5 miles to disqualification for a team's failure to comply with any regulation, appendix, or *Rules Update* not otherwise specifically set out in these rules. "Failure to Comply with Regulations" includes both "in fact" and "in spirit" violations that create a danger to the event or its participants.
- 27.10 **Failure to Secure** – Teams failing to secure loose equipment before a convoy begins to move may be penalized up to 5 miles.
- 27.11 **Hats** – All participants must wear full-brimmed hats when in direct sunlight. Failure to wear the full-brimmed hat will incur a 1 mile penalty.

## 28 PROTESTS

Any team desiring to file a protest must do so by submitting a written statement and a \$50 protest fee. The protest must be filed with the Event Director. All protests will be heard by the jury. The decision of the jury is final and no further appeals will be allowed.

- 28.1 **Time Limit** – Except on the last day, all protests must be filed before 12:00 PM (noon) the day following the incident in question. On the last day of the event, the protest must be filed no later than one hour after the end of the event.
- 28.2 **Opportunity to be Heard** – Representatives from the protesting team will have the opportunity to present their point of view to the jury at the earliest opportunity.

- 28.3 **Protest Judgments** – If the jury rules in favor of the protesting team, it will notify the Event Officials to make the necessary adjustments, and return the protest fee. If the jury rules against the protesting team, it will notify the team of its ruling and take such action with the protest fee as it deems appropriate.
- 28.4 **Jury** – The jury will be composed of the event director and event staff (chosen by the event director).
- 28.5 **Meetings of the Jury** – The jury will meet at the event headquarters each day to consider any questions. It will convene at 9:30 PM, pending the duration of that day's racing. Jury hearings will be open to the public; jury deliberations will not be open to the public.
- 28.6 **Jury Jurisdiction** – The jury will judge protests on the following: (1) penalties assessed by event officials; (2) conformity of racing with event regulations; and (3) cases which the jury deems appropriate.
- 29 **ADVERTISING/PROMOTION/PUBLICITY** – All advertising/publicity produced by teams or their sponsors will refer to the event as Solar Car Challenge. By entering the event, all teams and drivers associated with the event agree to the use of their names and pictures in any publicity materials that may be issued by the event organizer.
- 30 **FILM CREWS** – Camera crews or reporters must respect the drivers and their space. These crews need to pay attention to their safety practices in order to prevent a hazardous condition on the road. Alternatively, team sponsors must be aware that the nature of the event attracts publicity, and must take all necessary steps to help prepare their team to handle the demands of the media.
- 31 **APPROPRIATE ACTIONS BY TEAMS** –
- (a) It is not appropriate for teams, advisors, or sponsors to solicit sponsorship during the event. Teams failing to follow this guideline will be disqualified.
  - (b) Schools participating within the Solar Car Challenge may be asked to provide a venue for workshops or other special events.
- 32 **RESPONSIBILITY TO CHECK RULES UPDATES** – It is the responsibility of every team to acquaint themselves with the specific *Rules Updates* for each event. The event organizer reserves the right to alter, amend, or delete any published rule so long as it gives fair notice in the published *Rules Updates*. Lack of knowledge of new or amended rules is no defense.
- Rules Updates* will be published on the SCC Internet site: <http://www.solarcarchallenge.org>.