



2017 Regulations

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Amendments to regulations:

This page is reserved for listing future amendments

1. Preface

1.1. Fundamental Vision – The United Solar Challenge (USC), recognized by the International Solarcar Federation (ISF), is held every two years in the Middle East and North Africa (MENA). The first USC, the Abu Dhabi Solar Challenge, was held in the United Arab Emirates in January 2015. The next competition, the Egyptian Solar Challenge, will take place in Egypt in March 2017. The USC seeks to promote and celebrate educational excellence and engineering creativity. Fueled by the spirit of friendly competition and teamwork, the USC champions the creative integration of technical and scientific expertise across a range of exciting disciplines.

1.2. Missions

- 1.2.A. The support and encouragement of bright young minds to succeed in the technical fields of engineering, the sciences, mathematics, and business, through multi-disciplined experiential learning which in turn enables success in future careers.
- 1.2.B. The encouragement of partnerships between international teams and institutions of higher learning in the USC host country to facilitate knowledge transfer and foster future collaboration to participate in other ISF events.
- 1.2.C. The creation of public awareness and enthusiasm, both for education excellence and engineering creativity itself, and for the technologies and practices that emerge from that excellence.

1.3. Acknowledgement

- 1.3.A. This document is based in part on the 2014 regulations developed by Innovators Educational Foundation (IEF) for the American Solar Challenge. The Organizers of the USC express their gratitude to IEF for their explicit permission to utilize their regulations as a basis for developing this document, and acknowledge IEF's intellectual ownership of the original regulations and any of its language contained herein.

2. Administration

- 2.1. **USC** – Global Education Energy Environment (Global EEE) shall be the official Organizer of the United Solar Challenge (the “Event”), and shall be responsible for all management oversight and application of the regulations for the Event.
- 2.2. **Headquarters** – During the Event, a Headquarters unit will be established at a site appropriate to each function and will assume the management functions for the Event.
- 2.3. **Officials** – A team of Officials to conduct the Event, including all event components, will be selected by the USC Organizers. Officials having specific duties shall be announced to the teams through Briefings.
 - 2.3.A. **Technical, Safety and Fairness Officials**
 - 2.3.A.1. Clerk of the Course (COC) – COC is responsible for supervising all on-road activities
 - 2.3.A.2. Inspectors – These individuals have the responsibility to scrutinize the solarcars to determine compliance with and to enforce the Regulations, prior to the qualifying event, as well as during the on-road component. The Inspectors will be led by an official who is the “Chief Inspector”.
 - 2.3.A.3. Regulations Manager (RM) – The RM shall be responsible for developing and maintaining the official Regulations and amendments in consultation with the Organizers, COC, and Inspectors.
 - 2.3.A.4. Observers – During the on-road portion of the Event a team of “Observers”, led by a Chief Observer, will monitor the progress of the teams and report back to the COC.

2.3.B. Protests and Appeals Judges

- 2.3.B.1. Procedure – The USC shall follow the ISF Recommended Procedures for Protests and Appeals document number ISF01-V1, first published in March 2015, which calls for the formation of an independent Tribunal of Judges.
- 2.3.B.2. Chief Judge – The Chief Judge shall be appointed pursuant to ISF01-V1 to preside over the deliberations.

2.4. Application of Regulations – These Regulations will apply to the United Solar Challenge, which includes the selection of teams, registration of teams, the inspection of solarcars (“Scrutineering”), the qualification of solarcars (the “Qualifier”), and the on-road competition (the “Event”).

2.5. Supplemental Documents

- 2.5.A. Additional documents may be distributed to all teams entered in the Event to supplement these Regulations. These documents will clearly state that they are a supplement to the Regulations and they will have the same force and effect as these Regulations.
- 2.5.B. If there is a conflict between a supplemental document and these Regulations, the document having the later date shall take precedence. The Organizers reserve the right to revise these Regulations at any time.

2.6. Acceptance of Regulations – All persons or groups selected to participate in the Event are assumed to know these Regulations. Their participation in the Event will constitute acceptance of the Regulations. Teams with cars that complied with regulations for ISF-sanctioned events between 2013 and 2016 but are unable to comply with all regulations for the Event should contact the Event Organizer. Exemptions may be granted if non-compliance with the Event does not give a competitive advantage or compromise safety.

2.7. Interpretation of Regulations

- 2.7.A. Operationally, the only group authorized to interpret the Regulations to teams are the COC and Inspectors, in consultation with the RM as needed.
- 2.7.B. Teams requesting an interpretation shall identify whether their question requires an Official Interpretation or an Unofficial Interpretation.
- 2.7.C. Official Interpretations will be responded to such that all teams will have access to the question and response.
- 2.7.D. Official Interpretations will have the same force and effect as the Regulations.
- 2.7.E. Unofficial Interpretations of the regulations will be kept private between the team and the Inspectors.
- 2.7.F. Unofficial Interpretations will have no force and effect on the Regulations and may be superseded, and may not be considered as evidence in Tribunal of Judges deliberations.
- 2.7.G. **Prior to Scrutineering:**
 - 2.7.G.1. Teams requesting interpretation of the Regulations shall submit their question(s) to the COC through email at COC@unitedsolarchallenge.org
 - 2.7.G.2. All Official Interpretations will be posted to the Internet under “Official Interpretations” on the USC website.
- 2.7.H. **During and after Scrutineering:**
 - 2.7.H.1. All Official Interpretations will be announced at Briefings, posted at Headquarters, and be available on the Internet.

2.8. Advertising, Promotion, and Publicity – All advertising, sales promotion, and publicity material produced by the teams or their sponsors concerning or referring to the Event will refer prominently to the Event by its official name. All teams, by entering the Event, specifically agree to abide by this regulation. By entering the Event, all teams and team members agree to the use of their names and their likenesses in any publicity materials (brochures, magazines, videos, photographs, etc.) that may be issued by the Event's sponsors or organizers or their agents.

3. Entries

3.1. Entry Registration – The Event is open to registered participants that are affiliated with an educational institution. Each team wishing to participate in the Event must submit a registration package consisting of the following:

- 3.1.A. Team Entry Form & Team Participation Agreement Form (see Reg. 3.2.B for submission deadline for this item),
- 3.1.B. The entry fee, \$3000 USD (\$1500 USD if paid prior to December 31, 2016). No team will be considered officially registered until the full registration package is received by USC Headquarters. The entry fee is non-refundable.

3.2. Registration Deadlines

- 3.2.A. **Registration Dates:** The registration process for the USC is not complete until USC Headquarters has received all documentation and the entire Entry Fee.
- 3.2.B. Initial registration package including participation agreement is due December 20, 2016.

3.3. Vehicle Design Information – Vehicle design information including technical documents describing the solarcar's mechanical systems, electrical systems, batteries, and solar cell technical information must be presented with the entry at scrutineering, representing the as-built design. **USC Headquarters will also accept, and strongly encourages,** early submissions of this information to help expedite the scrutineering process. Information may be sent as individual technical documents or as a complete package for review. The technical information provided in these documents will not be made public. The information contained in each team's final submission must match the solarcar presented at Scrutineering. *Safety should be a primary concern with regard to the development and fabrication of the solarcars.*

- 3.3.A. **Document Format:** Vehicle design information documents shall be formatted as a PDF.
- 3.3.B. **Mechanical Technical Information:** Mechanical technical information must be presented with the entry at scrutineering representing the as-built design, addressing:
 - 3.3.B.1. Design issues involved in impact, roll over and suspension scenarios.
 - 3.3.B.2. Vehicle stability, including center of gravity and relative weights on each wheel. Documentation with calculations and/or testing may be provided. Photos, drawings and references are acceptable.
- 3.3.C. **Electrical Systems Technical Information:** Electrical technical information must be presented with the entry at scrutineering representing the as-built design, addressing:
 - 3.3.C.1. A functional system diagram showing all essential power circuits and electrical equipment of the solarcar in schematic form. The drawing must include power generation devices (array, regen, etc.), power storage (batteries, etc.), switching and isolation mechanisms, battery protection systems, motor, motor controller, and any auxiliary circuits.
 - 3.3.C.2. Battery Approval Forms for each battery type.

- 3.3.D. Battery Tech Information:** All storage batteries used in the solarcar must be approved by USC Headquarters. Battery technical information must be presented with the entry at scrutineering representing the as-built design. Mass will be based on manufacturer's data. If an intermediate supplier is used, submit only the cell manufacturer's data as required on the Battery Approval Form. Please note the definitions included in Reg. 5.4.A. Each team must provide a copy of the manufacturer's battery specification sheet, the Material Safety Data Sheet (MSDS) obtained from the battery manufacturer, and a battery approval form with the following battery information in the technical information presented at scrutineering:
- 3.3.D.1. Manufacturer's name, and contact information
 - 3.3.D.2. Stock number, type, or description
 - 3.3.D.3. Cell & Module voltage (e.g., 1.2, 4, 6, 12, or 24 V)
 - 3.3.D.4. Bus voltage
 - 3.3.D.5. Number of modules to be used in the solarcar
 - 3.3.D.6. Manufacturer's specifications, including capacity (kWh) and mass (kg).
 - 3.3.D.7. Spill/damage protocols and procedures (if these are not provided in the MSDS then the team must obtain this information from the manufacturer and submit it to Headquarters with the MSDS)
 - 3.3.D.8. A description of the battery box(es) and their mounting. Include the chemical compatibility of the box material and the electrolyte in case of leakage
 - 3.3.D.9. Description of battery protection system per Reg. 5.4
 - 3.3.D.10. Battery Approval Form for each battery type.
- 3.3.E. Battery Protection Tech Information:** All batteries must be protected with technology appropriate to the chemistry used. Battery protection technical information must be presented with the entry at scrutineering representing the as-built design approach used with respect to Reg. 5.4 including the following information:
- 3.3.E.1. Over temperature set points (charge and discharge if different) for each battery type
 - 3.3.E.2. Under voltage set point for each battery type
 - 3.3.E.3. Over voltage set point for each battery type
 - 3.3.E.4. Over current set point for each battery type
 - 3.3.E.5. Diagram of the Battery Protection System (BPS) for each battery type
 - 3.3.E.6. Description of how the BPS will operate for each battery type.
 - 3.3.E.7. Firmware or settings will be rendered static and un-modifiable after inspection. Unauthorized modification of these settings after inspection may result in disqualification of the team.
- 3.3.F. Solar Cell Tech Information:** Solar cell technical information must be presented with the entry at scrutineering representing the as-built design. Each team must provide a copy of the manufacturer's solar cell specification sheet, and a copy of invoice for all solar cells included, with the following solar cell information in the technical information:
- 3.3.F.1. Manufacturer's name and contact information
 - 3.3.F.2. Stock number, type, or description
 - 3.3.F.3. Manufacturer's quote for cell area (cm²)
 - 3.3.F.4. Manufacturer's quote for performance

3.3.F.5. Area (cm²)

3.3.F.6. A detailed layout map of the vehicle, showing all cell types/sizes and locations, as well as calculations of total area.

- 3.4. Use of Team Technical Documentation** – Team documents are submitted to give inspectors a general preview of what to expect at Scrutineering. Inspectors will use the documents during Scrutineering for clarification. No information in the technical documents will be released.
- 3.5. Team Data** – Each team must submit a team photo and data sheet to USC Headquarters by January 15, 2017. The photo and data will be publicly released and used in Event brochures. Late submissions will be omitted. Early submissions will not be made public prior to March 1, 2017 without permission of the team representative.
- 3.5.A. **Team Photo:** The team photo must clearly show the solarcar and team members. Team members in the photo must be identified by name and by their institution(s) (when there is more than one institutional sponsor). The photos will be used in USC programs and other publications. Additional instructions will be provided.
- 3.5.B. **Data Sheets:** The data sheet must include solarcar mass (Event-ready, without driver), solarcar dimensions, motor type and rating, solar cell type and manufacturer, estimated peak solar array power in competition configuration (overhead sun, clear sky), battery mass and estimated capacity, chassis description, braking system, and wheel type and size. All specifications must be provided in metric units (SI). The team leader, crew members, designated drivers, and faculty advisor(s) must also be listed.
- 3.6. Participant Registration** – All participants in the Event must be registered with USC Headquarters. This includes team members, sponsors, officials, guests, and the media. All participants must present themselves at Registration to complete all required forms. Badges will be issued and used to obtain access to restricted areas. These badges must be visible at all times.
- 3.7. Faculty Advisor** – The team must have at least one faculty advisor who will provide guidance as needed throughout the solarcar design, building, and testing process. The faculty advisor will be the official contact between the Event and the Institution.
- 3.8. Communication** – English is the official language of the Event. Teams will designate a Project Manager to manage communications with USC Headquarters. Correspondence between the team and the headquarters shall be through the designated individual and the Faculty Advisor or their designees.
- 3.9. Driver Requirements** – Only registered solarcar drivers will be allowed to drive the solarcars during the Event. Each team shall have a minimum of two drivers available at all times and may register at most four drivers.
- 3.9.A. Solarcar drivers must be 18 years old or older and must present a valid driver's license. All drivers will submit an information form and a copy of their driver's license at Registration, before Scrutineering. Teams are responsible to review the requirements for driving a vehicle in Egypt and must ensure that the driver's license issued by their home country is acceptable and complies with Egyptian visitor driver law.
- 3.9.B. The official mass of each driver, including driving clothes (shoes, helmet, with empty pockets), will be 80 kg. If a driver weighs less than 80 kg, ballast will be added to make up the difference. If a driver weighs more than 80 kg, no credit will be given.
- 3.10. Insurance** – All teams need to maintain vehicular liability and general public liability insurance with limits of liability for:
- (1) bodily injury of not less than US\$1,000,000.00 for each person and US\$1,000,000.00 for each occurrence, and for

(2) property damage of not less than US\$1,000,000.00 for each accident and US\$1,000,000.00 in the aggregate.

Teams will be required to provide a certificate of such insurance or proof of commensurate self-insurance by February 25, 2017.

3.11. Solarcar Markings

3.11.A. **Car Numbers:** Each team registered for the Event will have a unique number approved by USC Headquarters (positive integer, 3 digits maximum). This number must be clearly displayed on both sides of the solarcar and clearly visible from a distance of 3 m perpendicular to the side of the vehicle at a viewing height of 1.8 m above ground. Each number must have a minimum of 50 mm of unobstructed background color on all sides. These colors can be black on white, white on black, or another high-contrast color approved by USC Headquarters. The numerals themselves must be a minimum of 250 mm high, 120 mm wide (except the numeral one), and have a minimum brush stroke of 40 mm. Numbers containing more than one digit must have a minimum of 25 mm spacing between the digits.

3.11.B. **Institution Name(s) & Sponsors:** The name of the Institution(s) hosting the team must be clearly displayed on both sides of the solarcar and clearly visible from a distance of 3 m perpendicular to the side of the vehicle at a viewing height of 1.8 m above ground. Additional placement of the Institution(s) name on the nose of the car is also accepted but does not relieve obligation for placement on the sides of the solarcar. USC Headquarters must approve the use of abbreviations or initials. The Institution's name shall be larger and more prominent than any team sponsor logo or name. Additional graphics related to a team's institution(s) or sponsors are permitted, provided they are neither offensive nor disruptive.

3.11.C. **Logo:** The Event logo must be applied on both sides of the solarcar. The logo will be provided by USC Headquarters and will measure no more than 200 mm in height by 500 mm in width. The event logo shall be clearly displayed on both sides of the solarcar and clearly visible from a distance of 3 m perpendicular to the side of the vehicle at a viewing height of 1.8 m above ground.

3.11.D. **National Flag:** The national flag of the country of the team must be displayed on both sides of the solarcar adjacent to the windscreen. A minimum size is 70 mm by 40 mm.

4. Event Components

4.1. Scrutineering

4.1.A. **Acceptance at Scrutineering:** Only teams who have submitted approved Technical Submissions and who have paid the required Event fee will be accepted for Scrutineering.

4.1.B. **Participation at Scrutineering:** Each team registered for the Event must submit their entry for inspection prior to the Qualifier to verify compliance with these Regulations. In addition, spot checks for regulation compliance may take place during and immediately after the Qualifier and Event.

4.1.C. **Time and Location:** The date and location of Scrutineering for the Event shall be posted on the Event website. Teams with Green status on all their Technical Submissions prior to Scrutineering will be given preferential slots for Inspection. The order of inspection for the remaining teams will be determined by drawing. Teams that fail to present their solarcar at their designated time will drop to the back of the queue and risk not having enough time to complete the Scrutineering process. Additionally,

teams failing to participate in mandatory team meetings may be given last priority for Scrutineering and risk not having enough time to complete the process.

- 4.1.D. **Scrutineering Format:** Scrutineering will involve inspection stations for body & sizing, driver, electrical, battery protection, array, mechanical, dynamic tests to verify handling and braking performance, safety, and support vehicles. Instructions for Scrutineering and a detailed description of the Scrutineering tests will be distributed in advance to all registered teams.
- 4.1.E. **Configuration and Drivers for Scrutineering:** All Drivers must be present for designated scrutineering inspection stations. The driver selection and car configuration are at the discretion of the inspectors for each station. Teams may be required to repeat tests with different drivers and/or configurations as directed by the inspectors.

4.2. Qualifier

- 4.2.A. **Participation at Qualifier:** Each team must successfully participate in a *hot lap* Qualifier before they will be allowed to compete in the Event. The date and location of the Qualifier(s) for the Event will be posted on the Event website. Additional qualifying regulations will be provided to registered teams.
- 4.2.B. **Acceptance at Qualifier:** Only teams who have obtained Green status for each Technical Inspection Station will be accepted at the Qualifier.

4.3. The Event – The Event is an on-road event that is open to teams who have met all Scrutineering requirements, successfully passed the Qualification requirements and submitted all required forms and fees. Section 7 of these Regulations outlines the format for the Event.

4.4. Safety – Each team is responsible for the road-worthiness of its solarcar. Passing Event components of Scrutineering and the Qualifier or implementing changes suggested in comments on the team's technical documents does not relieve the team of any liability. All solarcars and support vehicles must be maintained in a safe, road-worthy condition and be operated safely at all times. A team may be disqualified and withdrawn from the Event at any time if it is judged to be operating in an unsafe manner.

Each team is responsible for the safety of its members, and any minimum criteria specified by the Organizers via these regulations and/or correspondence between the teams and the Organizers should not be construed as design specifications for the construction of a "safe" solar vehicle. These regulations represent a minimum requirement in terms of safety in the design, fabrication and operation of the solarcar.

- 4.4.A. Team Safety: Each team is required to have at least one member who is designated as the Team Safety Officer.
 - 4.4.A.1. The Team Safety Officer shall be trained in basic First Aid, including CPR.
 - 4.4.A.2. Proof of training needs to be submitted to USC Headquarters with their Team Data Sheet (available on the Event website).
 - 4.4.A.3. At least one member trained in basic First Aid and CPR will travel in the Lead or Chase Vehicles while the Solarcar is on the road. It is encouraged to have more than one team member who is trained in basic First Aid including CPR.

4.5. Withdrawals – Any team wishing to withdraw must notify USC Headquarters in writing. All written withdrawals signed by the team representative (Faculty Advisor/Project Manager) are final.

- 4.5.A. USC Headquarters may withdraw teams that do not meet the technical document deadlines or fail to present a solarcar at Scrutineering or the Qualifier.
- 4.5.B. Exclusion will occur if the Officials deem a team to have departed from the spirit of the Event by deliberately acting to gain unfair advantage over other teams.

5. Electrical

5.1. Power – Natural solar radiation received directly by the solar array is the only source of energy that can be used for propulsion, except for energy stored in the solarcar's battery system at the beginning of the first day of racing. Energy recovered from the motion of the car on the race route may also be used.

5.2. Solar Array – Solar Arrays cannot exceed a maximum of the size listed in Reg. 5.2.B, or the dimensions referenced in Reg. 6.1. Solar Arrays will be measured by summing the total area of each solar cell (including all exposed bus bars, junctions and internal structure) from manufacturer's data sheets, validated through measurements. All portions of the solar array and all electrical connections between the solar array and the solarcar must be carried by the solarcar.

5.2.A. Cell Type: Only solar cells which fall into the following cell types may be used:

5.2.A.1. Cell Type 1 – Silicon based solar cells

5.2.A.2. Cell Type 2 – GaAs or multijunction solar cells.

5.2.B. Solar Array Size Limits:

5.2.B.1. Cell Type 1: The solar array area must be no more than 6.000 m².

5.2.B.2. Cell Type 2: The solar array must be no more than 3.000 m².

5.2.B.3. For an array with a mix of Cell Types as defined above, the total area allowable will be based on an area ratio calculation. Any team pursuing this option must contact USC for determination of the total allowable area. *(The maximum area will be the summation $A_1 + A_2$ where A_1 is the area of cells of Cell type 1 and A_2 is the area of cells of Cell Type 2, and $A_1 + 2 A_2 < 6.000 m^2$)*

5.2.C. Maximum Number of Cell Types: Teams may use no more than six (6) types or sizes of solar cells.

5.2.D. Validation Documentation: At Scrutineering, teams must provide sample cells of each type and size installed on the vehicle as well as a detailed map of the vehicle array for validation per Reg. 3.3.F. Teams may also choose to submit sample cells to USC Headquarters prior to the Event with their Vehicle Design Reports to assist in the validation of their Solar Cell Tech Information.

5.3. Energy Storage – All solarcars are allowed to store solar-generated energy in an energy storage system composed of individual cells having a mass determined by the technology used. Adherence to mass limitations does not imply automatic battery approval. Battery approval forms must be submitted to USC Headquarters before official approval may be issued. The Inspectors reserve the right to refuse approval of modules. Unaltered samples of individual cells (minimum of 3) must be furnished to inspectors by the team for verification during Scrutineering.

5.3.A. Battery Mass Limits: Cars are limited to the following amounts of commercially available battery technologies:

Sealed Pb-Acid 125 kg

NiMH 70 kg

LiFePo₄ 40 kg

Li-Ion 20 kg

Li-Polymer 20 kg

- 5.3.B. **Other Energy Storage Methods:** Other energy storage technologies not mentioned (such as other battery technologies or fuel cells) will need to be evaluated by USC Headquarters. Samples and details of proposed systems must be submitted before the date indicated in Reg. 3.2.B.
- 5.3.C. **Supplemental Batteries:** Supplemental, replaceable batteries carried in the solarcar may be used to power: main disconnect relay, radios, commercially available electronic panel meters with internal batteries, cell phones, driver ventilation fans (if solely used for driver ventilation), and the horn. Supplemental battery power may be used to momentarily power the battery protection system as defined by Reg. 5.4 to verify safe battery parameters before energizing the main power switch.
- 5.3.D. **Other Storage Devices:** If any other energy storage devices are used (Reg. 5.3.B), they must be shown to be storing no energy and fully discharged before the start of each Event day.

5.4. Protection Circuitry

All batteries must have protection circuitry appropriate for the battery technology used. Proof is required at Scrutineering that the protection system is functional and meets manufacturer's specifications. Testing procedures will be provided, and the protection system design should allow for such testing. All measurement leads should be fused or current limited to less than 1 mA for non-isolatable sinks in the measurement circuitry. All protection circuitry should be contained in the battery enclosures per Reg. 5.5.

5.4.A. Definitions:

- 5.4.A.1. **Cell:** The smallest available source of energy in the battery pack as purchased from a manufacturer. A single electrochemical cell.
- 5.4.A.2. **Module:** The smallest easily removable group in a battery pack.
- 5.4.A.3. **String:** The smallest group of cells needed in a battery pack to provide the required voltage.
- 5.4.A.4. **Protection Limit:** The measured level determined to be adequate to protect from an event.
- 5.4.A.5. **Active Protection:** System in which measurements are constantly monitored and where actions are taken immediately without operator intervention. Any protection faults will latch such that a manual clearing process is required by the diver with the vehicle not in motion and only after faults have been verified clear by the protection system.
- 5.4.A.6. **Passive Protection:** System in which measurements are monitored by the driver and where action is driver controlled.

5.4.B. Types

- 5.4.B.1. **Li-Based:** All lithium based battery packs must have **active** protection such that over-voltage, over-temperature (for charge and discharge rating), over-current and under-voltage cause the pack to electrically isolate the source or sink from the battery pack. The level of protection measurement is required down to the module level at a minimum and may be required at a cell level depending on the cell manufacturer. Fuses are not acceptable for over-current protection of lithium based battery packs, but are required as per Reg. 5.6.
- 5.4.B.2. **Ni-Based:** All nickel based battery packs must be protected from over-temperature and over-voltage. Active Protection is not required but recommended if Passive Protection is unavailable.

- 5.4.B.3. **Pb-Acid:** All lead based battery packs must be protected from over-voltage. Minimum of passive protection is recommended.
- 5.4.B.4. **Supplemental:** All supplemental batteries must have at a minimum Passive Protection for under voltage where charging occurs remote to the solar vehicle unless they are primary cells. Active Protection is required if charging is within the solar vehicle.

5.5. Battery Enclosures – All registered and sealed battery modules, battery protection circuitry per Reg. 5.4, and main fuses per Reg. 5.6 must be fully contained in enclosures that are electrically isolated from the solarcar. The enclosures must be constructed from non-conductive, electrolyte-resistant material. No more than two separate such enclosures may be used. Enclosures must be designed such that they can be removed from the vehicle and placed in impound per Reg. 7.16.

- 5.5.A. **Isolation:** The resistance measured between the battery terminals and any portion of the solarcar chassis shall be greater than 1 MΩ for applied potentials up to 500 V. Any covers allowing access into the enclosures must be firmly secured.
- 5.5.B. **Mounting:** The battery enclosures must be secured to the solarcar chassis so as to prevent them or the modules within from coming loose in the event of an accident or rollover. Nylon luggage type buckles are not acceptable means of securing the battery enclosure.
- 5.5.C. **Marking:** The top of each battery enclosure must be marked using 10 mm high letters with “Caution: Chemical Hazard” and “High Voltage” and any other standard hazard markings specific to the type of battery enclosed. The type (i.e. Li-ion, Pb-Acid) of the battery must be marked on the top of the battery enclosures in 10 mm high letters.
- 5.5.D. **Ventilation:** Battery enclosures must be equipped with a forced ventilation system rated at a minimum of 280 L/min exhaust flow. Such ventilation systems should pull exhaust to the exterior of the solarcar and must be powered by the battery system. It must operate whenever the battery system is electrically connected to the solarcar or to the solar array. In the event of a Battery Protection Trip provisions should be made to power this fan from the Supplemental battery.
- 5.5.E. **External Cooling:** External supplementary cooling of the battery pack is not permitted beyond the ventilation requirements listed in Reg. 5.5.D unless the external cooling is powered by the main battery pack, or in an emergency situation.
- 5.5.F. **Security:** Battery enclosures must not be opened during the Event without Inspector support. To preclude unauthorized access to the battery enclosure, a seal will be placed to indicate contravention of this regulation. Provisions must be made by the team to seal the battery enclosure. Should access to a “sealed” battery enclosure be needed, the team needs to inform their Observer of their intent to access the battery enclosure, and request the Observer to log the activity and retain the seal.

5.6. Main Fuse

- 5.6.A. **Main:** A DC-rated fuse (or proper DC, time-delay, and current rated circuit breaker) must be placed first in series with the battery starting at the positive connection for each battery enclosure. The fuse rating must not exceed 200% of the maximum expected current draw or 75% of the rated wire current capacity.
- 5.6.B. **Branch:** All other wiring size off the main bus circuit must have properly sized fuses.
- 5.6.C. **Voltage Taps:** All battery protection circuitry (BPS) measurement leads or voltage taps off the battery must be fused or current limited to less than 1 mA for non-isolatable sinks in the Battery Protection or measurement circuitry.

5.7. Power Switch

5.7.A. Main Power Switch: The solarcar must be equipped with a single throw manually operated, high current and DC-rated, multiple pole switch to quickly isolate the battery, motor, and array from each other and the electrical system of the vehicle. This switch must be capable of interrupting the maximum DC-rated voltage and the full load current. Relays or contactors used for this purpose must also be DC-Rated, normally open, and non-latching. Power for the relay may be supplied by Supplemental batteries per Reg. 5.3.C. MOSFETs or other solid state switches that could fail in a closed circuit state are not acceptable for power switches.

5.7.A.1. Location: The switch must be located within easy reach of the driver in normal driving configuration.

5.7.A.2. Marking: The switch must be plainly marked in letters at least 10 mm high as the "Power Switch" with "ON" and "OFF" designations. These markings must be clearly visible to the driver inside the solarcar and to rescue personnel outside the solarcar. Use two sets of markings if necessary.

5.7.B. External Power Cut Off Switch: The solarcar must be equipped with an electrical cut-off switch that can be externally activated in emergency situations. This switch must meet the electrical requirements of Reg. 5.7.A and may be the same switch as in Reg. 5.7.A, provided it can meet all the requirements for both sections.

5.7.B.1. Location: The switch may be actuated remotely using a mechanical linkage or electrical relay. The switch actuator must be located on the exterior of the car, on an upper surface of the car, near the cockpit on either side of the driver. The switch actuator must be designed such that it can be operated instantly by someone unfamiliar with the car.

5.7.B.2. Marking: This external switch actuator must be clearly marked by the international marking of a red spark within a white-edged blue equilateral triangle, with a minimum side length of 150 mm. In addition, clear directions how to open the switch must be displayed using letters (10 mm minimum height). Non-limiting examples of such directions would include PUSH, PULL, or OFF with another arrow pointing in the correct direction of actuation.

5.7.B.3. Cover: If the switch is covered then the team must demonstrate that the cover can be quickly removed without tools or excessive force, or that the switch may be activated normally, without tools or excessive force, through the cover. The cover must be labeled in such a manner (10 mm minimum letter height) as to simply direct the user as to how either remove the cover or how the switch can be activated through the cover. The blue triangle marking may be located on the cover, but must not obstruct the view of the switch or actuator.

5.8. Cables

5.8.A. Cable Sizing: All electrical cables must be properly sized for expected system currents.

5.8.B. Umbilical Cords: Any umbilical cable which connects the solar array to the solarcar (of any length for static charging) shall be carried in the solarcar at all times while the solarcar is in motion.

5.9. Lighting

5.9.A. Position: Solarcars must have amber front turn indicators, amber side turn indicator marker light, red or amber rear turn indicators and red brake lights.

5.9.A.1. Front turn indicators must be located at the front of the vehicle at a distance at least 25% of the overall vehicle width away from the vehicle centerline and at a distance no further back than 175 mm from the absolute front of the vehicle.

- 5.9.A.2. Side marker turn indicators are recommended to be mounted on each side of the vehicle between 20% and 30% of the vehicle length rearward from the absolute front of the vehicle.
- 5.9.A.3. Rear Brake lights and rear turn indicators must be located at the rear of the vehicle and at a distance at least 40% of the overall vehicle width away from the vehicle centerline and at a distance no further forward than 175 mm from the absolute rear of the vehicle. It is permissible to have one set of lights per side of the car which operate as both the brake lights and turn indicators. The turn indicator operation has the priority in operation.
- 5.9.A.4. A third high mounted brake light is recommended to be located at the rear of the vehicle canopy at an elevation of not less than 700 mm above ground.
- 5.9.B. **Visibility:** All indicators must be clearly visible from 30 m and shall be brighter than a reference standard as defined in Appendix C. All lights required in Reg. 5.9 must be of the same brightness standard.
- 5.9.C. **Viewing Angle:** The geometric visibility of each individual light shall be as follows:
 - 5.9.C.1. Turn Indicators: 30° from center in both directions and 15° up from horizontal.
 - 5.9.C.2. Side Marker Turn Indicators: 60° from perpendicular to the centerline of the vehicle in both directions and 15° up from horizontal.
 - 5.9.C.3. Rear Brake and Turn Indicators: 30° from center in both directions and 15° up from horizontal.
 - 5.9.C.4. High Mounted Rear Brake: 30° from center in both directions and 15° up from horizontal.
- 5.10. Emergency Hazard** – The front turn indicators, side marker turn indicators and rear turn indicators shall be able to be activated simultaneously in an Emergency Hazard format.
- 5.11. Horn** – Solarcars must be equipped with a horn that can be heard at a sound power level between 75 and 102 dBA at a distance of 15 m in front of the solarcar. The horn must be permanently mounted and operated from the steering wheel. Horn must be able to operate for up to 5 minutes continuously at the required volume.
- 5.12. Accelerator** – Accelerator mechanisms on solarcars must be free moving, and when released must return to the zero position. If the solarcar is equipped with cruise control, it must be designed with an automatic shut-off when the brake is activated.
 - 5.12.A. **Pedal Accelerators:** if a pedal accelerator is used, it shall be mounted such that it is operated by the right foot and it shall be located to the driver's right of the brake pedal (if equipped).
- 5.13. Control** – Vehicle operation must be under the sole control of the driver.
- 5.14. Electrical Shock Hazards** – All exposed or easily exposed conductors, junction boxes, solar cells, etc., operating at greater than 32 V must be protected from inadvertent human contact and must be marked "High Voltage" in letters at least 10 mm high.
- 5.15. Water Spray** – Ambient-temperature water from an external source may be applied to the solar array using hand-pumped sprayers (of maximum volume of 5 gallons) if the water is applied while the solarcar is stationary and the application does not present a shock hazard.

6. Mechanical

6.1. Solarcar Dimensions – The solarcar (including solar array) may not exceed the following maximum dimensions when moving under its own power:

Length = 5.0 m

Height = 1.8 m

Width = 1.8 m

When turning corners, wheels and wheel fairings may exceed these dimensions.

6.1.A. Charging Configuration: When stationary, the solarcar body may be split into a maximum of two major components to maximize solar exposure for charging. Each component must not exceed the assembled dimensions of the solarcar.

6.1.B. Operational Configuration: While the vehicle is moving under its own power, reorientation and reconfiguration of wheel fairings and other aerodynamic devices is allowed, however, reorientation or tilting of the solarcar body is prohibited.

6.2. Body Panels – All moving or removable body panels and the array must be securely fastened to prevent unintended movement.

6.2.A. Covers and Shields: All moving parts must be suitably covered to prevent accidental human contact when the solarcar is fully assembled. The driver must be shielded from contact with all steering linkage and other moving parts.

6.2.B. Clearance: Interference or rubbing of the wheels with the solarcar's body, wheel well, or structure at full steering lock or suspension travel is not permitted. Movement of rod-end bearings may not be obstructed in any axis throughout the full travel of suspension and steering. Other moving parts, such as the motor shaft, must not contact stationary parts except through properly designed bearings. All wheels and their suspensions, steering linkages and geometries will be inspected for safe operation in normal and adverse conditions.

6.2.C. Array Attachment: The array must be positively secured to the vehicle structure. Taping around the array/vehicle interface is acceptable but cannot be the primary means of securing the array. If backup lanyards are incorporated, the team must demonstrate that this does not pose additional safety problems should the array separate from the vehicle and the only means of attachment are the lanyards.

6.3. Tire and Wheel Requirements

6.3.A. Wheel Configuration: The solarcar may have either three or four wheels. A minimum of three tires shall be in contact with the ground at all times.

6.3.A.1. A three-wheel vehicle shall be arranged such that two wheels are symmetrical around the vehicle centerline, and the vehicle center of gravity is between these two wheels and the third wheel.

6.3.A.2. A four-wheel vehicle shall be arranged such that the front wheels and rear wheels are symmetrical around the vehicle centerline.

6.3.A.3. The distance between the front wheel contact patches and the distance between the rear wheel contact patches (for a four wheel vehicle) must both be not less than half the maximum width of the solarcar.

6.3.B. Design Intent: The wheels and tires must be designed for the intended application and able to withstand the loads and forces imparted by the vehicle's mass, speed capability, and braking potential. Each wheel and tire on a single axle must be rated for the full weight applied to that axle.

- 6.3.C. **Tires:** Tires shall be loaded and inflated within the manufacturer's rating at all times during vehicle operation. If the tire deemed to be a tube-type tire as per the manufacturer's specification, the appropriate tire tubes shall be used.
- 6.3.D. **Wheels/Rims:** The rim profile must be shown that it is in accordance with (or matches) the bead requirements of the tire as specified by the tire manufacturer.
- 6.4. Driver Cockpit –** The driver's cockpit may not subject the driver to excessive strain during normal operation, and must be designed to protect the driver from injury in the event of an accident. The driver must be provided adequate space for safe operation of the vehicle.
- 6.4.A. **Seating Position:** The driver must be seated at less than or at a 27° angle, as measured in Appendix B. The driver's head must be above and behind the driver's feet. The seat must be appropriately constructed with a solid base and back rest.
- 6.4.B. **Belly Pan:** The cockpit must be equipped with a full belly pan to isolate the driver from the road. The belly pan must be strong enough to support the full weight of an 80 kg driver. The driver's torso and limbs must be above the lower element of the structural chassis.
- 6.4.C. **Safety Belts:** All solarcars must be equipped with a minimum of a 3-point lap and shoulder belt harness system for the driver.
- 6.4.C.1. The use of safety belts is mandatory.
- 6.4.C.2. The safety belts must be attached securely to the structural chassis, as recommended by the manufacturer.
- 6.4.C.3. The placement of the attachment points for seat belt harnesses that pass through slots in the seat back shall be such that a slightly downward slope is obtained for the seatbelt coming off the driver's shoulders in order to have a downward component of force on the driver's torso that will hold the driver in the seat in the event of a roll over. The resulting attachment points for the shoulder harnesses must be within the manufacturer's specification.
- 6.4.C.4. If the belt passes through the seat, it must pass through without wrinkling, crimping or bending the belt excessively. All sharp edges shall be removed or covered to prevent cutting or fraying of the belt.
- 6.4.C.5. Safety belt systems manufactured to SFI 16.1, SFI 16.5, UNECE Regulation 16 or US FMVSS 571.209 (or equivalent), and display the appropriate compliance marking, are allowed. The manufacturer must approve any modifications in writing.
- 6.4.D. **Structural Chassis:** The combination of the solarcar structural chassis and safety roll cage must encompass the entire driver in all directions. No part of the driver may be positioned outside of the structural chassis and roll cage combination.
- 6.4.D.1. All vehicles shall be constructed to protect, as far as is reasonably possible, the occupant(s) in the event of collision or vehicle roll-over. Steps should be taken to ensure that vehicle components, accessories or other components do not impinge on the occupants' space.
- 6.4.D.2. The safety roll cage and attachment and integration of the safety roll cage to the structural chassis shall be designed for a minimum of a $5 m g$ load from all directions, where m is the total gross mass of the vehicle including driver and ballast and $g = 9.8 \text{ ms}^{-2}$.
- 6.4.D.3. The protection provided for the driver in a collision must be documented in the team's Mechanical Technical Information as per Reg. 3.3.B.

- 6.4.E. **Outside Air Circulation:** Outside air, from intake vents and directed towards the drivers face, must be provided. Teams are advised to augment the natural air-flow rate with a ventilation fan.
- 6.4.F. **Egress:** The driver's cockpit must be designed to allow the driver to exit the vehicle unassisted.
- 6.4.F.1. Such egress openings must be able to be secured and released from both the inside and outside of the vehicle and may not be sealed or secured with adhesive tape at any time.
- 6.4.F.2. Teams will be required to demonstrate that the driver can exit the vehicle unassisted, standing clear of the car, in no more than 15 seconds.
- 6.4.F.3. The solarcar shall not be chocked during the egress test.
- 6.4.F.4. The perimeter of the egress opening shall be clearly marked with a 25 mm wide stripe that is of a high contrast color. The external canopy release shall be marked with letters "OPEN" with a minimum height of 20 mm in the same high contrast color as the egress opening marking.
- 6.4.G. **Number of Occupants:** The solarcar shall be configured for only a single driver without passengers.

6.5. Visibility

- 6.5.A. **Eye Height:** In the normal driving position with ballast on board, the driver's eyes must be at least 700 mm above the ground.
- 6.5.B. **Forward Vision:** From the normal driving position, the driver must be able to see at all times, without artificial assistance, points at the following locations:
- a point on the ground 15 m in front of the solarcar
 - a minimum of 17° above the horizon on level ground
 - a full 100° to either side of center.

The driver will be required to identify 40 mm high letters at a distance of 3 m through any of the required viewing angles.

Some elements of the roll cage may obstruct a portion of the forward vision. However, this view must be essentially unobstructed as much as is reasonably possible by the solarcar structure.

- 6.5.C. **Windshield:** All solarcars must have a windshield made of shatter-resistant material. The windshield must be free of excessive distortion. The windshield should not be tinted to the extent that the driver cannot be clearly observed from outside the solarcar.
- 6.5.D. **Rain Clearing:** Solarcars must have a method to clear the windshield from any falling rain or water from spray such that the vision requirements of Reg. 6.5.B can be met. The clearing method must be operable at all times and must be in use when it becomes necessary to use the windshield wipers on the team's support vehicles.
- 6.5.E. **Rear Vision:** All solarcars must be equipped with a rear view system that at all times will allow the driver to see a vehicle 15 m directly behind the solarcar and up to 30° off center. The system must provide the driver with a single reflex type image and must operate without driver input. The driver will be required to identify the direction of an arrow with a 200 mm thick brush stroke on a 1 m² board held about 1 m off the ground.
- 6.5.E.1. The camera and view screen shall be fixed in position such that road bumps and vehicle vibration will not alter the viewing angles.

6.5.E.2. The view screen shall be positioned such that the driver shall be able to see the view screen while seated in normal driving position.

6.6. Ballast – Any solarcar driver weighing less than 80 kg will require ballast to bring his or her mass to 80 kg as per Reg.3.9.B. Ballast mass will be measured into canvas bags provided by USC Headquarters. Teams will provide their own material for ballasting purposes.

6.6.A. **Ballast Bag:** Each registered solarcar driver will be allowed up to two bags to contain his/her required ballast (two containers are allowed if a common ballast container is used). Containers will be a single canvas bank (coin) bag with dimensions of 305 mm x 482.5 mm. Ballast must be able to be contained within the canvas bag allowing security seals to be applied. Consideration should be made to ensure that full ballast bags will be mechanically secured to a major structural member of the car.

6.6.B. **Common Ballast Bags:** Should a team elect to use a common ballast bag, then each solarcar driver shall have two ballast bags (an individual bag) and the common bag. The sum of the two ballast bags shall be equal or greater than the ballast required to bring the drivers mass up to 80 kg as per Reg.6.6.

6.6.C. **Carrier:** it is preferred that each solarcar have either one (1) or two (2) ballast boxes. Each box shall have a lid, which is secured closed for carrying ballast. The carrier must be securely fastened to a structural member of the solarcar and/or be demonstrated to hold the ballast fixed in the event of an impact. Teams choosing not to implement the use of a ballast box must demonstrate how full ballast bags will be mechanically secured to a major structural member of the car, and removed for driver changes.

6.6.D. **Common Ballast:** Common ballast will be secured, fixed and sealed in position at the start of the event.

6.6.E. **Ballast Access:** The ballast container (and sealed ballast box if applicable) and its identification and security markings must be visually accessible by the observer during driver changes.

6.6.F. **Ballast Type:** Removable ballast types allowed shall be steel or lead shot or coin only. All other types of ballast will not be allowed. Consideration should be made with respect to the density of material selected and a driver's mass to ensure that the required ballast needed will fit into the container provided. Common ballast may be monolithic metal such as lead but will need to fit into an official ballast bag before being attached to the frame.

6.7. Fasteners – All fasteners must be of suitable type, strength, and durability for their application. Friction or press fit assemblies will not be accepted in critical areas as the sole means of retention. Set screws intended to transmit torque or force will not be accepted. Fasteners must meet the following minimum requirements:

6.7.A. **Bolts:** Bolts used in critical areas must at minimum meet SAE grade 5, metric grade M8.8 and/or AN/MS specifications, or proof of appropriateness of alternatives must be supplied. Bolts must be of the correct length, and extend at least two threads beyond the nut. Bolts in tension must not have shaved or cut heads. All fasteners should be properly torqued.

6.7.B. **Securing of Fasteners:** All structural and other critical fasteners (bolts, nuts) must have an acceptable form of securing such that the fastener cannot loosen or be removed unintentionally. Acceptable methods of securing are:

- Bolts with flex-loc type nuts or other nuts that use flexure as the means of locking and are reusable.
- Bolts with pre-drilled shafts and castle nuts with cotter pins installed to prevent loosening
- Bolts with pre-drilled heads and/or nuts properly safety wired with stainless steel wire from 0.024" (0.6 mm) to 0.032" (0.8 mm) diameter conforming to Mil Spec MS20995C. The safety wire between fasteners and anchor points must be twisted to prevent loosening

rotation of the fastener.

- In blind hole applications, bolts with pre-drilled heads properly safety wired

Securing methods that are not acceptable are Nylon lock nuts, "lock" washers, Loctite, or lock nuts that use thread distortion as a means to securing the nut. Lock nuts with thread distortion are not considered to be re-usable. Other methods of securing fasteners where the above methods are not appropriate may be considered at the discretion of the Inspector. Non-critical fasteners need not be secured with lock nuts.

- 6.7.C. **Securing Rod Ends:** All rod ends shall be secured with jam nuts tightened with sufficient torque to prevent the rotation. The jam nuts on rod ends do not need to be safety wired.
- 6.7.D. **Buckles and Straps:** Plastic luggage type buckles or plastic single push release straps are not considered acceptable means of securing any Critical Area. If nylon type straps are used in securing any Critical Area, ratchet or cam type straps may be used.
- 6.7.E. **Critical Areas:** For application of the above, critical areas are defined to include: steering, braking, suspension, seat mounts, safety harness, drive train, battery box, and ballast carrier.

6.8. Brakes – Solarcars must have a balanced, co-reactive, dual braking system so that if one system should fail, the solarcar can still be stopped. The two systems must be operationally independent and may be either front/rear or redundant front or rear (one-sided systems, left or right, are not permitted). Hydraulic systems must have separate master cylinders. Regenerative brakes may not be considered as one of the braking systems.

- 6.8.A. **Brake Pads:** Each brake pad used in the braking systems must have full contact with the brake rotor. Pads must initially be at least 6 mm thick including the backing plate when installed on the car.
- 6.8.B. **Braking Performance:** Solarcars must be able to repeatedly stop from speeds of 50 km/h or greater, with an average deceleration, on level wetted pavement, exceeding 4.72 ms^{-2} . Performance shall be demonstrated with mechanical braking only.
- 6.8.C. **Brake Lines/Cables:** The brake lines (hydraulic or cable) shall be appropriately sized and constructed such that they have significant capacity beyond the pressure and/or loads that will occur under the worst-case driving conditions.
- 6.8.D. **Placement of Brake Pedal:** Any brake pedal shall be placed such that the brakes can be activated by a single pedal under the ball of driver's right foot.
- 6.8.E. **Clearance between Pedals:** If the team elects to have foot operated brake and accelerator pedals the team must demonstrate adequate clearance and arrangement that will allow for quick and easy transition of the foot from one pedal to the other. Refer to Reg. 5.11.A for placement of the accelerator pedal if equipped.
- 6.8.F. **Hand Activated Brakes:** Hand activated brakes are permissible if the driver can turn the steering wheel lock-to-lock without removing or repositioning either hand from the steering wheel.

6.9. Parking Brake – Solarcars must be equipped with a parking brake.

- 6.9.A. The parking brake shall be able to hold the car in place without wheel chocks on dry pavement under either a forward or rearward force equal to 10% of the cars weight in Event configuration with properly ballasted driver.
- 6.9.B. This brake must operate completely independently from the main braking system and may not be used in the performance tests specified in Reg.6.8.B.

- 6.9.C. It must be able to be locked into the “ON” position, such that the driver does not have to continue to hold it to maintain position. The driver shall be able to lock the parking brake while seated in the normal driving position and seat belted in.
- 6.9.D. The parking brake shall not be of a tire or wheel contact style (i.e. pad on tire or pad on rim styles are not considered as acceptable designs).

6.10. Steering

- 6.10.A. **Steering Wheel:** All steering in the vehicle must be controlled by the driver with a steering wheel designed to have a continuous perimeter as outlined in Appendix A.
- 6.10.B. **Steering Stops:** The steering system must include steering stops to prevent dangerous or damaging steering travel. Steering stops cannot be held in place by friction. They must be welded, pinned or bolted in place, and placed in the steering system in way that will not create loads that will deform or scar the contacting pieces.
- 6.10.C. **Turning Radius:** Solarcars must be able to make a U-turn in either direction, without backing up, such that any portion of the solarcar that is within 200 mm of the ground remain within a 16 m wide lane. Portions of the solarcar above 200 mm above ground may exceed the 16 m distance.

6.11. Towing Hardpoint – Solarcars must be equipped with a hardpoint where an appropriate rope or strap may be attached in order to tow the car for emergency recovery purposes. The hardpoint must be either securely attached to or part of a nonmoving structural component. The hardpoint or access to the hardpoint may be covered while not in use. The hardpoint must allow the car to be pulled with the body installed on the car; however the canopy may be removed.

6.12. Dynamic Stability – Solarcars will be tested for dynamic stability and handling performance. A combination of the following tests may be conducted:

- 6.12.A. **Figure-8:** Solarcars must be able to negotiate a figure-8 course in less than 12 seconds per side. The figure-8 course shall have a 5 m wide lane around two 8 m radius center circles, as illustrated in Figure 6-1. The vehicle shall not knock over any of the cones or exhibit signs of structural instability. No body work shall contact moving structural members per Reg. 6.2.B.

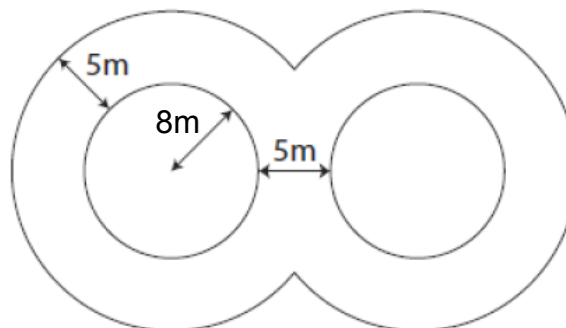


Figure 6-1 Figure-8 Course Layout

- 6.12.B. **Stability at Speed:** Solarcars must be able to stay within a 3.5 m lane for at least 250 m. Cars must be able to achieve this regardless of crosswinds or gusting conditions. If a car cannot do this at 100 km/h, the car speed will be limited to where it can stay within a 3.5 m lane for the entire event.

6.12.C. **Slalom Test:** Solarcars must be able to negotiate a slalom course in 13 seconds. The slalom course shall be 126 m long, with cones equally spaced every 18 m as in Figure 6-2

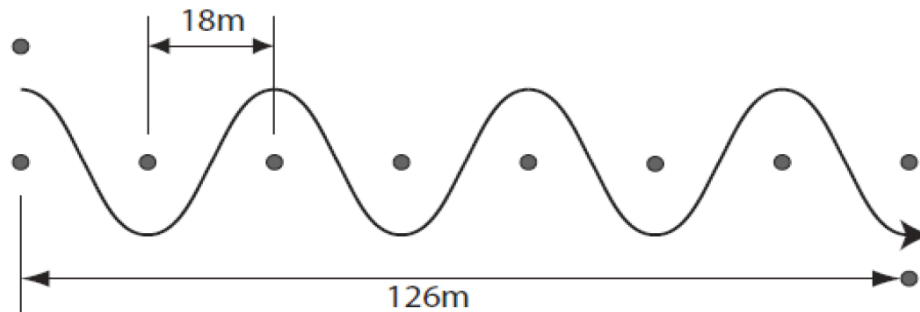


Figure 6-2 Slalom Course Layout

6.12.D. **Brake Test:** Solarcars will be tested to verify compliance with Reg.6.8.B (Braking Performance). The time interval over which the deceleration is averaged shall be from the first indication that the driver should stop until the solarcar comes to a complete halt. When braking, the solarcar must not veer excessively to the left or right, or exhibit structural instability. The tire pressure and mechanical systems settings used in this test will be considered Event configuration.

6.12.E. Solarcars may be required to demonstrate the brake performance a minimum of two out of three times.

6.12.F. **Disqualification of a driver:** Should it become apparent to the USC Officials that the solarcar is capable of passing the required dynamic stability requirements, but a particular driver is not able to proficiently handle the solarcar during one or more of the required components, that solarcar driver may be disqualified at the discretion of the USC Officials.

6.13. Data Logger – Solarcars may be required to carry a self-powered data logger specified by Event officials. The data from the logger will be used to determine vehicle location and speed. The unit weighs approximately 1 kg and has an antenna of approximately 50 mm² that requires clear exposure to the sky (can be through a radio-transparent medium).

7. On-Road Event

7.1. Event Format – The Event comprises a series of stages between predetermined locations (Stage Points) following a specific Event Route. Each stage will begin with a Staged Start, where all solarcars are released from the same point.

At the end of any Event Day in which an entry has not reached the predetermined Stage End Point within the allotted time, the team must then trailer to that Stage End Point. The team will begin the next morning in the start line with other competitors. Stages will also have mandatory Control Stops.

7.2. Entry Classes – Teams may register in the Fixed Distance Class or Open Class. The vehicle design regulations outlined in this document apply equally to both classes.

7.2.A. Fixed Distance Class: The on-road route will include a fixed distance of approximately 300 km per day which starts at a stage point and ends at a stage point. Fixed Distance Class vehicles must complete the daily distance in the allotted time.

7.2.B. Open Class: These teams will travel the same route as described in 7.2.A. However, along the route, there will be a number of Turning Points (TP) at which the teams can make a turn and drive in the opposite direction to increase the distance travelled along the route. The teams must still drive the entire route and reach the end of day stage point in

the daily allotted time. Where and when to make the intermediate turns is entirely up to each team, but a TP may not be used more than once on any day.

- 7.3. Determination of Winner** – Teams for both classes will be ranked by Official Distance travelled, and in case of a tie in distance, by Official Elapsed Time to complete that distance. The team with the longest Official Distance travelled will be declared the winner of the Event. Awards will be given for the top three Event finishers as well as top three Fixed Distance Class Finishers.
- 7.4. Solarcar Configuration** – Solarcars must operate in the same configuration as approved during Scrutineering and used at the Qualifier.
- 7.5. Drivers**
- 7.5.A. **Driver Helmets:** Drivers must wear a helmet while operating the solarcar. The helmet must meet or exceed the Snell 2005 or Snell 2010, ECE R22-05, DOT, or ISO motorcycle standards and will be inspected during Scrutineering.
- 7.5.B. **Driver Shoes:** Drivers must wear closed-toe shoes with a solid sole that will protect the driver from debris that may be found on the road in the event of an accident in the solarcar. Shoes with individually enclosed toes will not be permitted. Shoes that are securely fastened to a driver's foot are preferred to avoid unintentional removal when driving or egressing the solarcar. Driver's shoes shall be approved at the Inspectors discretion.
- 7.5.C. **Driver Ballast:** Drivers and their corresponding ballast will be identified with unique identification tags. The tags on the ballast carried by the solarcar must match the tags on the solarcar driver at all times.
- 7.5.D. **Driving Time:** No driver may drive more than a total of six hours in a given Event Day. If the solarcar is stopped on the side of the road such that the driver is allowed to exit the vehicle for an extended period of time, this stopped time is not counted towards the 6 hours driving time.
- 7.5.E. **Water/Fluids:** Each driver must have sufficient quantities of water/fluids in the cockpit area to stay properly hydrated. A minimum of one liter for each driver must be provided.
- 7.6. Support Vehicles** – All vehicles and trailers associated with a team other than the solarcar itself are support vehicles and must be registered with USC Headquarters. All vehicles must meet Egyptian Motor Vehicle Safety Standards.
- 7.6.A. **Lead Vehicle:** Each team must provide a "lead vehicle" to alert oncoming traffic to the presence of the solarcar.
- 7.6.A.1. The lead vehicle must travel within 500 m ahead of the solarcar, with its headlights on and with roof-mounted flashing amber lights visible from ahead.
- 7.6.A.2. The lead vehicle may not tow a trailer.
- 7.6.A.3. The lead vehicle shall not be larger in height or length than a standard 15 passenger, full-size van.
- 7.6.A.4. The lead vehicle shall carry at a minimum the following safety equipment: certified, stocked first aid kit, ABC fire extinguisher (4.5 kg or larger), safety vest (1 per occupant), 4 orange cones (minimum 300 mm high), and an orange warning flag.
- 7.6.B. **Chase Vehicle:** Each team must provide a "chase vehicle" to protect the solarcar from the rear.
- 7.6.B.1. The chase vehicle must follow directly behind the solarcar; with roof-mounted, flashing amber lights visible from the front and the rear.
- 7.6.B.2. The chase vehicle may not tow a trailer.

- 7.6.B.3. The chase vehicle shall be equipped with a commercially available/unmodified GPS unit that displays the current vehicle speed visible to the Observer.
- 7.6.B.4. The chase vehicle shall not be larger in height or length than a standard 15-passenger, full-size van.
- 7.6.B.5. The chase vehicle shall carry at a minimum the following safety equipment: certified, stocked first aid kit, ABC fire extinguisher (10 kg or larger), safety vest (1 per occupant), 4 orange cones (minimum 300 mm high), orange warning flag, battery MSDS, battery spill kit and method of containment of battery fires.
- 7.6.C. **Scout Vehicle:** Each team is permitted to include a “scout vehicle” in their convoy for the purpose of investigating road and traffic conditions ahead of the solarcar.
 - 7.6.C.1. The scout vehicle should maintain at least a 1 km separation from the solarcar caravan and all other solarcar caravans.
 - 7.6.C.2. The scout vehicle must not obstruct traffic or other solarcar convoys.
 - 7.6.C.3. The scout vehicle shall not be larger in height or length than a standard 15-passenger, full-size van.
- 7.6.D. **Other Support Vehicles:** Additional support vehicles, including truck/trailer units, may travel on the Event Route, but should maintain at least a 1 km separation from all solarcar caravans. These other support vehicles must not obstruct traffic or other solarcar caravans.
- 7.6.E. **Support Vehicle Graphics:** All support vehicles, including trailers, must be marked with:
 - 7.6.E.1. **Team Solarcar Number** (at least 250 mm tall, with a 40 mm brush stroke) on both sides and the rear.
 - 7.6.E.2. **Sponsoring Institution(s)** must also be displayed prominently on each vehicle.
 - 7.6.E.3. **Scout, lead, and chase** vehicles must also display the team’s solarcar number on the top passenger side of the front windshield (at least 15 cm tall).
 - 7.6.E.4. **Event Logo:** USC Headquarters will provide two Event Logos per support vehicle to be placed on the sides of each vehicle and trailer. These logos will not be larger than 310 mm in height by 460 mm in width.
 - 7.6.E.5. **Slow Moving Caravan:** A sign must appear on the rear of the chase vehicle to warn overtaking traffic of the solarcar caravan. Signs will be provided by USC Headquarters at a size of no larger than 500 mm by 500 mm
 - 7.6.E.6. Additional graphics are permitted, provided they are neither offensive nor disruptive.
- 7.7. **Radios / Communication** – The chase vehicle must be in two-way radio communication with the solarcar driver at all times. All two-way radio channels must be registered with USC Headquarters. All teams must also carry and use a separately monitored radio in every support vehicle on the route tuned to an “official event” channel to communicate with other nearby teams and officials. Two of these radios will be provided by USC Headquarters to each team.
 - 7.7.A. **Monitoring:** All communications between the solarcar driver and support vehicles must be audible (for voice communications) to the observer at all times. Any communications in languages other than English, or in code, must be explained to the observer if requested.
 - 7.7.B. **Driver Communications:** All communications by a driver of any vehicle (lead, chase, support, and solarcar) must be verbal and hands-free at all times. Hands-free operation for the solarcar driver is defined as operation where the driver can activate the radio without removing his/her hands from the steering wheel.
 - 7.7.C. **Cell Phone Use:** Cell phones are permitted within the solarcar. Any use of a cell phone in the car will need to be on a hands-free basis. Use of cell phone must comply with all local

laws pertaining to cell phone use within a vehicle. Any cell phone must be fixed in position (i.e. not loose within the driver compartment).

7.8. Observers – Trained Observers, appointed by USC Headquarters, will travel with each team to alert the COC to possible infractions of these Regulations, and to help report unforeseen events to USC Headquarters. Observers may not interpret these Regulations or give advice on Event strategy. Observers will be rotated in their team assignments at Stage Locations.

7.8.A. Observer Access for Inspection: Observers will be assigned to keep each solarcar in sight from the time the batteries are released from impound to the time they are impounded again each day. The Observers shall witness and note any and all work done on the solarcars. The Observers must be allowed access to the solarcars for inspection of ballast during all driver changes.

7.8.B. Observer Record of Performance: The details of the activities of a team will be recorded in a logbook carried by the Observer. The team leader and advisor will be permitted to review the book each day; however, failure to do so does not make any record invalid. The records kept by the Observer include the Official Start Time, stopping times (including Control stops and stage finishes), Turning Points crossed, impound times, distances traveled, and any possible infractions either by their assigned team or by any other team.

7.8.C. Observer Accommodations:

7.8.C.1. During Event Hours: Teams must allow the Observer the seat of his or her choice behind the driver or in the front passenger seat in the chase vehicle. The Observer must be able to see the solarcar and read the chase vehicle's speed via a commercially available/unmodified GPS unit from this location. The Observer must also be able to determine, at least periodically, how many vehicles are following behind the team.

7.8.C.2. Meals and Hospitality: Observers should be considered a guest of the team for whom the team will supply proper meals, drink, and amenities afforded to any member of the team or advisor.

7.9. Team Uniforms – On Event Days from 6:00 am to 7:00 pm, team members shall wear uniforms representing their Institution(s). The uniforms are required to have the Institution name, car number, and Event logo. Artwork for the Event logo may be obtained from USC Headquarters.

7.9.A. Solarcar Drivers Attire: Solarcar Drivers, while driving, are exempted from the above requirement. Clothing worn by Solarcar Drivers must provide suitable cover and be non-offensive.

7.10. Briefings – A Briefing will be held at each Stage Start location. Special meetings may be called in cases of emergency. Attendance at these meetings by a team representative and drivers is required. Briefing notes and other daily updates will be available at Control stops and posted to the Event website. All official statements, rule interpretations, and special instructions will be contained in these postings. It will be the responsibility of the team to check available outlets for updates and instructions.

7.11. Timing and Distance

7.11.A. Timing and distance determinations for the Event will be the responsibility of USC Timing Officials. USC Headquarters will recognize no other timing or distance information. An Official Segment Distance will be calculated for each entry based on the actual distance travelled between each Stage/Control stop to the next Stage/Control stop. The summation of these Segment Distances will yield an Official Total Distance Travelled for the entry. An Official Elapsed Segment Time will be calculated for each entry based on the actual Event Time that has elapsed between each Stage/Control stop to the next Stage/Control stop. The summation of these Segment Times will yield an Official Total Elapsed Time for the entry. Overall placing will be determined based on the longest Official Total Distance

Travelled followed by lowest Official Total Elapsed Time (reference Reg. 7.2).

7.11.B. Official Segment Distance: Official Segment Distance will be the entrant's total distance travelled in a given segment including additional kilometres travelled after turning at TPs. Any distance penalties or protest filing "distance fees" shall be subtracted from the distance travelled to determine the Official Segment Distance. Note that protest filing "distance fees" are counted against the segment on which the protest is filed, whereas distance penalties are counted against the segment in which the infraction occurred.

7.11.C. Official Elapsed Segment Time: Official Elapsed Segment Time will be the entry's elapsed Event Time from one Stage/Control stop to the next Stage/Control stop, plus any time penalties and any protest filing "time fees". Note that protest filing fees are counted against the interval on which the protest is filed, whereas penalties are counted against the interval in which the infraction occurred. Thus, the Official Elapsed Segment Time is not final until after the end of the Event. *Official Elapsed Segment Time = Elapsed Event Time + Penalties + Protest Filing Fees*

7.11.D. Team Off-Course: If a team departs from the Event Route, but then returns properly to the route and continues, their Elapsed Segment Time will be determined in the normal manner; no credit will be given for the time the team was off-course.

7.12. Event Hours

7.12.A. Standard Event Day: The Standard Event Day is from 8:00 am – 4:00 pm (8 hours) for all days of the Event. Actual event hours may be adjusted to start later or end earlier than the standard Event day based on the exact segment distances and coordination of activities at each of the Stages / Control stops. Actual Event hours will be announced at the pre-Event meeting.

7.12.B. Time Zones: Official clock time for the Event is set to Egyptian Standard Time.

7.13. Event Route

7.13.A. Route Book: The Egyptian Solar Challenge Route Book will be distributed to each team that qualifies for the Event. The Route Book will contain information to direct the team along the official route. It will specify days, distances, directions, route numbers, maps, Turning Points, Control Stops, and points of reference. For a team to receive official distance and time, they must follow the official Event Route.

7.13.B. Route Revisions: Due to unforeseen events, it may be necessary to detour from the official route. When advance warning is available, Event Headquarters will correct the official route accordingly and provide revisions to the Route Book to all Event teams, or provide written revisions at the Briefing or at Control stops.

7.13.C. Teams Departing from the Event Route: Any team leaving the Event Route must rejoin the route at the same intersection where they left the route, or they will receive no credit for distance driven beyond that point.

7.14. Stage Starts – Teams are released from the Start Line in 1 minute intervals. Assuming a Standard Event Day, all teams will be given a full 8-hour Adjusted Event Day. Each team's Lead and Chase vehicles must merge with their solarcar after it leaves the Start Line. The movement of all vehicles in the Start Line area will be under the control of the Start Line Officials.

7.14.A. Starting Order: For the first day of the Event, the starting order will be determined based on performance during the Qualifier. The team with the fastest lap in the Qualifier will be first in the starting order. For all other Stage Starts, the order is based on each team's Official Total Distance Travelled, available at 7:00 am of that morning, from longest to shortest. In case of a tie, the Official Total Elapsed Time, available at 7:00 am of that morning, will be used to determine the order of the tied teams.

- 7.14.B. Teams Not Ready:** If a team's solarcar, lead, and chase vehicles, with drivers in each vehicle, are not in their assigned starting positions 15 minutes before the start, the Start Line Officials may, at their discretion, move all of the following cars up one slot, and the tardy team must move to the end of the starting queue.
- 7.14.C. Official Start Time:** Each team will be assigned a tentative start time, which will be distributed to the teams at the Briefing the night before (order may change based on the official standings as of 7:00 am the morning of the start). If the team leaves the starting line at their assigned time, that becomes their Official Start Time for that day. If the team leaves before their assigned time because the Start Line Officials moved them forward in the queue, then the team's Official Start Time is their actual start time. If the team leaves after their assigned time because they were not ready, then the team's Official Start Time will remain their assigned time.
- 7.14.D. Delayed Start:** The start of the Event, and any stage start, may be delayed if inclement weather or other hazardous conditions appear likely to pose a threat to the solarcars or their drivers. If the start of the Event or any stage is delayed, then all assigned start times for that day will be adjusted accordingly.
- 7.15. Control stops –** A Control stop is a mandatory stop of 30 minutes in a predetermined location along the Event Route. Control stops may be added or subtracted as needed by Event Officials. Control stops will remain "active" for a specified number of hours during each stage. "Active" hours will be posted and announced at the pre-Event briefing.
- 7.15.A. Active Control stops:** Teams reaching an active control stop will be subject to a mandatory stop at the control stop. Mandatory time spent in an active Control stop will not be factored into a team's Official Total Elapsed Time. Failure to stop at an active Control stop will result in no credit for distance driven beyond that point. Within the Control stop area, the movement of all team vehicles shall be under the control of Control stop Officials.
- 7.15.A.1. Solarcar Maintenance:** Solar charging of solarcar batteries and solarcar maintenance are allowed during the mandatory Control stop time. Array stands are not permitted at Control stops and teams must not interfere with or block any other team's passage through the Control stop. Teams unable to leave the Control stop area after the mandatory time must move their solarcar elsewhere.
- 7.15.B. Closed Control stops:** After the specified number of active hours, Control stops will be permanently shut down and will be referred to as "closed". Teams are not required to stop at closed Control stops and should immediately proceed on the Event Route.
- 7.16. Stage Finishes –** A Stage Finish marks the completion of a stage and is a mandatory stopping point for all teams in a predetermined location along the Event Route. A Stage Finish will remain "active" for a specified number of hours. The stage will open based on the fastest car and will close at a predetermined time, to be announced at the pre-Event briefing. Once a team's solarcar crosses the Stage Finish Line the movement of that team's vehicles shall be under the control of Finish Line Officials. Specific areas will be designated for solar charging, impound, support vehicle parking, and Event Headquarters. Solarcars may be pushed within and between these areas, but regenerative braking may not be used during such times.
- 7.16.A. Teams Arriving After the Stage Finish is Closed:** Any team not at the Stage Stop by the close of the Stage Finish Line will be considered to have trailered. Trailering will be considered to have started as of the position where the team is on the route at the Stage Finish Time. Standard trailering penalties will apply even if the car is driven in on solar power.
- 7.17. Impound –** All battery enclosures per Reg. 5.5 must be removed from the solarcar and kept overnight in a lockable box/container that will be secured by the Observer. Headquarters should be appraised of special issues for impound.

7.17.A. Impound Times: Batteries must be impounded by 6:30 pm each evening and will be released from Impound at 5:30 am the following morning.

7.17.B. Impound Box/Container: Each solarcar team shall provide a lockable box/container in which the battery enclosures per Reg. 5.5 will be secured by the Observer per Reg. 7.16.

7.18. Charging Areas – A charging area will be provided for the teams at each Stage End Point and Stage Start Point. Internal combustion generators will not be permitted within the charging area. Only solar charging may occur within this designated area.

7.19. Passing Traffic – When six or more vehicles are lined up behind a team's chase vehicle, (including other teams' solarcar caravans wishing to pass) the team must pull over as soon as safely possible to allow the traffic to pass.

7.19.A. In Traffic: Teams need not disrupt their own progress to permit other vehicles to pass when they themselves are traveling at the posted speed limit or trapped behind other traffic.

7.20. Traffic Laws – During the course of the Event, all applicable traffic laws must be obeyed. Solarcars must observe a maximum speed limit of 110 km/h (68 mph), unless restricted by the Officials per Reg. 6.12.B. (Note: while event organizers may or may not be aware of or enforce specific local regulations, under no circumstances does this imply that jurisdictions will not enforce local ordinances, laws, or regulations.)

7.21. Passing Teams – In the event that one team is overtaken by another, the overtaking team signals their intention to pass by flashing the headlights of their lead vehicle between high and low beam. The overtaking team must also attempt to make radio contact with the team being passed to coordinate the pass. Once the overtaking team has signaled their intention to pass, the team being passed must facilitate the pass at the first available safe opportunity, either by slowing down by at least 10 km/h (6 mph) in a zone where passing is permitted and feasible, or by pulling completely out of the traffic lane.

7.22. Drafting – Drafting by a solarcar is prohibited. A solarcar will be considered to be drafting if it continuously follows behind another vehicle at less than a 3 second interval. The only exception to this is in congested traffic at speeds of 40 km/h (25 mph) or less.

7.23. Pushing – Except for the following situations, solarcars may not be pushed or pulled from the time they are moved into their starting position for the Daily Start until they reach the finish line. In no case shall regenerative braking be engaged while pushing or pulling the solarcar.

7.23.A. Control stops / Stage points: Solarcars may be pushed within the confined area of the Control stop or Stage Point.

7.23.B. Emergency: In an emergency or breakdown situation, the solarcar must be removed from the road as quickly as is prudent. In this circumstance, the car may be pushed or lifted off the roadway. Upon resuming Event, the solarcar may then be pushed or lifted back onto the roadway to the same location where it left the roadway.

7.23.C. Weather: The solarcar may be pushed onto and off of a trailer to protect it from the weather, provided the solarcar is moved back to its original location after it is unloaded from the trailer.

7.24. Trailering – Should it become necessary to load the solarcar onto a trailer for transport, it may be pushed onto the trailer. Battery charging from the solar array while trailering is allowed during non-impound hours. Once a team has decided to trailer, they must trailer to the Stage Finish prior to the evening battery impound at 6:30 pm on the day of the Stage Finish (See Reg. 8.5.N for Trailering Penalties). Teams may only resume driving their solar vehicles for credit by resuming at the point they began trailering or earlier along the Event route.

7.25. Accommodations and Lodging – All teams are responsible for team accommodations and food during the Event. Teams are responsible for their own reservations.

7.26. Accidents and Re-Inspection – All accidents involving either solarcars or support vehicles must be reported immediately to USC Headquarters. In the case of an accident involving personal injury, notification of the appropriate emergency medical services and public safety officials shall take priority. If a solarcar is involved in an accident it must:

7.26.A. Stop and be visually inspected by team members and the Observer.

7.26.B. Be re-inspected by an Inspector at or before the next Control stop. The Inspector may require repairs prior to resuming the Event.

8. Penalties – Any team failing to comply with these Regulations during Scrutineering, the Qualifier, or the Event will be penalized. Penalties range from official warnings to disqualification from the Event. It is the responsibility of the COC and Chief Inspector, with input from the other Inspectors and the Observers, to determine whether a penalty infraction occurred, the severity of the incident, and the appropriate penalty. All time or distance penalties will be submitted by the COC to Event Headquarters for subsequent posting. Disqualification of a team from the Event requires concurrence of the Event Manager and Event Organizer. Penalties will generally be applied to Total Distance Travelled or Total Elapsed Time on the Official Distance and Elapsed Time Sheet on stage stops or at Control stops.

8.1. Penalty Distances and Times – All penalties listed are suggested minimums. Driving conduct penalties (Regs. 8.5.A-8.5.H) may double with each subsequent infraction. Other penalties (Regs. 8.5.I-8.5.Q) will normally be the same for each infraction. If inspectors believe the teams are deliberately violating traffic or driving regulations for strategic advantage, they may impose more severe penalties.

8.2. Posting of Penalties – Penalties will be publicly posted by 11:00 pm the night before the start of the next stage. All teams must provide an e-mail address and alternate to USC Headquarters, which is checked regularly, where penalties can be officially delivered to the team. On the last day of Event, penalties per team will be posted no later than 30 minutes after the finish of the Event or the arrival of a team's car, whichever is later.

8.3. Protests – Each team shall designate a single individual that shall act on behalf of their team to submit protests. Any team desiring to file a protest must do so by submitting an official protest to Event Headquarters. Protests may be filed for any reason, including disputing a penalty levied against any team, correcting timing errors, or protesting the actions of another team. A "filing fee" of 10 minutes for Fixed Distance teams or 15 km for Open teams will be assessed against the team's Official Elapsed Time or Distance for the day on which the protest is filed. The Tribunal of Judges will hear all protests.

8.3.A. **Opportunity to Be Heard:** Protests will normally be heard by the Judges at the earliest possible Tribunal session. It may be necessary in some instances for the Judges to postpone the hearing on a protest.

8.3.B. **Time Limit:** Except for the last day, all protests against penalties must be filed by 8:00 pm the day following the day the penalty is posted. Protests that do not directly relate to a penalty must be filed by 6:30 pm or within 60 minutes of when the filing team finishes the stage where the offense occurred, whichever is later. On the last day of Event, protests for any purpose must be filed within 60 minutes after the finish of the Event or 60 minutes after a team arrives, whichever is later.

8.3.C. **Protest Judgements:** The decision of the Judges is final and no further appeals are allowed. The Chief Judge will notify Event Headquarters of the decision, and Event Headquarters will then inform the affected teams. The Judges may refund some or the entire filing fee, which will be credited to the day the filing fee was assessed.

8.4. Conduct – Penalties, including disqualification from the Event, may be imposed for improper conduct or the use of alcohol or illegal substances. Improper conduct may include, but is not limited to, improper language, unsportsmanlike conduct, unsafe behavior, or cheating. Teams are responsible for the conduct of all persons associated with the team, whether or not they are officially registered.

8.5. Penalties – Penalties are expressed as times in minutes. Teams in the Fixed Distance class will be given time penalties for infractions. Teams in the Open class will be given a distance penalty, in kilometres, equal to 1.5 times the time penalty in minutes.

8.5.A. **Speeding:** Any solarcar found to be speeding will be penalized. Speeding penalties may be assessed based on the following factors: (1) velocity over posted speed limits, (2) length of time of speeding infraction, (3) location of speeding infraction (i.e. work zones, school zones, etc. where typical penalties would be doubled automatically). The speed of either the solarcar itself or the chase vehicle may be used in determining a speeding infraction. Penalties will be determined by doubling relative advantage gained by the infraction or 1 minute per occurrence, whichever is greater. Speeding infractions including a rate of speed of 115 km/h (71.4 mph) or greater will result in a 1 hour penalty in addition to the calculated assessment.

8.5.B. **Traffic Violations:** Any solarcar committing a traffic violation may be penalized, up to disqualification. Any solarcar driver who commits three (3) traffic violations (including speeding) over the course of the Event may be individually disqualified from the Event.

8.5.C. **Failure to Allow Other Traffic to Pass:** Any team solarcar caravan that fails to properly facilitate passing by traffic or other teams may be penalized a minimum of 10 minutes.

8.5.D. **Support Vehicles Impeding Event:** Any support vehicles too close to solarcar caravans (Reg. section 7.5) or impeding another team's solarcar caravan may be penalized a minimum of 10 minutes.

8.5.E. **Drafting:** A minimum 5 minute penalty may be assessed for any time a solarcar drafts behind another vehicle

8.5.F. **Pushing:** A 2 minute penalty for every 15 seconds a team pushes may be assessed each time a team pushes or pulls their solarcar in order to advance along the Event Route. (Except in an emergency as in Reg. 7.24.)

8.5.G. **Improper Ballast:** A 30 minute penalty may be assessed each time a team operates their solarcar with ballast that does not match the solarcar driver

8.5.H. **Unauthorized Drivers:** Any solarcar that competes in the Event with an unauthorized driver will be required to return to the starting point of the infraction and drive with an authorized driver in order to receive credit for driving beyond that point.

8.5.I. **Non-Solar Charging of Batteries:** After the start of the Event until the official finish, teams will be disqualified from the Event for charging their solarcar's storage batteries from any source other than those allowed by Reg. 5.1, without specific written instruction from Event Officials. Such charging of a solarcar storage battery will constitute replacement and is subject to Regulation 8.5.K.

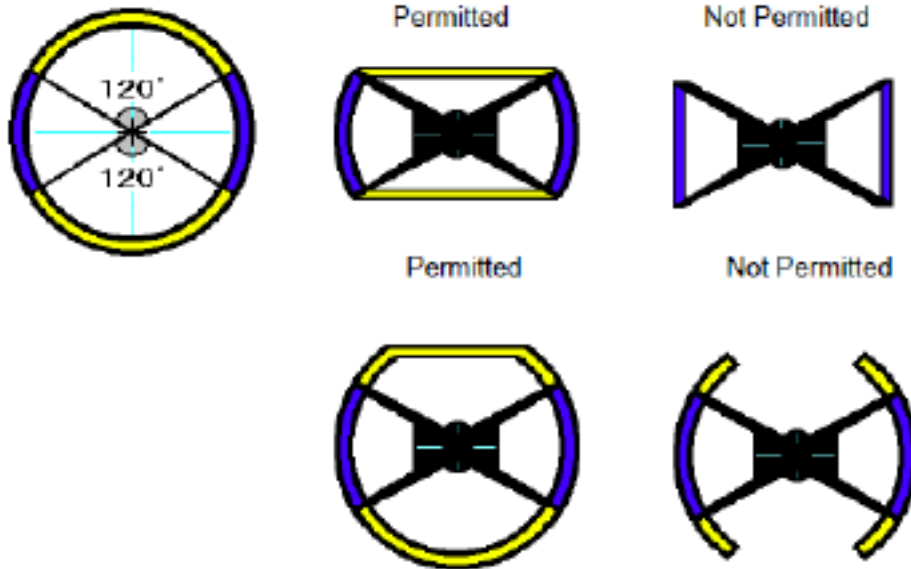
8.5.J. **Disturbing Official Battery Seals:** Solarcar batteries will be marked with an official seal. Disturbing these seals in a manner that prevents proper identification by Inspectors may be penalized as though all of the battery modules affected had been replaced as in Reg. 8.5.K.

- 8.5.K. **Replacement of Batteries:** Decisions to exchange (or externally recharge – see Reg. 8.5.I) all or part of a battery must be communicated formally to the team's Observer or the COC. The penalty will be computed as follows:
- $$\text{Time penalty (minutes)} = 480 (n + S) / N$$
- where: n = number of replacement modules; S = sum of all modules previously replaced; N = total number of modules in solarcar battery pack
- 8.5.L. **Failure to Impound:** A 2 minute penalty may be assessed for every minute a team presents their batteries late to impound.
- 8.5.M. **Exceeding Size Specifications:** Oversized solar arrays will be penalized 15 minutes per Event day per excess 1000 cm² beyond the allowed size specification. Oversized solarcars will be penalized 7 minutes per Event Day per excess 1000 cm². If both the array and car are oversized, both penalties will be applied.
- 8.5.N. **Trailing Penalties:** Teams electing to trailer their solar vehicles will be assessed the full published time for that Stage (Control stop credit would not be allowed). In addition, the team will receive a penalty per uncompleted (not driven by solarcar) kilometre of the interval(s) trailed of 2 minutes per kilometre. For teams in the Open class, any segment distance not driven by the solar car will attract a penalty of 2 km per trailed kilometre.
- 8.5.O. **Securing of Fasteners:** Failure to comply to Reg. 6.7 Securing of Fasteners will result in a penalty of 30 seconds per Event day per instance where proper securing is not applied. The head mechanical inspector shall determine which non-compliant fasteners **must** be brought into compliance with Reg. 6.7.
- 8.5.P. **Parking Brake Penalty:** A 10 minute per Event day penalty will be applied for a nonfunctioning parking brake based on Reg. 6.9.
- 8.5.Q. **Overweight Battery Penalty:** A per day time penalty will be applied as per the following equation for battery packs that are overweight as per Reg 5.3A:
- $$\text{Time penalty (minutes)} = 200 * (n - N) / N$$
- where: n = battery mass; N = allowable battery mass

Appendix A – ISF Steering Wheel Specifications

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To reduce the possibilities of driver injury in the event of collision and to minimize impediments to emergency egress, the steering system must be controlled by a steering wheel which has a continuous perimeter. A circular shape is preferred, however the upper part above 2/3 and/or the lower part below 2/3 of the circumference of the steering wheel may be flat as depicted in the diagram below).

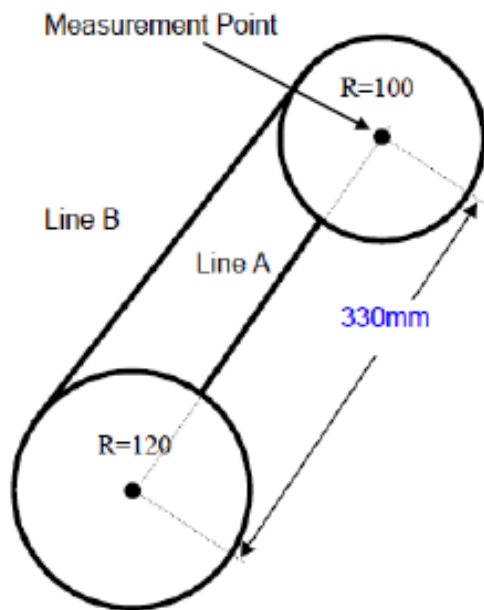
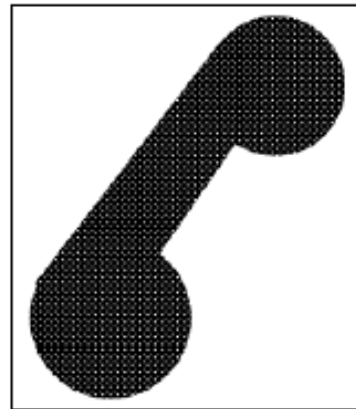


Appendix B – ISF Standard Measurement of Seating Angle

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The seating angle must not exceed 27°.

For ISF scrutineering purposes, measurement is effected by using a template based on the hip and shoulders of a two-dimensional form.



Making a Template

- Draw a circle with a radius of 120mm.
- At a point 330mm from the centre of the circle, draw another circle with a radius of 100mm
- Draw a line connecting the centre of the two circles (Line A).
- Draw a tangent to connect the circumferences of two circles (Line B)
- Cut the shape using suitable material
- Attach a plumb line to the measurement point
- The angle is measured between line A and the perpendicular.

Appendix C – Reference Standard for Lighting

Reference Reg. 5.9.

The reference standard lights are:

- TruFLEX
- 20 LED (Length 3.35 in)
- Item TF20 from Custom Dynamics
- Red lights are Red LED with Red lens
- Amber lights are Amber LED with Amber lens
- (www.CustomDynamics.com 1-800-382-1388)
-

The reference standard lights will be used in the following manner:

- Lights shall be powered by a 12 volt power source
- Light shall be centered on a flat surface with a matte white finish of 11" x 8.5".
- Separate light boards shall be used for each color type as the standard reference.
- Reference standard light boards shall be set aside of car to compare during inspections.