**Project – Specifications and Requirements**

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**1 Overview of the Design Team**

* Project Manager: George Nimick
	+ The project manager/lead engineer is responsible for introducing the team during presentations and closing the presentations.
	+ He/she is also responsible for splitting up responsibilities among the entire team. This includes things such as sections of a paper that must be written but does not include things such as tell the Electrical Engineers how to split up work among themselves.
* Deadline Manager: Scott Hill
	+ The deadline manager is responsible for keeping the entire team on track in terms of papers, presentations and any documents required by the Formula Hybrid competition. He/she should be aware of all deadlines and organize meetings for the entire team in order to complete assignments in a timely manner.
* EE team: Scott Hill, Danny Covyeau
	+ Scott Hill is currently in charge of researching batteries and a battery management system.
	+ Danny Covyeau is currently in charge of researching motors/drive systems and motor controllers.
* ME team: George Nimick, Sam Risberg, Stephen Kempinski, Tomas Bacci
	+ George Nimick and Sam Risberg are currently designing a chassis for the car to meet the 2012 Formula Hybrid Regulations.
	+ Stephen Kempinski and Tomas Bacci are researching suspension options for the car.

**2 NEEDS ANALYSYS**

**2.1 Overview of the Formula Hybrid Project**

* The objective of this design competition is to bring together students from different engineering disciplines to design, build and operate a small fully-electric vehicle that is competitive and has a high efficiency. Judging the efficiency of vehicles in the competition can be achieved by placing restrictions on accumulators and/or battery capacities and by restricting the amount of energy available to teams during the endurance event.

**2.2 Statement of the Problem**

* The team’s task is to successfully compete in the 2011-2012 Formula Hybrid Competition under an All Electric category. This entails following the objective of the competition, which is to design and fabricate a small prototype of an electric vehicle that would appeal to the non-professional weekend autocross competitor. The judges of the competition will pretend to be representatives from a manufacturing firm who will put the best design in production. Since the car is being evaluate as a finished product it needs to be operational, easy to maintain, and reliable. With potential customers in mind, it is desired that the vehicle looks nice to the eye. It should also be comfortable to sit in, and ride smoothly since it is intended to be market ready. It is also in our interest to complete the project weeks prior to competition in order to allow ample time for testing and tweaking of the vehicle.
* Required Capabilities of the Electric Vehicle:
	+ Must use accumulators (batteries) as its energy source (no ICE).
	+ The vehicle must follow all competition guidelines and rules to compete in the 2012 Formula Hybrid Competition by adhering to the Formula Hybrid 2012 Rules document.
	+ Must be capable of being operated by a single person.
	+ Should be lightweight and compact.
* Desirable Capabilities (in order of highest to lowest priority):
	+ Aesthetically pleasing design.
	+ Comparable performance to a similar sized vehicle with an internal combustion engine.

**2.3 Operational Description**

The vehicle will be operated like an average car, equipped with gas and brake pedals, and a steering wheel. Emergency buttons will allow the user to quickly shut down the vehicle should it ever be required. Input for the vehicle consists of charged batteries systems which will deliver power to the subsystems and ultimately drive the car. A skilled driver must be capable of safely operating the vehicle during the acceleration and autocross portions of the competition.

**3 Requirements Specifications**

**Note: This section has NOT been subdivided for the sake of fluidity and simplicity, but has been left in the basic organization seen in the rules document, to which the numbers below correspond.**

**1 Formula Hybrid – Overview and Competition**

Below is a table of the restrictions during the event:

|  |
| --- |
| **ELECTRIC**  |
| Maximum Accumulator Capacity1  | 5,400 Wh  |
| Accumulator Cost Limit  | $7,200.00  |

Note: Battery capacities are computed at the C20 (20 Hour) rate.

**3 Vehicle Requirements and Restrictions**

**3.1 General Design Requirements**

**3.1.1 Body and Styling**

* The vehicle submitted must be open-wheeled and have an open cockpit.

**3.1.2 Wheelbase and Vehicle Configuration**

* The vehicle must have a minimum of a 60 inch wheelbase, measured from center to center.

**3.1.3 Vehicle Track**

* The smaller track must be no less than 75% of larger track.

**3.1.4 Visible Access**

* Everything under scrutiny for the technical inspection must be visible.

**3.1.5 Warning Strobe Light**

* The vehicle must have an amber strobe light, J1318 Class 3, on whenever the vehicle is energized.

**3.1.6 Minimum Performance Requirements**

* The vehicle must complete a 75m run in less than 10 seconds.

**3.2.0 Chassis Rules**

**3.2.1 Suspension**

* The vehicle is required to have shock absorbers for both the front and rear.
* There must be at least 2 inch wheel travel.

**3.2.2 Ground Clearance**

* The vehicle must have a minimum of 1 inch of ground clearance.

**3.2.3.1 Wheels**

* The wheels on the vehicle must be at least 8 inches in diameter.

**3.2.3.2 Tires**

* There may be a set of dry and rain tires for the vehicle.
* Rain tires must have a minimum tread depth of 3/32 inch.

**3.2.4 Steering**

* Steering must affect at least 2 of the vehicle’s wheels.
* Steering free play must not exceed 7 degrees on the steering wheel

**3.2.5 Brake System**

* The brakes must act on all four wheels.
* 50% of the brake travel may be used as regenerative braking.
* The brake pedal must be able to withstand 2000N of force.

**3.2.5.1 Brake Test**

* The vehicle must be able to lock all 4 wheels in a straight line.

**3.2.5.1 Brake Over-Travel Switch**

* In the event of brake failure, this switch will shut down engine.

**3.2.5.3 Brake light**

* A 15 watt brake light is required.

**3.2.6 Jacking Points**

* Points capable of supporting the vehicle’s weight must be visible 3 feet from car, painted orange,12 inches long, 3 in height

**3.3 Structural Requirements**

* All teams must submit a structural equivalency form
* The main hoop must be 1 in diameter tubing
	+ This must have a 2mm wall thickness
* Side Impact Structure is also 1 in diameter tubing or square 1in x 1in
	+ This must have a 1.2mm thickness

**3.3.4 Roll Hoops**

* The main and front hoop must be a single piece of uncut steel tubing from above requirements. Aluminum alloys, titanium alloys and composite materials are not allowed for main hoop. Front hoop much have left, right, forward, and leg support for the members

**3.3.5 Frontal Impact Structure**

**3.3.5.3 Impact Attenuator**

* This must be placed ahead of front bulkhead.
* It must be at least 7.8 inches long and 3.9 inches high
* The attenuator must be filled with foam or honeycomb
* It must be attached securely to the vehicle.
* Impact Attenuator should be approved for a 7 m/s crash with the vehicle’s mass plus a 175lbs driver and full fluids.

**3.3.5.5 Dynamic Test**

* All non-crushable items must be rear of the bulkhead.

**3.3.6 Front Bodywork**

* No sharp edges are permitted on the front portion of the vehicle.

**3.3.7 Side Impact Structure**

* Three side impact members are required:
	+ The Upper Side Impact Member must be 11.8 to 13.8 inches from the ground.
	+ The Diagonal Side Impact Member must be attached between the main and front hoop from the top of the rear of the Upper Side Impact Member to the front of the Lower Impact Member.
	+ The Lower Impact Member must connect the bottoms of the front and main hoops

**3.3.8 Monocoque General Requirements**

* Equivalency to steel grade SAE/AISI 1010 must be proven.
* It must be proven that a side impact of monocoque will properly absorb an impact with a 3 point bending test
* The main monocoque hoop must also be a single piece of uncut, continuous, closed section steel.
* Any attachment should be able to carry a load of 30kN
* The drivers harness attachments points must support a load of 13kN
* Inspection holes that have the size 0.18 inches must be drilled in a noncritical location on main hoop and front hoop

**3.4.1.1 Cockpit opening**

* A template will be inserted into the opening of the cockpit. It will be held horizontally and moved vertically down until it passes below the top bar of the side impact structure.
	+ The steering wheel, steering column, driver’s seat, and padding can be removed for this test.
	+ The firewall may not be removed for this test.

**3.4.1.2 Cockpit Internal Cross Section – Figure 9 page 46 of the rules document**

* A template will be passed horizontally through the cockpit to a point 100mm rearwards of the face of the rearmost pedal when in the inoperative position.
* This area must be maintained over its entire length.
* Any adjustable pedals will be put in their forward most position.
* The steering wheel and any padding required by rule 3.4.17 that can be removed without tools may be removed for the test.
* Cables, wires, hoses, tubes, etc. may not impede the passage of the templates

**3.4.2 Driver Restraint System**

**3.4.2.2 Harness Requirements**

* All drivers must use a 5,6, or 7 point restraint system.
* All restraint systems must meet SFI Specification 16.1, SFI Specification 16.5, or FIA Specification 8853/98.
* The belts must bear the appropriate dated labels and a quick adjusting feature.
* There must be a single metal to metal quick release type latch.
* Only separate shoulder straps are permitted, the “Y”-type strap is not allowed. The straps should also be 76mm wide.
* Cars with a reclined driving position (seat back angle greater than 30 degrees) must make use of a 6 or 7 point harness.

**3.4.2.2.1 Harness Replacement**

* SFI spec harness must be replaced following 12/31 of the 2nd year after the date of manufacture. FIA spec harness must be replaced following 12/31 of the year marked on label; these belts are normally certified for five years.

**3.4.2.4 Lap Belt Mounting – Figure 10 page 50 of the rules document**

* The lap belt must pass around the pelvic are below the Anterior Superior Iliac Spines(hip bones).
* The lap belt should not be routed over the sides of the seat. The lap belt should the routed through the seat at the bottom of the sides of the seat and anchored at a straight line point from the entrance to the seat. The entrance where the seat passes through the belt must be rolled or grommeted to prevent belt chafing.
* The lap belt must be capable of pivoting freely with the use of a shouldered or eye bolt to accommodate drivers of different statures.
* With a reclined driving position, the lap must be between 60 and 80 degrees to the horizontal.

**3.4.2.5 Shoulder Harness – Figure 11 and 12 page50/51 of the rules document**

* The shoulder harness must be mounted behind the driver to a structure that meets rule 3.3.3.1 except for the main roll hoop bracing or attendant structure bracing without the additional bracing.
* If the harness is mounted to a tube that is not straight, the joints must be reinforced by gussets or triangulation tubes to prevent torsion.
* The shoulder harness mounting points must be between 178mm and 229mm apart.
* Mounting points or structural guides from the rear of the driver’s shoulders must lie 10 to 20 degrees above the horizontal.

**3.4.2.6 Anti-Submarine Belt Mounting**

* 5 point harness should be mounted in line with or angled up to 20 degrees forward of the drivers chest-groin line.
* 6 point harness should be mounted either:
	+ Belts going vertically downward from the groin or angled up to 20 degrees rearwards. Anchor points should be placed approximately 100mm apart.
	+ The anchor points on the primary structure at or near the lap belt anchors, the driver sitting on the anti-submarine belts, with the belts advancing past the groin to the quick release.

**3.4.3 Driver’s Equipment**

**3.4.3.1 Helmet**

* The helmet must be well fitted and closed face that meets the following requirements:
* Snell M2000, SA2000, M2005, K2005, SA2005, M2010, SA2010
* SFI 31.2A, SFI31.1/2005
* FIA 8860-2204

**3.4.3.2 Suit**

* This must be a one piece fire resistant suit that covers the body from the neck to the ankles and wrists.
* It must be in good condition with no tears or oil stains and labeled with one of the certified standards displayed in Figure 6 page 52.

**3.4.3.4 Gloves**

* Hole free fire resistant gloves. Leather gloves not allowed.

**3.4.4.1 Driver Visibility General Requirements**

* The driver must have a minimum field of vision of 200 degrees (A minimum of 100 degrees to either side of the driver). The driver may turn their head in order to obtain this field of vision.

**3.4.5 Head Restraint**

* The restraint must be provided on the car to limit the rearward motion of the driver’s head, have a minimum area of 232 sq. cm, be vertical or near vertical, and be padded with energy absorbing material such as Ethafoam or Ensolite with a minimum thickness of 38mm.
* The restraint, its attachment, and mounting must withstand an 890 Newton force.

**3.4.6 Roll Bar Padding**

* The roll bar must have a minimum 12mm thick padding anywhere the driver’s helmet may come into contact.

**3.4.7 Floor Closeout**

* Single or multiple panels must be set to separate the driver from the pavement. If multiple panels are used, the maximum gap allowed where panels meet is 3mm.
* The closeout area must extend from the foot area to the firewall and prevent any track debris from entering the car.
* The panels must be made of a solid, non-brittle material.

**3.4.8 Steering Wheel**

**3.4.8.1Circular shape**

* The steering wheel must have a continuous perimeter. Straight sections allowed but no concave sections.

**3.4.8.2 Quick Disconnect**

* The steering wheel must be attached to the steering column with a quick disconnect. The driver must be able to operate the quick disconnect with gloves on.

**3.4.9 Driver Egress**

* All drivers must be able to exit the side of the vehicle in no more than 5 seconds.

**3.4.10 Emergency Shutdown test**

* With obscured vision, all drivers must be able to operate the cockpit Big Red Button in no more than 1 second.

**3.4.11 Roll Over Stability**

**3.4.11.1 Tilt Table**

* The rollover stability of the vehicle will be evaluated with a 60 degree incline pass/fail test. This tests the center of gravity of the car to ensure the car is not likely to rollover during an event.

**3.4.12 Master Switches (“Big Red Buttons”)**

* There must be a minimum of three shutdown buttons, one on each side of the car just behind the driver’s compartment at the level of the driver’s head.
* When pushed they must break the flow of current holding the accumulator isolation relays closed, shut down the engine, fuel pumps, all power generation systems, and disconnect the LV systems from the LV battery.
* The two outer buttons must be 60mm wide and the driver’s shutdown must be 25.4mm.
* The driver must be able to activate and reset the driver’s shutdown button.

**3.4.13 HV Maintenance Disable**

* High Voltage must be able to be disabled allowing work to be done on other systems. It must be capable and equipped with a lock-out/tag-out to prevent accidental activation.

**3.4.14 Fire Protection**

**3.4.14.1 Firewall**

* A firewall must separate the driver compartment from the engine bay. The neck of the tallest driver must be out of sight of and fuel, oil, or cooling systems.
* The firewall must be made of a solid fire resistant material. Pass through holes for wiring and cables are allowed if they are sealed with grommets.
* Multiple panels are allowed if the joints are sealed.

**3.4.14.2 Fire Extinguishers**

* At all times at least 1 fire extinguisher must accompany the vehicle.

**3.4.15 Accessibility of Controls**

* All vehicle controls must be operational from inside the cockpit. No part of the driver should have to reach outside the planes of the side impact structure for any vehicle operation.

**3.4.16 Driver’s seat**

* The lowest point of the driver’s seat must be no lower than the bottom surface of the lower frame rails.
* When seated, heat insulation is required on any surface above 60 degrees Celsius that the driver may come into contact with.

**3.5 Powertrain**

**3.5.3 Transmission and Drivetrain**

* Any transmission and drivetrain may be used.

**3.5.2.4 Drive train shields and guards**

**3.5.2.4.1 General**

* Exposed high speed drivetrain equipment must be fitted with scatter shields in case of failure.

**3.5.2.4.2 Chain Drive**

* Scatter shields must be made of steel with 2.66mm minimum thickness with a minimum width of three times the chain width.

**3.5.2.4.3 Non-metallic Belt Drive**

* The scatter shield must be made of Aluminum alloy with 3.0mm minimum thickness and a width equal to the belt plus 35% belt width on each side.
* The centerline of the scatter shield must be in line with the drive belt under all conditions.

**3.5.2.4.5 Finger Guards**

* Finger guards are required to cover any drivetrain part that spins while the car is stationary with the engine running. They may be of a lighter material and perforated with a maximum hole of 12mm diameter.

**3.5.2.5 System sealing**

* The engine and transmission must be sealed to prevent leakage.

**3.5.2.6 Coolant Fluid Limitations**

* Water-cooled systems must use only plain water. Glycol-based antifreeze, water pump lubricants, or any other additives are strictly prohibited.

**3.5.2.7 Starter**

* The vehicle must be equipped with an on-board starter or equivalent and be functional without any outside assistance and any time during competition. Push starts are not allowed. A manual starting system operable by the driver while harnessed is permitted.

**3.5.4.5.1 Tilt Test-Fuel and Fluids**

* The car must be capable of being tilted 45 degrees without leaking any type of fluid.

**3.5.5.2 Throttle Actuation**

* All systems related to the driver’s control of the vehicle speed and acceleration must be designed fail-safe. The failure of any one system (mechanical or electrical) will not result in driver loss of vehicle control.

**3.6 Vehicle Identification**

**3.6.1 Car Number**

* Each car will be given a number at time of its entry and must be placed as follows:
	+ Three locations: front and both sides.
	+ Height: At least 15.24cm.
	+ Front: Block numbers only permitted.
	+ Color: either white on black or black on white. No other colors accepted.
	+ Background shape: round, oval, square, or rectangle. There must be 2.5cm between the edge of the number and edge of the background.
	+ Clear: view of the numbers must not be obscured by any parts of the car.

**3.6.2 School Name**

* Each vehicle must clearly display the school’s name or initials, given that it’s unique and generally recognized, in roman letters at least 5.08cm high on both sides of the vehicle.

**3.6.3 SAE & IEEE logos**

* SAE and IEEE logos must be 7.6 by 20.3cm displayed on the front and/or both side.

**3.6.4 Technical Inspection Sticker Space**

* Technical inspection stickers will be placed on the upper nose of the vehicle. A 25.4cm wide by 20.3cm high space must be left available along the vehicle centerline.

**3.7.1 Aerodynamics and Ground Effects`**

**3.7.1.1 Location**

* No part of the aerodynamic device, wing, under-tray or splitter can be further than 460mm in front of the leading edge of the front tires and no further back than the trailing edge of the rear tires.
* No part of the aerodynamic body can be wider than the outside edge of the front wheels.

**3.7.2.1 Fasteners Grade Requirements**

* All threaded fasteners used in the driver’s cockpit, steering, braking, driver’s harness, and suspension systems must meet (or exceed) SAE grade 5, Metric grade 8.8, or AN/MS specifications.
* The use of button head cap, pan head, flat head, or round head screws or bolts in the driver’s cell structure and driver’s harness is prohibited.

**3.7.2 Securing Fasteners**

* All critical bolts and nuts on the steering, brakes, driver’s restraint, and suspension must be securely fastened by using the following positive locking mechanisms:
	+ Correctly installed safety wiring
	+ Cotter pins
	+ Nylon lock nuts
	+ Prevailing torque lock nuts

**3.8.2 Transponder Requirement**

* All vehicles must be equipped with at least one AMB TranX260 rechargeable or direct current transponder.

**4 ELECTRICAL RULES**

**4.1 High-Voltage (HV) Isolation**

* High Voltage is defined as any system (individually or in series) containing or producing a voltage greater than 30V.
* There must be no connection between the frame of the vehicle (or any other conductive surface that might be inadvertently touched by a crew member or spectator), and any part of any HV circuits.
* HV and low-voltage circuits must be physically segregated and may not run through the same conduit
* Where both are present within an enclosure, they must be separated by insulating barriers made of moisture resistant; UL recognized insulating materials rated for 150 C or higher**.**
* Components and cables capable of movement must be positively restrained to maintain spacings. It is highly recommended that different color wires are used to clarify which wires are HV and LV. Failing to do so may result in a significant time spent trying to pass electrical safety inspection.

**Circuit Board Spacings**

|  |  |  |  |
| --- | --- | --- | --- |
| **Voltage**  | **Over Surface**  | **Thru Air** **(Cut in board)**  | **Under Coating**  |
| **0-50**  | 1.6 mm (1/16”)  | 1.6 mm (1/16”)  | 1 mm  |
| **50-150**  | 6.4 mm (1/4”)  | 3.2 mm (1/8”)  | 2 mm  |
| **150-300**  | 9.5 mm (3/8”)  | 6.4 mm (1/4”)  | 3 mm  |
| **300-400**  | 12.7 mm (1/2”)  | 9.5 mm (3/8”)  | 4 mm  |

**4.1.1 Ground Fault Detectors**

* All vehicles must be equipped with an on-board Ground Fault Detector (GFD). This must be a Bender IR486, IR475LY, IR155-1, IR155-2, **9** or equivalent if approved by the organizers.
* The output relay of this device must be wired in series with the shutdown buttons such that a ground fault will cause an immediate shutdown of all electrical systems. The ground fault detector must detect any fault below 500 ohms/volt or 40 kΩ, whichever is greater.

**4.1.3 HV Test Connector**

* A HV test connector must be installed in the vehicle and easily accessible by the inspectors during technical inspection.

**HV Test Connector Specs**

|  |  |  |
| --- | --- | --- |
|  | Amphenol P/N  | Newark P/N  |
| Box Mount Receptacle  | 97-3102A-14S-1S  | 93F1182  |
| Protective Cap  | 97-3106A-14S-1P  | 93F1179  |
| Cable receptacle  | 97-3101A-14S-1S  | 92F5539  |

**HV Test Connector Pinouts**

|  |  |
| --- | --- |
| Pin  | Connection  |
| A  | No Connection  |
| B  | HV+ connected on load side of main contactors (fused at <10A)  |
| C  | HV- connected on load side of main contactors (fused at <10A)  |

**4.1.4 Rain Certification**

* To become Rain Certified, a vehicle must pass a visual inspection that checks that all high and low voltage wiring and components are suitably protected from rain and water thrown up by tires.

**4.2 No Exposed High Voltage Connections**

* No HV connections may be exposed. Non-conductive covers must prevent inadvertent human contact.
* A 10 cm long, 0.6 cm diameter (4 x ¼ inch) insulated test probe must not be able to touch a HV connection.
* Note: Rubber boots and electrical tape are not adequate means of insulation
* All controls (including electronic throttle or regen. controls), indicators and data acquisition connections must be isolated using optical isolation, transformers or the equivalent.

**4.3 High Voltage Insulation, Wiring and Conduit**

* Insulated wires must be commercially marked with a wire gauge, temperature rating and insulation voltage rating. Other insulation materials must be documented.
* All HV wiring must be done to professional standards with appropriately sized conductors and terminals and with adequate strain relief and protection from loosening due to vibration etc.
* All HV wiring that runs outside of electrical enclosures must be enclosed in orange liquid tight non-conductive conduit type LFNC-A or LFNC-B.

**4.4 Fusing**

* All electrical systems (both low and high voltage) must be appropriately fused.

**4.4.1 Fuse Rating**

* The continuous current rating of a fuse must not be greater than the continuous current rating of the smallest wire it protects
* All fuses must be rated for the highest voltage in the systems they protect.

**4.4.3 Series and Parallel Cell Connections**

* In single-series string configurations, a series fuse is required.
* In parallel-string configurations, each string of batteries or capacitors must be individually fused.
* In parallel-cell configurations, each cell must be individually fused.

**4.4.4 Accumulator Monitoring System Sense Wires**

* Accumulator monitoring system, and other high-voltage sense wires, unless incorporated into a cell-terminal monitoring assembly, must be fused with ratings complying with Section **4.4.1**. Monitoring fuses may be soldered or otherwise connected in-line and covered with heat shrink tubing.

**4.5 Accumulator Type and Size**

* The maximum potential between any 2 points in the electrical systems may not exceed 300 V. Teams may petition the rules committee to allow voltages up to 600 V to allow for boost converters, motor controls etc.

**4.5.1 Accumulator Monitoring**

* An accumulator monitoring system appropriate for the accumulator type is required.

**AMS Required Functions**

|  |  |  |
| --- | --- | --- |
| **Accumulator Type**  | **Temperature Monitoring**  | **Voltage Monitoring**  |
| Lead Acid Battery  | Per module  |  |
| NiMh Battery  | Per module  | Per module  |
| LiIon Battery  | Per module  | Per cell  |
| Ultra Capacitor  | Per module  | `  |

**4.6 Energy Storage Container Electrical Configuration**

* All energy storage must be in closed containers containing normally open isolation contactors or relays**13**wired in such a way that when an incoming “energize” signal is interrupted no voltages will be present outside of the containers.

**4.7 Energy Storage Container Mechanical Configuration**

* The accumulator enclosure and mounting must be designed to withstand
	+ 20g static load in both the for/aft and side to side directions
	+ 8g static force in the vertical direction
* The materials used to construct the container should be electrically insulating, mechanically robust, fireproof, and transparent on at least one outer face to allow easy inspection.

**4.7.1 Energy Storage Container Cockpit Barrier**

* A fireproof barrier must be provided between energy storage containers and the cockpit.

**4.8 High Voltage Component Location**

* All parts containing high voltage must be positioned within the surface defined by the top of the roll bar and the outside edges of the four tires. In side view no high voltage component can be below the lower surface of the frame or monocoque.

**4.9 Low-Voltage Circuits**

* Low-voltage (< 30 V) circuits must be grounded to the frame of the car.

**4.9.1 Grounding**

* All exposed conductive parts on the vehicle must be well grounded ( < 300 mΩ).

**4.10 Charging Equipment**

* The accumulator enclosure must remain closed during charging

**6.2.1 Running in Rain**

* A vehicle must be Rain Certified to operate in wet conditions. This means that it must have rain tires and must pass the 60 second water spray.

**6.5.3 Autocross Course Specifications and Speeds**

* Average speeds should be between 25 and 30 miles per hour to be competitive.
* The Vehicle should be able to tackle the following track specifications with ease:
	+ 200 foot straights with hairpins at either end
	+ 150 foot straights with wide turns on either end
	+ Constant turns that are 75 to 148 feet in diameter
	+ Hairpin turns that are a minimum of 29.5 feet in diameter
	+ Slaloms with 25 to 40 foot spacing between cones
	+ Be able to drive on a track with a minimum width of 11.5 feet

**6.6 Endurance Event**

**6.6.5 Endurance Course Specifications and Speeds**

* Average speeds should range between 29.8 miles per hour to 35.4 miles per hour with top speeds near 65.2 miles per hour to be competitive in this event.
* The entire course must be completed in no more than 60 minutes
* All course specifications meet or exceed those specifications of the Autocross event.
* This event is a 13.67 mile course (22 km) that must be completed without any refueling/recharging of the vehicle.

**6.10.7 Safety Glasses**

* Safety glasses must be worn when working on the vehicle or by anyone within 10 feet of the vehicle while it’s being worked on.

**7. Required Equipment**

* Required Equipment is located in Appendix H of the Formula Hybrid Rules 2012 document in Section 10.
* All required equipment must be kept with the car.
* All team members must know how to use the equipment and where it is located.

**4 Preliminary Test Plan**

 In order to make sure that our design work meets all the required specifications, we will be closely following the Formula Hybrid 2012 Rules during the design process. Other documents can be found on the formula-hybrid.org website as well. The Mechanical Tech Inspection sheet and the Electrical Tech Inspection sheet will be used after construction of the vehicle to make sure that it fully conforms to the rules. We will also do many of the same tests that the judges will be doing at competition so that any undesired occurrences are corrected well in advance.

**5 References**

1. Web site: [www.hybrid-org.org](http://www.hybrid-org.org)

* Formula-Hybrid-2012-Rules.pdf