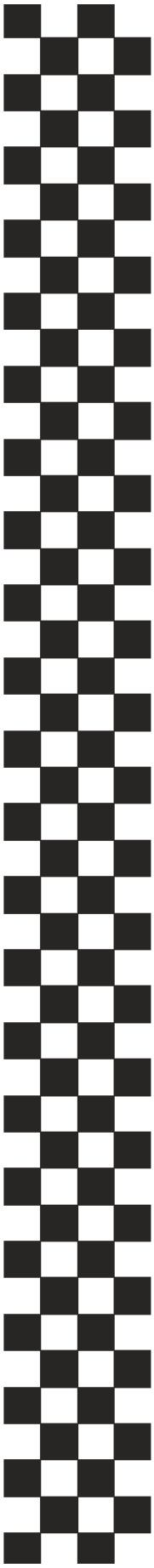


2014 Regulations

Revision B
October 17, 2013

Contents

1. Purpose

1.1 Fundamental Vision

The American Solar Challenge (ASC), hosted by the Innovators Educational Foundation, seeks to promote and celebrate educational excellence and engineering creativity. Fueled by the spirit of friendly competition and teamwork, the ASC 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 fields of engineering, the sciences, mathematics, business, in multi-disciplined experiential learning, and in subsequent careers.

1.2.B 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.

2. Administration

2.1 American Solar Challenge Organizers

The Innovators Educational Foundation shall be the official organizers of the American 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 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 American Solar Challenge Organizers. Officials having specific duties shall be announced to the teams through the Briefings.

2.3.A Several Officials will be assigned the role of "Inspector" who have the responsibility to scrutineer the solar cars and enforce the Regulations. The Inspectors will be led by an Official who is the "Chief Inspector / Regulations Manager".

2.3.B During the cross-country portion of the Event a team of "Observers" will monitor the progress of the teams and report back to the Inspectors.

2.3.C During the cross-country portion of the event, a team of "Staff" will support the event and will be Officials during the event.

2.4 Jury

A Jury will be formed to evaluate protests on conformity with these Regulations, to resolve team disputes, and rule on penalty appeals. In addition, the Jury is empowered to decide cases not specifically covered by these Regulations. The Jury will be available to teams during the Rayce. Jury meetings will be held in private. A representative of the team(s) involved may attend deliberations concerning disputes regarding their team, but not the vote. The Jury will consist of:

2.4.A The Event Organizer, who will chair the jury and only vote in the case of a tie.

2.4.B The Chief Inspector or designate. All Inspectors may attend the meeting, but only the Chief Inspector may vote.

2.4.C Distinguished individuals selected by the American Solar Challenge Organizers.

2.5 Application of Regulations

These Regulations will apply to the American Solar Challenge, which includes the selection of teams, registration of teams, the inspection of solar cars ("Scrutineering"), the qualification of solar cars (the "Qualifier"), and the cross-country competition (the "Rayce").

2.6 Supplemental Documents

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. 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.

2.7 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 them.

2.8 Interpretation of Regulations

2.8.A The only group authorized to interpret the regulations are the Inspectors.

2.8.B Teams shall identify if their question constitutes an Official or Unofficial Interpretation.

2.8.B.1 Official Interpretations will be responded to such that all teams will have visibility to the question and response.

2.8.B.2 Official Interpretations will have the same force and effect as the Regulations.

2.8.B.3 Unofficial Interpretations of the regulations will be kept private between the team and the Inspectors.

2.8.B.4 Unofficial Interpretations will have no force and effect on the Regulations and may be superseded.

2.8.C **Prior to Scrutineering:**

2.8.C.1 Teams requesting interpretation of the Regulations shall submit their question(s) to the Inspectors through email at: ascregs@americansolarchallenge.org

2.8.C.2 All Official Interpretations will be posted to the Internet under "Official Interpretations" on the ASC website.

2.8.D **During and after Scrutineering:**

2.8.D.1 All Official Interpretations will be announced at Briefings, posted at Headquarters, as well as on the Internet.

2.9 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 as "The American Solar Challenge". If in fact a naming sponsor is secured, teams will be required to append the Sponsor Name and to display the entire Event name, i.e. "The Acme - American Solar Challenge". 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.

3. Entries

3.1 Entry Registration

The Event is open to registered participants that are affiliated with an educational institution. Registration and Fees will occur as described below.

3.1.A **Registration - Initial Registration Package:** Each team wishing to participate in the Event must submit a registration package consisting of a (1) Team Entry Form, (2) Team Participation Form (see Reg. 3.2.A.5 for submission deadline for this item), (2) Proof of Insurance, (3) Preliminary Vehicle Design Report (as described in Section 3.3), and (4) the initial entry fee, US$1000. This portion of the entry fee is non-refundable. No team will be considered registered until the full registration package is received by ASC Headquarters.

3.1.B **Registration – Track Registration Package:** Each team participating in the Event must submit a track registration package consisting of a (1) Vehicle Design Report (as described in Section

3.4) and (2) the track fee, US$3000. This registration package is required for all teams planning to compete in Formula Sun Grand Prix (FSGP). All teams wishing to participate in ASC must also participate in FSGP as the qualifier. This portion of the entry fee is also non-refundable.

3.1.C **Registration – Road Registration & Fee:** Teams planning to compete in the ASC must also pay a road fee of US$3000. Teams desiring to only participate in FSGP do not need to pay this fee. This fee is partially refundable if a team withdrawals from the Event. US$2000 will be refunded if written notification is submitted to and confirmed by ASC Headquarters no later than the date listed in Reg. 3.2.A.4. No refunds will be made after that date.

3.1.D **Grants:** Teams with demonstrated financial need, and technical potential, may apply for a grant from the event organizers to cover all or part of the entry fees. Grants are limited to the Road Registration Fee portion only. Teams will be required to submit a proposal outlining their request and reasoning for requesting a Grant. The form of proposal will be provided to the team upon request. Award of a Grant is at the discretion of the Organizers.

3.1.E **Donations:** Teams that withdrawal after making payment will have funds considered as donations to the Innovators Educational Foundation in consideration that no services or goods are provided for said funds.

3.2 Registration Deadlines

3.2.A **Registration Dates:** The registration process for the ASC is not complete until ASC Headquarters has received all documentation and the entire Entry Fee of US$7000.

- **3.2.A.1** Initial registration package is due: August 15, 2013
- **3.2.A.2** Track registration package is due: November 15, 2013
- **3.2.A.3** Road registration & fee is due: March 15, 2014
- **3.2.A.4** Road registration & fee – refund cut-off: May 15, 2004
- **3.2.A.5** Team Participation Agreement is due: 30 days after the date specified on the ASC Website,

3.2.B **Late Penalties:** Late fees will be imposed for fees submitted more than 30 days beyond the deadline. A US$25 fee will be imposed for the Initial Registration Package, and US$100 fee will be imposed for the Track Registration Package, and US$100 fee will be imposed for the Road Registration Package.

3.2.C **Payments**

- **3.2.C.1** **Wire Transfers:** A US$25 wire transfer fee shall apply for all wire transfers made to the Innovators Educational Foundation for the purpose of covering bank fees associated with a wire transfer on the Innovators Educational Foundation side of the transaction. This should be included with any payment made utilizing this method of payment.
- **3.2.C.2** **Transaction Fees:** Any additional fees resulting in payments made to the Innovators Educational Foundation for entry into the Event shall be the responsibility of the team making payment utilizing such methods incurring the added fees.
- **3.2.C.3** **Foreign Currency:** It is the responsibility of the team for making payment in US currency. The Innovators Educational Foundation is not obliged to accept payments made in any currency other than US dollars.
- **3.2.C.4** **Acceptable Methods of Payment:** Payments shall be made via cheque payable to Innovators Educational Foundation, or wire transfer (note Reg. 3.2.C.1 above).

3.3 Preliminary Vehicle Design Report (PVDR)

3.3.A A preliminary vehicle design report must be submitted to ASC Headquarters by the date indicated in Reg. 3.2.A.1. The report shall include a preliminary design review of your vehicle's mechanical, electrical systems and proposed battery, instructions are provided in Appendix D. The report shall include the preliminary design information on the structural chassis and roll cage providing protection to the driver, an overview of the electrical approach to the solar car and proposed battery system. Particular attention will be given to:

3.3.A.1 Mechanical Team leader contact information (phone & email)

3.3.A.2 Roll over and impact protection for the driver

3.3.A.3 An overview of the electrical approach to the solar vehicle

3.3.A.4 Electrical Team leader contact information (phone & email)

3.3.A.5 A preliminary electrical diagram showing greater than 24 volt service plans.

3.3.A.6 Preliminary battery approval document including the battery team leader contact information (phone & email)

3.3.A.7 Battery types and suppliers/manufacturers' being considered if one is not already chosen

3.3.A.8 Battery testing plans with critical dates.

3.4 Vehicle Design Report

A vehicle design report including technical documents describing the solar car's mechanical systems, electrical systems, batteries, and solar cells must be submitted to ASC Headquarters for approval by the date indicated in Reg. 3.2.A.2. Early submissions will receive prompt review and feedback by ASC Headquarters. Early submissions may be sent as individual technical documents for review without the complete vehicle design report. The technical information provided in these documents will not be made public prior to the end of the Event. The information contained in each team's final submission must match the solar car presented at Scrutineering. Safety should be the primary concern with regard to the structural development and fabrication of the solar cars.

3.4.A **Document Format:** Vehicle design reports shall be formatted as a PDF Package with each technical document appearing as a single PDF within the vehicle design report PDF Package. PDF Package file names shall contain sponsoring organizations name_ASC 2014VDR. Example: a report from the University of ACME may appear as "UnivOfACME_ASC2014VDR.pdf" with the first letter of each new word capitalized and common abbreviations accepted.

3.4.B **Mechanical Technical Report:** A detailed mechanical technical report must be submitted to ASC Headquarters as part of the Vehicle Design Report by the date indicated in Reg. 3.2.A.2. The mechanical tech report must present the as-built design; addressing:

3.4.B.1 design issues involved in impact, roll over and suspension scenarios

3.4.B.2 address vehicle stability, including center of gravity and relative weights on each wheel.

Documentation with calculations and/or testing should be provided. Photos, drawings and anecdotal references are acceptable. The entire technical document including appendices shall not exceed fifty (50) pages (not sheets) in length. Detailed instructions are provided in Appendix E.

3.4.C **Electrical Systems Technical Report:** An electrical systems technical report must be submitted to ASC Headquarters as part of the Vehicle Design Report by the date indicated in Reg. 3.2.A.2. The tech report must document the electrical design approach. The tech report must include:

3.4.C.1 a functional system diagram; and, rough schematic; showing all essential power circuits and electrical equipment of the solar car in schematic form. The drawing should 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

3.4.C.2 Battery Approval Forms for each battery type

Detailed instructions are provided in Appendix F.

3.4.D **Battery Tech Report:** All storage batteries used in the solar car must be approved by ASC Headquarters. Battery tech report must be submitted to ASC Headquarters as part of the Vehicle Design Report by the date indicated in Reg. 3.2.A.2. Mass and cost 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. Battery Approval Forms shall be provided on the Event website, and in Appendix G. 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 tech report:

3.4.D.1 Manufacturer's name, and contact information

3.4.D.2 Stock number, type, or description

3.4.D.3 Cell & Module voltage (e.g., 1.2, 4, 6, 12, or 24 V)

3.4.D.4 Bus voltage

3.4.D.5 Number of modules to be used in the solar car

3.4.D.6 Manufacturer's specifications, including capacity (kWh), weight (kg), and cost (US$)

3.4.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)

3.4.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

3.4.D.9 Description of battery protection system per Reg. 5.4

3.4.D.10 Battery Approval Form for each battery type

3.4.E **Battery Protection Tech Report:** All batteries must be protected with technology appropriate to the chemistry used. Battery protection test report must be submitted to ASC Headquarters as part of the Vehicle Design Report by the date indicated in Reg. 3.2.A.2. The tech report must document the design approach used with respect to Reg. 5.4 including the following information:

3.4.E.1 Battery Approval Forms for each battery type

3.4.E.2 Over temperature set points (charge and discharge if different) for each battery type

3.4.E.3 Under voltage set point for each battery type

3.4.E.4 Over voltage set point for each battery type

3.4.E.5 Over current set point for each battery type

3.4.E.6 Block diagram for BPS for each battery type

3.4.E.7 Description of how the BPS will operate for each battery type.

3.4.E.8 How firmware or settings will be rendered static and un-modifiable after inspection (i.e. sealed in battery enclosure)

3.4.F **Solar Cell Tech Report:** All solar cells must be approved by ASC Headquarters. Solar cell tech reports must be submitted to ASC Headquarters by as part of the Vehicle Design Report by Reg. 3.2.A.2. Solar Cell Approval Forms shall be provided on the Event website and in Appendix H and should be submitted as early as possible for approval. Each team must provide a copy of the manufacturer's solar cell specification sheet, copy of invoice for all solar cells included, and a solar cell approval form with the following solar cell information in the tech report:

3.4.F.1 Manufacturer's name and contact information

3.4.F.2 Stock number, type, or description

3.4.F.3 Manufacturer's quote for cell area (cm^2)

3.4.F.4 Manufacturer's quote for performance

3.4.F.5 Cost (US$) per cell

3.4.F.6 Cell area (cm^2)

3.4.F.7 A detailed layout map of the vehicle, showing all cell types/sizes and locations, as well as calculations of total area

3.5 Grading of Team Reports

Team documents will be reviewed by the Inspectors and a grading will be given to each document with the following general meanings:

(1) Green – accepted by the Inspectors.
(2) Yellow – partially accepted by the Inspectors. Some revision to design or additional reporting is required. An updated report is required prior to attendance at Scrutineering
(3) Red – a rejected report. Significant revision to the design or significant additional reporting is required. An updated report that fully addresses Inspector comments is critical for further participation in the Event.

The grading of a team report will NOT assure passing Scrutineering. All solar cars are subject to detailed scrutineering at the event and not all aspects of a design can be reviewed in detail during evaluation of written reports.

3.6 Team Data

Each team must submit a team photo and data sheet to ASC Headquarters by May 1, 2014. 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 June 1, 2014 without permission of the team representative.

3.6.A **Team Photo:** The team photo must clearly show the solar car and team members. Team members in the photo must be identified by name and by their institution when there is more than one institutional sponsor. The photos will be used in ASC programs and other publications. Additional instructions will be provided.

3.6.B **Data Sheets:** The data sheet must include solar car weight (Rayce-ready, without driver), solar car dimensions, motor type and rating, solar cell type and manufacturer, estimated peak solar array power in Raycing configuration (overhead sun, clear sky), battery weight 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.

3.7 Participant Registration

All participants in the Event must be registered with ASC 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.

3.8 Faculty Advisor

All teams must have at least one faculty advisor who will provide guidance as needed throughout the solar car design, building, and testing process. The faculty advisor will be the official contact between the Event and institution.

3.9 Communication between ASC Headquarters and Teams

Teams may elect a Project Manager and/or Department Managers (i.e. Mechanical Manager). Correspondence between the team and the Organizers shall be through the named individuals and the Faculty Advisor.

3.10 Driver Requirements

Only registered solar car drivers will be allowed to drive in solar cars during the Event. Each team shall have a minimum of two drivers available at all times and may register at most four drivers. Solar car drivers must be 18 years old or older and must present a valid driver's license. All drivers will submit an informational form and a copy of their driver's license before Scrutineering.

3.10.A **Weight:** The official weight of each driver, including driving clothes (including shoes, excluding 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.

3.11 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 self-insurance.

3.12 Solar Car Markings

3.12.A **Solar Car Numbers:** Each team registered for the Event will have a unique number approved by ASC Headquarters (positive integer, 3 digits maximum). This number must be clearly displayed on both sides of the solar car 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 ASC 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.

3.12.A.1 **Number Retention / Reservation:** Teams which have participated in four (4) or more previous ASC (Sunrayce, NASC) cross-country events have the right to

reserve their car number from those openly available for selection by other teams. The number being selected for reservation must be the number used in the four (4) events.

3.12.A.2 Requests to reserve a number shall be made in writing to ASC Headquarters, with a listing of the events which the team attended and car number.

3.12.A.3 Car numbers (either use of a reserve number or new unallocated number) will be confirmed as teams complete registration paperwork and submit entry fees.

3.12.A.4 **Number Conflict:** If a conflict in car numbering arises, ASC Headquarters will determine the numbers assigned. Resolution will be based on order of requests and payment of entry fees with respect to when the car number request is made. If a team fails to maintain schedule of their entry fees their requested number can become available to another team who is current on their fees.

3.12.A.5 **Tracking of Reserved Numbers:** ASC Headquarters will track the Reserved Numbers, and will post a list of the Reserved Numbers and the corresponding team on the ASC website.

3.12.A.6 **Re-enstatement of Reserved Numbers**: Should a team with a reserve number desire to change their number, the previously reserve number will become unallocated and available to other teams. A team cannot have more than one reserve number.

3.12.A.7 **Car #1:** The winning team from the previous ASC has the right to use the Car Number "1". This number is not available to any other team. Use of the Car Number "1" does not forfeit the retention of a Reserved number as per the regulations above.

3.12.B **Institution Name(s) & Sponsors:** The name of the Institution(s) hosting the team must be clearly displayed on both sides of the solar car 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 solar car. ASC 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.

3.12.C **Event Logo:** The Event logo must be applied on both sides of the solar car. The logo will be provided by ASC Headquarters and will measure no more than 200 mm in height by 300 mm in width. The event logo shall be clearly displayed on both sides of the solar car 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.

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

4. Event Components

4.1 Scrutineering

4.1.A **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 Rayce. The top five overall finishing cars will be impounded immediately following the Rayce for a final inspection at the discretion of the Inspectors.

4.1.B **Scrutineering Time and Location:** The date and location of Scrutineering for the Event shall be posted on the Event website. The first five teams to obtain Green status on all their Technical Submissions 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 solar car 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.C **Scrutineering Format:** Scrutineering will involve inspection stations for body & sizing, driver, electrical, battery protection, array, mechanical, dynamic tests to verify handling and braking performance, 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.D **Acceptance at Scrutineering:** Only teams who have obtained Green status on their Technical Submissions and who have paid the required Event fees will be accepted for Scrutineering.

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 Qualifer:** Each team must successfully participate in a Qualifier, a track rally for solar cars, before they will be allowed to compete in the Rayce. 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 or Blue status for each Inspection Station will be accepted at the Qualifier.

4.3 The Rayce

The Rayce is a cross-country event that is open to teams who have met all Scrutineering requirements, successfully passed the Qualification requirements and who have paid the full Event fee.

Section 7 of these Regulations outlines the format for the Rayce.

4.4 Safety

Each team is responsible for the road-worthiness of its solar car. 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 solar cars 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 solar car.

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 ASC 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 Solar Car is on the road.
- **4.4.A.4** 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 ASC Headquarters in writing. All written withdrawals signed by the team representative (Faculty Advisor / Project Manager etc.) are final. ASC Headquarters may withdraw teams that do not meet the technical document deadlines or fail to present a solar car at Scrutineering or the Qualifier.

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 solar car'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 solar car must be carried by the solar car.

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 with efficiency less than 20.0%. These cells do not need to be listed on the ASC 2014 Approved List.

5.2.A.2 Cell Type 2 – Silicon based solar cells with efficiency greater than 20.0% which fall on the ASC 2014 Approved List based on Reg. 5.2.E.

5.2.A.3 Cell Type 3 – Silicon based solar cells with efficiency greater than 20.0% which are not on the ASC 2014 Approved List.

5.2.A.4 Cell Type 4 - single-junction, dual-junction or triple-junction, non-concentrated Ga/As solar cells.

5.2.B **Solar Array Size Limits:**

5.2.B.1 Cell Type 1 and/or Cell Type 2 = The solar array cannot exceed a maximum of 6.0 m^2.

5.2.B.2 Cell Type 3 = The maximum area of the solar array is defined as the minimum value from the three individual functions below:

- 6 m^2
- -0.5 x Cell Efficiency + 17.25 m^2
- -3/56 x Cell Efficiency + 99/14 m^2

5.2.B.3 Cell Type 4 = 3.0 m^2.

5.2.B.4 For an array with multiple Cell Types as defined above the total area allowable will be based on an area ratio calculation. ASC Headquarters shall be contacted by any team pursuing this option for determination of the total allowable area. [1]

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. 3.4.F. Teams may also choose to submit sample cells to ASC Headquarters prior to the Event with their Vehicle Design Reports to assist in the validation of their Solar Cell Tech Report.

5.2.E **ASC Approved List:** Silicon based cells on the ASC 2014 Approved List have been determined to be available to all teams at a price not exceeding US$10/Watt for bare cells. Teams may spend additional money on cutting, tabbing, or lamination of cells, however substantial modification of crystal structure, junction, or metallization will constitute manufacture of a new cell and disqualify it from the List. Teams or suppliers wishing to make an addition to the Approved List must submit all appropriate data to ASC Headquarters by the date indicated in Reg. 3.2.A.2.

5.2.F **Grandfathering Arrays:** Previously used arrays including non-Silicon based arrays, and

[1] For example for Cell Types 1 or 2 and 4 the maximum area is the summation of $A_g + A_s$ where $A_g = 3 \times (1 - A_s/6)$ and A_s is limited to values between 0 m^2 and 6.0 m^2, where A_g is the total area of Cell Type 4 Ga/As solar cells and A_s is the total area of Cell Type 1 or 2 silicon solar cells.

Silicon based arrays that employ cells not on the ASC 2014 Approved List will be permitted into the event.

5.2.F.1 this grandfathering is one time only, i.e. this array would not be allowed in ASC 2016.

5.2.F.2 this grandfathered array can only be an array that has been used in a previous ASC event. New arrays cannot fall into this rule.

5.2.F.3 the amount of array area that will be left active will be determined by the Inspectors. For arrays employing cells not on the ASC 2014 Approved List, this agreement will be based on a conservative calculation (favoring the silicon based array employing silicon based cells from the ASC 2014 Approved List) based on the efficiency of the array on the car versus that of a silicon based array employing cells from the ASC 2014 Approved List.

5.2.F.4 the team will have the opportunity to choose the portion of array which remains active. The active portion needs not to be contiguous. The portion which is active must remain constant across the duration of the event, i.e. no reconfiguration of the active portion. The non-active portion must stay on the car.

5.2.F.5 The non-active portion of the array will need to be isolated in a manner agreeable to the Inspectors.

5.3 Energy Storage

All solar cars are allowed to store solar-generated energy in an energy storage system composed of individual cells having a weight determined by the technology used.

Adherence to weight limitations does not imply automatic battery approval. Battery approval forms must be submitted to ASC 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) will be furnished for verification during Scrutineering.

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

Sealed Pb-Acid	125 kg
NiMH	60 kg
$LiFePo_4$	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 ASC Headquarters. Samples and details of proposed systems must be submitted before the date indicated in Reg. 3.2.A.2.

5.3.C **Supplemental Batteries:** Supplemental, replaceable batteries carried in the solar car 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 Rayce 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, 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. A 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 solar car. 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. 7.18.

5.5.A **Isolation:** The resistance measured between the battery terminals and any portion of the solar car 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 solar car 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(s) 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 must pull exhaust to the exterior of the solar car and must be powered by the battery system. It must operate whenever the battery system is electrically connected to the solar car 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 will not be opened during the Rayce without Inspector support. To preclude unauthorized access to the battery enclosure, a seal will be placed to indicate contravention of this regulation. Provisions shall be made to seal the battery enclosure by the team. 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 (not a 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 solar car 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 solar car and to rescue personnel outside the solar car. Use two sets of markings if necessary.

5.7.B **External Power Cut Off Switch:** The solar car must be equipped with an electrical cutoff 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 the driver's left hand side of the car. 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 **Covering:** The switch may be covered with a colorless, transparent cover. It must be demonstrated that such a cover must be quickly removable 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 to expected system currents.

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

5.9 Lighting

5.9.A **Position:** Solar cars 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 shall 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 must 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 will 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** Front 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.

5.9.D **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.

5.10 Horn

Solar cars 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 solar car. The horn must be permanently mounted, operated from the steering wheel. Horn must be able to operate for up to 5 minutes continuously at the required volume.

5.11 Accelerator

Accelerator mechanisms on solar cars must be free moving, and when released, must return to the zero position. If the solar car is equipped with cruise control, it must be designed with an automatic shut-off when the brake is activated.

5.11.A **Pedal Accelerators:** should a pedal accelerator be 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).

5.12 Control

Vehicle operation must be under the sole control of the driver.

5.13 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.

5.14 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 solar car is stationary and the application does not present a shock hazard.

6. Mechanical

6.1 Solar Car Dimensions

The solar car (including solar array) may not exceed the following maximum dimensions when moving under its own power:

(1) Length = 5.0 m
(2) Height = 1.8 m
(3) Width = 1.8 m

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

6.1.A **Charging Configuration:** When stationary, the solar car 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 solar car.

6.1.B **Raycing 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 solar car 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 solar car 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 solar car’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:** As a back-up system the array must be attached to the solar car chassis with a lanyard constructed from braided steel cable of minimum 3/32” (2.4 mm) diameter or alternative material with equivalent tensile strength. The lanyard may have up to 1 m of slack to allow for initial lifting of the array. Care must be made that the lanyard is electrically isolated from all energy sources.

6.3 Tire and Wheel Requirements

6.3.A **Wheel Configuration:** The solar car 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 the front wheels are symmetrical around the vehicle centerline, and the third wheel is behind the vehicle center of gravity.

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 solar car.

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 **Definitions:** the following definitions shall be incorporated into the Regulations:

6.4.A.1 **Roll Cage:** is the structural cage that encompasses the drivers head and upper body as per Reg.6.4.F. The roll cage shall be integrally attached to the structural chassis of Reg. 6.4.E.

6.4.A.2 **Roll Bars:** are the series of tubular bars which comprise the roll cage.

6.4.A.3 **Structural Chassis:** is the tubular frame / monocouque composite chassis / hybrid of composite & tubular frame which encompasses the driver's body, and to which the vehicle suspension system is connected.

6.4.B **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.C **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.D **Safety Belts:**

6.4.D.1 All solar cars must be equipped with a minimum of a 5-point lap and shoulder belt harness system for the driver.

6.4.D.2 The use of safety belts is mandatory.

6.4.D.3 The safety belts must be installed and attached securely to the structural chassis, as recommended by the manufacturer.

6.4.D.4 The placement of the attachment points and seat belt harness 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.D.5 If the belt passes through the seat, it must pass through without wrinkling, crimping or bending the bent excessively. All sharp edges shall be removed or covered to prevent cutting or fraying of the belt.

6.4.D.6 Only safety belt systems manufactured to SFI 16.1 or SFI 16.5 are allowed. Any modifications must be approved by the manufacturer.

6.4.E **Structural Chassis**: The combination of the solar car structural chassis and 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. The structural chassis shall be designed for a minimum of a 5g load from all directions, where g is the total gross mass of the vehicle including driver and ballast as outlined in Appendix E.

6.4.E.1 **Crush Zone**: An additional structural crush zone attached to the structural chassis must be provided in the area of the driver's torso. The crush zone shall be on both sides of the solar car and spaced a minimum of 150 mm from and parallel to both

sides to the structural chassis and shall be considered as integral to the structural chassis and included in the impact analysis. The outer face of the crush zone shall encompass a perimeter of a minimum of 100 mm (4") vertical, and length greater than the distance between the driver's hips and shoulders. The outer face of the crush zone shall be vertically positioned below the driver's shoulders, adjacent to the driver's chest. The outer face of the crush zone shall be horizontally placed adjacent to the drivers torso (waist to shoulder). The outer face of the crush zone shall be vertically and horizontally braced back to the structural chassis to prevent buckling.

6.4.E.2 **Crush Zone Material**: The crush zone can take the form of additional tube frames which are designed to yield at 5g impact, or other energy absorbing material. The energy absorbing material needs to stay intact, i.e. materials that splinter would not be acceptable. Teams are required to provide documentation of the Crush Zone design as part of the Mechanical Design Report.

6.4.F **Roll Cage:** All solar cars must be equipped with a roll cage that is fixed and integrally connected to the structural chassis. The roll cage and structural chassis combination shall encompass the entire driver in all directions including the full free range of motion of the driver's head in all directions with the safety belts in use. (The roll cage must encompass the driver well enough that a cloth stretched around the roll cage is clear of the driver.)

6.4.F.1 The protection provided for the driver in a collision must be documented in the team's Mechanical Technical Report as per Reg. 3.4.B.

6.4.F.2 A preliminary sketch and description of the roll cage must be submitted to ASC Headquarters the date indicated in Reg. 3.2.A.1, as per Reg.3.3.

6.4.F.3 In addition to providing collision and rollover protection, the roll cage must be designed so as to deflect body/array panels of the car up and away from the driver in the event of an accident. Note, the forward portion of the roll cage shall be far enough forward that in the event of a collision causing the drivers head to move forward, the furthest extent of the drivers head is still within the confines of the roll cage

6.4.F.4 The roll cage must be padded with energy-absorbing material which is bonded and secured to the roll cage, meeting SFI-45.1 or better, wherever it may come into contact with the driver's helmet covering 50% of the roll cage member. In addition, a headrest of at least 20 mm thick resilient material must be securely mounted behind the driver's head such that it supports the drivers head in normal driving position.

6.4.F.5 There must be 50 mm of clearance in all directions between any member of the roll cage and the helmet of the driver seated in the normal driving position. There must be at least 30 mm of clearance between the driver's helmet and the padding to allow for free movement of the driver's head.

6.4.F.6 The roll cage and attachment of the roll cage to the structural chassis shall be designed for a minimum of a 5g load from all directions, where g is the total gross mass of the vehicle including driver and ballast.

6.4.G **Outside Air Circulation:** Outside air, from intake vents and directed towards the drivers face, must be provided. Should intake vents from the wheel openings be used, the natural air flow rate through the ducting to the driver compartment shall be augmented by a ventilation fan.

6.4.H **Egress:** The driver's cockpit must be designed to allow the driver to exit the vehicle unassisted towards both the left and right sides of the vehicle.

6.4.H.1 Such 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.H.2 Teams shall define primary and secondary directions for egress.

6.4.H.3 Teams will be required to demonstrate that the driver can exit the vehicle unassisted, standing clear of the plane of the car, in no more than 10 seconds for the primary direction and in no more than 15 seconds for the secondary direction.

6.4.H.4 The solar car shall not be chocked during the egress test.

6.4.H.5 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.I **Number of Occupants:** The solar car shall be configured for only a single driver without passenger(s).

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:

(1) A point on the ground 8 m in front of the solar car
(2) A minimum of 17° above the horizon on level ground
(3) A full 100° to either side of center
(4) 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 solar car structure.

6.5.C **Windshield:** All solar cars 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 solar car.

6.5.D **Rain Clearing:** Solar cars must have a method to clear the windshield from any falling rain 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 solar cars 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 solar car 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 stoke on a 1 m^2 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 solar car drivers weighing less than 80 kg will require ballast to bring his or her weight to 80 kg as per Reg.3.10.A. Ballast weight will be measured into containers provided by ASC Headquarters.

6.6.A **Ballast Bag:** Each registered solar car driver will be allowed up to two containers to contain his/her required ballast (two containers are allowed if a common ballast container is used). Containers will be a single colored 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 a full ballast container will fit securely in the car’s ballast carrier(s).

6.6.B **Common Ballast Bags:** Should a team elect to use a common ballast bag, then each solar car 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 weight up to 80 kg as per Reg.6.6.

6.6.C **Carrier:** Each solar car must 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 solar car and/or be demonstrated to hold the ballast fixed in the event of an impact.

6.6.D **Common Ballast Box:** For solar cars equipped with two (2) ballast boxes, one of the two boxes shall carry a Common Ballast Bag (see Reg.6.6.B). This box will be sealed 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:** Ballast types allowed shall be either 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 weight to ensure that the required ballast needed will fit into the container provided.

6.7 Fasteners[2]

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 much 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. 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:

(1) Bolts with flex-loc type nuts or other nuts that use flexure as the means of locking and are re-useable.
(2) Bolts with pre-drilled shafts and castle nuts with cotter pins installed to prevent loosening
(3) 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.
(4) 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 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 type straps (without hook terminators) shall 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.

[2] Fasteners are a complex subject and much care should be taken to choose appropriate fasteners for each application. Excellent references on proper use and securing of bolts can be found:

- Smith, Carrol. Prepare to Win.
- Reithmaier, Larry. Standard Aircraft Handbook.
- Federal Aviation Administration. FAA Advisory Circular AC43-13-1B. Chapter 7.

6.8 Brakes[3]

Solar cars must have a balanced, co-reactive, dual braking system so that if one system should fail, the solar car 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 a contact area with the brake disk that is greater than 6.0 cm^2, and the pad 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:** Solar cars 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 m/s^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:** The brake pedal shall be placed such that it 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 turn the steering wheel lock-to-lock without removing or repositioning either hand from the steering wheel.

6.9 Parking Brake

Solar cars 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 Rayce 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).

6.9.E If a parking brake employs a brake pad on rotor then each brake pad used in the parking brake system must have a contact area with a brake disk that is greater than 6.0 cm^2.

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.

[3] Braking systems for solar cars should be designed in accordance with standard automotive engineering practice. In general, bicycle type brakes are deemed to be too fragile for this kind of application and will not pass scrutineering. This includes mountain bike type disc brakes. While such brakes may have enough stopping power to slow down a solar car, over long periods of application descending hills common in the ASC competition, they do not have appropriate levels of brake energy dissipation. Larger pads with more contact area can help ensure that vehicle braking systems are designed to dissipate heat to prevent failures involving boiling brake fluid, disc warpage, and loss of braking force. Vehicles that do not heed these recommendations may not pass scrutineering or be allowed to compete.

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:** Solar cars must be able to make a U-turn in either direction, without backing up, such that any portion of the solar car that is within 200 mm of the ground remain within a 16 m wide lane. Portions of the solar car above 200 mm above ground may exceed the 16 m distance.

6.11 Towing Hardpoint

Solar cars 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 non-moving 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

Solar cars will be tested for dynamic stability and handling performance. A combination of the following tests may be conducted:

6.12.A **Figure-8:** Solar cars must be able to negotiate a figure-8 course in less than 9 seconds per side. The figure-8 course shall have a 5 m wide lane around two 6 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.

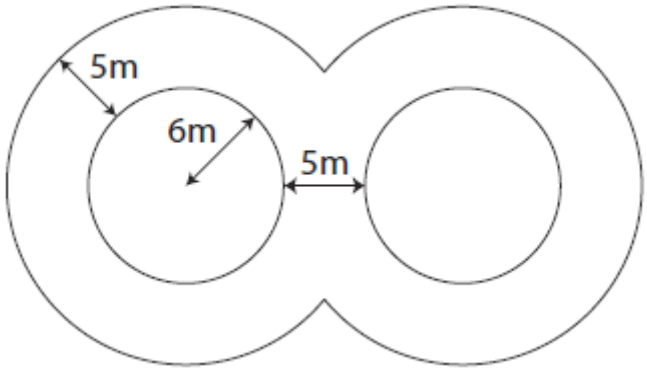


Figure 6-1 Figure-8 Course Layout

6.12.B **Stability at Speed:** Solar cars 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 104.6 km/h (65 mph), 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:** Solar cars must be able to negotiate a slalom course in 11.5 seconds. The slalom course shall be 126 m long, with cones equally spaced every 18 m as in Figure 6-2.

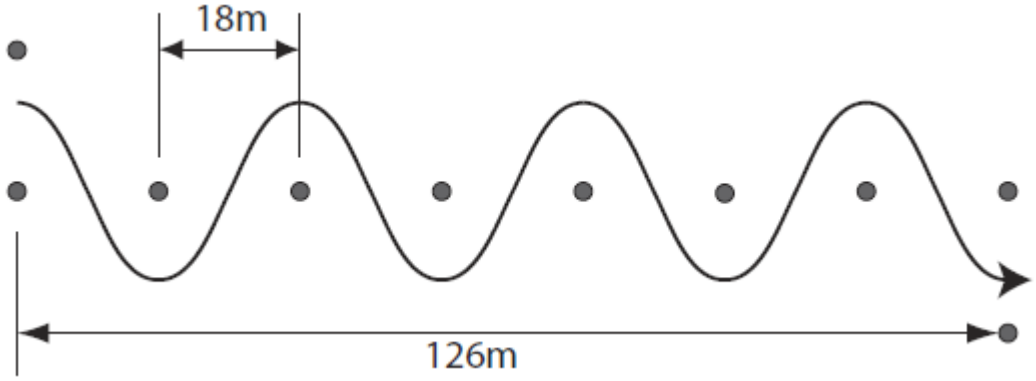


Figure 6-2 Slalom Course Layout

6.12.D **Brake Test**: Solar cars 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 solar car comes to a complete halt. When braking, the solar car 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 Raycing configuration.

6.12.D.1 Solar cars may be required to demonstrate the brake performance a minimum of two out of three times.

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

6.13 Data Logger

Solar cars may be required to carry a self-powered data logger specified by Rayce 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 mm^2 that requires exposure to the sky (can be through a transparent medium). Additional details will be provided by ASC Headquarters during Scrutineering.

7. Raycing

7.1 Rayce Format

The Rayce is comprised of a series of stages between predetermined locations (Stage Points) following a specific Rayce Route. Each stage will begin with a Staged Start, where all solar cars are released from the same point. At the end of any Raycing Day during which an entry has not reached the next planned Stage Point (and does not trailer to that Stage Point), the team will stop where they are located along the Rayce Route. The team will begin the next morning at the same point, following regulations established for Non-Staged Starts. Stages may also have mandatory Checkpoints.

7.2 Determination of Winner

The team with the shortest Official Total Elapsed Time will be declared the winner of the Rayce. Subsequent placings will be based on the ranking of Official Total Elapsed Times.

7.3 Solar Car Configuration

Solar cars must rayce in the same configuration as approved during Scrutineering and used at the Qualifier.

7.4 Drivers

Only one person, the authorized driver, may ride in the solar car at any time. Drivers must be registered and have appropriate ballast per Reg.3.10.

7.4.A **Driver Helmets:** Drivers must wear a helmet while operating the solar car. The helmet must meet or exceed the Snell95, DOT, or ISO motorcycle standards and will be inspected during Scrutineering.

7.4.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 solar car. 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 solar car. Driver's shoes shall be approved at the Inspectors discretion.

7.4.C **Driver Ballast:** Drivers and their corresponding ballast will be identified with unique identification tags. The tags on the ballast carried by the solar car must match the tags on the solar car driver at all times. Drivers must supply their own ballast material.

7.4.D **Driving Time:** Each individual driver may not drive more than a total of six hours in a given Rayce Day. If the solar car 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.

7.4.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.

7.5 Support Vehicles

All vehicles and trailers associated with a team other than the solar car itself are support vehicles and must be registered with ASC Headquarters. All vehicles must meet US/Canada Federal Motor Vehicle Safety Standards.

7.5.A **Lead Vehicle:** Each team must provide a "lead vehicle" to alert oncoming traffic to the presence of the solar car.

- **7.5.A.1** The lead vehicle must travel within 500 m ahead of the solar car, with its headlights on and with roof-mounted flashing amber lights visible from ahead (single bulb rotating beacon lights are not considered to be acceptable).
- **7.5.A.2** The lead vehicle may not tow a trailer.
- **7.5.A.3** The lead vehicle shall not be larger in height or length than a standard 15-passenger, full-size van.
- **7.5.A.4** The lead vehicle shall carry at a minimum the following safety equipment: certified, stocked first aid kit, ABC fire extinguisher, safety vest (1 per occupant), 4 orange cones (minimum 300 mm high), and an orange warning flag.

7.5.B **Chase Vehicle:** Each team must provide a "chase vehicle" to protect the solar car from the rear.

- **7.5.B.1** The chase vehicle must follow directly behind the solar car; with roof-mounted, flashing amber lights visible from the front and the rear (single bulb rotating beacon lights are not considered to be acceptable).
- **7.5.B.2** The chase vehicle may not tow a trailer.
- **7.5.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.
- **7.5.B.4** The chase vehicle shall not be larger in height or length than a standard 15-passenger, full-size van.
- **7.5.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.

7.5.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 solar car.

- **7.5.C.1** The scout vehicle should maintain at least a 1 km separation from the solar car caravan and all other solar car caravans.
- **7.5.C.2** The scout vehicle must not obstruct traffic or other solar car convoys.
- **7.5.C.3** The scout vehicle shall not be larger in height or length than a standard 15-passenger, full-size van.

7.5.D **Other Support Vehicles:** Additional support vehicles, including truck/trailer units, may travel on the Rayce Route, but should maintain at least a 1 km separation from all solar car caravans. These other support vehicles must not obstruct traffic or other solar car caravans.

7.5.E **Support Vehicle Graphics:** All support vehicles, including trailers, must be marked with:

- **7.5.E.1** the team's solar car number (at least 250 mm tall, with a 40 mm brush stroke) on both sides and the rear.
- **7.5.E.2** The name of the team's sponsoring Institution(s) must also be displayed prominently on each vehicle.
- **7.5.E.3** the scout, lead, and chase vehicles must also display the team's solar car number on the top passenger side of the front windshield (at least 15 cm tall).
- **7.5.E.4** **Event Logo:** ASC 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.
- **7.5.E.5** **Slow Moving Caravan:** A sign must appear on the rear of the chase vehicle to

warn overtaking traffic of the solar car caravan. Signs will be provided by ASC Headquarters at a size of no larger than 500 mm by 500 mm. Teams desiring to create their own signs may do so provided "CAUTION: SOLAR CAR CARAVAN ADHEAD" is the wording used and is clearly indicated on a contrasting background. Alternative signage must be pre-approved before arrival at Scrutineering by the Inspectors.

7.5.E.6 Additional graphics are permitted, provided they are neither offensive nor disruptive.

7.6 Radios / Communication

The chase vehicle must be in two-way radio communication with the solar car driver at all times. All two-way radio channels must be registered with ASC Headquarters. All teams must also have a separately monitored CB radio in every support vehicle on the route tuned to an "official event" CB channel to communicate with other nearby teams and officials.

7.6.A **Observer Monitoring:** All communications between the solar car driver and support vehicles must be audible (for voice communications), to the observer at all times. Any communications in languages other than English, in code, must be explained to the observer if requested.

7.6.B **Driver Communications:** All communications by a driver of any vehicle (lead, chase, support, and solar car) must be verbal and hands-free at all times. Hands-free operation for the solar car driver is defined as operation where the driver can activate the radio without removing his/her hands from the steering wheel.

7.6.C **Cell Phone Use:** Cell phones are permitted within the solar car. 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).

7.7 Observers

Trained Observers selected and sponsored by ASC Headquarters, will travel with each team to alert the Inspectors to possible infractions of these Regulations, and to help report unforeseen events to ASC Headquarters. Observers may not interpret these Regulations or give advice on Rayce strategy. Observers will be rotated in their team assignments at Checkpoints and Stage Locations.

7.7.A **Observer Access for Inspection:** Observers will be assigned to keep each solar car 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 solar cars. The Observers must be allowed access to the solar cars for inspection of ballast during all driver changes.

7.7.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 Checkpoints and stage finishes), impound times, distances traveled, and any apparent rule infractions either by their assigned team or by any other team.

7.7.C **Observer Accommodations:**

7.7.C.1 **During Raycing Hours:** Teams must allow the Observer the seat of his or her choice behind the driver in the chase vehicle. The Observer must be able to see the solar car 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.

7.7.C.2 **Before and After Raycing Hours:** Teams must provide a secure shelter for the observer of the quality of the best provided accommodations to any team member or advisor. Teams must also provide a secure location approved by the observer for the battery impound box.

7.7.C.3 **Meals and Lodging:** Observers should be considered a guest of the team for whom the team will supply proper meals, drink, shelter, and amenities afforded to any member of the team or advisor.

7.8 Team Uniforms

On Rayce Days from 7:00 am to 8:00 pm, team members shall wear uniforms representing their Institution(s). The uniforms are required to have the Institution name, car number, and ASC logo. If team sponsors are displayed, the event sponsor(s) must also appear in a similar manner on the team uniform. Artwork for the ASC logo and for the event sponsor(s) may be obtained from ASC Headquarters.

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

7.9 Briefings

A Briefing will be held at each Stage Start location. Special meeting may be called in cases of emergency. Attendance at this meeting by a team representative and driver(s) is required. Briefing notes and other daily updates will be available at Checkpoints and posted to the Event website. All official statements, rule interpretations, and special instructions will be contained in these postings. On Non-Staged Days it will be the responsibility of the team to check available outlets for updates and instructions.

7.10 Timing

7.10.A Timing and distance determinations for the Event will be the responsibility of ASC Timing Officials. ASC Headquarters will recognize no other timing or distance information. An Official Elapsed Segment Time will be calculated for each entry based on the actual Rayce Time that has elapsed between each stage/checkpoint to the next stage/checkpoint. The summation of these Segment Times will yield an Official Total Elapsed Time for the entry. Overall placing will be determined based on the lowest Official Total Elapsed Time reference Reg. 7.2.

7.10.B **Official Elapsed Segment Time:** Official Elapsed Segment Time will be the entry's elapsed Rayce Time from one stage/checkpoint to the next stage/checkpoint, plus any penalties and any protest filing 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 Rayce.

Official Elapsed Segment Time = Elapsed Rayce Time + Penalties + Protest Filing Fees

7.10.C **Team Off-Course:** If a team departs from the Rayce 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.

7.11 Raycing Hours

7.11.A **Standard Raycing Day:** The Standard Raycing Day is from 9:00 am – 6:00 pm (9 hours) for all days of the rayce. Actual raycing hours may be adjusted to start later or end earlier than the standard racing day based on the exact segment distances and coordination of activities at each of the stages / checkpoints. Actual raycing hours will be announced at the pre-rayce meeting.

7.11.B **Time Zones:** Official clock time for each entry on each day of the Rayce will be based on the local time at that day's start line, as displayed by the Rayce Officials. The same official clock time (Rayce Time) will remain in effect for each team for the entire day (until midnight), even though that day's route may cross into a different time zone.

7.12 Rayce Route

7.12.A **Route Book:** The American Solar Challenge Route Book will be distributed to each team that qualifies for the Rayce. The Route Book will contain information to direct the team along the official route. It will specify days, distances, directions, route numbers, maps, and points of reference. For a team to receive official time, they must follow the official Rayce Route.

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

at Checkpoints.

7.12.C Teams Departing from the Rayce Route: Any team leaving the Rayce 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.

7.13 Stage Starts

Teams are released from the Start Line in 1 minute intervals. Assuming a Standard Raycing Day, all teams will be given a full 9-hour Adjusted Raycing Day. Each team's Lead and Chase vehicles must merge with their solar car 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.

7.13.A Starting Order: For the first day of the Rayce, the starting order will be determined based on performance during the Qualifier. The team with the most completed laps in the Qualifier will be first in the starting order. In the event of a tie at the Qualifier, the team with the fastest recorded lap will start first. For all other Stage Starts, the order is based on each team's Official Total Elapsed Time available at 7:00 am of that morning, from shortest to longest. In case of a tie, the first of the tying teams to cross the previous stage's finish line will precede the others in the starting line-up.

7.13.B Teams Not Ready: If a team's solar car, lead, and chase vehicles, with drivers in each vehicle, are not in their assigned starting positions at 8:45 a.m., 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.

7.13.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 time 7:00 am the morning of the start). If the team leaves the starting line at their assigned time, then 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.

7.13.D Delayed Start: The start of the Rayce, at any stage start, may be delayed if inclement weather or other hazardous conditions appear likely to pose a threat to the solar cars or their drivers. If the start of the Rayce is delayed, then all assigned start times for that day will be adjusted accordingly.

7.14 Non-Stage Starts

Solar cars will be released from their start point at 9:00 am, or as adjusted based on the end of day grace period from the previous day per Reg. 7.16.

7.15 Checkpoints

A Checkpoint is a mandatory stop (typically 1 hour) in a predetermined location along the Rayce Route. Checkpoints may be added or subtracted as needed by Rayce Officials. Checkpoints will remain "active" for a specified number of hours during the first day of any new stage. "Active" hours will be posted an announced at the pre-Rayce meeting.

7.15.A Active Checkpoints: Teams reaching an active checkpoint will be subject to a mandatory stop at the checkpoint. Mandatory time spent in an active Checkpoint will not be factored into a team's Official Total Elapsed Time. Failure to stop at an active Checkpoint will result in no credit for distance driven beyond that point. Within the Checkpoint area, the movement of all team vehicles shall be under the control of Checkpoint Officials.

7.15.A.1 Solar Car Maintenance: Solar charging of solar car batteries and solar car maintenance are allowed during the mandatory Checkpoint time. However, array stands are not permitted at checkpoints and teams must not interfere with or block any other team's passage through the Checkpoint. Teams unable to leave the Checkpoint area after the mandatory time must move their solar car elsewhere.

7.15.B Closed Checkpoints: After the specified number of active hours, Checkpoints will be permanently shut down and will be referred to as "closed". Teams are not required to stop at closed checkpoints and should immediately proceed on the Rayce Route.

7.16 Overnight Stops[4]

For days not ending at a Stage Finish, a "grace period" of up to 15 minutes early or 30 minutes late can be applied to the end of each team's Official Raycing Day to allow time to find a safe place to stop. The corresponding time adjustment will be made to the Official Start Time for the next morning. No credit is given for teams choosing to stop more than 15 minutes early. Teams that Rayce beyond 30 minutes past their Official Stop Time will be penalized two minutes for every minute beyond that limit. The grace period cannot be applied to a Stage Start or Finish.

7.17 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 Rayce 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-Rayce briefing.

Once a team's solar car 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 Rayce Headquarters. Solar cars may be pushed within and between these areas, but regenerative braking may not be used during such times.

7.17.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.

7.18 Impound[5]

All battery enclosures per Reg. 5.5 must be removed from the solar car and kept overnight in a lockable box/container that will be secured by the Observer. Headquarters should be appraised of special issues for impound.

7.18.A Impound Times: Batteries must be impounded by 8:00 pm each evening and will be released from Impound at 7:00 am the following morning.

7.18.B Impound Rules at Stage Locations: After crossing the finish line at the end of a stage, each team will be given 30 minutes to impound their batteries. This time includes moving the solar car to an area designated by the Finish Line Officials, removing the battery pack, placing the batteries in the approved impound box, and having the approved impound box sealed by an ASC Official. At 6:00 pm that evening, the batteries will be released from impound, and the team may charge from then until the regular night impound time, as described in Reg. 7.18.A.

7.18.C Impound Rules at Checkpoint Locations: After arriving at the checkpoint, each team will be given 15 minutes to impound their batteries. This time includes moving the solar car to an area designated by the Checkpoint Officials, removing the battery pack, placing the batteries in the approved

[4] Example: Team A elects to drive 17 minutes late to find an appropriate overnight venue. The following morning, their Official Start Time will be 8:17 am. Team B elects to stop Raycing 7 minutes early. The next morning their Rayce Time begins 7:53 am.

[5] Impounding of batteries is designed such that all teams will have equal amounts of charging time. This prevents teams that arrive to a checkpoint early from have more charging time than teams that arrive later. Teams should recognize that should the need arise, they will require additional power sources to power or troubleshoot vehicle systems while batteries are impounded.

Impounding Example: Team A crosses the Finish Line at 2:25 pm and will have until 2:55 pm to impound their batteries. Team B crosses the Finish Line at 5:30 pm and must impound their batteries by 6:00 pm at which time their batteries are immediately released for evening charge. Team C crosses the Finish Line at 5:31 pm and will not have to impound their batteries since the 30 minutes allowed to impound would expire at 6:01 pm, after which regular evening charging has already begun.

impound box, and having the approved impound box sealed by an ASC Official. Batteries will be released 15 minutes prior to the departure time from the checkpoint, yielding a total of 30 minutes potential charging time during each checkpoint.

7.18.D **Impound Box/Container:** Each solar car team shall provide a lockable box/container in which the battery enclosures per Reg. 5.5 will be secured by the Observer per Reg. 7.18.

7.19 Charging Areas

7.19.A **Staged Stop:** A charging area will be provided for the teams. Internal combustion generators will not be permitted within the charging area. Only solar car charging may occur within this designated area.

7.19.B **Non-Staged Stop:** Teams are responsible for choosing appropriate charging areas.

7.20 Passing Traffic

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

7.20.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.

7.21 Traffic Laws

During the course of the Rayce, all state and local traffic laws must be obeyed. Solar cars must observe a maximum speed limit of 104.6 km/h (65 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.

7.22 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 CB 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 8 km/h (5 mph) in a zone where passing is permitted and feasible, or by pulling completely out of the traffic lane.

7.23 Drafting

Drafting by a solar car is prohibited. A solar car 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 40.2 km/h (25 mph) or less.

7.24 Pushing

Except for the following situations, solar cars 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 solar car.

7.24.A **Checkpoints / Stage points:** Solar cars may be pushed within the confined area of the Checkpoint or Stage Point.

7.24.B **Emergency:** In an emergency or breakdown situation, the solar car 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 Raycing, the solar car may then be pushed or lifted back onto the roadway to the same location where it left the roadway.

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

7.25 Trailering

Should it become necessary to load the solar car 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 8:00 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 stopped raycing or earlier along the race route.

7.26 Accommodations and Lodging

All teams are responsible for team accommodations and food during the Rayce. Teams are responsible for their own reservations.

7.27 Accidents and Re-Inspection

All accidents involving either solar cars or support vehicles must be reported immediately to ASC 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 solar car is involved in an accident it must:

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

7.27.B Be re-inspected by an Inspector at or before the next Checkpoint. The Inspector may require repairs prior to resuming the Rayce.

8. Penalties

Any team failing to comply with these Regulations during Scrutineering, the Qualifier, or the Rayce will be penalized. Penalties range from official warnings to disqualification from the Event. It is the responsibility of the Chief Inspector, with input from the other Inspectors and the Observers, to determine whether an infraction occurred, the severity of the incident, and the appropriate penalty. All time penalties will be submitted by the Chief Inspector to Rayce Headquarters for subsequent posting. Disqualification of a team from the Event requires concurrence of the Director. Penalties will generally be applied to Total Elapsed Time on the Official Elapsed Time Sheet on staged days, at the start of non-staged days, or at Checkpoints.

8.1 Penalty Times

All penalty times listed are suggested minimums. Driving conduct penalties (Regs. 8.7.A-8.7.H) may double with each subsequent infraction. Mathematical penalties (Regs. 8.7.I-8.7.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 ASC Headquarters, which is checked regularly, where penalties can be officially delivered to the team. On the last day of Raycing, time penalties per team will be posted no later than 30 minutes after the finish of the Rayce 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 Rayce 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 will be assessed against the team's Official Elapsed Time for the day on which the protest is filed. The Jury will hear all protests.

8.3.A **Opportunity to Be Heard:** Protests will normally be heard by the jury at the earliest possible jury sitting. It may be necessary in some instances for the jury 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 9:00 pm the following day the penalty is posted. Protests that do not directly relate to a penalty must be filed by 6:30 pm on the last day of the stage when the offense occurred. On the last day of Raycing, protests for any purpose must be filed within 60 minutes after the finish of the Rayce or 60 minutes after a team arrives, whichever is later.

8.3.C **Protest Judgements:** The decision of the Jury is final and no further appeals are allowed. The Jury will notify Rayce Headquarters of their decision, and Rayce Headquarters will then inform the affected teams. The Jury 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 Time Penalties

8.5.A **Speeding:** Any solar car 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 solar car 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 112.6 km/h (70 mph) or greater will result in a 1 hour penalty in addition to the calculated assessment.

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

8.5.C **Failure to Allow Other Traffic to Pass:** Any team solar car 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 Rayce:** Any support vehicles too close to solar car caravans (Reg. 7.5.C.1, 7.5.D) or impeding another team's solar car caravan will be penalized a minimum of 10 minutes.

8.5.E **Drafting:** A minimum 5 minute penalty may be assessed for any time a solar car 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 solar car in order to advance along the Rayce 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 solar car with ballast that does not match the solar car driver.

8.5.H **Unauthorized Drivers:** Any solar car that is rayced 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 Rayce until the official finish, teams will be disqualified from the Event for charging their solar car's storage batteries from any source other than those allowed by Reg. 5.1, without specific written instruction from Rayce Officials. Such charging of a solar car storage battery will constitute replacement and is subject to Regulation 8.5.K.

8.5.J **Disturbing Official Battery Seals:** Solar car 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 an Inspector. The penalty will be computed as follows:

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 solar car battery pack

8.5.L **Failure to Impound:** A 2 minute penalty may be assessed for every minute between 8:00 pm and 7:00 am, required time during a checkpoint, or any time between the 30 minutes after finishing allowed at the end of a stage and 6:00 pm, that a solar car's Raycing batteries are not in Impound.

8.5.M **Exceeding Size Specifications:** Oversized solar arrays will be penalized 10 minutes per Rayce day per excess centimeter in each dimension beyond the allowed size specification. Oversized solar cars will be penalized 5 minutes per Rayce Day per excess centimeter in each dimension. If both the array and car are oversized, both penalties will be applied.

8.5.N **Trailering Penalties:** Teams electing to trailer their solar vehicles will be assessed the full published time for that Stage (Checkpoint credit would not be allowed). In addition, the team will receive penalty per uncompleted (not driven by solar car) mile of the interval(s) trailered of 3 minutes per mile.

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 Rayce 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.

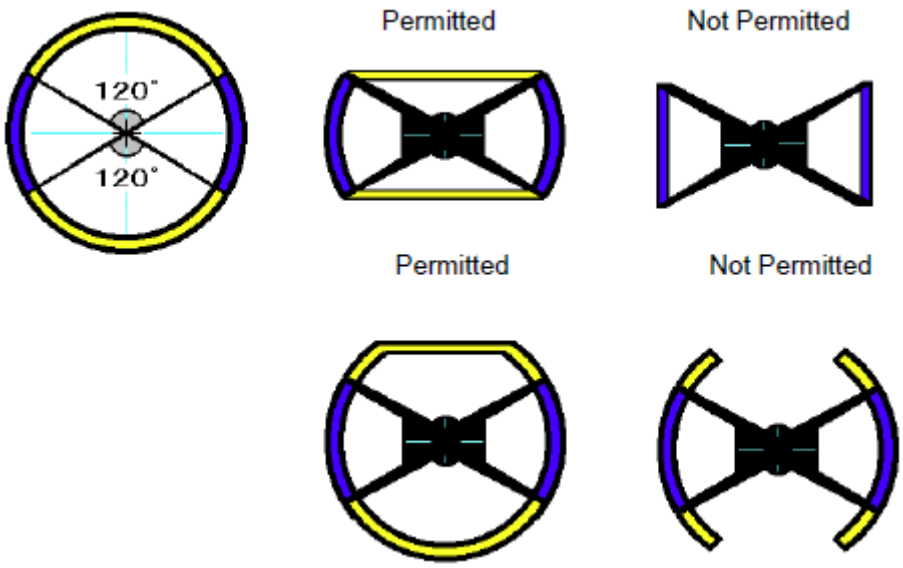
8.5.P **Parking Brake Penalty**: A 10 minute per Rayce day penalty will be applied for a non-functioning parking brake based on Reg. 6.9.

8.5.Q **Roll Cage Clearance Penalty**: a 2 minute per Rayce day penalty will be applied for each centimeter of clearance lacking between the roll cage padding and a driver's helmet based on Reg. 6.4.F.5. It will be at the discretion of the inspectors whether less clearance will be allowed with the penalty.

Appendix A ISF Steering Wheel Specifications

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.

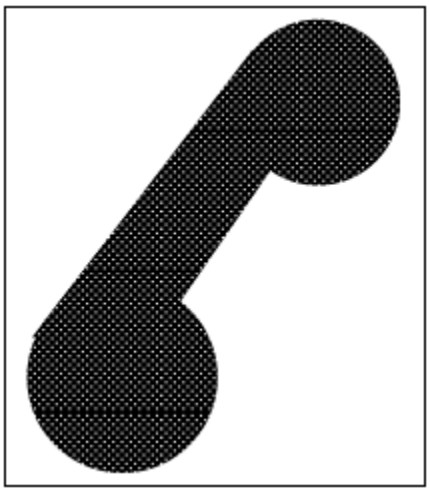
A circular shape is preferred, however the upper part above 2/3 and/or the lower part below 2/3 of the circumference of the steering wheel may be flat as depicted in the diagram below).

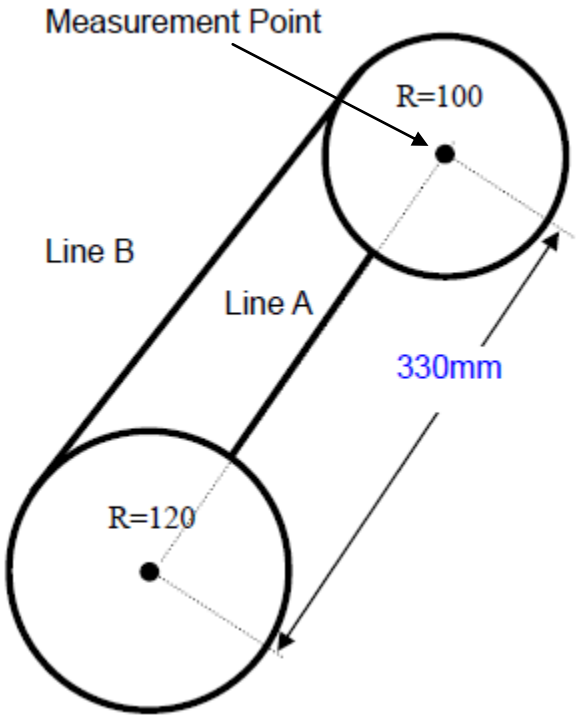


Appendix B ISF Standard Measurement of Seating Angle

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.

Appendix D PVDR Instructions

It is the intent of the Event to maintain the safest entries possible while encouraging a wide variety of designs and materials for solar-powered vehicles. The purpose of the structural report is to require each team to document, by calculation or testing, the structural integrity of their vehicle and the protection provided to their drivers. Note that each team is responsible for the safety of its members, and any minimum criteria specified by the Organizers should not be construed as design specifications for the construction of a "safe" solar vehicle.

The Preliminary Vehicle Design report as per Reg. 3.3 should outline the basic mechanical, structural, electrical and battery design of the vehicle. It should be written to be as concise as possible, limited to a total of 20 pages.

The report shall be submitted in PDF format, and the text have at least 10 point font.

Report format shall be a single PDF Package containing: (1) technical document on your mechanical system, and (2) an overview of the electrical approach to the solar vehicle. PDF Package file names shall contain sponsoring organizations name_ASC 2014PVDR. Example: a report from the University of ACME may appear as "UnivOfACME_ASC2014PVDR.pdf" with the first letter of each new word capitalized and common abbreviations accepted.

The report should describe:
Mechanical:

(1) Mechanical Team leader contact information (phone & email)
(2) Brief summary of the vehicle and overall layout
(3) Roll over and impact protection for the driver
(4) Driver protection including crush space, roll cage construction, driver harness attachment (dimensions sketches, drawings etc are required).
(5) Some basic initial analysis should be shown documenting the roll cage for driver protection in the event of a 5g roll over impact (Ref. Reg. 6.4.F.6).
(6) The vehicle frame and construction techniques (aluminum space frame, composite monocoque, etc.), including the materials to be used, important dimensions, and assumed properties
(7) Plans for the methods used to prove structural integrity (Beam theory hand calculations, finite element analysis, etc.) for each major component (suspension components, chassis, battery mounting, etc). Final analysis should not be presented, just plans for how the analysis is to be accomplished.
(8) Suspension design and arrangement, including steering and braking systems

Electrical & Battery:

(1) An overview of the electrical approach to the solar vehicle
(2) Electrical Team leader contact information (phone & email)
(3) A preliminary electrical diagram showing greater than 24 volt service plans.
(4) Preliminary battery approval document including the battery team leader contact information (phone & email)
(5) Battery types and suppliers/manufacturers' being considered if one is not already chosen
(6) Battery testing plans with critical dates.

Appendix E Mechanical Report Instructions

It is the intent of the Event to maintain the safest entries possible while encouraging a wide variety of designs and materials for solar-powered vehicles. The purpose of the structural report is to require each team to document, by calculation or testing, the structural integrity of their vehicle and the protection provided to their drivers. Note that each team is responsible for the safety of its members, and any minimum criteria specified by the Event should not be construed as design specifications for the construction of a “safe” solar vehicle.

The structural report shall be presented in the format described in this document. Reports that do not meet this format will not be read and could jeopardize a team’s chances for competing in the event. The report should be written to be as concise as possible and should only present information relevant to the requirements of the report. The report is limited to a total of 50 pages, including appendices.

Section 1: Introduction
A brief summary of your project and the overall design of your vehicle. This should include overall dimensions, component location and layout, and driver position. Teams should describe the vehicle both in its normal racing configuration, and in its stationary charging configuration.

Section 2: Mechanical Systems Analysis
The mechanical systems analysis section must include the following six sub-sections:

- Front suspension
- Rear suspension
- Brakes
- Steering
- Wheels & Tires
- Battery Enclosure

Each sub-section must contain all of the following information:

- **Material Specifications:** Describe the materials utilized, their important dimensions (e.g., tubing diameter and thickness), and material properties (in the “as welded” or “as fabricated” condition).
- **Loading Conditions:** Describe the specific loading conditions used in the analysis of the component. Teams should consider road and traffic conditions when determining loading criteria and potential failure modes. For suspension and steering systems, analysis needs to include at least a 1G turn, a 2G bump, and 1G braking case. Loads should be provided in dimensional units. Include any relevant assumptions used in the analysis.
- **Drawings:** Include component drawings or photographs and mechanical system assembly drawings or photographs. All drawings must be identified by number and must include a description. In the case of purchased or procured components, include the manufacturer and part numbers.
- **System Analysis:** Mechanical components and systems must be analyzed to show that they will not fail due to fatigue and possess a reasonable factor of safety for strength and stress. Provide a summary of both the analytical methods used and the analytical results for each mechanical component or system. Analyzes may be in the form of either calculations, computer modeling (such as finite-element analysis), or empirical testing of the actual vehicle or its components. If testing is not completed at the time the report is submitted, detailed plans of the scheduled testing must be included in the report. The results from the described tests must be submitted once they have been completed. All teams must include the expected static weight on each tire.

Teams must show how they intend to build and secure battery enclosures to meet the requirements of Reg. 5.5. Include a description of how the enclosure will be ventilated and how the cells will be secured within the battery enclosure. Provide a discussion of your findings and how the results impacted your design.

Section 3: Vehicle Impact Analysis
The vehicle impact analysis section must include the following topics:

- **Specifications:** The report must describe the vehicle frame and construction techniques (aluminum space frame, composite monocoque, etc.), including the materials utilized, their important dimensions (e.g., tubing diameters and thicknesses, number and types of plies in composite constructions), and their properties (in the "as welded" or "as fabricated" condition). The report must also list the specific impact

criteria that are assumed for each case, as well as sample calculations and computer output as applicable. Other relevant assumptions used in the analysis should be listed.

- **Drawings:** The report must include structural drawings of the vehicle from five viewpoints: top, front, side, rear, and isometric. These drawings must illustrate the following:
    - Driver location and orientation
    - All members considered "structural"
    - Locations of ballast and batteries
    - Locations of chassis hard points (points of attachment).
    - Calculated center of mass

The report must contain structural drawings of the driver's compartment from three viewpoints: top, front, and side. These drawings must illustrate the following:

- Driver location
- Crush Zone
- Roll cage design and location
- Location of structural members
- Driver's harness attachment points

The report must contain an isometric drawing of the body and solar array. All drawings must be identified by number and must include a description.

- **Analysis:** Analyzes may be in the form of computer modeling (such as a finite-element analysis) or empirical testing of the actual vehicle or its components. The report must document the performance of the vehicle regarding front, rear, side, and rollover impact, using appropriate forms of analysis. Front, rear, and side impact with another vehicle assumes a bumper height of 100 mm and elevation off the ground of 350 mm as shown in Figure 1. Rollover analysis must address loads at a minimum vertical and two increments between horizontal and vertical.

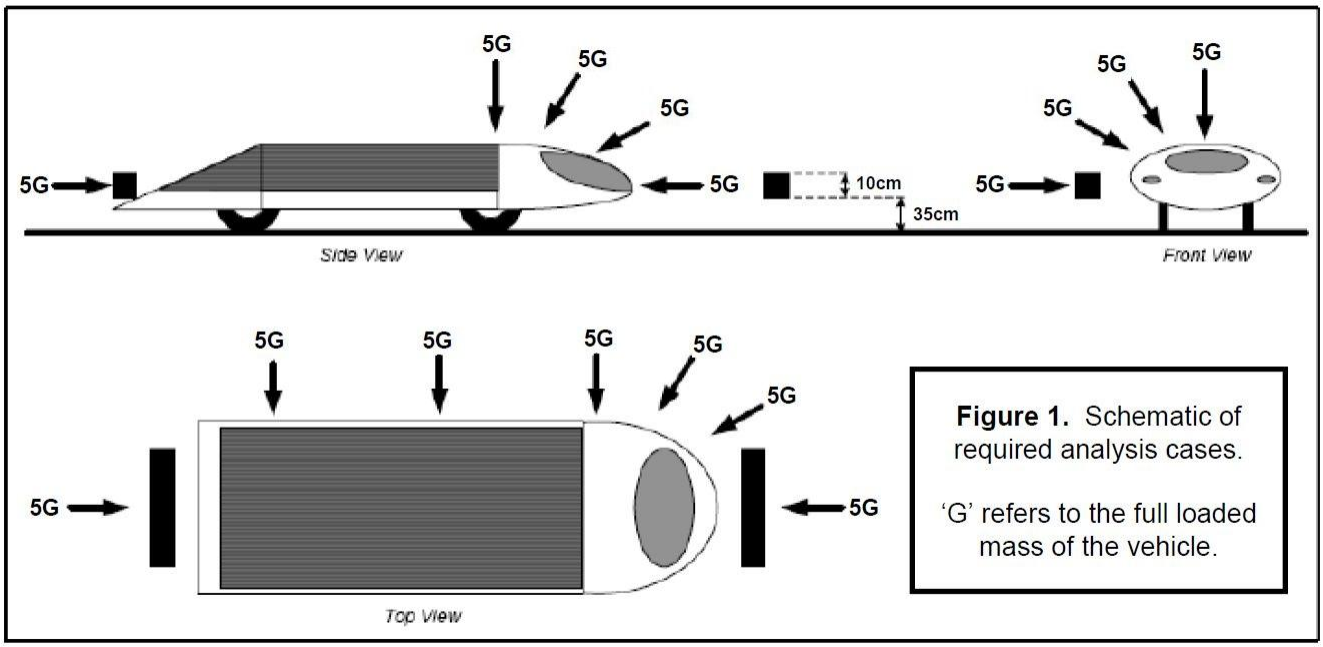


Figure 1. Schematic of required analysis cases.

'G' refers to the full loaded mass of the vehicle.

The minimum criteria for these impacts are 5G loads, where the G is the total gross mass of the vehicle (including driver and ballast) as illustrated in Figure 1. Emphasis should be placed on how protection is provided for the driver under these conditions. All impact scenarios must take into account movement of body panels and the vehicle's solar array to ensure that these members do not penetrate the space occupied by the driver during the impact.

- **Conclusions:** The report should contain a summary of the findings for each impact case and a brief discussion of the results. Raw data should be attached as an appendix to the report.

Section 4: Appendix

The appendix should only include relevant information that is referenced from the main body of the report.

Appendix items should be organized into two appendices. Examples of what could possibly be included in the appendices are: detailed calculations and results, empirical testing data, details on construction techniques, and component specifications that are particularly relevant to the analysis.

- **Appendix A** - Mechanical Systems Analysis Supporting Documentation
- **Appendix B** - Vehicle Impact Analysis Supporting Documentation

Appendix F Electrical System Report Instructions

It is the intent of the Event to maintain the safest entries possible while encouraging a wide variety of designs and materials for solar-powered vehicles. The purpose of the electrical system report is to require each team to document, the design of the electrical system of the solar car.

The report shall be presented in the format described in this document. Reports that do not meet this format will not be read and could jeopardize a team's chances for competing in the event. The report should be written to be as concise as possible and should only present information relevant to the requirements of the report.

The following sections shall be provided:

1. Introductory paragraph telling the Inspectors about the solar car: new design, carryover from prior event, etc…
2. If the solar car design is not to the state of describing these functions, submit your "PLANS" and describe that aspect in the Introductory Statement.
3. High Voltage Schematic – Minimum of ALL propulsion wiring
4. Descriptive understanding of the ALL high voltage functions during a Battery Event – Paragraph and possibly schematics
5. Descriptive understanding of Battery Fan function – schematic may be used here as well
6. Who to contact if an issue is found in this document:
7. Team Electrical Contact
8. Team Battery Contact

Appendix G Battery Approval Form

ASC2014 Battery Form

NOTE: The manufacturer's specification sheet, the battery's MSDS sheet with accident protocol, and a description of the protection circuitry (protection circuitry schematic, high level description, list of items protected) must also be submitted to ASC prior to approval. Battery approval is subject to verification at Scrutineering. If the manufacturer changes the battery's specifications, the new specifications must be submitted for re-approval. Teams should bring unmodified cells for weight verification.

CONTACT INFORMATION

Date: _____ **Team Number:** _____

Organization: _____ **Team Battery Contact:** _____

Email: _____ **Phone:** _____

MANUFACTURER INFORMATION

Manufacturer: _____ **Type (lead acid, LION, etc):** _____

Battery Name: _____ **Model Number:** _____

Battery Capacity (Ah): _____ **Rate (C/3, C/20, etc):** _____

Battery Mass (kg): _____ **Battery Voltage:** _____

Battery Cost (US$): _____ **Max Current per Cell:** _____

VEHICLE BATTERY PACK SPECIFICATIONS

Number of batteries in the vehicle battery pack : _____

Pack Mass (kg): _____ **Pack Voltage:** _____

Pack Configuration: _____

_____

_____

SUPPLIER INFORMATION

Information for the company that is supplying the batteries to the team. This may be the original manufacturer or a reseller. If the supplier uses a different model name or number than the manufacturer, please provide that information.

Supplier: _____ **Contact:** _____

Email: _____ **Phone:** _____

Supplier Battery Name: _____ **Supplier Model #:** _____

Note: For this form, the term "battery" refers to the smallest single unit produced by the manufacturer. A lithium ion battery usually contains one cell. A typical 12v lead acid battery contains six cells. Teams or suppliers may group batteries together to form "modules". The term "battery pack" refers to the full vehicle battery system made up of multiple batteries.

Appendix H Solar Cell Report

Your report will be based on the type of solar array you intend to use in the ASC 2014 event based on Reg.5.2. The following are instructions on preparing your team's report. Prepare your report using the instruction set that matches your solar car entry's style of array.

Your report should contain the following:

1. Team Name
2. Team Number
3. Array type (Silicon only, Ga/As only, or mixture) based on Reg. 5.2.B
4. Complete list of cells used on your solar array. List should indicate (Reg. 3.4.F) for each unique type of cell used:
    - Cell manufacturer's name and contact info
    - Stock number, type, or description
    - Manufacturer's quote for cell area (square centimeters)
    - Manufacturer's quote for performance
    - Cost (US$) per cell
    - Cell area (square centimeters)

    Include a copy of the manufacturer's data sheets in the appendix of your report for each type of cell. *NOTE: you are only allowed a maximum of 6 types of cells. Any change in any of the cell characteristics would dictate a new cell type being used.*
5. A detailed breakdown of the size and dimensions of each type of cell listed in #4 after trimming or cutting as placed on the solar car. Show your calculations on how you determined cell area. Cell area should be in square centimeters (Reg. 3.4.F.6).
6. A detailed drawing showing the specific layout of your solar array including how the array is broken into sub arrays and the layout for each solar cell indicating which type of cell is used where on the array (Reg. 3.4.F.7).
7. Calculations determining the total cell area for your whole solar array. Show your calculations and use square centimeters (Reg. 3.4.F.7).
8. Indicate all other non-photovoltaic/ photovoltaic technology used as defined in Reg. 5.1. Report how these technologies will be used during Racying and charging times. Indicate how these technologies will fit into the car volume allowed per Reg. 6.1.

All calculations should be reproducible by inspectors.

The purpose of these reports is to pre-scrutineer your car's solar array. Inspectors will compare your report to your car at Scrutineering. Be sure to remember to bring a sample raw solar cell (Reg. 5.2.D) of each type used to Scrutineering for validation purposes.

Appendix I Recommendations

These are not binding parts of the regulations, as they are impractical to enforce fairly, but the ASC officials believe they are essential to creating a good, safe solar car. All teams should meet these recommendations on their own.

- **Driver Training** Driver Training is essential to ensuring your car can be driven safely. Solar vehicles have substantially different controls, field of vision, and feedback from regular vehicles. We recommend that every team trains all drivers in a gradual and controlled manner. This means that a driver will begin learning to handle the vehicle in a very controlled setting (such as a large closed parking lot or track) and progress to more challenging situations as he/she gains experience. Prior to any driving, the vehicle should always be given a safety check and the driver should have properly functioning safety equipment. As training progresses, the driver (and all team members in the caravan) should practice handling the following situations:
    1. Blow-outs and run flats, especially of the single rear wheel on a three wheel vehicle
    2. Loss of power
    3. Primary brake partial and complete failure
    4. Passing protocols
    5. Merging protocols
    6. Road hazard avoidance
    7. Moving to shoulder from operational speed
    8. Caravan communication and protocols for possible emergencies
    9. Emergency stop and egress

- **Vehicle Stability and CG** CG location has an important influence on vehicle stability. Your CG location should be a design requirement, not something you find after you build the car. Information about recommended CG location, and its influence, will be posted on the ASC website.

Appendix J Revision Table

Rev	Description	Date
A	Initial Release of Document.	Nov. 2, 2012
B	3.1.A – updated Initial Registration Package requirements 3.1.D – added limitation to Road Fee 3.2.A.1 – updated date 3.2.A.2 – updated date 3.2.A.4 – added date 3.2.A.5 – added date 3.2.B – updated Late Penalty format 3.2.C.1 – clarified bank transfer fee 3.2.C.4 – added Acceptable Methods of Payment 3.6.A – removed reference to “company” 3.12.A.1 through 3.12.A.7 – significant additions and revisions 3.12.B – removed reference to “organization” 4.1.B – removed wording “(regs)” 4.2.A – updated 4.4 – updated requirements 5.2.A – significant revision 5.2.B – significant revision 5.2.D – added “type and” 5.3.A – increased NiMH allowable weight 6.4.D.3 – corrected grammar 6.4.E – added force requirement 6.4.E.1 – significant revision 6.4.E.2 – added 6.4.F.6 – corrected grammar 6.6.A - added “(s)” to carrier 6.6.C – clarified statement on number of ballast boxes 6.7.B – added safety wire specification 6.8.A – added requirement for brake pad contact 6.12.D.1 – added as separate numbered clause 6.12.E – added 7.1.A - deleted 7.13.A – amended Starting Order definition 7.18.B – revised impound location requirement 7.18.C – revised impound location requirement Appendix E - added Appendix F - added Appendix G – corrected title	Oct. 17, 2013