

Electric Vehicle Specifications

High School SMARTT Challenge

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SECTION I – GENERAL

A. OVERALL OBJECTIVE

This program is an education program with the objective of furthering the knowledge of students and the general public about electric vehicles, electric vehicle technology and the issues associated with transportation fuels. Interpretation and implementation of these specifications and other event instructions must be in a manner which maximize the opportunity for accomplishing this objective in a safe manner. SMARTT Challenge officials have final interpretation of these specifications.

The Vehicle Specifications are necessary so that the competition will be safe and enjoyable for all participants. An effort will be made to maintain a relative equality among teams and vehicles. Efforts have been taken to minimize the impact on creativity.

B. COMPLIANCE WITH SPECIFICATIONS

All EVs will be inspected for compliance with these vehicle specifications. Penalties may be assessed for failing to comply with these specifications. Such penalties will be assessed to allow a vehicle to compete only if event officials feel the safety of participants will not be jeopardized.

The vehicle inspection process requires that components be viewed and identified at the competition. Design of vehicles must ensure that all conversion components (batteries, cables, controller, etc.) are accessible allowing inspection and ease of repair.

C. MINIMUM VEHICLE PERFORMANCE

The Organizers reserve the right to intervene or disqualify any vehicle having sub-standard performance, if that vehicle is deemed a hazard to other vehicles, its operators, or to spectators.

D. STATE VEHICLE REQUIREMENTS

Each vehicle must have a current license tag, appropriate state-required liability insurance, and have passed and display a current state inspection sticker. The inspection sticker must have been obtained after the vehicle was converted to electric power and all other structural and safety modifications were completed. Any subsequent changes to the vehicle which may affect state inspection approval will require re-inspection by an approved state inspection agency. Vehicles that are licensed in a state that does not perform a safety inspection will be subject to an in-depth inspection by event officials and school official (instructor, etc.) verification that the vehicle meets all applicable regulations.

E. VEHICLE CONVERSION

Vehicles chosen for conversion must have been manufactured by a recognized auto manufacturer and at least 10,000 produced.

Novice schools (schools that are building their first conversion) must first build a vehicle for the Car or Truck Class -- see [Vehicle Classes](#) to learn more.

Schools building a vehicle must inform SMARTT Challenge officials of the vehicle's make and model before beginning the conversion process. This will ensure that the vehicle fits appropriately into the SMARTT Challenge classes and save the school time and money if an inappropriate vehicle is chosen for conversion.

Each participating school must enter a vehicle they converted from gasoline to electric power. Vehicles that have previously been converted to electric power by anyone other than the participating school's students will not be allowed to compete. Vehicles that were built by the manufacturer as an electric vehicle will not be allowed to compete.

Schools that utilize vehicles converted by students in a previous year must provide current students with opportunities to rebuild, modify and understand the vehicle. School officials planning to enter vehicles built by previous year students must work closely with the Director of the SMARTT Challenge to ensure that program objectives are met and to avoid disqualification.

SECTION II – VEHICLE CLASSES

A. THREE CLASSES

SMARTT Challenge vehicles will be divided into three separate classes: Car, Truck, and Modified. These classes will only apply to the vehicle-specific events: Range, Autocross, and Vehicle Design.

B. DESIGN OBJECTIVE

It is the design objective of the SMARTT Challenge to have schools build street-legal vehicles that have the same functionality and stock appearance as the original vehicle. However,

if a successful Veteran school wishes to enter a vehicle in the Modified Class, the school has the option of modifying the vehicle according to the guidelines for Modified vehicles within these Specifications.

C. DESCRIPTION

All vehicles must be built according to the SMARTT Challenge Vehicle Specifications. The table below illustrates some of the general differences between the classes. Refer to the Specifications for a more thorough description of these and other differences.

	Car	Truck	Modified
Who	Any participating school	Any participating school	Successful Veteran Schools may be approved by event officials to build a Modified vehicle
Vehicle Type	Any vehicle that doesn't fall into the Truck class and meets SMARTT Challenge specs.	Open bed pickups only (Chevy S-10, Ford Ranger, GMC S-15, etc.) that meet SMARTT Challenge specs.	No limitation on vehicle type as long as it meets SMARTT Challenge specs.
Gross Vehicle Weight Rating	GVWR of no greater than 3800 lbs.; converted vehicle must weigh no more than GVWR	GVWR of 3575 lbs. or greater; converted vehicle must weigh no more than GVWR	Converted vehicle must weigh no more than GVWR
Voltage	96 volts or less	96 volts or less	156 volts or less
Motor	One DC motor	One DC motor	One or more DC motors
Controller	One controller rated at 600 battery amps or less	One controller rated at 600 battery amps or less	One or more controllers rated 1200 battery amps or less
Tires	Standard DOT approved street tires	Standard DOT approved street tires	Standard DOT approved street tires or DOT approved competition tires
Tire Change	Unless damaged, tires cannot be changed at event	Unless damaged, tires cannot be changed at event	With limitations, tires may be changed between events
Interior	Stock	Stock	Stock with limited modifications allowed
Exterior	Stock	Stock	Stock with limited

Body/Lights			modifications allowed
Battery Location	Not allowed in front passenger area	Not allowed in front passenger area	With limitations, batteries allowed in front passenger area
Vehicle Production	Original vehicles must have been manufactured by a recognized auto manufacturer and at least 10,000 produced		
Wheels	All original vehicles must have been designed with a wheel of at least 13 inches. Converted vehicle must have wheel of at least 13 inches.		

SECTION III – ELECTRICAL

A. TRACTION BATTERIES

1. Battery Pack Voltage: Maximum battery pack voltage must be 96V or less for vehicles in the Car and Truck Classes. Vehicles entered in the Modified Class will be allowed a maximum battery pack voltage of 156 volts. No restriction is placed on battery capacity (measured in kWh) as long as maximum battery pack voltage is within the above specified voltage. No restrictions are placed on size or number of cells (however, resulting vehicle weight is a restriction; see “Maximum Vehicle Weight”).

2. Battery Type: Battery type must be Lead-Acid. Teams will not be allowed to change to a different battery configuration, voltage, or type during the competition.

3. Battery Installation: The battery packs must be supported by a metal frame or metal container that is securely fastened to a frame member or structural load bearing member (unibody) of the vehicle (not thin sheet metal) to prevent movement, spillage, or a dangerous situation in case of collision or rollovers. The battery pack must be fastened in multiple locations so as to distribute the inertial load of the pack. Batteries must be mounted so that terminals always maintain a safe distance from one another, even in the case of severe jarring or vehicle collision. It is recommended that all battery terminals and conductors be individually covered or sealed with insulating material rated for full DC bus voltage.

Batteries located in an enclosed area (such as the trunk or passenger area) must be housed in an enclosed container that is constructed and mounted as described above. This container must be vented (see below).

Battery pack must be electrically isolated from chassis (a floating ground).

4. Battery Ventilation: Battery containers within enclosed areas (see above) must be equipped with forced-air ventilation to the outside of the vehicle to remove gases and vapors, but not so as to require removal, cutting away or in any way taking out body part(s) that alter the stock appearance. This regulation applies to both sealed and wet-cell batteries. It is recommended that the venting system have the exhaust mounted on the top of the battery enclosure to draw air from the bottom to the top. The fan must be rated at least 10 cfm and be brushless or have an explosion-proof rating such that it does not produce sparks. The fan can draw its power from any power source. It must operate at any time the vehicle is operating and during recharging of the batteries.

5. Multiple Battery Packs: The packs may be contained in any number of battery enclosures, as long as each conforms to the above specifications.

6. Battery Change-out: Changing of batteries, battery type or voltage will not be allowed during the entire event. Individual batteries may be replaced in the event of a battery failure or malfunction (melted post, physical damage, etc.) Batteries discharged during normal use does not constitute failure. Batteries discharged in the course of vehicle operation, but otherwise undamaged, may not be exchanged for fully charged batteries. Event officials must be notified prior to the replacement of any batteries.

7. Battery Disconnect Device: All vehicles must be equipped with a battery disconnect device capable of disrupting full battery current, as would result from a wiring fault or component failure. The disconnect must have two stable states: open and closed. The device must be manually operable from the driver's seat and installed in the main traction battery cables. Solid-state relays are strictly forbidden. Wiring, linkages, cables, etc., must be located in a manner to minimize damage in the event of an accident. Exposed terminals or contacts are strictly forbidden (see Electrical Safety).

The place where the disconnect is located or actuated must be clearly marked as "Battery Disconnect" and be clearly labeled "ON" and "OFF". Letters must be at least 1 inch high and be in a high contrast color.

8. Battery Location: Batteries must be located to maximize safety and vehicle performance. Batteries may but be put in the long, enclosed "drive shaft tunnel" area, only if completely enclosed on all sides and safety sealed off from driver. Batteries may be mounted in rear passenger area if enclosed.

For the Modified Class only, batteries may be placed in the front passenger (not driver) area. Modification of the floor and seating area is allowed. However, design must be done in such a way as to maintain the vehicle's safety and ability to comfortably carry a front passenger. Additionally, modifications must be done in such a way as to not be obvious to the casual observer (i.e. no large battery box simply placed in this area).

9. Battery Fuses: Batteries must be current-limited via at least one fuse (not a circuit breaker) that is installed half-way through the total battery string. The fuse rating must be as follows:

500 amp fuse maximum – for vehicles with motor controller limits of 700 amps
800 amp fuse maximum – for vehicles with motor controller limits of 1200 amps

B. CHARGING

1. General Regulations: Vehicles should 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.

(Sections 2-4 below are suggestions only.)

2. All Chargers: Charger AC input and extension cords should be a minimum of two wire and ground, outdoor rated (SO) cord. Minimum wire size should be #12 AWG for 20 ampere service and #8 AWG for 50 ampere service. Cords should be in excellent condition with no splices abrasions or cuts penetrating the outer jacket. Cords should be rated for use at 400 volts or greater.

DC to DC connections should either be hard-wired or use a shielded connector that does not allow human contact with the energized terminals. Alligator clips or other temporary connections are not recommended.

Charging power should 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 should be capable of operation from this source.

The charger should 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. On-board Chargers: Charger connections should be configured to ensure that the frame of the vehicle is grounded to the AC power supply ground (earth ground) whenever the charge connector is inserted into the vehicle. The ground circuit should be a minimum #12 AWG for 20 ampere service and #8 AWG for 50 ampere service. Connectors should be similarly rated.

The DC output wires/cord should be rated for at least 125% of the maximum charger output current.

4. Off-board chargers: DC output cord should be rated for at least 125% of the maximum charger output current. The outer jacket of this cord should be rated for outdoor use at a voltage of at least 200% of the charger output. The DC connector to the vehicle should be rated for at least 125% of the maximum charger output current.

C. AUXILIARY 12 VOLTS

The non-powertrain components may be serviced by an additional, auxiliary battery or small pack, as long as it is isolated from the traction batteries and cannot provide current

to the traction motors in any manner. It may be recharged from the traction batteries (i.e., via a DC-DC converter), or from a separate battery charger.

D. ELECTRIC MOTORS

Propulsion motors must be DC. No restrictions will be placed on motor size, number, or power for a Modified Class vehicle. Vehicles in the Car and Truck Classes are limited to one motor, with no size or power restriction.

E. CONTROLLER

Each vehicle must be equipped with a commercially available controller designed for electric vehicle use with the motor selected. Vehicles in the Car and Truck Classes are limited to a single controller of no greater capacity than 600 battery amps. Modified Class vehicles can have more than one controller. Modified vehicle controllers may be rated at greater than 600 battery amps and must be no more than 1200 battery amps.

No controller bypass switches, or other means designed to bypass the design capacity of the controller will be allowed.

SECTION IV – ELECTRICAL SAFETY

A. DEFINITIONS

1. "Ampacity" is a value in amperes that expresses the maximum safe current handling value for a particular wire and insulation combination. This value is dependent upon the conductor type, its cross-sectional area, the insulator type and thickness, the desired maximum operating temperature, and the ambient temperature.
2. "Break-down voltage" is the voltage at which the dielectric strength of a wire's insulation is exceeded and the insulation ceases to be a high-impedance path to the flow of current.

B. CONDUCTOR RATING

Battery conductors and cables must be sized in such a way that the ampacity of the chosen conductor exceeds the highest operating current expected in that conductor by a factor of at least 25%. As an example, a conductor chosen for a maximum of 200 amps must be able to withstand 250 amps. Conductor insulation must have a breakdown voltage of at least two times the peak ground-reference voltage expected in that conductor. The wiring should be considered with respect to the temperature and conditions of service to which the wiring may be subjected (suggested under vehicle routing be covered with flexible, waterproof electrical conduit).

C. FUSE AND WIRING COMPATIBILITY

Thought should be given to the fuse and conductor selection. Battery power wiring should be capable of carrying the current of the fuse rating for the time delay experienced by the fuse until it is blown. That is, in the instance of short circuit, the

battery cables should not fail (melt insulation and/or cause fire) before the fuse has severed.

D. CONDUCTOR ROUTING

The conductors must be routed such that there can be no inadvertent physical contact with high-voltage electrical equipment or components. All conductors must be securely fastened to minimize movement. When a conductor must pass through a panel or bulkhead, the use of appropriate strain relief's, grommets, and feed throughways will prevent insulator chafing.

E. QUICK DISCONNECTS, PLUGS, ETC.

All high-power disconnects must be made through devices rated at greater than 125% of the peak current that is to be conducted through that connector. All disconnects must be made in such a manner that when disjoined, the energized side of the connection has completely shrouded contacts.

F. INCIDENTAL CONTACT

No exposed conductors carrying voltages in excess of 36 V with respect to the system ground or with respect to other exposed conductors will be allowed. There will be no metal contacts or wiring of any voltage exposed such that a tool or any metal device may inadvertently fall into or touch to cause a short circuit (even small voltages can cause large, dangerous currents through a metal hand tool). All conductors falling into this class must be equipped with insulating shields with sufficient breakdown voltages to prevent shock through incidental contact. This applies to batteries and all other connections above 36V, whether the vehicle is in operation or display.

These guidelines are accepted in industry and are given as "working values" only. The vehicle design team is encouraged to research works on human exposure to electrical currents such as the studies conducted by Charles Dalziel (IEEE Publication, Reevaluation of Lethal Electrical Currents, 1970).

G. BLEED-DOWN DEVICES

Many controllers contain capacitors that can retain a dangerous charge for many minutes after being disconnected from the battery source. As such, it is strongly recommended that a bleed-down procedure be known and followed as necessary.

H. WARNING SIGNS

Areas of the vehicle that contain conductors or equipment that operate with high current or at a voltage greater than 36 V must be properly insulated and marked with "Warning-High Voltage" signs.

SECTION V – MECHANICAL

A. VEHICLE CONTROLS

All EVs must be equipped with conventional, functioning automotive controls, including steering wheels, brake pedals, accelerator pedal, and parking brake.

B. RUNNING GEAR

All vehicles must have four wheels. Vehicle must be propelled by the wheels. Two-wheel drive, 2-wheel front drive, or 4x4 vehicle must remain as such as originally produced or sold. Examples: Pontiac Fiero must remain mid-engine, 2-wheel drive; Ford Escort must remain front-engine, 2-wheel drive, and AMC Eagle 4WD must remain front engine, 4-wheel drive.

C. PARTS TO BE REMOVED

The following parts should be removed when the vehicle is converted to an electric vehicle: internal combustion engine and attached units, radiator and catch tank, fuel tank, fuel lines, canisters (anything that held or could hold fuel and or liquids non-essential to the electric car), and exhaust system. It is recommended that the vehicle retain components such as the hubcaps, trim rings, jack, spare tire, and necessary tire changing tools. Any loose items (spare tire, jack, etc.) should be removed from the vehicle or securely tied down before the autocross and after it has completed technical inspection and the vehicle design event.

D. SUSPENSION

Suspension must remain stock for the vehicle with the following exceptions: springs and shocks which may be reinforced or replaced with heavier duty units if mounting points remain in their stock location. Coil-over shocks are permitted if the mounting location is retained. Suspension load areas, mounting points, may be reinforced. Suspension adjustments for camber are allowed to compensate for changes in front or rear ride height caused by battery weight. Stiffening or softening of chassis can be accomplished by using larger or smaller diameter anti-roll/sway bars as are used on many passenger cars, or by adjusting "pre-load" on anti-roll/sway bars by adjusting length of vertical links such as those attaching A-frame to sway bar. Vehicle may have "sway bars" on front and rear, even if it did not come so equipped when produced. After-market sway bars are permitted if they do not go outside the spirit of these stock vehicle rules. Stock links may be replaced with spherical rod-end style links. No cockpit operated suspension adjusters allowed.

E. WHEELS AND TIRES

1. General: All vehicles must have four wheels. A spare must be available at all times. Tires must be DOT approved, 13-in wheel diameter or greater. Original vehicles must have been designed with a wheel of at least 13 inches in diameter. Vehicles in the Car and Truck Classes must use a DOT approved stock type street tire with a treadwear rating of 140 or higher. Modified Class vehicles may use either DOT approved stock type street tires or DOT approved competition tires. The total load rating of the tires must be greater than the weight of the fully loaded vehicle, including occupants, cargo, and batteries. If non-production wheels are used, the team must ensure that the wheel is capable of withstanding the expected loads as well as a reasonable amount of road

abuse. Each vehicle should have available an appropriate spare tire/wheel and equipment necessary to change that tire/wheel (see [Parts to be Removed](#)).

2. Tire Pressure: Tire pressures must be within the range stated on the tire or as directed by event officials.

3. Tire Modifications: Tire tread depth cannot be less than 4mm (5/32 in.) at the start of any event. Manufacturer markings on the tire sidewalls may not be altered or removed. Tires may not be regrooved or altered in any way, other than tread shaving or truing.

4. Tire Replacement: Vehicles in the Car and Truck Classes may not change wheels and tires during the event. If a change is necessary due to failure or excessive wear, replacement(s) should be identical to the wheel or tire being replaced, and any replacement tire must be inspected and approved by event officials.

The wheels/tires on a Modified Class vehicle may be changed between events. This will allow vehicles in the Modified Class to use competition tires for the autocross and street tires for the range event. In the event of inclement weather, SMARTT Challenge officials may decide that competition tires are unsafe and a school will be required to use standard street tires due to wet track/road conditions.

5. Tire Softeners and Warmers: Teams may not use tires that have been subjected to liquids or chemical compounds that soften the tire or change its composition. Tire warmers may not be used.

F. STEERING MECHANISM

Must remain stock OEM steering mechanism. Some rack & pinion systems may be modified with permission of the Challenge Technical Manager. Steering mechanism must work freely with no binding or wheel/body contact. No steer by wire systems are permitted.

G. BRAKES

1. General: All vehicles must have an operating brake system. If power brakes were originally equipped on the vehicle, they must be retained (suggest an electric vacuum pump w/ reservoir). Regenerative braking systems will be allowed, but cannot be employed as the primary braking system.

2. Parking Brake: All vehicles must have an operating manual parking brake capable of holding the vehicle's weight (with the extra battery weight) at rest on a grade.

H. THROTTLE RETURN

The throttle on all vehicles must be free moving and, when released, must return to the zero-current position on the electric motor. If cruise control is used, it must be deactivated when the brake pedal is depressed.

I. COVERS AND SHIELDS

Any exposed drivetrain, suspension, and steering components must be shielded from the occupants. Series-wound DC motors, upon being disconnected from the drive system, can free-rev and explode in just a few seconds. Vehicles must include safety provisions to ensure that motors cannot free-rev or have appropriate shielding so that if motor or armature would disintegrate, that driver, spectators, or anyone else cannot be harmed. High-speed (greater than 1000 rpm) components (flywheels, clutches, belt drives, chain drives, and torque converters) that are not appropriately shielded must have a scattershield constructed of at least 12 gauge mild steel or documented equivalent. Finger guards made of expanded metal or heavy screen may be used to shield low-speed components if cooling air-flow is required.

J. DRIVETRAIN COMPARTMENTS

The motor and battery compartments must be separate and isolated from the passenger compartment by bulkheads or securely fastened and sealed covers to protect the occupants from mechanical failure, fluids, and fumes.

K. FASTENERS

It is recommended that all fasteners on critical vehicle components such as suspension, steering, brakes, battery containment, seat belts, ballast carrier, and drivetrain be stock configuration or be secured with lock nuts, double nuts, nuts secured by safety wires, or cotter pins. If the location precludes the use of one of these devices, products such as Loctite may be used.

SECTION VI – VEHICLE BODY AND INTERIOR

A. VEHICLE APPEARANCE

It is a primary design objective for the vehicle to remain as stock appearing as possible. Casual observation should lead one to believe that the vehicle is an OEM internal combustion vehicle as produced in that vehicle's year of manufacturer.

B. VEHICLE BODY

1. Car and Truck Classes: The body may not be removed, replaced, or modified in any manner, except for venting purposes. Vents must not be placed in structurally vital areas nor change the profile or general appearance of the vehicle. Body panels may not be reduced in thickness for weight savings. It should be a primary design objective of each team to ensure that vehicle appearance remains as close to the original vehicle design as is reasonably achievable.

2. Modified Class: The original body panels may be modified or replaced with stock appearing panels of fiberglass or other suitable material in an effort to improve vehicle performance. These modifications must not be made in a way that event officials feel interfere with safety of the participants or spectators. Modified vehicles must retain a close resemblance to their original vehicle design.

3. General: Belly pans may be used to smooth airflow under the vehicle, but must not be visible to a casual observer and must not impair vehicle operation (suspension movement, steering, etc.). It is the team's responsibility to ensure that all vehicle components are weatherproof in case of inclement weather. Vehicles may be painted as desired as long as it is in good taste.

C. DECALS AND STICKERS

An area 9" wide X 12" tall must be left vacant on the bottom rear of each front fender OR on the bottom front of each passenger door. An event specific sticker will be provided for placement in this area.

Additional sponsor stickers may be provided by event officials. Although Challenge officials request that these additional stickers be placed on the front fenders, the final decision is up to the school's individual vehicle design team.

Additional stickers may be placed on vehicles and are the responsibility of the school and must be in good taste as judged by event officials.

D. VEHICLE STRUCTURE

If modifications are made to a vehicle's structure, it is the team's responsibility to ensure that the safety of the vehicle has not been compromised through appropriate calculations or testing.

E. ROLL BARS

The SMARTT Challenge does not require roll bars except in the case of convertibles or open cockpit vehicles. Convertibles or open cockpit vehicles must have a roll bar installed to provide driver protection in the event of the vehicle turning over. Closed cars may install roll bars if school officials feel it is advisable. When installing roll bars, the requirement contained in the section "Vehicle Interiors" must be observed.

F. DOORS

Doors must perform flawlessly and latch securely. Manufacturer's latch and release mechanisms should be used where appropriate. Modified Class vehicles may seal doors shut provided they can demonstrate a quick vehicle operator access and egress.

G. HOOD AND TRUNK

Hoods and trunk must be secured. This may be done by using the original manufacturer's latching mechanism or properly installed hood/trunk pins.

H. GROUND CLEARANCE

Ground clearance must be a minimum of 4.0". If the original vehicle had less than 4.0" ground clearance, documented measurements taken prior to conversion must be provided to event officials.

I. WEIGHT

1. Gross Vehicle Weight Rating: The GVWR is the maximum amount of weight that a

vehicle can carry, as stated by the vehicle manufacturer. This weight is normally found on a metal plate on one of the door pillars. All Car Class vehicles must have a GVWR of no greater than 3800 pounds. All Truck Class vehicles must have a minimum GVWR of 3575 pounds. There are no GVWR restrictions for the Modified Class other requiring the vehicle to weigh less than the manufacturers GVWR (see Maximum Vehicle weight).

2. Maximum Vehicle Weight: The weight of a conversion vehicle may not exceed the production Gross Vehicle Weight Rating (GVWR) as indicated on the vehicle's manufacturer's identification plate (in competition-ready configuration; excluding driver). Tampering of the manufacturer's identification plate will not be permitted. If a manufacturer's identification plate is not available, suitable documentation to indicate the production GVWR may be accepted by event officials. Participants must submit this documentation to event officials at least 60 days prior to event.

3. Weight Bias: It is recommended that right-to-left weight bias, as measured at the wheels, be within 5%. Teams should also consider the effect of the front/rear weight bias on the handling and stability of the vehicle.

4. Vehicle Lean: It is recommended that the vehicle stay neutral with respect to front to back (and left to right) sag. The extra weight of the batteries should be considered and measures taken to prevent the vehicle from unequal suspension deflection. Suspension geometries can be severely affected by unequal sag and give the vehicle unsafe driving characteristics. Any vehicle that event officials feel will be unsafe to drive will not be allowed to compete in dynamic events.

J. OCCUPANT VISIBILITY

Visibility must not be obstructed by any vehicle modifications or additional hardware.

K. WINDOWS AND WINDSHIELD

1. General: All vehicles must have a windshield, with functional windshield wiper(s) to mechanically clear the windshield of rain. The original safety-glass windshield in stock location/angle with original molding must be used. Car and Truck Class vehicles must keep the rear window and all side windows in place and operational as designed by the vehicle manufacturer.

2. Window Tinting: Tinting, shading, or any process that alters the transmission of light through the glass must meet all applicable state laws.

3. Decals: Decals, graphics, or lettering must not be placed on windows in such a manner as to impair a driver's visibility.

L. MIRRORS

All vehicles must have appropriate mirrors.

M. EXTERNAL LIGHTING

Car and Truck Class vehicles are required to have all of the original functioning equipment exterior vehicle lighting. Modified Class vehicles must have functional lighting required by state safety inspection.

N. AUDIBLE WARNINGS

1. Horn: All vehicles must be equipped with a functioning production type electric automotive horn.

2. Backup Alarm: All vehicles must be equipped with a backup alarm that operates whenever the vehicle is placed into reverse.

O. VEHICLE INTERIOR

1. Car and Truck Classes: It should be a primary design objective of each team to ensure that vehicle appearance remains as close to the original vehicle design as is reasonably achievable. In addition to the additional interior specifications, vehicles should keep carpet, headliner, and interior panels in place.

2. Modified Class: As stated in [Section II.B](#), it is the design objective of the SMARTT Challenge to have schools build street-legal vehicles that adhere to the functional and stock design objectives of the original vehicle. However, if a Veteran school wishes to enter a vehicle in the Modified Class, the school has the option of modifying the vehicle's interior in such a way as to possibly improve vehicle performance or safety.

3. General: If it is necessary to remove interior materials to facilitate installation of battery boxes, safety equipment, or other items necessary for the conversion to electric power or to enhance safety, care must be taken to eliminate sharp edges or protrusions. The metal structure of a vehicle, unibody panels, floor, etc., may be removed only as necessary to install safety equipment, electric motor or batteries.

Vehicles must have a separate passenger compartment such that bulkheads or firewalls separate occupants from drivetrain components, etc., and have a solid panel floor closeout separating the occupants from the road.

P. DASHBOARD

All vehicles must have a functioning speedometer. Car and Truck Class vehicles must have a completely stock dash, except for minor modifications necessary to install gauges necessary for an electric vehicle. Modified Class vehicles may modify the dashboard to enhance vehicle operation or safety.

Q. FIRE PROTECTION

Vehicles must be equipped with a 5-pound minimum class ABC fire extinguisher. It must be readily accessible to a belted-in driver and securely mounted on the transmission tunnel (rwd) or on floor without interfering with driver controls. Mounting brackets must be provided of sufficient strength such that the extinguisher is retained in the event of a collision.

R. SEATS

A front driver and passenger seat are required. Teams may use production, after-market, or original design seats. The seats must be firmly connected to the chassis.

For the Modified Class only, the front passenger seat must be available at technical inspection. However, the front passenger seat need not be installed in the vehicle when the vehicle is weighed or during competition.

S. SEAT BELTS

The driver and passenger seats must be properly equipped with lap belts and shoulder harnesses that meet or exceed OEM specifications. "Y" type OEM lap belt/shoulder harness combinations are permitted. Strap materials must be Nylon or Dacron polyester or materials meeting OEM, SCCA, NHRA, or NASCAR specifications. Straps materials must be in new or perfect condition. Buckles must be metal to metal quick release type. The shoulder harness must be mounted at the OEM location or behind the driver and above a line drawn downward from the shoulder point at an angle of forty (40) degrees with the horizontal. Mounting of all belts and harness must be with SAE Grade 8 bolts or with OEM hardware. OEM mounting fixtures must be used or mounting should include large diameter washer or equivalent to spread the load. Any design documentation should address lap and shoulder harness mountings and should document the adequacy of any modifications.