

Solar BikeRayce USA 2004

Regulations

***Sponsored by
Kansas Corporation Commission
Crowder College MARET Center
New Resources Group***

Solar BikeRayce USA Regulations

Solar BikeRayce USA is dedicated to the educational development of high school students and others of all ages. The objectives of *Solar BikeRayce USA* are to stimulate interest in science and technology; promote energy efficiency and the use of renewable sources of energy; and raise awareness of alternatives that make fewer demands on the environment.

Part 1 - Event Structure

- 1.1 Dates and Locale** - The Rayce will be held in May in Topeka, Kansas. Final registration of teams and inspection of solar bikes will begin on two days before the Event at the event site. Team and bike data sheets are due on April 15, 2004. Initial team registration should be completed as soon as possible (see the **Entries** section below).
- 1.2 Application of Regulations** - These *Regulations* (“Regs”) apply to all aspects of *Solar BikeRayce USA* (the “Event”). The Event includes final registration of the teams (“Event Registration”), inspection of solar bikes (“Scrutineering”), a 200 meter acceleration contest (“Sprint”), and a 100 kilometer marathon (the “Rayce”). In these Regulations, each competing vehicle (whether pedaled or non-pedaled, and regardless of the number of wheels) is inclusively referred to as a “solar bike”.
- 1.3 Supplemental Documents** - Additional documents may be distributed to teams entered in the Event as supplements to these Regulations. These documents will state that they are supplemental to the Regulations and become part of the Regs when distributed. If there is a conflict between these publications, the document having the latter date shall take precedence. The organizers reserve the right to revise these *Regulations* at any time.
- 1.4 Acceptance of Regulations** - Teams selected to participate in the Event are assumed to know the Event Regulations. Participation in the Event by the teams will constitute acceptance of the Regulations.
- 1.5 Event Headquarters** - The Event is organized by the Formula Sun Education Foundation and the Missouri Alternative and Renewable Energy Technology (MARET) Center at Crowder College. The Event is sponsored by the MARET Center, the Kansas Corporation Commission, and New Resources Group. The Event Headquarters mailing address is: *Solar BikeRayce USA, 100 East Main Street, Freeman, MO 64746*; PHONE: 816-899-5512; FAX: 816-250-5430; e-mail is hq@solarbike.org; web page is www.solarbike.org.

1.6 Jury - A Jury made up of three to five members will be formed by the organizers. The Jury will judge protests on conformity with these *Regulations*, team disputes, and penalties. In addition, during the Event the Jury is empowered to decide cases not specifically covered by the *Regulations*.

1.7 Advertising, Promotion, and Publicity - All advertising, sales promotion, and publicity material produced by the entrants or their sponsors concerning or referring to the Event will refer prominently to the Event as the *Solar BikeRayce USA*. All entrants, by entering the Event, specifically agree to abide by this regulation. By entering the Event, all teams agree to the use of their names and photographs in any publicity materials that may be issued by the Event's sponsors or organizers.

1.8 Entries

1.8.1 Entry Registration - Registration fees are assessed for each registering team as listed below. The entry fee is due at the time of registration. Teams that withdraw prior to May 1, 2004 will receive a full refund of their entry fee.

Categories

1. High School (15 to 18 years)	\$100
2. Adult (15-49 years)	\$125
3. Senior (50+ years)	\$125

1.8.2 Selection of Rayce Entries - Rayce entries will be admitted in the order received. Registration forms may be requested from Event Headquarters and registration information may be submitted by teams through mail, fax, or e-mail. The first 60 registrants received for the A, B, and X classes combined and the first 40 submitted for the S class will be selected to participate in the Rayce. In the interest of safety, entries beyond these numbers may be limited. Registration will not be considered complete until the registration fee (see section above) is received.

1.8.3 High School Teams - The "High School" category is open to high schools, technical schools, and other secondary educational institutions. Team members within this category must be 18 years of age or younger and credit-earning students with good academic standing at the sponsoring institutions. Teams not representing such schools must register in categories 2-6 (see below).

1.8.4 Data Sheets - Each team must submit team and bike data sheets for their team and entries to Event Headquarters no later than April 15, 2004. The data may be publicly released and used in event brochures; late submissions may be omitted from these publications. Early submissions will not be made public before April 15, 2004.

Team Data Sheet - A data sheet provided by Headquarters must be completed by each team. This sheet will include the team leader, designated rider(s), crew members, and faculty advisors(s), and team contact information.

Bike Data Sheet - A data sheet provided by Headquarters must be completed by each team. This sheet will include the bike frame manufacturer, dimensions and wheel sizes; motor type and rating; solar cell manufacturer and estimated total power; and battery type, weight, capacity and manufacturer.

Data Changes - Teams may change specifications of their bike and crew up to the scheduled time of scrutineering. Any changes after April 15, 2004 may not be timely enough to appear in event publicity.

1.9 Event Registration - Anyone participating in the Rayce must be registered at Rayce Headquarters. This includes team members, sponsors, officials, guests, and media representatives. A maximum of 10 team members, excluding advisors, will be registered for access to restricted areas.

1.10 Scrutineering - Each team registered for the Rayce must submit their solar bike for inspection to verify vehicle safety and compliance with the Regulations. In addition, spot checks for regulation compliance may take place during and immediately after the Rayce. Modifications made to an entry after Scrutineering may require re-inspection.

1.11 Awards - The sponsors will recognize all teams participating in the Event. The top three teams in each category will receive special recognition.

Part 2 - Technical Regulations

2.1 Technical Summary - Below is a summary of the categories and classes that may participate in *Solar BikeRayce USA*.

2.1.1 Categories are defined on the basis of team and driver make up. The High School categories (1-2 below) are defined in terms of the *entire team*: team members are to be composed of a faculty advisor and students from a single secondary educational institution (high school or technical school). The high school category of "men's/mixed" and "women's" are further determined by the make-up of the riders. All other team categories (3-6) are defined on the basis of the riders only.

Solar BikeRayce USA category:

1. High School (=18 years) - Men's/mixed
2. High School (=18 years) - Women's
3. Adult (= 49 years) - Men's/mixed
4. Adult (= 49 years) - Women's
5. Senior (= 50 years) - Men's/mixed
6. Senior (= 50 years) - Women's

2.1.2 Classes are defined on the basis of vehicle type - A, B, X, and S - as described below. Classes A (Stock Solar Cycle) and B (Modified Solar Cycle) each include the 6 categories described above. Class S (Solar Vehicle) and Class X (Open Class) consist of a single category for high school teams and a single category for non-high school (adult) teams. Abbreviations in the class descriptions below are as follows: meters (m), length (L), width (W), height (H) square meters (m²), peak watts (W_p), watt-hours (Wh), and kilograms (kg). Battery types are described as lead acid (Pb), nickel metal-hydride (NiMH), nickel cadmium (Ni/Cd), and Lithium Ion (Li Ion).

Class A - Stock Solar Cycle

Size: Total bike dimensions within 2.4 m X 1.0m X 1.6 m (LxWxH).

Solar Array Size: = 0.15 m² carried on bike; = 1.6 m² total for bike+pit.

Battery: =16 kg **SEALED** Pb-acid batteries.

Category: 1-6.

Fairing: The use of a front cowl shall be permitted. Cowl may not extend rearward past the back of the forward most wheel(s).

Chassis: Bike must use stock frame.

Wheels: 2 or more, as originally manufactured.

Other: Rear view mirrors required.

Class B - Modified Solar Cycle

Size: Total bike dimensions within 3 m X 1.2 m X 1.6 m (LxWxH).

Solar Array Size: = 0.15 m² carried on bike; =1.6 m² total for bike+pit charger.

Battery:

= 16 kg of **SEALED** Pb-acid battery

= 06 kg of NiMH battery (includes charge controllers)

= 10 kg of NiCad battery

= 03 kg of Li Ion / Li Ion Polymer / Li Ion Alloy battery (includes charge controllers).

Lithium batteries require submission of sample cell and spec sheet to HQ by March 15th, 2004.

(This weight will be determined using scales provided by the organizers).

Category: 1-6.

Fairing/Chassis: No restrictions.

Wheels: 2 or more.

Other: No assistance may be provided to the rider outside of the pits, rider must be able to start, stop egress from the vehicle unassisted. Rear view mirrors, 180° front vision required.

Class S - Solar Vehicle

Size: Total bike dimensions within 4 m X 1.6 m X 1.6 m (LxWxH).

Solar Array: = 0.15 m² and =1.6 m² on vehicle (no charger in the pits during the Rayce).

Battery:

= 32 kg **SEALED** Pb-acid batteries.

= 12 kg of NiMH battery (includes charge controllers)

= 20 kg of NiCad battery

= 06 kg of Li Ion / Li Ion Polymer / Li Ion Alloy battery (includes charge controllers).

Lithium batteries require submission of sample cell and spec sheet to HQ by March 15th, 2004.

(This weight will be determined using scales provided by the organizers).

Category: High School or Adult.

Fairing/Chassis: No restrictions.

Wheels: 3 or more.

Other: No assistance may be provided to the rider outside of the pits, rider must be able to start, stop, and egress from the vehicle unassisted. Rear view mirrors, 180° front vision are required.

Class X - Open Class Vehicle

Size: Total bike dimensions within 4.0 m X 1.6 m X 1.6 m (LxWxH).

Solar Array Size: =0.15 m² carried on bike; =1.6 m² total for bike+pit charger.

Battery: =16 kg **SEALED** Pb-acid battery.

Category: High school or Adult.

Fairing/Chassis: No restrictions.

Wheels: 2 or more.

Other: No assistance may be provided to the rider outside of the pits, rider must be able to start, stop, and egress from the vehicle unassisted. Rear view mirrors, 180° front vision are required.

2.2 Solar Bikes

2.2.1 - The Stock Solar Cycle and Modified Solar Cycle (classes A and B) are pedal-powered cycles with 2 or more wheels and are equipped with a functional electric propulsion system, battery, and solar array. The rider may use any combination of muscle power, solar energy, and stored energy.

2.2.2 - The Solar Vehicle (class S) is a vehicle with 3 or more wheels and equipped with a functional electric propulsion system, battery, and solar array. The driver may use no source of energy other than the battery and solar array to propel the vehicle. S class drivers will be ballasted such that the vehicles carry a minimum 80 kg payload.

S-Class entries must have roll over protection (ROP) for the driver. The ROP be of sufficient strength to help protect the driver in the event of a roll over and should shield the driver from the incidental movement of body and chassis parts.

2.2.3 - The Open Class Vehicle (Class X) is intended for vehicles not covered by the other classes. These vehicles must follow regulations as described above, but may incorporate multiple riders and other innovations. The rider may use any combination of muscle power, solar energy, and stored energy.

2.3 Fairings and Streamlining

2.3.1 Class A - A front cowl is permitted on the solar bike, but no other structure with the sole purpose of streamlining is allowed. Structures for reducing wind resistance shall be located between the front of the vehicle and the rear of the front tire. Riders must be able to get on and off the solar bike without assistance.

2.3.2 Classes B, S, and X - There are no restrictions to streamlining provided the solar bike does not exceed the permitted dimensions. Streamlining enclosures shall not interfere with operation of the solar bike and must permit 180° of front vision. Riders must be capable of exiting the solar bike without assistance.

2.4 Solar Bike Dimensions - Solar Bikes, including propulsion, battery, and carried solar systems, must fit within the dimensions listed in the above summary. Dimensions are exclusive of the rider.

2.5 Solar Panels and Reflectors - Solar power shall be provided by photovoltaic cells that are assembled into functional modules. These modules, along with any augmenting reflectors, are combined to form the vehicle solar array. The carried solar array must be within the maximum bicycle dimensions and must not hinder safety (no sharp edges, points, mounting hardware, etc.). The solar array must not interfere with operation of the solar cycle, nor may it be attached to a rider in any manner.

2.5.1 Solar Cell and Module Limitations - The minimum functional solar cell area carried on the solar bike, not including the gaps between solar cells, shall be 0.15 m². The maximum solar cell area and may not exceed 1.6 m².

2.5.2 Solar Array Configuration - Teams in classes A, B, and X may divide their solar array into a carried array (fully visible, functioning, and attached to the solar bike during racing) and a stationary array that is mounted in their team charging area in the pits. The maximum combined solar cell area of the total array shall be a maximum of 1.6 m², exclusive of gaps between cells. The entire solar array in the class S entries must be carried on the solar vehicle while racing.

2.5.3 Reflector Limitations - Reflectors may be used on both the carried and stationary solar arrays but must fit within the pit area assigned.

2.5.4 Functioning - The vehicle array in combination with any power conditioning electronics must be rated at (and demonstrate the ability to produce) a voltage sufficient to charge the vehicle battery.

2.6 Batteries - The battery is made up of all battery modules used for vehicle propulsion. The maximum battery storage is as listed in the above technical summary. The manufacturer's published data must be provided to Headquarters before approval may be issued. The battery must be electrically isolated from the solar bike and securely fastened to the frame. The battery carried during the Rayce must be the same size and configuration as approved in Scrutineering. After the start of the Rayce, the only method of recharge is by raycing and stationary arrays.

2.6.1 SEALED LEAD ACID BATTERIES – Teams that use lead acid batteries must use sealed lead acid batteries or the entry will not pass Scrutineering. Sealed lead acid batteries are also known as Valve Regulated Lead Acids (VRLA). These batteries are not “wet” or “flooded”. If a team is unsure if a battery is sealed, they should contact the battery manufacturer and Rayce Headquarters before the Event.

2.7 Supplemental Batteries - Replaceable batteries may be used to power solar bike accessories such as radios, speedometers, electronic instrumentation, lights, and horns. Supplemental batteries must be isolated from the solar bike propulsion system. These batteries and the devices they power must be presented at Scrutineering.

2.8 Electrical Safety

2.8.1 Electrical Shock Hazard - Exposed or easily exposed conductors, junction boxes, solar cells, etc., operating at greater than 30 volts must be protected from inadvertent human contact and must be marked “High Voltage” in letters at least 10 mm high.

2.8.2 Controls - Motor controls must return to “off” when released.

2.8.3 Fuses - A separate fuse (not a circuit breaker) must be placed in series with the battery system and the rating must not exceed 150% of the maximum rated motor amps. 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.

2.8.4 Disconnect - Entries must have a quick disconnect to isolate the battery and motor. The disconnect must be available to the driver and from the outside of the vehicle. The disconnect may be a DC rated switch or another method demonstrated upon request and must have an interrupt capacity greater than or equal to the battery fuse in 2.8.3.

2.9 Number of Wheels - As specified in the technical summary above. Each wheel must be in contact with the road during normal (non-emergency) operation of the solar bike.

2.10 Steering - All solar bicycles must have a front-wheel steering system that is safe and stable.

2.10.1 Turning Radius - Each vehicle must be able to make a U-turn in either direction such that all wheels remain within a 16-meter-wide lane.

2.10.2 Handling Performance - Each driver must demonstrate vehicle maneuverability by driving a slalom course of cones placed **3 meters apart for A/B Classes** and **6 meters apart for X/S Classes**.

2.11 Brakes - All solar bicycles must be equipped with an adequate braking system for at least two wheels. Each vehicle must be capable of coming to a complete stop within 22 m from a speed of 30 km/h. Operation of the brakes must leave both hands free for steering.

2.12 Horn and Mirror - Solar bikes must be equipped with a functional horn or bell and a rear view mirror.

Part 3 - Raycing Regulations

3.1 Events - Each team entered and successfully scrutineered in Solar BikeRayce USA will have the opportunity to compete in two separate events:

- 1) Sprint Contest (200 meter qualifier)
- 2) Rayce (100 km) - each team has an opportunity to travel the full distance
 - a) Classes A,B,X (complete in approx. 4 hours + 3 hr. recharge)
 - b) Class S (complete within 3 hours)

The same vehicle configuration must be used for both the Sprint and Rayce, although drive gearing changes are permitted if desired.

3.2 The Sprint is a test of vehicle and rider acceleration and top speed. The sprint consists of an untimed 100 m distance for acceleration immediately followed by a timed 200 meter distance. Elapsed time through the 200 meter trap is used to determine placement in starting grid the Rayce describes below. The fastest solar bicycle wins the pole position for the start of the Rayce.

- 3.3 The Rayce** is a test of vehicle and rider endurance and consists of a 100 kilometer timed event on a closed course. The finish positions in the Rayce are ranked by the laps and then by time for those laps (including the last lap completed after the time expires). During the Rayce, batteries may not be replaced on the solar bike, although riders may be rotated in any manner desired.
- 3.3.1 Rayce classes A, B, and X** - The 100 km Rayce in these classes is divided in two time segments separated by a 3.5 hour recharge break. The first raycing segment lasts 1.5 hours. At the end of that time, the solar bikes complete their current lap and return to the pit area. Once in the pits, teams may recharge their batteries with only the carried and stationary solar arrays. At the end of the 3.5 hour break, the solar bikes are restarted in the same sequence and time separation as their first-half finish. The solar bikes then have 2.5 hours to complete the 100 km distance.
- 3.3.2 Rayce class S** - The 100 km Rayce in this class is to be completed in a single time block lasting 3 hours. These solar vehicles will rayce during the recharge break of the class A, B, and X Rayce.
- 3.4 Starting Line** - Solar bikes will be released simultaneously from the starting line at the beginning of each Rayce. Teams must report to their starting position 15 minutes prior to the beginning of the Rayce. Control of solar bikes in the start-line area is under the direction of the Start-Line Officials.
- 3.4.1 Teams Not Ready** - If a solar bike is not in its assigned starting position 15 minutes before the Rayce, the Start-Line Officials may, at their discretion, move all of the following bikes up one slot and place the tardy team at the end of the starting queue. All teams will have their average speed calculated based upon the official start time.
- 3.4.2 Delayed Start** - The Start-Line Officials may delay or cancel the start or other components of the Rayce in the event of inclement weather other hazardous conditions.
- 3.5 Riders** - A team may register up to 4 riders for each event. Except in the X Class, only one authorized rider at a time may ride the solar bicycle. Changing a rider during the competition is allowed only while the bicycle is stationary and in the pit area.
- 3.5.1 Helmets** - Riders must wear an approved bicycle helmet. The helmet must have a minimum ANSI Z90.4 or Snell B90 rating.
- 3.5.2 Shirt and Shoes** - Riding apparel must include a shirt and close-toed shoes (no sandals).
- 3.5.3 Riding Style** - While the solar bicycle is in motion, the rider's toes must be ahead of the hip joint at some point in the pedal cycle.
- 3.5.4 Rider's Meeting** - All riders must attend a rider's meeting at the times specified by the organizers.

- 3.5.5 Entry Numbers** - Teams registered for the Event will be issued numbers to be worn on the rider(s) and displayed on both sides of the solar bike.
- 3.6 Riding Procedures** - Team riders are to abide by official rules at all times while on the rayce course. Riders must not obstruct other teams or make dangerous maneuvers at any time. Overtaking teams must signal slower teams by using bells or horns. Slower team may not interfere with passing by faster riders.
- 3.7 Breakdowns** - A solar bike rider that stops on the rayce track because of fatigue, mechanical problems, or an accident shall be moved off the active track as soon as possible. A rider or solar bicycle unable to continue will be taken to the pit area by the safety crew. No team support vehicles will be allowed on the track during the Rayce.
- 3.8 Timers** - An official timer will be assigned to record the progress of each team during the Rayce. Each team must also provide an assistant to the official timer, and the two will work together to ensure that every lap is properly credited to the team.
- 3.9 Flag Signals** - A master flag position will be located at the start/finish line to display flag signals. Track safety teams will also be located at various positions around the course and will have the ability to display "local" flag conditions.
- 3.9.1 Green Flag** - Track clear, proceed at your chosen speed. This flag will be displayed at the starting line only.
- 3.9.2 Yellow Flag** - Caution, obstruction on or near track. A yellow flag means that all solar bicycles are to slow down and that no passing is allowed. The flag may be displayed at the starting line, indicating full course caution conditions. It also may be displayed at various locations around the course to indicate that "local" caution conditions exist. Under "local" caution conditions, each rider must slow down and obey the no passing rule until after they have passed the obstruction.
- 3.9.3 Black Flag** - The rider must return to the pit area for consultation. This flag may be presented at any position around the course.
- 3.9.4 Red Flag** - Total stoppage due to major accident or some other reason. All riders must slow down and return to pit area.
- 3.9.5 White Flag** - Given to individual rider, this signifies one lap remains.
- 3.9.6 Black and White Checkered Flag** - Given to individual rider, this signifies the completion of 100 km and the end of the Rayce for the entry.