# EV EDUCATION RALLY
## E-KART SPECIFICATIONS

The objective is to convert a conventional internal combustion – powered racing go-kart to an electric vehicle in a safe, manner that is in compliance with the following rules and specifications. All E-karts will be inspected prior to any competition and must adhere to all rules and specifications.

***All modifications must be designed with safety as the principal concern. Modifications must not interfere with safe operation, result in frame modifications, or pose a safety risk to other participants. All modifications must be described in writing by email to Alan Shedd at alan@EVEducation.org. Modifications will be closely inspected during tech inspection. It will be the discression of the EV Rally staff to accept or reject modifications. To avoid disqualifications due to non-compliant modifications, it is strongly suggested that you discuss your plans ahead of time. Prior to the rally, modifications will be treated in confidence.***

### VEHICLE

1. Vehicle Type
   Vehicles shall be conversions of commercially manufactured racing go-karts with internal combustion engines. Vehicles shall have four wheels, one or more of which may drive the vehicle and all of which must be load bearing and designed to remain in contact with the racing surface at all times, even under hard cornering. The kart shall have originally been designed for one occupant. Custom-fabricated karts constructed specifically as an E-kart and E-karts constructed from recreational go-kart components are not permitted.

2. Conversion
   Fuel tanks, hoses, and other gasoline storage and distribution equipment shall be removed from the vehicle.

3. Dimensions
   The vehicles shall meet the following dimensions:
   - minimum ground clearance of 0.05 meters,
   - maximum turning circle (curb to curb) of 15.5 meters.

4. Track
   The vehicle tract shall not be altered by the conversion to electric.

5. Offset
   Offset or straight frames shall be permitted.

6. Vehicle Weight:
   The vehicle shall weigh a minimum of 400 pounds, with the driver and in race configuration. Vehicles not meeting the minimum weight requirement must carry ballast. Ballast must:
   - be capable of being removed during weigh-in,
   - be securely fastened to prevent movement in the event of a crash,
   - be non-liquid,
   - be contained without loss during the race,
   - not be performance related or performance enhancing equipment or material.

   Teams should pay close attention to maintaining the original weight distributions of the original vehicle. Handling and stability can be adversely affected by improper weight distribution.

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**SAFETY EQUIPMENT**

1. Roll Cage

*A roll cage is not required or recommended. Instal lation of a roll cage on a kart not specifically designed for one can adversely affect handling and may cause metal fatigue through excessive frame stiffness.*

2. Fire Extinguisher

Each pit crew shall have at the ready a 2 1/2 pound or larger dry chemical 1A, 10BC fire extinguisher with a positive indicator showing charge, during all vehicle operation and charging. It is not necessary for a fire extinguisher to be mounted on the kart.

3. Driver's Position

The driver shall be seated facing forward with legs forward. The driver must be able to exit the vehicle unaided within 20 seconds. Kart bodywork, battery placement, seat, steering wheel, and seat belt latch placement should take this into account.

4. Driver's Seat

A contoured, molded racing kart seat must be used. It is recommended that a seat with molded side edges or bolsters be used to hold the driver securely in place. The seat's position should allow the driver to naturally reach the vehicle controls.

5. Safety Belts

If a racing seat with side bolsters as described above is not used, a two-inch wide seat belt with standard automotive quick-release buckle shall be installed in the vehicle with the ends anchored to the structural frame.

6. Steering Wheel

The steering wheel shall be metal with a padded rim. The center of the steering wheel shall be padded with at least 2 inches of resilient foam material.

7. Shock Hazards

All voltages greater than 14 volts shall be insulated and protected from incidental contact. No exposed propulsion battery voltages shall be permitted.

8. Clothing

It is recommended that drivers were driving suits of fire resistant material that effectively covers the body from neck to ankles to wrists. If such clothing is unavailable, the driver must, as a minimum, be dressed in long sleeved upper body garment and full-legged lower body garment. The upper and lower body garments must meet and overlap. Gloves and shoes must also be worn.

9. Helmet

Each team shall supply their own driver's helmet with a Snell 90 or better rating. The helmet must be equipped with a face shield or separate goggles. A neck collar must be worn.

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BATTERY SYSTEM

1. Battery Type

Only commercially available rechargeable lead acid batteries shall be permitted. Batteries shall be either "sealed" (valve-regulated) type or completely enclosed in marine-type battery boxes. The propulsion battery pack voltage shall be a single string of up to 48 volts nominal. The battery pack shall be isolated from the chassis (i.e. a floating ground). Batteries shall have less than 5 milli-amps current from both the positive and negative high voltage terminals to the chassis ground. *(Use of flooded batteries are allowed for E-karts constructed prior to 2002 to encourage participation of existing e-karts. All new vehicles must be constructed using valve-regulated, spill-proof batteries.)*

2. Battery Charging

Vehicles should be brought to the event with a full charge. It is recommended that battery chargers be limited to 120 Volts, 16 amp AC. Chargers should be equipped with Class A GFI protection. Verify that all chargers work properly when supplied by standard Class A GFI receptacles.

3. Battery Enclosure

Batteries shall be contained in non-porous, non-absorbent durable enclosures. Marine-type battery boxes with a secured overlapping lid that will contain the electrolyte in the event of an impact or roll-over are required for non-sealed batteries. The enclosures or battery anchoring system shall be of sufficient strength to contain the batteries in the event of a crash or overturned vehicle. Batteries must be restrained from movement in all planes (vertical as well as side to side)

4. Battery Location

The propulsion batteries shall be placed in the vehicle to minimize polar and roll moments of inertia.

5. Battery Enclosure Mounting

Battery enclosures shall be securely mounted to structural members of the vehicle chassis. Attachments shall be adequately reinforced to prevent tearing and breakage.

6. Spare Battery Modules

Replacement of failed battery modules shall be permitted prior to or subsequent to competition using spare battery modules. Replacement of modules will not be permitted during an event. Modules shall only be replaced after consulting the EV Rally staff.

7. Battery Disconnect Switch

The propulsion battery shall be equipped with a readily accessible manually operated, high current switch to quickly disconnect the battery from the electrical system. The switch shall be capable of carrying the full load current. The switch shall not be operated only as a load break device. The switch shall be electrically located as near the center of the battery string as practical. Operation of the switch shall disconnect all propulsion battery powered equipment including battery gauges. The battery disconnect shall be accessible to both the driver in the normal operating position and to a member of the pit crew.

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**BATTERY CHARGERS**

*To use on-site charging, chargers must comply with this section. If you opt to charge off-site, compl iance is recommended but not mandatory.*

1.1 General Regulations: Vehicles shall be brought to each event fully charged. Vehicles will operate throughout the day on a single charge. Charging will not be allowed at the location of any competition, except as directed by event officials.

2.1 All Chargers: Charger AC input and extension cords shall be a minimum of two wire and ground, outdoor rated (SO) cord. Minimum wire size shall be #12 AWG for 20 ampere service. Cords shall be in excellent condition with no splices abrasions or cuts penetrating the outer jacket. Cords shall be rated for use at 400 volts or greater.

Chargers shall be equipped with standard NEMA plug connectors suitable for the voltage and current requirements of the charger. The charger AC plug shall be NEMA 5-15P 120 Volts, 15 amps. The AC breaker feeding the receptacle will be 20 amps. The AC receptacle in the charging area will be a NEMA 5-15R. Current will be limited to 16 amps AC. Charging power shall be provided through Ground Fault Current Interrupter Circuit Breakers which will trip free at a ground current (or branch circuit current imbalance) of greater than 5 milliamperes. Chargers shall be capable of operation from this source.

The charger shall be equipped with an output fuse rated for use at 250 volts or greater and an ampacity no greater than 125% of maximum charger DC output.

3.1 Off-board chargers: *It is assumed that all E-karts will use off board- chargers. If an on-board charger is installed, refer to the EV Rally Vehicle Specifications for additional guidance.* Off-board charges shall have a utility ground connection to the charger shell. DC output cord shall be rated for at least 125% of the maximum charger output current. The outer jacket of this cord shall be rated for outdoor use at a voltage of a least 200% of the charger output. The DC connector to the vehicle shall be polarized and rated for at least 125% of the maximum charger output current. The plug and receptacle electrical connections shall be shrouded to prevent contact. Alligator clips or other temporary connections shall not be permitted.

4. Extension cord: Each team shall provide one UL-listed extension cord, designed for exterior use, at least 30 feet in length and rated for the appropriate voltage and current of your charger. If your vehicle utiliizes more than one charger, you must either provide a cord with multiple plug-ins or separate cords for each charger. To avoid excessive voltage drop in the extension cord, a 14-guage cord is recommended for 15-Amps, 12-guage cord for 20-Amps, and a 10-guage cord for 30 Amps.

**MOTOR / CONTROLLER**

1. Motor Type

Motors shall be of the direct current type using any configuration of field and mechanically commutated armature.

2. Controller

Controller shall be DC, pulse-width modulating type. Maximum current rating of 400 Amps at nominal 48 Volts DC input. The controller shall be equipped with a high-pedal disable interlock to to prevent energizing the controller with the accelerator depressed. Controller bypass switches are not permited.

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3. Accelerator Mechanism

The controller shall utilize a foot-operated, low-current accelerator position sensor designed to switch the controller off if the sensor shorts or a wire becomes disconnected. Accelerator mechanisms shall be free moving and shall return to the zero current position when released. At least one energy source (e.g. springs) in addition to the pot box spring shall be provided to return the accelerator to the zero current position.

4. Cables

Cables carrying with propulsion battery voltage and current shall be of sufficient capacity to handle the anticipated loads. (A minimum #4 AWG multi-strand copper with an abrasion resistant insulating jacket is recommended. If a different cable is used, it must be that specified or provided by the motor / controller manufacturer. Documentation must be provided.)

5. Battery Cable Routing

Cables energized at propulsion battery voltage shall be routed to ensure they do not contact moving chassis components. Cables shall be secured to prevent movement. Cables shall be protected from abrasion where they pass through bulkheads or metal enclosures by insulated bushings or grommets.

6. Propulsion Battery Fuses

Batteries must be current-limited via at least one DC rated fuse (not a circuit breaker) placed halfway through the battery string such that it divides the pack Voltage in half. Fuses shall be DC rated for a minimum Voltage of 1.5 times the nominal pack voltage and have a capacity rating not exceed to exceed 250 Amps. It is recommended but not required that each separate grouping of batteries connected by an exposed battery cable be protected by a fuse. Where possible, locate the fuses within the battery string rather than at the end. No device of any type shall be connected between the fuse and the battery.

7. Instrumentation

Gauges such as Volt meters, Ammeters, and Energy Meters (kWh or amp/hour) are recommended to help in understanding the efficiency and operation of the electric vehicle. They are not required for competition.

8. Contactors

Contactors, if used, must be shielded.

**DRIVE TRAIN**

1. Drive Components

Drive components including gears, sprockets, chains, transmissions, shafts, bearings, and other rotating components shall be designed, selected, and installed to meet the high loads and stresses the vehicle operation will impose. Safety is the ultimate concern. Do not substitute light-weight bicycle components that will fail under load.

2. Chain Guard

Chain drive vehicles shall be equipped with a chain case to contain the chain in the event of failure and protect the driver from exposure to moving parts. Motors shall be equipped with guards to contain brush and armature explosions. Chain cases and armature guards shall be designed to deflect fragments from moving vertically or out to the sides of the vehicle where they might endanger the driver or a bystander. The guards do not have to prevent the fragments from falling to the ground.

3. Motor and Transmission Mounts
Motor and transmission mounts shall be secure and adequate.

**BODY / STRUCTURE**

1. Body
Karts should be equipped with body panels or other vertical surfaces suitable for displaying vehicle numbers and sponsors' names on each side of the kart. Numbers shall be at least 6 inches high and in a contrasting color. Space shall be provided for displaying one set of event and event sponsor decals.
Vehicles may be equipped with body shells provided that:
Sharp edges, corners, or protrusions that could cause injury are avoided.
Fins, spoilers, air dams, and other aerodynamic devices must comply with the vehicle dimension requirements and not present sharp edges that can be a hazard to drivers and crews.
Bodywork, including windscreens and fairings, must not interfere with driver egress or access to the battery disconnect switch.

**CHASSIS**

1. Springs and Shock Absorbers
Karts shall not be fitted with suspension components including springs and shock absorbers.

2. Hardware
Replacement of hardware, such as nuts and bolts, shall be permitted when replaced with similar strength hardware performing the same fastening function. Fasteners on steering linkages, brake linkages and securing hardware shall be equipped with locking nuts, double nuts, or be fitted with locking wire or cotter pins.

**BRAKES**

1. Brakes
All vehicles must be constructed so that at least two wheels are braked. Both wheels of a common axle must be either braked simultaneously by a single foot pedal or by a single disc brake on the common axle. Brakes shall be foot-operated, dual-circuit hydraulic.

2. Regenerative Braking
The use of regenerative braking is permitted.

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**WHEELS / TIRES**

1. Wheel Size
   Wheels may be of any design material and size suitable for use under the loads and conditions of E-kart racing.

2. Tires
   Tires shall be inflatable racing tires of any design and size suitable for use under the loads and conditions of E-kart competition. Tires may be grooved or smooth. Tire warmers or chemical softeners shall be prohibited.

3. Tire Pressure
   Tire Pressure at the beginning of any competition shall be no greater than the rated pressure shown on the tire sidewall. Tire pressure will be inspected prior to the events as well as at technical inspection.

4. Tire Replacement
   Tires shall not be replaced subsequent to final technical inspection. If a tire fails or is excessively worn, approval from a EV Rally official must be obtained prior to replacement.