

FORMULA SUN GRAND PRIX™ 2004 REGULATIONS
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FORMULA SUN GRAND PRIX 2004 REGULATIONS

1. PURPOSE

1.1. The fundamental missions of the Formula Sun Grand Prix™ are to promote and celebrate educational excellence and engineering creativity. Fuelled by the spirit of friendly competition and teamwork, the Formula Sun Grand Prix (FSGP) champions the creative integration of technical and scientific expertise across a range of exciting disciplines.

1.2. Our mission includes:

1.2.1. The support and encouragement of bright young minds to succeed in the fields of engineering, sciences, mathematics, in multi-disciplined learning and in subsequent careers.

1.2.2. The creation of public awareness and enthusiasm, both for education excellence itself, and for the technologies that emerge from that excellence.

2. ADMINISTRATION

2.1. Application of Regulations - These Regulations will apply to the Formula Grand Prix (the "Event"), which includes the selection of teams, registration of teams, the inspection of solar cars ("Scrutineering"), the "Sprint", and the three-day rally competition (the "Rayce").

2.2. 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. Supplemental documents specifically referenced in these Regulations include the Formula Sun newsletter, Official Interpretations and Instructions for Scrutineering. The organizers reserve the right to revise these Regulations at any time.

2.3. Acceptances 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.

2.4. Interpretation of Regulations – Prior to Scrutineering all interpretations must be published in the Formula Sun newsletter or posted to the Internet under "Official Interpretations" on the FSGP page in order to become official. During and after Scrutineering, all official interpretations will be announced at Briefings and posted at Headquarters and on the Internet. The only group authorized to interpret the regulations is the Regulations Committee.

2.5. 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 Formula Sun Grand Prix. 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.

2.6. Headquarters - During Scrutineering, and the Event, a Headquarters will be established at the site of each function and will assume the management functions for the Event.

2.7. Officials - A team of Officials to conduct Registration, Scrutineering, and the Event will be selected by Formula Sun Grand Prix Organizers. Officials having specific duties shall be announced to the teams through the Formula Sun newsletter and briefings.

2.8. Jury - A Jury will be formed to evaluate protests on conformity with these Regulations, to resolve team disputes, and assign penalties. 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.

3. ENTRIES

3.1. Entry Registration - The Event is open to all to participate. Each team wishing to participate in the Event must submit an Entry Form. No team will be officially registered until the Entry Form and Entry Fee are submitted to Headquarters. The Fee Schedule is as follows:

3.1.1. Open Class - \$500 US

3.1.2. Stock Class - \$300 US

3.2. Registration Deadlines - Registration opens December 1, 2003 and closes April 15, 2004.

3.3. Number of Entries - In the interest of safety, the number of solar cars entered in the Event will be limited to thirty.

3.4. Faculty Advisor – Teams representing an educational institution 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.

3.5. Technical Documents - Technical documents describing the solar car's structure, batteries, and solar cells must be submitted to FSGP Headquarters for approval (see below for deadlines). Early submissions will receive prompt review by Headquarters. The technical information provided in these documents will not be made public. The information contained in each team's final submission must match the solar car presented at Scrutineering. Additionally, teams must bring copies of each of these documents with them to Scrutineering.

Safety should be the primary concern with regard to the structural development and fabrication of the solar cars.

3.5.1. Roll Cage/Suspension/Steering Report - Particular attention should be given to the roll over and impact protection systems for the driver/passenger. A preliminary sketch and description of the roll cage must be submitted to ASC Headquarters by March 1, 2004. Additional instructions will be provided.

3.5.2. Mechanical Documentation - A formal Structural Report is not required for this event, however, teams must bring documentation of suspension, body, and roll cage to Scrutineering. If a Structural Report was written for a previous event, this will be suitable.

3.5.3. Electrical Documentation – Teams must present a wiring diagram and documentation about fuses and other critical electrical components during Scrutineering.

3.5.4. Battery Approval - All storage batteries used in the solar car must be approved by FSGP Headquarters. Each team must provide a copy of the manufacturer's battery specification sheet, the MSDS (Material Safety Data Sheet) obtained from the battery manufacturer, and the following battery information to Headquarters by March 1, 2004:

- Manufacturer's name, and contact information
- Stock number, type, or description
- Module voltage (e.g., 6, 12, or 24 V)
- Buss voltage
- Number of modules to be used in the solar car
- Manufacturer's specifications, including capacity (kWh), weight (kg), and cost (US\$).
- 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).

3.5.5. Solar Cell Approval - All solar cells must be approved by FSGP Headquarters. Each team must provide a copy of the manufacturer's solar cell specification sheet, and the following solar cell information to Headquarters by March 15, 2004:

- Manufacturer's name and contact information
- Stock number, type, or description
- Manufacturer's quote for cell area (cm²)
- Manufacturer's quote for performance
- Cost (US\$) per cell
- Cell area (cm²) after trimming or cutting or placement on the solar car

3.6. Team Data - Each team must submit team photos and data sheets to Formula Sun Headquarters by April 15, 2004. 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 May 1, 2004 without permission of the team representative.

3.6.1. 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 company or institution when there is more than one company or institutional sponsor. The photos may be used in FSGP programs and other publications. Additional instructions will be provided.

3.6.2. Data Sheets - The data sheet must include solar car weight (with battery but no driver/passenger), solar car dimensions, motor type and rating, solar cell type and manufacturer, estimated peak solar array power in both Raycing and charging 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, crewmembers, designated driver/passengers, and faculty advisor(s) must also be listed.

3.6.3. Team Data Changes - Teams may change specifications of the solar car and crew up to the scheduled time of Scrutineering, with the exception that solar cell and battery specifications may not change after March 15, 2004 without specific approval from FSGP Headquarters. Any changes submitted after April 15, 2004 may not appear in print.

3.7. Registration - All people taking part in the Event must be registered with Headquarters. This includes team members, sponsors, officials, guests, and the media. Badges will be issued and used to obtain access to restricted areas. These badges must be visible at all times.

3.8. Crew Requirements - All team members involved in the ("crew") must present themselves at Registration to complete all required forms. Team members will be required to complete and sign liability waivers and emergency medical information forms.

3.9. Driver/passenger Requirements - Only registered solar car driver/passengers will be allowed to drive/ride in solar cars during the Event. A team shall have a minimum of two (2) driver/passengers available at all times. In addition to meeting the crew requirements, solar car driver/passengers must be 18 years old or older. Drivers must present a valid driver's license. Driver/passengers must supply their own ballast (sand or metal shot only). The official weight of each driver/passenger, including driving clothes, helmet, and shoes, will be 80 kg. If the driver/passenger weighs less than 80 kg, ballast will be added to make up the difference. If the driver/passenger weighs more than 80 kg, no credit will be given.

3.10. Insurance – All teams must purchase the liability insurance provided by the Organizers or show a certificate of commensurate purchased insurance or self-insurance.

4. EVENT COMPONENTS

4.1. Scrutineering- Each team registered for the Formula Sun Grand Prix must submit their solar car for inspection prior to the Event to verify compliance with these Regulations. In addition, spot checks for regulation compliance may take place during and immediately after the Sprint and the Rayce, and the top five overall finishing cars will be impounded immediately following the Rayce for a final inspection.

4.1.1. Scrutineering Time and Location - Order of inspection 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 will 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.

Scrutineering location and schedule is TBD.

4.1.2. Scrutineering Format - Scrutineering will involve inspection stations for sizing, body, electrical, mechanical, and dynamic tests to verify handling and braking performance. Instructions for Scrutineering and a detailed description of the Scrutineering tests will be distributed in advance to all registered teams.

4.2. Sprint – Teams competing in FSGP may choose to participate in the Sprint competition before they compete in the Rayce. The Sprint will be held the day before the start of the Rayce. The format of the Sprint will be in heats of two vehicles from a standing start through a quarter mile. The overall winner is determined by shortest elapsed time through the quarter mile. Pole position for FSGP is determined by the order of the finish in the Sprint and then by times for the figure-8 test.

4.3. The Rayce - A maximum of thirty qualified teams will be permitted to participate in the Rayce, a track rayce for solar cars. Solar cars must rayce in the same configuration used during Scrutineering. The team with the most officially logged laps in the least amount of time will be declared the winner of the Rayce or class thereof.

4.4. Safety - Each team is responsible for the road-worthiness of its solar car. Passing Scrutineering or implementing changes suggested in comments on the team's Structural Report does not relieve the team of any liability. All solar cars 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.

4.5. Withdrawals - Any team wishing to withdraw must notify Formula Sun Grand Prix Headquarters in writing. All written withdrawals signed by the team representative are final. Formula Sun Headquarters may withdraw teams that do not meet the technical document deadlines or fail to present a solar car at Scrutineering.

5. SOLAR CAR REGULATIONS - ELECTRICAL

5.1. Power - Global solar radiation received by the solar car without artificial external augmentation 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 Raycing. Wind energy as well as direct and diffuse radiation are considered forms of global solar radiation. With the exception of the effects of wind on the basic shape of the car, all components used to convert global solar radiation for propulsion shall be considered part of the solar array described below.

5.2. Solar Array - At any given moment, the solar array comprises all components that are involved in the conversion of the above-defined solar energy for use by the vehicle. In addition to direct energy conversion components (such as photovoltaic cells), the solar array includes any reflective surfaces, refractive lenses, or thermal-cooling systems employed to increase power output. Components that carry or process the energy after conversion are not considered part of the solar array, nor are structural members whose sole function is to support the solar array. The entire solar array must fit within an imaginary right rectangular parallelepiped ("box") of limited size whenever the solar array is connected to the solar car's motor or battery. The "box" may not exceed:

5.2.1. Dimensions:

5.2.1.1. For Classic Dimension Solar Cars - up to 5 meters in length, 2 meters in width, 1.6 meters in height. Furthermore, the product of the length and width, less any single rectangular region not occupied by solar array components, may not exceed 8 m².

5.2.1.2. ISF5000 Solar Cars - up to 5 meters in length, 1.8 meters in width, 1.6 meters in height.

5.2.1.3. Two Person Solar Cars – up to 6 meters in length, 2 meters in width, 1.6 meters in height.

5.2.1.4. ISF4000 – up to 4 meters in length, 1.6 meters in width, 1.6 meters in height.

5.3. Raycing Configuration - Whenever the solar car is moving under its own power, the solar array must be in its Raycing configuration. In Raycing configuration, the "box" must be defined such that the length and width lie parallel to the ground. Furthermore, all portions of the solar array must remain fixed with respect to the solar car chassis, in the same orientation and configuration used when the solar car was inspected during Scrutineering.

5.4. Charging Orientation - Whenever the solar car is stationary, the solar array may be reoriented to maximize solar exposure for charging. Reconfiguration of the array is NOT allowed. In charging orientation, the “box” can have any orientation relative to the ground. Charging configuration will be demonstrated as part of Scrutineering.

5.5. Electrical Connection - All connections between the solar array and the solar car must be carried by the solar car.

5.6. Water Spray - Ambient-temperature water from an external source may be applied to the solar array using hand-pumped sprayers if the water is applied while the solar car is stationary and the application does not present a shock hazard. This is a unique exception to the general requirement that cooling systems must be considered part of the solar array.

5.7. Solar Cell Technology Limitation

5.7.1. Stock Class - If photovoltaic technology is used, only solar cells that are listed on the FSGP Stock Class Approved list will be allowed. These will have been determined to be available to all registered teams at a price not exceeding US\$10/watt for bare cells; teams may pay extra for cutting, tabbing, or lamination of the cells. Substantial modification of the crystal structure, junction, or metallization constitutes manufacture of a new cell. Teams or suppliers wishing to make an addition to the list must submit all appropriate data to FSGP Headquarters by January 15, 2004.

5.7.2. Open Class – There are no limitations on cells that may be used. Solar Cell information listed in 3.5.5. must be provided to Headquarters.

5.8. Storage Batteries – All solar cars are allowed to store solar-generated energy in a battery system composed of individual modules having a weight determined by the technology used (see 5.8.1. and 5.8.2.).

Adherence to weight limitations does not imply automatic battery approval. Battery approval forms must be submitted to Headquarters before official approval may be issued. FSGP Officials reserve the right to refuse approval of modules.

5.8.1. Stock Class – Teams may use up to 165 kg of sealed (non-spill) lead-acid battery. Battery weight shall be based on the manufacturer’s published specifications submitted by the team. The solar car storage battery may be composed only of rechargeable, commercially produced lead-acid modules. Batteries must be available in sufficient quantities to be accessible to all participating teams. The battery modules may not be modified in any manner, including the addition of electrolyte additives; case modification; or plate addition, removal, or modification. Only batteries that are listed on the FSGP2003 Stock Class Approved list will be allowed. Teams or suppliers wishing to make an addition to the list must submit all appropriate data to FSGP Headquarters by January 15, 2004. Stock class teams may use more than one type of lead-acid battery, but teams must describe the composition of their packs in their battery approval forms.

5.8.2. Open Class - May use up to:

- 165 kg of sealed Pb-acid battery
- 60 kg of NiMH battery (see 5.8.2.1 for exception)
- 100 kg of NiCad battery
- 30 kg of Li Ion battery
- 30 kg of Li Ion Polymer / Li Ion Alloy (polymer) battery

5.8.2.1. Hybrid Battery Packs - Allowances for hybrid packs will be based on percentages of the weight allowances for the types of modules used. For example, if a NiMH/Lead acid hybrid pack is comprised of 50% of the allowable weight for NiMH, then the lead acid allowance for that pack will be 50% of the 165 kg allowance for lead acids. The total of the percentages used in the pack may not exceed 100%.

5.8.3. Supplemental Batteries - Supplemental, replaceable batteries carried in the solar car may be used to power only the following accessories: radios, electronic panel meters, driver/passenger ventilation fans (if solely for driver/passenger ventilation), main disconnect relay, horn, and data telemetry.

5.8.4. Other storage techniques - If any other storage techniques are used, they must be shown to be storing no energy before the start of each day of the Rayce. For example, if a power condenser is used, the electric charge must be proved to be zero before the start of each day of the Rayce. If a flywheel is used, it must be proved not to be rotating before the start of each day of the Rayce.

5.9. Battery Enclosures - All battery modules 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. The battery enclosure covers must be constructed from the same material used in the fabrication of the rest of the enclosure. The cover must be firmly secured. The resistance measured between the battery terminals and any portion of the solar car chassis shall be greater than 1 mega ohm for applied potentials up to 500 V. 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. Velcro fasteners/straps will not be approved. All sides of each battery enclosure, including top, 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.

5.9.1. Battery Removal - Battery enclosures must be designed such that the entire set may be removed and placed in impound (see 7.14.). Teams must remove their entire battery pack nightly and place it in a single, solid, box/container, securable with a standard padlock. This box constitutes the impound space and as such must be situated per rayce official request.

Cell/module level removal is allowed but discouraged.

5.9.2. Battery Stacking - Stacking the batteries is discouraged. If it is necessary to stack the batteries, a battery rack must be used. The rack must be made of non-conductive, electrolyte - resistant material that is strong enough to support the weight of the entire battery system. The rack shall meet the same electrical isolation requirements as the battery enclosures.

5.9.3. Battery Ventilation - Battery enclosures must be equipped with a forced ventilation system rated at a minimum of 280 liters per minute. It must operate whenever the battery system is electrically connected to the solar car or to the solar array. Such ventilation systems must exhaust to the exterior of the solar car and must be powered by the battery system.

5.10. Main Fuse - A separate fuse (not a circuit breaker) must be placed in series with the battery system and the rating must not exceed 200% of the maximum expected current draw. All low-voltage taps from the battery system must be separately fused. All fuses must be placed first in series with the battery starting at the positive connection.

5.11. Power Switch – The solar car must be equipped with a single throw manually operated, high current 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 voltage and the full load current. The switch must be located within easy reach of the driver.

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 (canopy removed); use two sets of markings if necessary. Relays for this purpose must be normally open, and power for the relay may be supplied by auxiliary batteries.

5.12. Cable Sizing - All electrical cables must be properly sized to expected system currents.

5.13. Electrical Shock Hazards - All exposed or easily exposed conductors, junction boxes, solar cells, etc., operating at greater than 36 volts must be protected from inadvertent human contact and must be marked "High Voltage" in letters at least 10 mm high.

5.14. Lighting - Solar cars must have amber front indicators, red or amber rear turn indicators, and red brake lights which must all be clearly visible from 30 meters in full sunlight. Turn signals must be located at the front extremity of the vehicle with a 1.5-meter minimum left to right separation. Turn signals and brake lights must be located at the rear extremity of the vehicle with a 1.5-meter minimum left to right separation. The geometric visibility of each light shall be 30 degrees from center and 15 degrees up and down. Additional brake lights may be centrally located if desired.

5.15. 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 meters in front of the solar car. The horn must be permanently mounted.

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

5.17. Control - Acceleration, braking, and steering must be under the sole control of the driver.

6. SOLAR CAR REGULATIONS - 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. These define both Open and Stock Classes (see 5.2. for array dimensions)

6.1.1. Classic - Length=6 meters, height=1.6 meters, width=2 meters. When turning corners, wheels and wheel fairings may exceed these dimensions.

6.1.2. ISF5000 - Length=5 meters, height=1.6 meters, width=1.8 meters. When turning corners, wheels and wheel fairings may exceed these dimensions.

6.1.3. Two Person – Length=6 meters, height=1.6 meters, width=2 meters. When turning corners, wheels and wheel fairings may exceed these dimensions.

6.1.4. ISF4000 – Length=4 meters, height=1.6 meters, width=1.6 meters. When turning corners, wheels and wheel fairings may exceed these dimensions.

6.2. Tire and Wheel Requirements - The solar car shall have a minimum of three tires in contact with the ground at all times. The wheels and tires shall be designed for the intended application.

6.3. Tire ratings - Tires in contact with the ground shall be loaded and inflated within the manufacturer's rating at all times during vehicle operation. Each wheel and tire on a single axle must be rated for the full weight applied to that axle.

6.4. Dynamic Stability - All wheels and their suspensions, steering linkages, and geometries will be inspected for safe operation in normal and adverse conditions.

6.5. Driver/passenger Cockpit - The driver/passenger's cockpit may not subject the driver/passenger to excessive strain during normal operation, and must be designed to protect the driver/passenger from injury in the event of an accident. The driver/passenger must be clear of moving parts and linkages, so as to provide adequate space for safe operation of the vehicle.

6.5.1. Seating Position - The normal driving/riding position must place the driver/passenger's entire head higher than the highest point of his or her legs and feet. No headfirst positioning is allowed for the driver. If a passenger is seated headfirst, she/he must be located such that her/his head is located rearward of the driver's.

6.5.2. Belly Pan - The cockpit must be equipped with a full belly pan to isolate the driver/passenger from the road. The belly pan must be strong enough to support the full weight of an 80 kg driver/passenger.

6.5.3. Roll Cage - All solar cars must be equipped with a roll cage that encompasses the entire driver/passenger. The roll cage shall be a fixed, integral part of the solar-car structure. The protection provided for the driver/passenger in a collision must be documented in the team's Roll Cage Report and Mechanical Documentation (3.5.1. and 3.5.2.). In addition to providing collision and rollover protection, the roll cage must be designed so as to deflect body/array panels of the car away from the driver/passenger in the event of an accident. There must be 5 cm of clearance in all directions between the roll cage and the helmet of the driver/passenger seated in the normal driving position. The roll cage must be of steel tubing having a minimum carbon content of 0.18 percent. The roll cage tubing must have a minimum outside diameter of 2.5 cm and minimum wall thickness of 2 mm. Alternate materials which afford equivalent protection for the driver/passenger are permitted, provided they are fully documented in the team's Roll Cage Report. A preliminary sketch and description of the roll cage must be submitted to FSGP Headquarters by February 1, 2004 (3.5.1.).

6.5.4. Padding - The roll cage must be padded with energy-absorbing material wherever it may come into contact with the driver/passenger's helmet. This energy-absorbing material may be included within the required 5 cm of clearance. In addition, a headrest of at least 2 cm thick resilient material must be mounted behind the driver/passenger's head.

6.5.5. Crush Space - The driver/passenger, when seated, must have a minimum of 15 cm of horizontal distance between his or her shoulders, hips, and feet and the car's outer body surface.

6.5.6. Safety Belts - All solar cars must be equipped with a minimum of a five-point lap and shoulder belt (harness system) for each driver/passenger. The use of safety belts is mandatory. The safety belts must be attached securely, as recommended by the manufacturer, to a strong component connected to a main frame member, or to a main frame member itself in the solar car. The harness must be attached with bolts and nuts; bolts threaded into a structural member or "insert" are not allowed. If a hammock-type seat is used, the safety belts must remain functional in the event of a structural failure in the driver/passenger's seat. Only commercially manufactured safety belts are allowed. They must bear the manufacturer's emblem, and they must not be modified in any way from the condition in which they were received from the manufacturer.

6.5.7. Outside Air Circulation - Outside air from intake vents or wheel openings must be provided for the solar car's driver/passenger.

6.5.8. Egress - The driver/passenger's cockpit must provide for the driver/passenger's unassisted exit within 10 seconds. Driver/passenger's doors and/or canopies may not be taped shut at any time.

6.6. Visibility:

6.6.1. Eye Height - In the normal driving position with ballast on board, the driver's eyes must be at least 70 cm above the ground.

6.6.2. Windshield - All solar cars must have a windshield made of shatter-resistant material. The windshield must be free of excessive distortion. This will be tested by having the driver identify 4 cm high letters at a distance of 3 meters through any of the required viewing angles referenced below. Solar cars must have a method to clear at least 0.1 m² of the windshield of rain. 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.

6.6.3. Forward Vision - From the normal driving position, the driver must be able to see at all times without artificial assistance: 1) a point on the ground 8 meters in front of the solar car, 2) a minimum of 17 degrees above the horizon on level ground, and 3) a full 100 degrees to either side of center. To provide an "encompassing" roll cage, some elements of the roll cage may obstruct a portion of the forward vision. However, this view must be essentially unobstructed by the solar car structure so the driver can easily see the road and traffic.

6.6.4. 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 meters directly behind the solar car and up to 30 degrees off center. The system must provide the driver with a single reflex type image and must operate without driver input. This will be tested by having the driver identify the direction of an arrow on a 1 meter square board held approximately 1 meter above the ground.

6.7. Fasteners - All fasteners must be of suitable type, strength, and durability for their application, with the following minimum requirements:

6.7.1. Bolts - Bolts used in the steering, braking, suspension, seat mounts, safety harness, drive train, and battery box systems must at minimum meet SAE grade 5, metric grade M 8.8 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

6.7.2. Securing of Bolts - The bolts described above must be secured from unintentional loosening by safety wire, cotter pins, and nylon lock nuts. In difficult areas only, Inspectors may allow Loctite, or other means deemed appropriate. Lockwashers may not be used.

6.7.3. Hose Clamps - Hose clamps must not be used to secure any structural or critical members of the car. Their use to secure ducting or wire cables is allowable.

6.8. Covers and Shields - All moving parts must be suitably covered to prevent accidental human contact when the solar car is fully assembled. The driver/passenger must be shielded from contact with all steering linkage and other moving parts.

6.9. Steering Stops - The steering system must include steering stops to prevent dangerous or damaging steering travel.

6.10. 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.

6.11. Ballast – Any Solar Car driver/passengers weighing less than 80 kg will require ballast to bring his or her weight to 80 kg. Ballast weight will be measured into containers provided by Headquarters.

6.11.1. Ballast Carrier – Each solar car must have a single box or other suitable carrier for carrying ballast container(s). The carrier must be securely fastened to a structural member of the solar car and/or be demonstrated to hold the ballast container(s) fixed in the event of an impact. (2 person vehicles may have two carrier locations.)

6.11.2. Ballast Access -The ballast container and its identification and security markings must be visually accessible during driver/passenger changes.

6.12. Brakes - 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.

6.12.1. Braking Performance - Solar cars must be able to repeatedly stop from speeds of 50 kph or greater with an average deceleration on level WETTED pavement exceeding 17 kph per second. 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.

6.13. Handling Performance – Solar cars will be tested for handling performance. A combination of the following tests may be conducted:

6.13.1. Figure-8 - Solar cars must be able to negotiate a figure-8 course (of which the center circle of each half of the figure-8 has a radius of 6 meters) with a 5-meter-wide-lane without knocking over any of the cones or exhibiting signs of structural instability in less than 9 seconds per side.

6.13.2. Stability at Speed – Solar cars must be able to stay within a lane while traveling at speed (TBD).

6.13.3. Slalom Test – Solar cars must be able to negotiate a slalom course TBD.

6.14. Turning Radius - Solar cars must be able to make a Uturn in either direction, without backing up, such that all wheels remain within a 16-meter-wide lane.

6.15. Graphics - Solar cars must prominently display their assigned number, Institution name, and the Event logo such that they are clearly visible from a roadside vantage point. Additional graphics related to the team's Institution(s) or sponsors are permitted, provided they are neither offensive nor disruptive.

6.16. Solar Car Numbers - Each team registered for the Event will have a unique number approved by Formula Sun Grand Prix Headquarters (positive integer, 3 digits maximum). This number must be clearly displayed on both sides of the solar car. Each number must have a minimum of 5 cm of unobstructed background color on all sides. These colors can be black on white, white on black, or another high-contrast color approved by Formula Sun Grand Prix. The numerals themselves must be a minimum of 25 cm high, 12 cm wide (except the numeral one), and have a minimum brush stroke of 4 cm. Numbers containing more than one digit must have a minimum of 2.5 cm spacing between them.

6.16.1. Teams fielding vehicles that have participated in previous ISF events have priority for retaining the numbers they used in the ISF events, provided that they express an intent to register to FSGP Headquarters by January 15, 2004.

6.16.2. If a conflict arises, Formula Sun Grand Prix Headquarters will determine the numbers assigned.

6.17. Institution/Company Name - The name of the Institution(s) or organization sponsoring the team must be displayed on the solar car. Formula Sun Grand Prix Headquarters must approve the use of abbreviations or initials. The Institution's name shall be larger and more prominent than any team sponsor's logo or name.

6.18. Event Logo - The Event logo must be applied on both sides of the solar car. The logo will be provided by Formula Sun Grand Prix Headquarters and will measure no more than 20 cm in height by 30 cm in width.

7. RAYCING REGULATIONS

The Formula Sun Grand Prix 2003 event will be a multiple-day closed-course competition.

Formula Sun Grand Prix Headquarters and track representatives reserve the right to cancel the track activity at any time.

7.1. Traffic Laws - During the course of the Rayce, all track regulations must be obeyed. Solar cars must observe a maximum speed limit of 65 mph. All activity on the track and in the pits will be under the control of the Qualifying Manager.

7.2. Team Uniforms - On Rayce days from 6:00 a.m. to 9:00 p.m., team members on the track facilities shall wear uniforms representing their Institution(s)/Company(s). The uniforms are required to have the Institution/Company name, car number, and FSGP logo.

If team sponsors are displayed, the event sponsor must also appear in a similar manner on the back of the team uniform. Artwork for FSGP logo and for the event sponsors may be obtained from FSGP Headquarters.

7.3. Rayce Time - Official clock time for each team each day of the Rayce will be based on the local time, as displayed by the Officials. Timing and lap determinations for the Event will be the responsibility of Formula Sun Grand Prix Timing Officials. No other timing or lap information will be recognized by FSGP Headquarters.

7.3.1. Raycing Hours – The track will be open for three consecutive days. . The first and second days will have a raycing period of eleven hours (8:00 a.m. to 7 p.m.). The third day will have a raycing period of nine and one half hours (8:00 a.m. to 5:30 p.m.).

7.3.2. Lap Totals – Teams may accumulate laps at any time during the Raycing Hours. Only complete laps will receive credit in the Official Lap Total.

7.3.4. Final Standings – The final standings will be determined by Official Lap Totals. In the event that two or more teams have the same total, standing will be further determined by the lowest time. Teams with tied lap totals and tied times will be considered tied.

7.4. Drivers/Passengers - Only one person, the authorized driver, may ride in the solar car at any time with the exception of an authorized passenger in a two person vehicle.

7.4.1. Driver/passenger Helmets - Driver/passengers must wear a helmet while operating/riding in the solar car. The helmet must meet or exceed the Snell M95 or DOT motorcycle standard. Bicycle helmets will not be allowed.

7.4.2. Driver/passenger Shoes - Driver/passengers must wear closed-toed shoes in the solar car. Sandals are not permitted.

7.4.3. Driver/passenger Ballast - Driver/passengers and ballasts will be identified with unique identification tags. The tags on the ballasts carried by the solar car must match the tags on the solar car driver/passenger at all times.

7.4.4. Driving/Riding Time - Driver/passengers may not drive/ride more than a total of six hours in a given Rayce Day.

7.4.5. Water/Fluids - The Driver/passenger must have sufficient quantities of water/fluids in the cockpit to stay properly hydrated. (*Minimum one liter for each driver/passenger switch*).

7.5. Briefings - A Briefing will be held each morning and in the case 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 Headquarters. All official statements, rule interpretations, and special instructions will be contained in these postings.

7.5.1. Official statements, including starting order, rule interpretations, and special instructions are announced at Briefings.

7.6. Starting Line – The solar cars will be released from the official starting line in a mass start each morning beginning at 8:00 a.m.

7.7. Starting Order - The starting order for the first day of the Rayce will be determined first by the Sprint and then by the figure-8 test. On all other days, the order will be determined by the first team prepared for line-up.

7.7.1. Teams Not Ready - If a team's solar car is not in its assigned starting position 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.

7.8. Delayed Start - The start of the Rayce may be delayed if inclement weather or other hazardous conditions appear likely to pose a threat to the solar cars or their driver/passengers.

7.9. Teams Departing from the prescribed course - Any team leaving the FSGP Course will receive no credit for laps driven beyond the point where they departed from the route. In addition teams may, at the discretion of the organizers, be penalized extra laps depending on the seriousness of the offense.

7.10. "On Track" Rules:

7.10.1. Communications – All teams must have operable two-way radios to communicate with their solar car and driver/passenger from the pit area and the start line.

7.10.2. Starting – The "starting line" for the Formula Sun Grand Prix, and any subsequent re-start, will be located at the start line as defined during a team meeting prior to the Rayce Start. Each solar vehicle intending to enter the track must enter and proceed through the pit area to the starting line to register with officials and be sequenced into traffic. This must be done each time a vehicle returns to the track.

7.10.3. Timers – The official timers will be assigned to each team. Each team is responsible for ensuring that an official timer has been assigned to its car in order to have laps count. Each team must also provide a team member to work with the official timer and assist with timing. This team member must be in radio contact with the solar car driver. Timing devices and score sheets will be provided by FSGP Headquarters.

7.10.4. Timing – A master clock providing the "Official Time" will be located near the starting line to allow timers to record each lap as it is completed for each team. A solar car must cross over the starting line to begin and end an official lap.

7.10.5. Safety Equipment – Whenever a team's solar car is on the track or in the pits, the team must have proper battery safety equipment in its cold pit space.

7.11. Flag Signals:

7.11.1. Master Flag Position – The master flag position will be near the starting line. Track officials will also be located at various positions around the course to display "local" flag conditions.

7.11.2. Green Flag – Track clear, proceed at your chosen speed. This flag will be displayed at the starting line only.

7.11.3. Yellow Flag – Caution, obstruction on or near track. A yellow flag means that cars are to slow down, and no passing is allowed unless waved around by a track official. The flag may be displayed at the starting line, indicating a full track caution condition. It may also be displayed at various locations around the track to indicate that a "local" caution condition exists. When "local" caution flags are displayed, the flag position at the starting line will display green and yellow flags simultaneously. During "local" caution conditions, each driver must slow down and obey the no passing rule until they have passed the obstruction or have passed a flag position displaying no flag.

7.11.4. Black Flag – (To be given to an individual car.) You must return to the pit area for consultation.

7.11.5. Red Flag – Total stoppage due to major accident or some other reason. All cars must pull to the side and stop where they are on the track without passing. Proceed only when instructed to do so by track officials.

7.11.6. White Flag – Six minutes remaining in the day's Rayce Hours. This flag will be displayed at the starting line only and signifies that there are less than six minutes remaining to complete your last lap in the session.

7.11.7. Black and White Chequered Flag – Given to the individual solar car, it signifies meeting the minimum qualifying requirement of 140 miles of 25-mph official laps in one session.

7.12. Driving Procedures:

7.12.1. Lane Procedures - All vehicles will proceed around the raycecourse in a counter-clockwise direction at all times. Upon entering the track from the pit area, solar cars are to hug the inside of the raycetrack, keeping the inside white line on their immediate left. The only time this procedure will not be followed is when a faster car overtakes and passes a slower car. The faster car must always pass on the right side of the slower car (toward the outside of the raycecourse).

7.12.2. Maximum – No solar car shall exceed the maximum speed of 65 mph anywhere on the track.

7.12.3. Safety Vehicles – If a track safety vehicle is needed on the course, it will attempt to stay to the extreme inside of the track.

7.12.4. Breakdowns – Any solar car that stops on the raycetrack because of mechanical problems or an accident will be moved to the infield by track officials as soon as possible. No major work may be conducted on any solar car in the infield. All teams must carry a nylon tow strap in their solar car to facilitate a tow to the pit area by the track officials. No team support vehicles will be permitted on the track at any time.

Each solar car shall provide a towing eye rigidly affixed to the vehicle frame.

7.12.5. 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 later that day. In no case shall regenerative braking be engaged while pushing or pulling the solar car.

7.12.5.1. Cold Pits – Solar cars may be pushed within the defined area of the Cold Pits.

7.12.5.2. Emergency – In an emergency or breakdown situation, the solar car must be removed from the course. In this circumstance, the car may be pushed or lifted off the roadway. The solar car may then be pushed or lifted back onto the roadway at the same location where it left the roadway.

7.13. Accidents and Reinspection - All accidents involving solar cars must be reported immediately to FSGP 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 resulting in structural damage, it must be checked by an Inspector to understand the cause of the accident and to verify structural integrity before raycing is resumed. The Inspector may require repairs prior to resuming the Rayce.

7.14. Impound – All registered and sealed batteries must be kept overnight in battery boxes/containers (see 5.9.1.) that will be secured by an official. FSGP Headquarters should be appraised of special issues for impound (i.e. other than ambient temperature, super ventilation needs, propensity to explode).

7.14.1. Impound Time – Batteries must be in Impound by 9 p.m. each evening and will be released from Impound at 6 a.m. the following morning.

7.15. Designated Areas – Solar cars must remain within the designated charging area, pit area, or track from 6 a.m. to 9 p.m. Solar cars may not leave these areas without permission from Headquarters.

8. PENALTIES

Penalties may be assessed against teams because of infractions. Penalties may include a black flag, no credit for fastest lap, or disqualification from the Event.

8.1 Penalty Situations:

8.1.1. Passing another solar car on the inside.

8.1.2. Failure to heed flag signal.

8.1.3. Unsportsmanlike driving.

8.1.4. Inappropriate driving in the pit lane.

8.1.5. Driving support vehicle on the rayce course (without permission).

8.1.6. Exceeding 65 mph speed limit.

8.1.7. Minor infractions will receive warnings and repeated minor infractions may receive a penalty. They include:

8.1.7.1. Failure to give way to a passing vehicle.

8.1.7.2. Failure to report to the starting line before entering the track.

8.1.7.3. Failure to communicate with the driver from the start line.

8.2. Disqualification – FSGP Headquarters reserves the right to disqualify from the Event any car that suffers a major safety related failure during practice or raycing sessions. Major safety related failures may include, but are not limited to: wheels, suspensions, steering, electrical shorts/fires, and structural failures.

8.3. Posting of Penalties - Except for the last day, all compiled time penalties will be posted and broadcast by Rayce Headquarters by 8 a.m. the following morning. On the last day of Raycing, time penalties will be posted no later than 30 minutes after the finish of the Rayce.

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.

8.5. 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 of energy other than the solar car's solar array, without specific written instruction from Rayce Officials. Such charging of a solar car's storage battery will constitute replacement and is subject to Regulation 8.6.

8.6. Replacement of Batteries - Decisions to exchange (or externally recharge- see 8.5) all or part of a battery must be communicated formally to an Inspector. The penalty will be computed as follows:

Time penalty (lap) = $200 * (n+S)/N$, where:
n = number of replacement modules
S = sum of all modules previously replaced
N = total number of modules in solar car battery pack

8.7. 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 will be penalized as though all of the battery modules affected had been replaced.

8.8. Improper Ballast - A penalty of up to 10 laps will be assessed each time a team operates their solar car with ballast that does not match the solar car driver/passenger.

8.9. Unauthorized or Missing Drivers/Passengers - Any solar car that is rayced with an unauthorized or missing driver/passenger, may receive lap penalties.

8.10. Failure to Impound - A penalty of up to 1 lap will be assessed for every minute between 9 p.m. and 6 a.m. that a solar car's battery pack is not in Impound.

8.11. Protests - Any team desiring to file a protest must do so by submitting an official protest (signed by the team leader) 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 5 laps will be assessed against the team's Official Total Lap Count. The Jury will hear all protests.

8.11.1. Protest Judgments - 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.

8.11.2. 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.

8.11.3. Time Limit - Except for the last day, all protests against penalties must be filed by 8:30 p.m. the day the penalty is posted. Protests that do not directly relate to a penalty must be filed by 8:30 p.m. on the day after the offence occurred. On the last day of Raycing, protests for any purpose must be filed within 60 minutes after the finish of the Rayce.

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