2016 Albi Eco Race

Level 2 Technical document

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I. GENERAL INFORMATION

In this document, functions and roles are defined as follows:
1) 'Team' – group of individuals with a team name and one vehicle that has been accepted for entry to the competition.
2) 'Participant' – member of a Team.
3) 'Team Manager' – a Participant that has been appointed on the event registration document as single focal point for his/her team towards the Organisers.
4) 'Faculty Advisor' – a professional staff member of the educational institute which represents the Team.
5) 'Race Director' – person appointed by the Organisers, who is responsible to manage and sanction all on-track activities.
6) 'Track Marshall' – person appointed by the Race Director to act on his/her behalf, in particular to ensure on-track safety and observe on-track rule compliance.
7) 'Technical Director' – person appointed by the Organisers, who is responsible to ensure the technical standards and integrity of the competition.

A. ORGANISTION

Article 1: ACCEPTANCE
a) By fact of their entry, Participants accept all provisions of the Official Rules and agree to abide by all decisions made by the Organisers. The Organisers reserve the right to add, modify or delete any article of the Official Rules. In such an event, the Teams will be notified. The Organisers are solely empowered to pronounce on cases not provided for in the Official Rules.
b) The Organisers reserve the right to modify, postpone or cancel the competition for any reason. No claims for compensation will be accepted.
c) The Participant is aware that photo, audio and video recordings will be made of the event. By entering the competition, the Participant permanently relinquishes all rights in respect of these photos, audio and video recordings, which are made by third parties, the Organisers and its affiliates. The organiser may use said photos, audio and video material for internal and external communications and own presentations (including but not limited to promotions, advertising, internet presence, TV and radio reports and press reports).

Article 2: TRACK ACCESS CONDITIONS
a) During both the practice runs and the competition, all vehicles must comply with the technical and safety rules of the event. Whenever the track is entered, the vehicle body must be in place and bear all the competition numbers, sponsor stickers required by the Official Rules. Organisers will supply these numbers and logos.
b) Three blank spaces of 20x20 cm must be kept free (one in front of the car, two on the sides of the vehicle).
c) Two additional blank spaces 40x10 cm must be kept free on each side of the vehicle.

Article 3: COMPLIANCE
a) Only those vehicles that comply with the present Official Rules are allowed to participate. No vehicle will be allowed on the track for practice or competition until the Organisers have approved it. The decisions of the Organisers are final in all matters concerning the compliance of vehicle design and construction with the present Official Rules.

b) The Organisers reserve the right to rescind vehicle approval upon further or more detailed checks. The Organisers must be notified of any modifications to the vehicle after inspection. Non-compliance with this rule will lead to vehicle disqualification.
c) Vehicles complying with all safety rules but not with some of the other technical rules will not qualify for the competition, however may be allowed on the track for practice or demonstration at the discretion of the Technical Director.

Article 4: PROTESTS
The Team Manager is the only person authorised to lodge protests. Protests must be brought to the attention of the Technical Director via the results desk. Depending on the nature protests must be lodged within the following times:
a) Vehicles: before track closure on the current day
b) Team and Driver behaviour: within 30 minutes following the end of the attempt.
c) Results: within 1 hour after the result of an attempt has been posted.

Article 5: DISPUTES
In the event of any disputes, all decisions made by the Race Director are binding and final.

II. SAFETY

Article 6: SAFETY RULES
a) As with any Motorsport activity there should be an understanding that certain inherent risks will be present. Recognising and controlling these risks are vital for the well-being of people and local surroundings. Safety is an essential consideration for the Organisers. These Rules are to protect all individuals and surrounding areas and are in no way intended to curtail the spirit of the competition. Any activity deemed unsafe or outside of the spirit of the event will be met with appropriate action by the event Organisers.
b) Therefore, compliance with safe driving and sporting rules, as well as any instructions given by Track Marshals is mandatory for everyone. All Participants must comply with the safety measures and must notify Organisers about any anomalies or incidents. In the event that dangerous conditions are present leave the area immediately. During the event the paddock area will be monitored by the Organisers to assist Teams to comply with safe practices.
c) The Race Director is responsible for and has the final authority in determining the safe conditions for track operations in regards to weather.
d) Non-compliance with any of these Rules may lead to disqualification from the competition at the sole and absolute discretion of the Organisers.

B. DRIVING RULES

Article 7: DRIVING KNOWLEDGE AND TEST
a) Only the registered Drivers will be authorised to drive the vehicle.
b) Drivers may be questioned about their knowledge of the driving rules during inspection. The Organisers reserve the right to deny track access to Drivers with insufficient knowledge of the Rules.
c) Driving on-track: In the interest of safety it is important that Drivers learn and apply smooth and predictable driving techniques, e.g. thinking well ahead, avoiding sudden directional changes, and being fully aware of other vehicles around them.

Article 8: DRIVING UNDER THE INFLUENCE OF ALCOHOL/ ILLEGAL SUBSTANCES

a) Driving under the influence of any alcohol and or illegal substance(s) is forbidden. This applies to all Drivers entering the track.
b) Any breach will lead to the disqualification of the team for the entire competition.

Article 9: ACCESS TO THE TRACK
a) Vehicles must pass a safety inspection prior to accessing the track for practice runs. A safety sticker will be clearly affixed once the vehicle has passed the inspection.
b) To access the track, the car must have successfully passed the safety safety.
c) The safety inspection allows teams to participate to the three challenges but they will not be ranked if they have not passed the technical inspection.
d) The Organisers will allow opportunity for Team Managers and Drivers to inspect the track, i.e. before any vehicles are allowed on the track.

Article 10: PUSHING THE VEHICLE
At no time on the race track are drivers allowed to push their vehicle or have it pushed, including to start the race or to cross the finish line.

Article 11: RACE DIRECTION
It is forbidden to drive in reverse gear or to drive against the race direction.

Article 12: RADIO COMMUNICATION
The use of hand-held communications is forbidden in the vehicle. However, the use of a “hands-free” kit is allowed as long as both hands of the driver remain on the steering system.

Article 13: OVERTAKING
Drivers are required to give clear passage for other vehicles wishing to overtake.
a) Drivers of the vehicles being overtaken must use their mirrors and must not change course suddenly.
b) On the track, overtaking is authorised on both the right and the left, as long as the above-mentioned safety rules are followed.

Article 14: BREAKDOWNS AND OTHER INCIDENTS
a) Intentional stopping on the track is forbidden.
b) The Driver is allowed 1 minute to attempt to re-start the vehicle from within its driving position.
c) If a vehicle breaks down or is involved in a minor disabling accident on the track, the Driver must immediately make every attempt to drive the vehicle to the side of the track and wait in the vehicle for the Track Marshalls to arrive.
d) In an emergency, the Driver must get out of the car and wait in a safe place off the track for the Track Marshalls to arrive and recover him/her and the vehicle.
e) It is forbidden to carry out repairs on the track.

Article 15: OFF-TRACK VEHICLE MOVEMENTS
a) All vehicles must be parked inside the designated paddock area or directly in front of it. When off the track, vehicles must be moved without the use of the engine. They must be pushed or pulled. Test-driving in the paddock area is forbidden.
b) Track Marshals will notify the Race Director of any breaches and any unsafe or unfair behaviour.

C. DRIVERS & EQUIPMENT

Article 16: DRIVERS WEIGHT
a) For the Prototype class, the average of the three drivers’ weight must be at least 50 kg. If it is lower, some ballast will be attached to the chassis of the vehicle during the scrutineering.

The weight of this ballast will be equal to the difference between the average of the three drivers' weight and 50kg.
b) For the Urban Concept class, the average of the three drivers' weight must be at least 70 kg. If it is lower, some ballast will be attached to the chassis of the vehicle during the scrutineering. The weight of this ballast will be equal to the difference between the average of the three drivers' weight and 70kg.
c) The Driver Weight is defined as the weight of the person driving the vehicle including full driving gear and communication devices. If the Driver Weight does not meet the minimum weight requirement ballast needs to be fitted to the vehicle. This ballast must be provided by the Team, in form of scuba diving weights or rectangular metal plates. No other form of ballast is permitted. Any ballast must be effectively secured to the vehicle chassis to ensure Driver safety in the event of collision or rollover, and it must be easily detachable for weighing.
d) Drivers (in full driving gear, including communication devices) and their ballast may be weighed before or after each race. A weight loss of up to 1 kg during a race will be tolerated.

Article 17: HELMETS
a) For practice and competition, Drivers must wear full-face or three quarter helmets suitable for motorsport activities. Bicycle/riding/skating type helmets are not permitted. Helmet labels must be clearly readable. Helmets worn by all Drivers will be subject to inspection.
b) All helmets must be affixed with a face shield (or visor). The face shield (or visor) must cover all of the face down to the chin. Tinted face shields or sun glasses to be worn under the face shield are permitted. The helmets must correctly fit the Drivers and be secured by a chin strap.

Article 18: DRIVER CLOTHING
a) All Drivers must wear a racing suit homologated by the FIA as the outermost layer of clothing (fire retardant). Casual clothing and streetwear are not permitted. Wearing synthetic clothes or underwear is strictly forbidden for Drivers when seated in their vehicle.
b) Gloves (covering all fingers fully) and shoes are required and must be provided by the team; bare feet or socks only are prohibited.

Article 19: DRIVER COMFORT
Please note that in the event of hot weather conditions high temperatures could be attained inside the vehicle, potentially affecting Driver comfort and/or causing heat stress.
a) It is recommended to properly ventilate the inside of the vehicle to provide cooling to the Driver.
b) It is recommended to provide sufficient drinking liquids to the drivers for the duration of an attempt. If fluid containers are provided to the driver(s), these containers must be hands free, e.g. camel- back style or bottles secured inside the driver's compartment with flexible feed straw.
c) It is recommended to equip the vehicle with an effective sunscreen.

D. TEAM SAFETY EQUIPMENT

Article 20: EQUIPMENT AND MATERIALS
Teams are required to provide and use the following at the event:
a) Gloves for general work: leather or canvas material.
b) Safety glasses for all Team members. (Disposable types are permitted).
c) Hearing protection for all Team members. (Approved Earplugs or muffs).
d) Duct tape to secure any cords or cables lying on the pit floor.
e) Own tools and materials.
f) Each Team must provide an extinguisher for their pit area with a minimum extinguishing capacity of 1 kg in addition to the vehicle's extinguisher suitable for "ABC" class of fires. The extinguisher must be accessible in the Team's specific pit area. The extinguisher must be full

(i.e. never used) and have a manufacturing or expiry date. If the extinguisher does not have an expiry date the unit will be acceptable (i.e. valid) if it was manufactured within the past three years. Any extinguisher beyond the expiry period that has been re-inspected and tagged with an official dated recertification will also be permitted.

i) Effective equipment suitable to mitigate and/or control Lithium-based battery fires must be used during battery charging whether the battery is charged in or outside of the vehicle. The equipment must prevent or contain the spread of any fire or battery event during charging. Equipment that may be used includes:

j) A battery charging bag that is designed for containment of a Lithium battery fire, or a fireproof blanket that can be placed over AND under the battery being charged. The blanket must be of sufficient size to fully cover and contain any potential fire or battery event.

III. VEHICLE DESIGN

A. GENERAL

Article 21: VEHICLE DESIGN

a) During vehicle design, construction and competition planning, participating Teams must pay particular attention to all aspects of safety, i.e. Driver safety, the safety of other Team members and spectator safety.

i. Prototype vehicles must have three or four running wheels, which under normal running conditions must be all in continuous contact with the road.

ii. UrbanConcept vehicles must have exactly four wheels, which under normal running conditions must be all in continuous contact with the road. A fifth wheel for any purpose is forbidden.

b) Aerodynamic appendages, which adjust or are prone to changing shape due to wind whilst the vehicle is in motion, are forbidden.

c) Vehicle bodies must not include any external appendages that might be dangerous to other Team members; e.g. pointed part of the vehicle body. Any sharp points must have a radius of 5 cm or greater, alternatively they should be made of foam or similar deformable material.

d) Vehicle body panels must be rigid with an appropriate stiffness not to be prone to changing shape due to wind.

e) The vehicle interior must not contain any objects that might injure the Driver during a collision.

f) Windows must not be made of any material which may shatter into sharp shards. Recommended material: Polycarbonate (e.g. Lexan). The windows (windshield, rear window…) must be at least 2 mm thick.

g) Any cover of the energy compartment (engine/motor/transmission/battery, etc.) should be easy to open for quick inspection access.

h) All parts of the drive train, including hydrogen system components, etc. must be within the confines of the body cover.

i) All objects in the vehicle must be securely mounted. Bungee cords or other elastic material are not permitted for securing heavy objects like batteries.

j) All vehicles must have a solid floor and frame that prevents any part of the driver's body from contacting the ground.

k) All vehicles (including Prototypes) must be fully covered. Open top vehicles are not allowed. Vehicles that look like bicycles, tricycles or wheelchairs are not acceptable.

Article 22: CHASSIS/ MONOCOQUE SOLIDITY

a) Teams must ensure that the vehicle chassis or monocoque is designed wide and long enough to effectively protect the driver's body in the case of collisions or rollovers. The Organizers will exclude any vehicle whose construction is deemed to be dangerous.

b) The vehicle chassis must be equipped with an effective roll bar that extends 5 cm around the driver's helmet when seated in normal driving position with the safety belts fastened.

c) This roll bar must extend in width beyond the driver's shoulders when seated in normal driving position with the safety belts fastened.

d) Any roll bar must be capable of withstanding a static load of 700 N (~ 70 kg) applied in a vertical, horizontal or perpendicular direction, without deforming (i.e. in any direction).

Article 23: PROPULSION AND ENERGY STORAGE SYSTEM ISOLATION

a) A permanent and rigid Bulkhead must completely separate the vehicle's propulsion and energy storage systems from the driver's compartment.

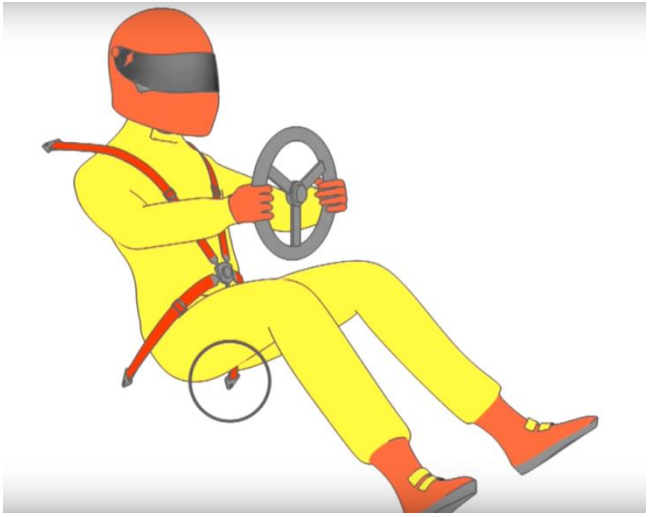
b) This bulkhead must be of fire retardant material.

c) The bulkhead must effectively seal the driver's compartment from the propulsion and fuel system.

d) The bulkhead must prevent manual access to the engine/energy compartment by the driver.
e) If holes are made in the bulkhead to pass through wires, cables, etc. it is essential that the wires/cables are protected by a grommet or similar protective material to prevent chafing or damage. All gaps/holes must also be filled.

Article 24: VISIBILITY
a) The Driver must have access to a direct arc of visibility ahead and to 90° on each side of the longitudinal axis of the vehicle. This field of vision must be achieved without aid of any optical (or electronic) devices such as mirrors, prisms, periscopes, etc. Movement of the Driver's head within the confines of the vehicle body to achieve a complete arc of vision is allowed.
b) The vehicle must be equipped with a rear-view mirror on each side of the vehicle, each with a minimum surface area of 25 cm² (e.g. 5 cm x 5 cm). The visibility provided by these mirrors, and their proper attachment, will be subject to inspection. An electronic device must not replace a rear-view mirror.
c) For UrbanConcept vehicles wet weather visibility is also mandatory (see Article 47).

Article 25: SAFETY BELTS
a) The Driver's seat must be fitted with an effective safety harness having at least five mounting points to maintain the Driver securely in his/her seat. The five independent belts must be firmly attached to the vehicle's main structure and be fitted into a single buckle, specifically designed for this purpose. The mounting points should be fitted so that the belts will self-align with the direction of the load.
b) The safety harness must prevent any upward or forward motion of the driver's torso. Any slack in the harness must be adjusted by using the seat belt length adjuster. The adjustor must be located as close as possible to the connection point. The crotch strap mounting point should be behind the chest line and the topmost straps should be at an angle of at least 10° below the shoulder line.
c) The safety harness must be worn and fastened at all times to prevent the driver from having any free movement when the vehicle is in motion.
d) The vehicle safety harness must be specifically manufactured for motorsport use (certified by the FIA).
e) It is essential that the fifth (and sixth if there is one) mounting points of the safety harness is fixed at the bottom of the driver's backbone as shown on the following picture:



(Extracted from the Shell Eco Marathon Tech Tips)

Article 26: VEHICLE ACCESS
a) It is imperative for Drivers, fully harnessed, to be able to vacate their vehicles at any time without assistance in less than 10 seconds.

b) Prototype vehicles must be equipped with a sufficiently large opening for the cockpit. The driving position must be designed so that emergency services can easily extract the Driver from his/her vehicle, if necessary.
c) For Prototype vehicles, the said opening may be enclosed wholly or partly by means of hinged, detachable and/or folding doors, provided that a release mechanism is easily operable from inside and that the method of opening from the outside is clearly marked by a red arrow and does not require any tools.
d) For Urban Concept vehicles, the opening release mechanism must be easily and intuitively operable from the inside and the outside of the vehicle. The method of opening from the outside must be clearly marked by a red arrow and must not require any tools.
e) It is forbidden to use adhesive tape to securely close the Driver's opening from the outside.

Article 27: HORN
Each vehicle must be equipped with an electric horn mounted towards the front of the vehicle, in such a manner that is effectively audible to other vehicles and track marshals.

Article 28: ON-BOARD FIRE EXTINGUISHER
a) Each vehicle must be fitted with a fire extinguisher (ABC or BC type). All Drivers must be trained in the use of said fire extinguisher. This extinguisher must have a minimum extinguishing capacity of 1 kg (2 lb for US application); equivalent size extinguishers are not permitted. The extinguisher must be full (i.e. never used) and have a manufacturing or expiry date. If the extinguisher does not have an expiry date the unit will be acceptable (i.e. valid) if it was manufactured within the past three years. Any extinguisher beyond the expiry period that has been re-inspected and tagged with an official dated recertification will also be permitted.
b) Plumbed-in extinguishers may be located in the engine compartment and must discharge into the engine compartment. Triggering systems must be located within the cockpit and be operable by the Driver in his/her normal driving position.
c) Hand held extinguishers must be located within the cockpit and be accessible to the Driver once they have vacated the vehicle. These should be securely mounted to prevent movement while driving/braking. In the event of a fire, Drivers should first exit the vehicle and then if possible, remove the extinguisher and attempt to extinguish the fire if safe to do so.
d) The on-board fire extinguisher does not replace the need for an adequate fire extinguisher for the team's garage area.

Article 29: DRIVER POSITION
For safety reasons, the head-first driving position is prohibited. The driver position should be such that the helmet is 5 cm below the roll bar AND that the visibility for the driver is unimpaired at the same time.

Article 30: CLUTCH AND TRANSMISSION
a) All vehicle propulsion must be achieved only through the friction between the wheels and the road.
b) For centrifugal/automatic clutches the starter motor speed must always be below the engagement speed of the clutch.
c) The installation of effective transmission chain or belt guard(s) is mandatory.

Article 31: EXHAUST SYSTEM
a) The exhaust gases must be evacuated outside the vehicle body.
b) Exhaust pipes must not extend beyond the rear or the side of the vehicle body.

Article 32: SOUND LEVEL
a) The sound level of the vehicle must not exceed 85 dBA when measured 4 metres away from the vehicle.

Article 33: EMERGENCY SHUTDOWN

a) The purpose of the emergency shutdown system is to disable the propulsion system of the vehicle.

b) For Battery Electric vehicles the emergency shutdown mechanism must provide a physical isolation of the propulsion battery from the vehicle electrical system. If relays are used, the relays must be a normally open contact type. The use of a power controller or other logic systems to drive an isolation device is not permitted.

c) There must be both an internal and an external shutdown mechanism.

i. The internal emergency shutdown mechanism is for operation and can be designed in any effective way.

ii. The external emergency shutdown mechanism must be at the rear-left of the vehicle and permanently installed on a non-detachable part of the bodywork. It must be visible when the wheels of the car are in contact with the ground.

iii. A red arrow (on a white background) at least 10 cm long and 3cm wide at the widest point must be positioned on the vehicle body to indicate clearly the exterior position of the emergency shutdown actuator.

d) The following external emergency shutdown mechanisms must be a latching red push button.

e) In addition to the above devices, all vehicles must be equipped with a “dead man’s safety device” or sometimes referred to as “operator presence control.” The purpose for this device is to ensure that in case the driver becomes incapacitated the vehicle’s propulsion power is automatically disengaged (i.e. returns to an idle condition). This device may consist of a spring loaded hand operated accelerator or foot pedal lever. An electric deadman switch is permissible as long as the switch is located on the steering wheel. If an electric deadman switch is used the driver must directly (for example by thumb or index finger) engage the switch at all times while driving.

Article 34: ADDITIONAL INSPECTIONS

a) After passing technical inspection, the replacement and/or alteration of the engine, any vehicle wiring, or any other vehicle part must be re-approved by the Organisers.

b) After any significant incident to the vehicle, it must be re-inspected.

c) At any time, the Organisers may perform unannounced inspections on the vehicles.

B. PROTOTYPE GROUP

Article 35: DIMENSIONS

a) The vehicle maximum height must be less than 100 cm.

b) The vehicle track width must be at least 50 cm, measured between the midpoints where the tyres of the outermost wheels touch the ground.

c) The ratio of maximum height divided by the maximum distance between two wheels must be less than 1.25.

d) The vehicle wheelbase must be at least 100 cm.

e) The maximum total length must not exceed 350 cm.

f) None of the body dimensions above must be achieved by design singularities such as ‘stuck-on’ appendages or cut-outs.

Article 36: TIRES, WHEELS, AXLES AND WHEEL HUBS

a) All types of tires and wheels are allowed.

b) Any type of wheel rim may be used. Rims must be compatible with the dimensions of the selected tires in order to satisfy safety standards.

c) Wheels located inside the vehicle body must be isolated from the Driver by a bulkhead.

d) Any handling or manipulation of wheels by the Driver is forbidden from the moment the vehicle is at the starting line until it crosses the finish line.

e) All installations must be carried out in a way that there is no likelihood of the wheels coming into contact with other parts of the vehicle (i.e. cables, wires, hoses, and engine compartment components like batteries, etc.). These must be safely mounted/secured so that they cannot interfere with the turning wheel during driving and cause accidents.

Article 37: TURNING RADIUS AND STEERING

a) Only front wheel steering is permitted. If the Organisers are not satisfied with the effectiveness and/or control of a vehicle's steering system, this vehicle will be removed from the competition.
b) The turning radius must be 8 m or less. The turning radius is the distance between the centre of the circle and the external wheel of the vehicle. The external wheel of the vehicle must be able to follow a 90° arc of 8 m radius in both directions.
c) Electrically operated indirect steering systems are permitted providing they are operated by a steering wheel or similar (rotary potentiometer), joystick operation is not permitted. When electronic steering systems are used, then in event of release of the steering wheel by the driver or electrical failure, the vehicle should revert to the straight ahead position.
d) A vehicle handling course may be set up in order to verify the following when the vehicle is in motion: driver skills, turning radius and steering precision. In particular, the Organisers will verify that steering is precise, with no excessive play.

Article 38: BRAKING

a) Vehicles must be equipped with two independently activated brakes or braking systems; each system comprising of a single command control (lever(s) working together or foot pedal), command transmission (cables or hoses) and activators (callipers or shoes).
b) One system has to act on all front wheel(s), the other on all rear wheel(s). When braking on two steering wheels at the front, two activators (callipers or shoes) have to be used (one on each wheel), commanded by only one command control. In addition, the right and left brakes must be properly balanced.
c) It must be possible to activate the two systems at the same time without taking either hand off the steering system. Foot control is recommended.
d) The effectiveness of the braking systems will be tested during vehicle inspection. The vehicle will be placed on an incline with a 20 percent slope with the driver inside. The brakes will be activated each in turn. Each system alone must keep the vehicle immobile.
e) The use of a hydraulically controlled braking system is highly recommended.
Cable operated systems are allowed as long as they are effective and pass the brake test.

C. URBAN CONCEPT GROUP

Article 39: DEFINITION

Under the name “Urban Concept”, the organiser offers an opportunity to design and build energy efficient vehicles that are closer in appearance to today’s production type passenger cars. Urban Concept vehicles must comply with the specific rule of the competition for this group. One particular feature of this group is that vehicles competing in this group will require “stop & go” driving. During all practice and competition driving at the event only one person (the Driver) is allowed inside Urban Concept vehicles, regardless of the number of seats installed.

Article 40: DIMENSIONS

a) The total vehicle height must be between 100 cm and 130 cm.
b) The total body width, excluding rear view mirrors, must be between 120 cm and 130 cm.
c) The total vehicle length must be between 220 cm and 350 cm.
d) The track width must be at least 100 cm for the front axle and 80 cm for the rear axle, measured between the midpoints where the tyres touch the ground.
e) The wheelbase must be at least 120 cm.

f) The Driver's compartment must have a minimum height of 88 cm and a minimum width of 70 cm at the Driver's shoulders.
g) None of the body dimensions above must be achieved by design singularities such as 'stuck-on' appendages or cut-outs.

Article 41: VEHICLE BODY
a) The body must cover all mechanical parts whether the vehicle is viewed from the front, the rear, the sides or from above. However, the wheels and suspension must be fully covered by the body when seen from above and up to the axle centre line when seen from front or rear. The covering for the wheels and suspension must be a rigid integral part of the vehicle body.
b) It is prohibited to use any commercially available vehicle body parts.
c) Access to the vehicle by the Driver must be as easy and practical as typically found in common production type passenger cars. The "door" opening must have a minimum dimension of 500 x 800 mm. This means a rectangular template of this dimension must be able to pass through the door opening in the vertical plane.
d) Any access opening mechanisms (e.g. doors) must be firmly attached to the vehicle body (e.g. by means of hinges, sliding rails, etc.). Adhesive tape, Velcro, etc. are not permitted for this purpose.
e) The vehicle must have a roof covering the Driver's compartment.
f) A windscreen with effective wiper(s) is mandatory.
g) Luggage space must be available for a rectangular solid box with dimensions of 500 x 400 x 200 mm (L x H x W). This space must be easily accessible from the outside and must include a floor and sidewalls to hold the luggage in place when the vehicle is moving.
h) Vehicle bodies must not include any external appendages that might be dangerous to other Team members; e.g. sharp points must have a radius of 5 cm or greater, alternatively they should be made of foam or similar deformable material.
i) A towing hook or ring is mandatory at the front of the vehicle. It can be rigid or flexible (cable or strap). If it is rigid, it must be placed fully under the body for safety reasons. Alternatively, it may be retractable or removable as in a regular car but should be easily accessible. It must be used to tow the vehicle in case of breakdown on the track. It must have a traction resistance equivalent to the weight of the vehicle and have an opening width of at least 3 cm.

Article 42: TURNING RADIUS AND STEERING
a) Vehicle steering must be achieved by one system operated with both hands using a turning motion. It must be precise, with no play or delay.
b) Steering must be achieved using a steering wheel or sections of a wheel with a diameter of not less than 25cm.
c) Steering bars, tillers, joysticks, indirect or electric systems are not permitted.
d) The turning radius must be 6 m or less. The turning radius is the distance between the centre of the circle and the external wheel of the vehicle. The external wheel of the vehicle must be able to follow a 90° arc of 6 m radius in both directions.
e) A vehicle handling course may be set up in order to verify the following when the vehicle is in motion: driver skills, turning radius and steering precision. In particular, the Organisers will verify that steering is precise, with no excessive play.

Article 43: WHEELS
a) The rims must be between 13 to 17 inches in diameter.
b) The wheels located inside the vehicle body must be made inaccessible to the Driver by a Bulkhead. Any handling or manipulation of the wheels is forbidden from the moment the vehicle arrives at the starting line until it crosses the finish line.

Article 44: TYRES
The choice of tyres is free as long as they are fitted on the type and size of rims recommended by their manufacturers and have a minimum tread of 1.6 mm. The tyre/rim assembly must have

a minimum width of 80 mm, measured from tire sidewall to tire sidewall. The width is measured with the tyre fitted on its rim at its rated pressure.

Article 45: LIGHTING

The vehicle must have a functional external lighting system, including:
a) Two front headlights
b) Two front turn indicators
c) Two rear turn indicators
d) Two red brake lights in the rear
e) Two red rear lights (may be combined with the brake lights)
f) The centre of each headlight unit must be located at an equal distance and at least 30 cm from the longitudinal axis of the vehicle.

Article 46: BRAKING

a) The vehicle must be equipped with a four-disc hydraulic brake system, with a single brake pedal, which has a minimum surface area of 25 cm^2.
b) The brakes must operate independently on the front and rear axles or in an X pattern (i.e. right front wheel with left rear wheel, and left front wheel with right rear wheel).
c) A single master cylinder may be used, provided that it has a dual circuit (two pistons and dual tank).
d) The effectiveness of the brake system will be tested during vehicle inspection. The vehicle must remain immobile with the Driver inside when it is placed on a 20 percent incline with the main brake in place. Moreover, a dynamic inspection may be performed on the vehicle-handling course.
e) Wet weather braking capability is mandatory (see Article 47).

Article 47: WET WEATHER RUNNING

a) During weather conditions of light rain/drizzle, the Urban Concept vehicles (only) may be required to drive on the track during competition with approval from the Race Director. Therefore, all Urban Concept vehicles must be adequate for running under such conditions.

i) The vehicle must be equipped with an effective electric windscreen wiper arm assembly typically found in a production car.

ii) The operation of the wiper assembly must be activated by an independent switch easily accessible to the driver.

iii) The wiper operation must provide the driver a clear view.

iv) The vehicle must be adequately ventilated to prevent driver's compartment from fogging.

v) The vehicle's electrical system must be suitable for wet weather conditions (e.g. will not malfunction during wet conditions).

vi) The vehicle's brake effectiveness may be re-inspected before and/or after any run.

vii) The effectiveness of the vehicle to run in wet conditions will be evaluated during the initial inspection phase.

b) These technical characteristics are for Urban Concept vehicles only because Prototypes are not allowed to race on a wet track.

IV. ENERGY SOURCES

A. GENERAL

Article 48: ENERGY TYPES

a) The use of any internal combustion engine, even as a range extender, is forbidden.

b) The vehicles may be powered by one or two electric engines and be equipped with a maximum of two energy storage devices: an energy storage device that powers the engine(s) (a propulsion battery or a hydrogen cylinder) and an accessory battery.

c) The teams are allowed to use an accessory battery in their vehicle. The accessory battery provides for all allowed electrical needs such as safety devices (horn, windscreen wipers, lights, hydrogen sensors, hydrogen relays and hydrogen shutdown valve) and ventilation/cooling fan for the driver. The capacity of the accessory battery must be sufficient to power all the accessory loads with a sufficient safety margin. The accessory battery is not allowed to power blowers in the engine compartment, engine cooling systems or motors.

d) In case where solar panels are used, these must be completely integrated in the shape of the vehicle body. The addition of a wing or any prominent part to integrate them is forbidden.

Article 49: ENERGY RECOVERY SYSTEM

a) The surface of solar panels has to be less or equal to 0.20 m^2.

Article 50: VEHICLE ELECTRICAL SYSTEMS

a) For safety reasons, the maximum voltage on board of any vehicle at any point must not exceed 48 Volts nominal and 60 Volts max (this includes on-board batteries, external batteries, Super capacitors, fuel cell stack, etc.).
b) A Battery Management System adapted to the battery must be installed.
c) Any Lithium based battery must be equipped with a metal tray under the battery suitable to prevent the battery, in the event of a fire or battery event, from burning through the vehicle body and dropping to the ground.
d) All batteries and Super Capacitors must be short circuit protected. Protection may be in the form of a fuse, fusible link, or a current interrupting device (circuit breaker). Automatic reclosing current interrupting devices are not allowed. Short circuit protection devices must be located on the positive conductor and as close as possible to the battery or Super Capacitor itself. The rating of the short circuit protection device must be such that the battery or Super Capacitor will be able to supply enough short circuit current at all times to open the device. For vehicles with a starter motor, the starter motor cable is NOT required to be protected.
e) For safety reasons, both the positive and negative circuits of the propulsion battery or Super Capacitors must be electrically isolated from the vehicle frame.
f) All vehicle electrical circuits must be protected against electrical overload. Overload protection may be in the form of fixed current limits within electric controllers or by the insertion of individual circuit fuses.
g) The accessory battery (see article 48) must maintain a negative ground.
h) Both propulsion and accessory batteries must be installed outside of the driver's compartment behind a bulk head.
i) The following devices may be powered by batteries other than the propulsion or accessory battery provided they use built-in or small capacity batteries: radio communication system, GPS system, data loggers excluding engine management units, driver ventilators.

j) All electrical/electronic enclosures built and populated by the teams must be made of transparent material or at least have a transparent cover to allow the technical inspectors to view the contents.

Article 51: TECHNICAL DOCUMENTATION

a) Competitors need to provide printed technical documentation the day of the technical inspection.

This should be a precise technical description of the vehicle. During technical inspection, the documentation will be compared against the vehicle. Deviations between the technical documentation and the vehicle will be required to be reconciled prior to passing technical inspection.

b) Technical Documentation

i. Wiring diagram

ii. Propulsion system diagram

iii. Chassis diagram

iv. Battery characteristics

v. Provide battery/BMS manufacturer component specifications at the lowest level of purchased components. The BMS data MUST include:

1. Cell over-voltage and under-voltage protection limits
2. Battery over-current limit (not required for accessory battery)
3. Battery over-temperature limit (not required for accessory battery)

vi. Motor/Motor Controller: Provide motor/motor controller manufacturers component specifications at the lowest level of purchased components.

vii. Fuel Cell: Provide fuel cell manufacturers component specifications at the lowest level of purchased components. This should also include the surface area of the fuel cells, rated power and voltage.

viii.Super Capacitors: Provide super capacitor manufacturers component specifications at the lowest level of purchased components. At a minimum, include super cap system rated voltage and max current.

B. ELECTRIC PROPULSION

Article 52: FUEL CELL POWERED VEHICLES

a) Fuel system

i. Participants must provide a description and a precise technical drawing of the fuel supply system.

ii. The fuel system must be easily accessible for inspection and measurements.

iii. The fuel cell must run by itself. The electricity needed for temperature regulation, fan, compressor, electronic management system for the fuel cell and the electric motor must be supplied by the fuel cell and not by the accessory battery.

iv. The hydrogen system must be designed as follows: H2 cylinder -> Pressure regulator directly attached to the cylinder -> Emergency shutdown *valve directly attached to the outlet of the pressure regulator -> Fuel Cell*

b) Hydrogen cylinders

i. FC-powered vehicles must use a compressed hydrogen cylinder, referred to hereafter as a cylinder. Only one cylinder may be fitted to a vehicle at any time. To ensure competitive fairness, all teams in the fuel cell energy class will be given the same quantity of hydrogen before the long-run. The amount of energy provided to the fuel cell powered vehicles will be equivalent to the amount of energy contained in the batteries of the same class vehicles (Prototype or Urban Concept).

ii. Cartridges and any other means of hydrogen storage are not permitted.

iii. The cylinder will be filled by or under the supervision of a Marshal before each race.

c) Ventilation

The vehicle body must allow for ventilation at the highest point of the fuel cell compartment, providing an orifice with a minimum opening of 5 cm². Another 5 cm² opening must be provided at the highest point of the driver compartment.

d) Hydrogen detector

i. An hydrogen sensor must be installed in the fuel cell compartment, near the main ventilation orifice mentioned above. This hydrogen sensor must drive the emergency shutdown valve and relay mentioned below. The trip level of the hydrogen sensor must be tuned to 25% of the LEL (Lower Explosive Limit) of hydrogen, i.e. 1% of hydrogen in air.

ii. The reset of the hydrogen detector, i.e., the hydrogen sensor and its electronics, must be done manually via a switch located in the fuel cell compartment. This switch must not be accessible by the Driver from the cockpit.

e) Emergency shutdown valve and relay

i. The hydrogen supply circuit must be equipped with a solenoid emergency shutdown valve. This valve must be normally closed in the absence of electricity.

ii. The power supply to the motor must be automatically cut off at the same time as the above emergency shutdown valve is activated. This is to be achieved by a suitable fail-safe relay.

iii. This valve and relay must be activated by any of the following three scenarios:

1. Through hydrogen detection as explained above.

2. Through the emergency push-button located on the outside of the vehicle. A red arrow (on a white background) at least 10 cm long and 3 cm wide must be positioned on the vehicle body to clearly indicate the place of this emergency push-button. (Note: It must not be part of the detachable bodywork used to allow driver access).

3. Through another emergency push-button, accessible by the Driver in driving position

iv. In case of activation by one of these three scenarios, the valve and relay must act simultaneously.

f) Pipes and connections of the hydrogen circuit

i. In all cases, piping and connectors of the hydrogen circuit must be designed for hydrogen use. The Team Manager must be able to present during the technical inspection the technical data sheets from the manufacturer of these piping and connectors to show that they are suitable for hydrogen use.

ii. If the pressure in the hydrogen circuit is higher than 1.5 bar absolute (=0.5 bar above atmospheric pressure) piping must be made of steel and connectors must be screw/compression type.

iii. If the pressure in the hydrogen circuit is lower than 1.5 bar absolute (= 0.5 bar above atmospheric pressure) flexible piping and unscrewed connectors are accepted.

iv. PTFE (Teflon) sealing tape must not be used because it can damage the flow meter. In any case Participants are responsible for damage to the flow meter due to wrong connections.

g) Purge pipe

If a purge pipe is needed, its end must be located outside the vehicle.

h) Measurements and Equivalencies

i) Oxygen and air reserves

The use of non-replaced oxygen or compressed air reserves is forbidden.

j) Super Capacitors

i. If an embedded electric storage device is part of the power-train, it must be of capacitor type, referred to hereafter as ‘Super Capacitor’. Other types of embedded electric storage device (Pb, NiMh, etc. batteries) are forbidden.

ii. The Super Capacitor must be uncharged before each start.

k) External starter battery

i. An external battery can be used on the starting line to start the fuel cell system. As soon as the grid is evacuated, this battery must be unplugged.

ii. If an external battery is used, two connectors must be installed outside the vehicle to allow a quick connection and fuel cell system start on the starting line. These external connectors must be securely fastened to the vehicle.

iii. As mentioned in i) it is mandatory to power the hydrogen detector and the horn using the accessory battery. This battery must also power the emergency shutdown valve, relay and lighting system for Urban Concept vehicles.

l) Electrical circuit/Electronics

i. All wiring associated with the accessory battery circuit must be clearly distinguishable from the propulsion system by physical isolation or the use of different wire colours.

ii. A fuse must be installed on the positive terminal of the fuel cell stack. Its melting current (expressed in Amps) must be less than the active area (expressed in square centimetres) of one cell of the stack.

iii. If a Super Capacitor is used in the circuit, a fuse must be installed on the positive terminal of the Super Capacitor pack. The fuse rating must be less than or equal to the maximum usable power divided by the rated voltage.

m) Other equipment

Compressors, fans and coolers for the fuel cell system must be powered by the fuel cell or Super Capacitor, not by the accessory battery.

Article 53: BATTERY ELECTRIC VEHICLES

a) The drive train in the 'Battery Electric' category is restricted to a maximum of one electric storage device, and up to two electric motors, with associated control units. The electric motors may be purchased, purchased-and-modified, or purpose-built.

b) The energy storage device for prototype class has to weight a maximum of 1.5 kg and the energy storage device for Urban Concept class has to weight a maximum of 4.5 kg. This mass corresponds approximately to 230Wh and 670Wh respectively for Prototypes and Urban Concept (based on a Li-Ion battery).

c) This energy storage device will be weighted during technical inspection. It must contain the battery but can also contain the BMS, cables, protective packing,... if they cannot be separated from the battery.

d) The Lithium-based battery and any accessory circuits are subject to the maximum voltage defined above.

e) Participants are required to present electrical schematics at Technical Inspection.

f) All batteries must be placed outside the Driver's compartment behind the bulkhead and securely mounted. Bunge cords or other elastic materials are not permitted for securing the battery.

g) All electrical circuits must be protected as defined in Article 50.