RULES

2019

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1. SCOPE OF ACTIVITY

The objectives of “Efficiency Challenge Electric Vehicle”, organised by TÜBİTAK since 2005, are to contribute to technologic development, create awareness of alternative and clean energy sources, and provide the participants with knowledge and professional and social experience. In this regard, it is necessary to closely follow global technological advancements and changes. When we look at the research and practices all over the world concerning electrical vehicles, we see that battery-fed vehicles are at the forefront and in the near future battery-fed vehicles will become common in our daily lives.

Hydrogen-fuelled vehicles receive their power from a fuel cell system that converts hydrogen stored in the vehicle into energy. With the Hydromobile category, which have been held as part of Efficiency Challenge Electric Vehicle since 2007, a community of young engineers and scientists with knowledge and experience to encourage industrial implementation of hydrogen energy and strengthen its potential have been brought together. In the 2014 competition, it was stipulated that the vehicles be domestically produced, focusing the race concept on energy efficiency.

The competition is organised by the TÜBİTAK Science and Society Division, and the implementation and supervision of technical rules are undertaken by the Jury. Questions related to the technical rules are to be directed to forum.tubitak.gov.tr. The official explanations published on the forum have a sanctioning effect at the level of technical rules.

The sportive part of the competition is undertaken in collaboration with the Turkish Automobile Sports Federation (TOSFED). For this reason, participants are required to comply with the sportive racing rules set out by TOSFED.

TÜBİTAK has the right to make changes to the rules mentioned in this document as well as to the weekly schedule. In case of any ambiguity in the technical rules, the decision of the Jury shall be final.

This document explains the technical specifications of vehicles to compete in the Electromobile and Hydromobile categories. Please see the text in blue colour for the additions and updates to the rules of 2018.

2. EVENT SCHEDULE

The overall process of the organisation and deadlines are given in Table 1.
3. PROGRESS REPORT AND TECHNICAL DESIGN REPORT

Every team is required to fill out the progress and technical design reports in the specified format and e-mail it to challenge@tubitak.gov.tr before the deadline.

Every team is required to present a summary of information about the work it has carried out during the specified period in the progress report. If the progress report is not sent by the specified date, or is incomplete, a penalty score of 150 Wh will be applied or the team will be disqualified. The deadline for delivery of the progress report is May 31st 2019.

The deadline for delivery of the technical design report is August 26th 2019. Teams may be asked to make changes to the technical design reports that are submitted. The teams’ reports will be scored according to compliance with the format and the contents therein. Award or penalty scores will be applied depending on the scores they receive. Technical design report can be written in Turkish or English.

A penalty score of 150 Wh will be applied for teams that get less than 300 points from the technical design report. In the case where there is any “domestic sub-component violation”, a “domestic sub-component penalty” shall be applied separately (See the Annex 2: Penalty List).

Design Awards and Domestic Product Awards shall be decided taking into account the technical design report scoring (See 5. Awards and Support)

Teams are required to have a copy (in electronic media) of technical design reports during technical inspections.
Teams with reports that are highly similar to one another shall not be candidates for Design Awards and Domestic Product Awards and they will be disqualified from the competition. The teams from the same university competing in both Electromobile and Hydromobile categories, with the same team name and team members may submit similar reports.

3.1. Technical Drawings

In the technical design report it is necessary to provide a drawing of A4 size that demonstrates all power circuits of the electrical hardware of the vehicle (21 × 29.7 cm). The drawing should include the battery, fuse, circuit breakers, power adjustment buttons, capacitors, motor control circuits (drivers), motor or motors, recharging unit, and connection cables.

In a second drawing that shows the vehicle from above, the places of these components in the vehicle should be clearly indicated.

4. THE COMPETITION AND TECHNICAL INSPECTION

The competition will be held at İstanbul Atatürk Airport within the scope of TEKNOFEST Istanbul Aeronautics, Space and Technology Festival between 16th and 22nd September 2019. Detailed information on the race track and the event area will be posted on the website.


The vehicle technical inspection shall start on Tuesday, 17 September 2019, and end on Thursday, 19 September 2019.

In order for vehicles to be included in the technical control they shall be expected to complete the reverse, forward, and other manoeuvres specified in the video in the attached link¹ within 120 seconds on a small track of 50 meters during “Vehicle Dynamic Testing”. The teams that pass this inspection will be taken to the technical inspection garage for a detailed examination. Since teams that do not pass the vehicle dynamic testing will not participate in the technical inspection, they will not be included in the competition.

For vehicle dynamic testing, the teams should be ranked by 4:00 pm on Wednesday, September 18th 2019, at the latest. Teams that are in the queue shall not be permitted to work on their vehicles at that time. A checklist shall be provided to the teams so that they can rectify deficiencies found during the technical inspection.

Teams that pass vehicle dynamic testing will be given time until 3:00 pm on Thursday, September 19th 2019, to complete a detailed technical inspection. Teams that are in the queue until that time shall not be permitted to make changes to their

¹https://goo.gl/pThTrk
vehicles. A sticker demonstrating that they are entitled to participate in the competition shall be attached to the vehicles that complete the technical inspection successfully. Vehicles that receive a sticker can start training laps at approved times on the track.

For the teams that receive stickers on their first try on the first day of the technical inspection after vehicle dynamic testing, **50 Wh will be reduced from the final energy consumption value.** For the teams that enter the technical inspection more than three times, **5 Wh will be added to the final energy consumption value.**

As the technical inspections are completed, the list of teams that can participate in the competition will be determined by 6:00 pm on Thursday, 19 September 2019.

### 4.2. Training Laps

When the track conditions are suitable, teams that receive a sticker demonstrating that the technical inspection has been completed successfully could have energy consumption measurements made during training laps. However, these consumption values are not considered in final evaluation.

### 4.3. Electromobile and Hydromobile Final Race Rules

The final race for Electromobile and Hydromobile will be held **twice** within the rules defined in “10. The Electromobile and Hydromobile Race.” The first final race for both categories **will be held all together** (without category separation) on Friday, September 20th 2019; and the second final race will be held all together on Sunday, September 22nd 2019. **The formula for ranking may change depending on the condition of the track where the race will take place.**

In the final races, all teams will start the race at the same time and complete the race within the time specified for the category. During the race, the team is responsible for following the number of laps of their vehicle and the race time.

The starting order for the first final race will be determined by a draw and the order of the second final race will be determined according to the result of the first final race. Teams not participated in the first final race will start the second race from the last position in alphabetical order. If the number of vehicles that participate in the race is high, both of the final races could be done in two groups.

Teams have the right not to participate in one of the final races. Failure to compete in a final race or not completing the race will not affect the final result of the other race and the valid race score will be evaluated. The teams that participate in both final races will be evaluated for the best result they have. Teams that do not enter two final races or complete both of them will be out of order.

All teams must enter the inspection area for their technical inspection and brake test.
4.4. Rule for Completing the Race

According to the sportive racing rules, in order for a team that participates in the race to be accepted as having completed the race, it is necessary that it completes the race in the pit area within the given time.

Example: a team that completes a lap, enters the pit, and waits for the end of the race shall be deemed as having completed the race; a vehicle that breaks down in the last lap shall be deemed as not having completed the race.

5. AWARDS AND SUPPORT

The awards / supports and the amounts to be given in the event are given in Table 2.

<table>
<thead>
<tr>
<th>Award / Support</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Award 1st place (Electromobile, Hydromobile)</td>
<td>40,000 TRY</td>
</tr>
<tr>
<td>Performance Award 2nd place (Electromobile, Hydromobile)</td>
<td>30,000 TRY</td>
</tr>
<tr>
<td>Performance Award 3rd place (Electromobile, Hydromobile)</td>
<td>20,000 TRY</td>
</tr>
<tr>
<td>Efficiency Record Award</td>
<td>20,000 TRY</td>
</tr>
<tr>
<td>Technical Design Award</td>
<td>20,000 TRY</td>
</tr>
<tr>
<td>Visual Design Award</td>
<td>15,000 TRY</td>
</tr>
<tr>
<td>Jury Award</td>
<td>10,000 TRY</td>
</tr>
<tr>
<td>Communication Award</td>
<td>3,000 TRY</td>
</tr>
<tr>
<td>Domestic Product Award 1st Place</td>
<td>20,000 TRY</td>
</tr>
<tr>
<td>Domestic Product Award 2nd Place</td>
<td>18,000 TRY</td>
</tr>
<tr>
<td>Domestic Product Award 3rd Place</td>
<td>16,000 TRY</td>
</tr>
<tr>
<td>Financial Support (See 5.6. Financial Support)</td>
<td>10,000 – 35,000 TRY</td>
</tr>
</tbody>
</table>

Table 2. Awards and supports

5.1. Performance Awards

Performance awards are given to teams that are top-ranked in the races that are completed according to the rules specified for the “10. The Electromobile and Hydromobile Race”. To be eligible for the Performance Award, a team’s race score according to the formula specified in “10. The Electromobile and Hydromobile Race” must be at least 2,000, which may be updated based on the changes in the race track.

In Electromobile category, Efficiency Record Award will be given to the team who
completes the race successfully with 30 valid laps and consumes less energy than “730 Wh” which is the lowest energy consumption recorded in this category in the last 5 years. The energy consumption measuring device will be used for this purpose, and the penalty lap(s) will not affect the result. If there are more than one team that breaks the record, the team with the lowest consumption shall be awarded. The record consumption value may change depending on the changes in race track.

5.2. Design Awards

5.2.1. Technical Design Award

This is the award given to the team whose product/vehicle is innovative, has superior engineering work in terms of mechanical and electronic design, and is domestic. The evaluation will be based on both the inspections made during the week of competition and the technical design reports. Technical Design Award will be given to one team without category separation. The award will be shared among the teams in the event that several teams are deemed worthy of the award. In order to be eligible for the award, teams must successfully pass all the necessary tests for Electromobile or Hydromobile category and earn a sticker to compete the race.

5.2.2. Visual Design Award

This award will be given to the team whose vehicle’s external and internal design (shell, cockpit etc.) is original and aesthetically pleasing. The award also considers the designs industrial producibility and usability. The evaluation will be based on both the inspections made during the week of competition and the technical design reports. Visual Design Award will be given to one team without category separation. The award will be shared among the teams if several teams are deemed worthy of the award. In order to be eligible for the award, teams must successfully pass all the necessary tests for Electromobile or Hydromobile category and earn a sticker to compete the race.

5.3. Jury Award

This is the award given to the team that brings innovation in realms other than performance and design, either as a vehicle or as a team, and that demonstrates such characteristics and behaviours contributing to the spirit of the activity, etc. For award evaluation, the observations by the jury and TÜBİTAK authorities during the week of competition and recommendations presented by teams by written petitions shall be taken into consideration. Jury Award will be given to one team without category separation. The award will be shared among the teams if several teams are deemed worthy of the award.

5.4. Communication Award

This is the award given to the teams that demonstrate superior activity in creating and disseminating societal awareness concerning the event. In the award evaluation, any type of press, communication, and promotional activities carried out relating to
alternative energies and technologies as concerns the competition and the vehicles, workshop activities, seminars, and congresses/conferences targeting various sections of the public, as well as the widespread impact on the target audience within a national or international framework as part of these activities, shall be taken into account. The reporting format to be presented for award application and the evolution criteria shall be announced on challenge.tubitak.gov.tr. The award will be given to all teams that provide sufficient amount of activities in their reports in the required format.

5.5. **Domestic Product Awards**

These are the awards given to Turkish teams with superior domestic designs and products. The teams must receive at least 1,000 points from the technical design report and must satisfy one of the following criteria:

a) Domestically producing any **four of the mandatory sub-components** specified in “6.1 Being Domestic”

b) Domestically producing any **three of the mandatory sub-components** and **two of the optional sub-components** specified in “6.1 Being Domestic”

In the event that there are more than 3 teams that meet the criteria, awards shall be granted to the top 3 Turkish teams (including Northern Cyprus) according to the scoring done by taking into account the technical design report and technical evaluations made of the vehicle, where Electromobile and Hydromobile categories will be considered together.

5.6. **Financial Support**

Support of **10,000 TRY** for teams from Turkey and **15,000 TRY** for international teams shall be given to those who apply for Electromobile or Hydromobile category and are accepted for participation in the competition.

Financial support of **25,000 TRY**, in addition to the aforementioned support, shall be given to teams from Turkey whose universities apply for the first time in the Electromobile category.

In Hydromobile category, Turkish teams whose universities apply for the first time since 2016 (including 2016) will be given **25,000 TRY**. In addition, in case there are more than one team from the same university that apply for Hydromobile category, the teams none of whose member ever applied for the competition (i.e. teams that are completely different) will be given **25,000 TRY**.

Responsibilities of the teams in relation to the spending of such funds shall be indicated in the contract signed by the teams at the time of application.

In the event that vehicles are not ready for the competition and technical inspections are not completed, the financial support given to the team could be requested to be
returned upon the decision of the jury.

In case there are multiple applications made from the same university in one category, these applications will be valid on the condition that teams’ work and the financial and administrative management are completely different from each other. Teams that are given the impression that they are divided into different teams in order to benefit more from incentives or to prepare with more vehicles, but who work together in official correspondence and reporting, are dismissed from the competition, and incentive is requested in accordance with the specified conditions in the contract.

5.7. Transfer and Spending of Awards and Financial Support

For participating teams from Turkey, the awards and/or financial support granted within the scope of the activity shall be transferred by TÜBİTAK to a special account to be opened by the accounting manager/authority of the participating authority following the approval of the applications. Amounts to be transferred to the special account shall be followed according to the accounting regulations to which the organisation is subject under escrow accounts without being reflected to the income – expenditure accounts by the participating organisation. Expenditures shall be made by the academic advisor of the team within the framework of the allowance. Teams that declare their withdrawal from the competition in writing before 20 June 2019 are required to return all of the support given to the relevant account of TÜBİTAK within 15 days. Teams that declare their withdrawal after 20 June 2019, do not complete their competition registry on 16 September 2019, or are disqualified by the jury due to technical incompliance or unfair play shall return all of the support given to the TÜBİTAK account together with the default interest.

Amounts that are kept in special accounts are monitored under escrow accounts and could be spent as preparation support for the activity in the coming years upon the demand of the person in charge if necessary.

Financial support for international participants shall be delivered by EFT to the special account of the academic advisor or delivered by hand upon complete registration in the competition area on 16 September 2019 and completion of the general examination of the vehicle.

Awards to be given at the end of the activity shall be transferred to the same private account by TÜBİTAK. Distribution of the awards to team members shall be made by the academic advisor.
6. GENERAL VEHICLE SPECIFICATIONS

6.1. Being Domestic

Teams are required to design all four mandatory sub-components of the following sub-components themselves in accordance with the criteria indicated in technical design report.

Mandatory sub-components:

a) Motor (Electromobile and Hydromobile)
b) Motor driver (Electromobile and Hydromobile)
c) Battery management system (BMS) (Electromobile and Hydromobile)
d) Embedded recharging unit (Mandatory for Electromobile, Optional for Hydromobile)
e) Energy management systems (Hydromobile)

The teams that do not prepare these sub-components themselves can participate in the final race with a 400 Wh penalty for each missing component. However, for a team to complete the technical inspections successfully and participate in the race, the team shall domestically produce at least one of the mandatory sub-components (See Annex 2: Penalty List).

In order to be eligible for the Domestic Product Award and Technical Design Award, teams are encouraged to prepare the following sub-components in addition.

Optional sub-components:

a) Battery packaging (Electromobile and Hydromobile)
b) Electronic differential application (Electromobile and Hydromobile)
c) Vehicle control unit (Electromobile and Hydromobile)
d) Fuel cell (Hydromobile)
e) Fuel cell control unit (Hydromobile)

In the technical inspections, it will be determined whether or not the components declared to be “domestic” in the technical design report meet the conditions of being domestic. Teams are expected to produce and report domestic sub-components themselves. Teams that use the same component or present a component report that are similar to a significant extent will be disqualified from the competition.

Parts that are accepted as domestic in previous years will not be accepted as domestic unless it fulfills the necessary conditions specified in this document. Student members of teams are responsible for the design, production, reporting, and required explanations during technical inspections.

The teams from the same university competing in both Electromobile and Hydromobile categories, with the same team name and team members can use the same domestic
sub-components. **However, teams are expected to produce vehicle parts separately, since final races for both categories will be held at the same time.**

### 6.2. Drive System and Electrical Hardware

In Electromobile category, a group of batteries is used as main (and only) energy source in the vehicles. No second type of energy supply (super capacitor, fuel cells, etc.) shall be used in the vehicles. No such equipment as capacitors and/or fuel cells, etc., shall be used in the motor driving system (between the battery output and motor) with capacities that exceed the intended purpose for the aim of storing energy. The energy capacity of the energy storage elements in the motor driving system (passive components used for filtering purposes) is limited to a maximum of 1000 J (to be calculated from the label value of the capacitor).

For Hydromobile category, the total of the label values of output power for nominal fuel cells (which could be multiple) to be used in vehicles may be a maximum of 3 kW. The output power of fuel cell modules may change in positive or negative directions depending on the type of reactant gasses fed inside (for example, using O2 instead of air) and gas feeding conditions (temperature, humidity, pressure values, etc.). For this reason, only the label values of power modules will be taken into account (the teams are requested to certify these label values) and inspections will be based on this value. While the operating conditions of fuel cell modules may be different for each team to the extent to which they comply with safety precautions, the output performance of the modules could be increased provided that suitable safety measures are taken. In the event that the fuel cell is fed with oxygen, oxygen and hydrogen lines should be located with a minimum distance of 10 cm between them.

Fuel cell anode and cathode outputs must be independent of each other, and they must be released into the atmosphere from the back of the vehicle by two separate evacuation lines.

In Hydromobile category, a super capacitor may be used in vehicles provided that its specifications are indicated in the design report. The super capacitor to be used should be connected to the system through a converter. **Circuits and equipment such as contactors, relays, or static switches that only turn on and turn off will not be accepted as converter.** If used, super capacitor is limited to a maximum of 110 kJ (to be calculated based on the label value of the capacitor). The energy difference will be calculated by measuring the super capacitor voltage before and after the race. In order to measure super capacitor voltage, the capacitor terminals should be accessible. Using super capacitor for Hydromobile vehicles and energy measurement are shown in Figure 13. Only electric motor types may be used in vehicles that will participate in the competition.
6.3. Motor

Teams whose motor design and production are domestic shall be responsible for the following during technical inspections:

a) Awareness of electrical and mechanical specifications,
b) Providing information on magnetic and thermal analysis,
c) Providing information visually with items such as photographs and videos about production stages,
d) Providing information about test method and results.

It will be checked in both the Technical Design Report and technical inspections whether the requested analyses have been conducted by the team. Use of thermal, magnetic, and electrical analyses provided by commercial suppliers for some parts of the motor (like core, windings) is a certain reason to consider the motor nondomestic. The design, optimisation, and computer simulation steps of the motor must be explained in both the Technical Design Report and technical inspections.

In order for the motor to be regarded as a domestic component, the raw files of the programs showing the design and simulation results of the motor must be submitted with the technical design report. At technical inspections, the Jury may request these files to be run.

6.4. Motor Driver

Teams whose motor driver design and production are domestic shall be responsible for the following during technical inspections:

a) Providing information about electric circuit design,
b) Providing information about simulation works and control algorithms,
c) Providing information about printed circuit board design,
d) Providing visual information such as photographs and videos about the production stages,
e) Providing information about the test method and results.

The design, optimisation, and computer simulation steps of the motor driver must be explained in both the Technical Design Report and technical inspections. Motor driver circuit must be covered with box and the covered system must be fixed in the vehicle. Box must be designed to protect the motor driver circuit against water, oil, dust etc. During technical inspections, the Jury may ask the motor driver to be released from the place where it is fixed and see the motor driver circuit for detailed inspection.

In order for the motor driver to be regarded as a domestic component, the raw files of the programs showing the design and simulation results of the motor must be
submitted with the technical design report. At technical inspections, the Jury may request these files to be run.

6.5. Battery

Currently, lithium-based batteries are used in all electrical vehicles. Thus, in this challenge only lithium-based batteries are allowed.

The battery group should be placed inside the vehicle and be protected against short circuits and leakage by protective housing. The vehicle’s battery should be easily accessible from the outside of the vehicle. The battery should be easily reachable without removing any other component of the vehicle (i.e. hood, motor, seat, BMS, etc.). The protective housing should be fixed strongly at the bottom of the vehicle by means of nuts and bolts of grade 8.8 and a minimum diameter of 8 mm. The fixing process must be done in such a manner that the fixing apparatus and fixing points will not move out of position even in the event of an accident.

6.5.1. Battery Management System (BMS)

The BMS is an electronic system that enables the rechargeable battery cells and package to operate within safe operating limits; it is obligatory to use it. The BMS should monitor the voltage, current, temperature (the hottest cell of the battery), and state of charge of each battery cell and package and its life estimation (state of health) and take relevant safety measures when safe operating limits are exceeded. The data regarding the voltage, current, temperature, and state of charge of each battery cell and package must be monitored on the display in the driver’s cockpit. If one or more of these data (except the temperature information) are missing on the display in the driver’s cockpit, the regulation in 6.9. Vehicle Control Unit (VCU) (g) is required and must be measurable on the vehicle as well. Passive and active balancing systems should be included in order to overcome voltage imbalances that could occur in BMS battery cells.

a) The temperature measurement value and the voltage of battery package should be transmitted to the temperature indicator in the driver’s cockpit unconditionally. If a single temperature value is shown in the indicator, this value should be the temperature value of the hottest cell. The methodology that determines the hottest cell should be detailed in the document.

b) The temperature indicator should be electrically connected to a warning flasher. The flasher should emit an audible warning when the battery temperature reaches the critical temperature value. The audible warning must be heard from a distance of 2 m at 80 dB. The electrical connection of the battery group to the system should then be broken by an automatic protection system.
c) It is required that the cells be integrated in groups of 4 or 5 (series or parallel) and that each group be separated from each other by inflammable material (See Figure 7).

Teams that develop the BMS domestically shall be responsible for the following items during technical inspections:

a) Demonstrating the BMS physically,

b) Providing general information about the BMS design and operating principles,

c) Providing information about the balancing method and its implementation.

In technical inspections, the passive and active balancing systems, the safety measures described above, and whether the flasher is functional shall be checked.

6.5.2. Battery Packaging

The battery’s protective housing must completely encircle the batteries (so as to prevent short circuit of conducting parts as well as battery poles) and be made of a material that is resistant to mechanical impacts and fire (protective vessels manufactured from wood, Plexiglas, polystyrene, and inflammable plastic are not acceptable) and that prevents leakage of battery liquid (See Figure 7). The team that owns the vehicle is obliged to prove that the battery fixing mechanism and battery compartments are strong enough to resist the stresses defined for the roll bars.

a) For every battery group located inside the vehicle, ventilation channels should be provided with an outlet outside the vehicle.

b) The valves, electric fans, and pumps of the cooling air or liquid systems should be initiated when the temperature reaches a critical value.

c) “High Voltage” warning signs should be visible on each battery group/pack.

d) The control measures given below should be implemented in the event of a fire hazard in the vehicles.

e) A physical and electrical separation must be placed between the battery pack and BMS.

The cells inside the battery pack should not be simply connected to each other by a cable. For the connecting of the cells, bus bar or special connecting apparatuses should be employed. Thus, welding (laser, ultrasound, direct, etc.), soldering, or screwed systems can be used for connecting the cells to each other. The cells should be fixed to the battery housing. Inflammable materials such as silicone or polyurethane foam should not be used for fixing.
The battery housing, battery and BMS should provide easy access to the battery from the outside of the vehicle. Connection and fixing equipment must definitely be in accordance with the previous definitions and suitable for instant external measurement.

In technical inspections, the data sheets for the batteries used, the battery's protective housing, and safety measures will be checked. It will not be possible to participate in the competition with unsuitable battery and battery components, including those with problems in terms of location and those that cannot be accessed from the outside.

In order to be accepted as a domestic product of the battery pack, the following points need to be detailed in the technical design report as well as explained during the technical controls.

a) Cell type (pouch, cylindrical, prismatic, etc.), electrochemical data-sheets (charge-discharge characteristics of the cells, nominal voltage of the cells, energy density of the cells, etc.),

b) Battery case material need to detailed in terms of mechanical (tensile strength, impact resistance), thermal (melting point) and electrical (dielectric constant) properties

c) Cell placement inside the battery (case) housing,

d) Fixing methods of the cells in the battery container,

e) Thermal and mechanical properties of each component (including the battery shell) used in the battery container,

f) Thermal analysis of the battery pack,

g) Battery cooling system (air, water, etc.) details,

h) The placement and fixing details of the battery pack inside the vehicle,

i) If the battery case material is electrically conductive (i.e. carbon fiber, stainless steel etc.), inner surface of the battery case should be isolated with an insulated and nonflammable material (i.e. nonflammable PVC- nonflammable paper, etc.). The mechanical and thermal properties of the isolation materials used as an inner surface protection should be detailed,

j) The details of the design should be supported by photographs in the technical design report.

**6.5.3. Embedded Recharging Unit**

This is a switched power supply that is fixed on the vehicle and can charge the battery group by being fed from the grid. It is not obligatory to use this unit; however, it is recommended since it will avoid such risky processes as detaching and reattaching the battery box for charging and it could be easily recharged anywhere. For this
purpose, a ready-made power supply could be used. However, it should be designed and manufactured by the team in order to meet domestic design criteria. Since this power supply will manage the recharging process of the battery group together with the control unit, it could be considered a part of the BMS. The specifications of this unit are listed below.

a) It should have a minimum power level of 500 W in order to recharge the battery group in an acceptable time.

b) It should be able to recharge the battery group over a single-phase grid. Three phase sources could be used; nonetheless, a single separate phase input should be provided.

c) Active or passive power factor correction feature is not obligatory but are recommended.

d) Besides full-bridge or half-bridge converter, other switching converter topologies can also be used. It is necessary to provide electrical insulation of the power supply between the grid and the battery group.

e) A transformer operated at grid frequency (50/60 Hz) cannot be used as the main power transformer inside a switching power supply. These kinds of power supplies will not be accepted as switching converters. Similarly, if a grid frequency operating transformer is used as electrical insulation between the grid and the vehicle that power supply will not be regarded as a switched power supply. Chopping grid voltage by thyristor or triac will also not be considered as switched power supply. These kinds of on-board power supplies that contain a grid frequency operating transformer can be used to charge batteries and partial report points will be given, but they will not be regarded as domestic components.

f) For electrical safety, a converter that rectifies the grid and decreases the voltage by a buck converter and charges the battery will not be permitted since galvanic electrical insulation between the grid and the vehicle is not provided.

g) An embedded recharging unit must be on the vehicle during the races.

The recharging unit will be inspected in technical inspections by measuring the current and voltage values from the output ends.

6.6. Electrical Safety

a) All vehicles are required to comply with rules established by national authorities in relation to standardisation and use of low-voltage electric equipment.

b) The power circuit and electrical hardware must power all parts used for moving the vehicle.
c) The auxiliary circuit (network) must power the parts of the electrical hardware used for signalling, lighting, and communication.

d) Although it is required to provide minimum IP 44 type protection for all parts of the electric hardware (for safety against dust and water spillage), IP 55 type protection is recommended.

e) All types of electric connections between the energy-consuming units and the energy-producing hardware shall be the non-sparking type and should be cut by 2 circuit breakers, one inside and one outside the vehicle (emergency breaker switch with top-pressing/emergency stop) (See Figure 8). The internal switch should be placed in such a way that the driver can easily see and reach it from outside when required. The button of the general circuit breaker in closed vehicles, on the outside the vehicle, should be placed on the left side of the driver in the driving direction under the cockpit window. Both general circuit breakers should comprise a red button together with a yellow circle with a minimum diameter of 8 cm. “Emergency STOP” should be written in red or black letters on the circle. Attention should be paid to the location of the emergency stop button, to be placed outside. Considering the fact that the vehicles pass very close to one another during the race, it should be thought that the whole circuit would be cut in the case of any unintentional contact with the emergency stop button, and precautions should be taken to prevent this situation in the shell design. See the circuit drawings attached for sample circuit breaker. In technical inspections it will be tested whether emergency stop buttons functionally operate when the vehicle is in operating conditions and when it is moving, after the vehicle completes all other inspections successfully. It will also be checked whether both emergency stop buttons comprise a red button in the middle of a yellow circle with a minimum diameter of 8 cm and whether “Emergency” is written in red or black letters on the circle.

f) The overcurrent breaker is a circuit element that automatically cuts off the electricity current in the circuit in which it is located if it exceeds the limit value defined for a certain period. Fuses and circuit breakers (excluding the motor circuit breaker) shall be considered overcurrent circuit breakers (it is acceptable to use high-speed electronic circuit fuses and high-speed fuses). Overcurrent breakers shall never replace emergency stop buttons. The cables should be placed in a suitable cable sheath and no bare cable should be used. Cable beams should be clamped in a suitable manner. In addition, for all conductors installed on the vehicle, the maximum RMS current that can pass through the conductor shall not exceed 5 times the conductor size in mm$^2$. (For example, a 16 mm$^2$ cable is allowed to carry a maximum of 80 A RMS current.)

g) At the output of the battery it is recommended to use a DC-type miniature circuit breaker. If an AC-type miniature circuit breaker or thermal magnetic breaker is used, its DC voltage and current breaking capacity should be suitable for the
connected cable and load. Also fuses or protective components should be used to feed loads that are connected to the battery or DC/DC converter (see Figure 11).

6.7. Energy Management System (EMS)

For Hydromobile vehicles, a software and hardware that optimises power flow between the energy sources and the load can be regarded as an EMS. Figure 13 should be checked for details.

Teams that develop a domestic EMS will be responsible for the following items during technical inspections:

a) Demonstrating the EMS product physically,

b) Providing general information about the EMS design and operating principles,

c) Measuring and showing the current and voltage values at which the DC-DC converters operate.

6.8. Electronic Differential Application

Detailed information about the differential application to be used in electric vehicles is published on the website as an Annex.

It is expected that teams that design their own electronic differential application conform to the principles detailed in this Annex. To this end, teams must possess sufficient information about the design steps and give correct and clear answers to questions about the application. Furthermore, in order for the electronic differential application to be approved as a domestic component, demonstration of the motor reference signals through a suitable digital platform integrated into the vehicle is mandatory. If necessary, the design will be validated using this digital platform by repeating 4.1 Vehicle Dynamic Testing.

6.9. Vehicle Control Unit (VCU)

Vehicle Control Unit (VCU) is a central control system which acquires, analyzes and interprets various signals coming from different constituents and sensors of the vehicle to command and regulate same subsystems those items belong to or substantially distinct other units. Particularly, VCU is an embedded electronic component enabling control of several subsystems implemented on the vehicle such as the battery management system, the DC-DC converter and the motor control unit utilizing obtained information from the same subsystems. The VCU consists of software and hardware. A microprocessor, EPROM or flash memory, and some other electronic components make up the hardware. The software is low-level code written into the microprocessor.

Generally the VCU is characterized as follows:

a) Many analogue and digital I/O data (low and high power)
The VCU shall perform the following main functions:

a) Motor Torque Control; it will receive the acceleration reference from the vehicle driver and convert it to reference engine torque by both improving driving quality and energy efficiency. It will also provide the necessary safety functions such as providing predefined acceleration and deceleration measures, current limiting during sudden load changes, limiting over speed by its motor torque control algorithm.

b) Regenerative Braking Optimization; it will take the deceleration reference from the vehicle driver and convert it to the motor torque reference which is required for additional electrical braking to increase energy efficiency without interrupting mechanical braking.

c) Vehicle’s Energy Management System; It should limit the excessive use of energy resources in the vehicle and optimize the use of energy.

d) Management of Vehicle’s Communication System,

e) Diagnostics; evaluation of signals coming from various subsystems to detect and diagnose possible faults occurs during the operation and informing the driver of suggested corrective actions.

f) Monitor Vehicle’s Condition and Warn the Driver, demonstration of critical data reflecting the current situation of the vehicle such as vehicle speed, temperatures of the components, battery and motor voltages via a proper display.

g) Signal Acquisition and Data Transfer, Attaining the specified information about different constituents (Speed, temperature, voltage, current etc.), transferring the collected data to the team's data centers via RF or GSM modules and logging the collected data in the data center.

It is mandatory for teams to perform the signal acquisition and data transfer function given in g item. Teams can use on-the-shelf microcontrollers to fulfill this task.
However, it is forbidden to use PC, laptop or other mobile devices.

The developed VCU will not be approved as domestic unless it performs at least three of the above listed functions on a single mainboard. During technical examinations, teams asserting to have domestic VCs shall provide:

- a) The VCU hardware with a detailed verbal description,
- b) Comprehensive information about the main functions and the mandatory signal acquisition and data transfer function,
- c) A clear description of the communication protocols used between the VCU and the other subsystems,
- d) Demonstration of the signal acquisition and data transfer function,
- e) Demonstration of the logging function in the data center.

Vehicle sub-systems understand the surrounding environmental conditions from the available sensor data, evaluate these sensor data, and send commands to its actuators or other components. For example, the existing Electromobile vehicles’ battery management system activates the flasher of the vehicle when the temperature of the battery exceeds the specified limit. However, it cannot take any preventive action to inhibit the very high battery temperature. If there is a VCU, the desired electric motor power can be limited according to the temperature of the batteries. Even if temperature continues to increase, all current flow can be set to zero and if temperature continues to increase it can open the emergency contactors. As described in the example, the VCU collects all information, evaluates the collected data according to written algorithms, and sends commands to the actuator to apply the decision.

In order to collect data from all sub-systems, to evaluate them, and to send commands, there must be a communication protocol for the VCU. (Figure 10)

7. HYDROGEN LINES AND METAL-HYDRIDE HYDROGEN CYLINDERS

Specifications of hydrogen systems used in Hydromobile category can be found below.

- a) Low-temperature metal hydride hydrogen cylinders (maximum of 15 bar) may be used in vehicles. These cylinders must not be replaced during the race and no fuel (hydrogen) additions may be made to the existing tank.

- b) A pressure safety valve must be provided at the outlet of the metal hydride hydrogen cylinders to evacuate the gas in the event of excessive pressure before entering the fuel cell. The output of the safety valve should be outside the vehicle, perpendicular to the ground, and the evacuation line output should be outwards from the vehicle.

- c) A gas flow safety valve (flame trap or check valve) should be provided following
the output of the metal hydride hydrogen cylinders, before entering the fuel cell.

d) The vehicle should have the following fire safety measures:
   i. A thermocouple must be provided on the surface of the metal hydride cylinders to measure the temperature. The thermocouple must transmit the temperature measurement values to the temperature indicator in the vehicle’s cockpit.
   ii. The temperature indicator should be electrically connected to a warning flasher.
   iii. An audial and visual alert should be emitted by the flasher when the surface temperature of the metal hydride cylinder goes 10 °C above the maximum operating temperature of the metal hydride as declared by the manufacturer.
   iv. The flasher should be placed where the visual alert can be seen by the referees and the driver during the race. The diameter of the flasher should not be less than 4 cm and the height should not be less than 5 cm. The flasher should be red and rotating with a reflector.

e) The cylinders should be located behind a protective shield with mechanical resistance for protection against mechanical impacts from the outside. The cylinders with the protective shield can be placed behind the driver’s seat or at the front of the vehicle beyond the windscreen. Cylinders located inside the vehicle should be located together and behind the protective shield, connected with resistant belts or clamps, and in the form of bundles. The protective shield should allow the natural ventilation of cylinders.

f) The section where the cylinders are located should be designed so as to not be subject to static electricity.

g) The hydrogen line should not pass through the cockpit. All valves and fittings used on the hydrogen line should be of 316 quality and stainless steel or brass, and pipes should be of 316 quality and stainless steel or PTFE (Teflon) material. Changes may be demanded by the technical team if any violations are observed related to safety during technical inspections. While designing the parts of the vehicle related to hydrogen gas and mounting these parts, the requirements of the following standards must be taken into account:
   i. ISO/TR 15916:2004 - Basic considerations for the safety of hydrogen systems.

h) A stainless steel or brass globe valve of 316 quality must be provided for a second line of safety on the hydrogen cylinders-fuel battery line. The valve should be located in a place where it can be reached by the driver and inspected.

i) During technical inspections, technical specification documents and certificates will be checked for all materials used on the hydrogen line (pipe, valves, and connection elements).

j) Hydrogen sensors to be located in the driver cabin should emit an alarm in the event of the presence of 2% hydrogen in volume in the environment.

k) It is necessary to provide a dry-powder fire extinguisher in the vehicles.

8. PHYSICAL SPECIFICATIONS

It is expected that battery-fed vehicles are automobile vehicles suitable for urban driving that take into account efficiency. It is therefore expected that the vehicles have a minimum of two seats (with an approximate length of 1.70 m for driver and passenger weighing 70 kg) and are 4-wheel vehicles (within specified measurements).

8.1. Vehicle Measurements

a) Vehicle height must be a minimum of 100 cm and less than 1.25 time of the vehicle width (100 cm < vehicle height < vehicle width x 1.25 (150 to 225cm)).

b) The distance between opposite wheels must be greater than half the width of the vehicle.

c) The vehicle width must not be less than 120 cm or more than 180 cm (119 cm < vehicle width < 181 cm).

d) Vehicle length must be a minimum of 200 cm and a maximum of 425 cm.

e) Track width of the front wheels must be a minimum of 100 cm, and the track width of the rear wheels must be a minimum of 80 cm.

f) The wheelbase distance must be a minimum of 130 cm.

g) The gap between the driver and passenger seats and the top of the vehicle must be a minimum of 85 cm, and the width of the parts between the seat and front window of the vehicle must be a minimum of 65 cm. Adherence to this rule will be checked visually and with an emergency evacuation test.
h) The height of the vehicle from the ground must be a minimum of 10 cm.

i) There is no lower limit for the vehicle weight, but vehicles whose doors and other parts the jury considers to be unsafe and possibly damaged by wind shall be excluded for violation of safety rules.

During technical inspections, the dimension of the vehicle shall be tested by checking whether it is inside the lines drawn on the ground in the inspection area. For the bottom height, it will be tested whether a stick with a length of 9 cm passes under the vehicle without hitting the ground. Dimensional measurements of the vehicle during technical inspection will be done according to Figure 51.

8.2. Vehicle Body

a) The vehicle body must cover all mechanical and electrical parts. All parts must be completely inside the vehicle body when viewed from the front, the back, or top. The shell of the vehicle shall not be in contact with the road, tires or any other component. The shell shall have at least one cover in the front and one cover in the back. It shall be possible to access / inspect internal parts by opening these covers if required.

b) In cases where it is required to mount such equipment as brake wires, pipes, hoses, electricity cables, and electrical equipment, this equipment should be protected against such possible damage as stone impact, staining, and mechanical damage. It is required that all equipment to be mounted inside the vehicle shell be protected against risks such as fire and short circuits.

c) The vehicle body must not have any sharp and pointing protrusions that could damage other vehicles during the race. The cockpit location must be completely isolated from the external environment. The cockpit and the driver must be protected from foreign materials such as stones that may come from the road.

d) The vehicle should not be designed as a roadster; the upper part of the vehicles should be completely closed.

During technical inspections, elements that could create risks for the driver and other vehicles shall be examined.

8.3. Door

It should be easy for the driver and the passenger to enter and exit the vehicle. There shall be at least one door that opens from the top or two doors that open from the sides allowing the driver to get out in the event of vehicle turnover.

The doors should have minimum dimensions of 50 cm × 80 cm. During technical inspections, it is required that a frame of 50 cm × 80 cm shall pass through the doors. If the frame is bigger than the door, the vehicle is not suitably designed.
Any door to be used for access to the vehicle should be fixed to the body with a safe connecting element such as a hinge or sliding mechanism. The door mechanism must be self-closing, and when it is opened, it must be able to stand firmly without deforming the hinges.

It must be possible for the door to be opened from the inside and outside in the event of an emergency. The door locking mechanism should completely stabilise the door and should not allow the door to move or bend in any direction. Only having a key to open the door from the outside is not permitted.

Unsafe and non-resistant closure mechanisms such as adhesives or plastic clamps (hook and loop) are not acceptable.

It is not acceptable to use adhesions on the door or to attach the door with a plastic clamp from the inside. Teams will be disqualified if such conditions are observed during the inspection before, during, or after the race.

8.4. Weight

Since the main purpose in the competition is efficiency, there is no lower limit for vehicle weight. However, if a vehicle is not deemed suitable in terms of driver safety, it could be disqualified from the competition by the jury.

8.5. Wheels

a) The wheels to be used in vehicles should comprise a hub, rim, and tyre. It is obligatory to use air tyres.

b) It is prohibited to heat the wheel tyres by any method or subject them to any chemical process.

c) There is no limit for wheel rim dimensions and the materials used, provided that the wheels are completely inside the vehicle body.

d) The wheel width should be a minimum of 70 mm.

e) The size written on the label of the wheel used shall be checked; using a wider rim or increasing the tyre width by changing the air pressure is not acceptable.

In technical inspections, the width shall be checked by looking at the label on the wheel. No further width measurements shall be made.

9. SAFETY HARDWARE

Vehicles that could create danger in terms of design and production will be disqualified from the competition by referees and the jury.
9.1. Battery Group Location

The area where the battery group will be placed should be separated from the cockpit with a strong partition that is resistant to fire for at least 5 minutes (metal, etc.).

9.2. Fuel Cell Location

In Hydromobile category, the area where the fuel cell is placed should be separated from the cockpit with a strong partition that is resistant to fire for at least 5 minutes (cast polyamide, etc.).

9.3. Battery Group and Fuel Cell Placed Together

In the Hydromobile category, the battery group and the hydrogen gas connection lines (hose, valve, etc.) must be definitely separated from each other. For this purpose,

a) Battery group and hydrogen gas connection lines should be placed in different location (i.e. front and rear hood) or

b) Fire resistant materials should be used to separate those battery group and hydrogen gas connection lines.

9.4. Brakes

a) A dual-circuit hydraulic brake system operated by a single pedal is obligatory. The same pedal should activate all brakes. In the event of any breakdown in a circuit, the other circuit should be effective on a single axle. Wire brakes are not acceptable.

b) Brake performance of the vehicle will be performed on a braking platform. Figure 16 shows the dimensions of the platform for brake test. Length, height and width of the platform are 485 cm, 85 cm and 200 cm, respectively. Angle of the platform is approximately 10 degrees. The brake test will be performed before and after the race and consists of two parts. First, the vehicle should stay still on the platform without slipping. Then, the driver will be asked to release the brake pedal completely so that wheels start turning. Finally, the driver should brake fully to prove that vehicle can stay still on the platform again.

c) Vehicle should be precisely aligned with the platform either by driving or pushing. Team members are not allowed to put the vehicle on the platform by carrying. Teams should consider the dimensions of the platform during the design phase of the vehicle.

d) The Jury will decide on the position of the vehicle (whether to place the vehicle on the ramp front/rear first) according to the dimensions of the vehicle during the brake test.

e) There will be a brake test after the final race.
f) In case braking platform is not available during races, the pushing test of 650 N shall be conducted by two persons pushing the vehicle. It is necessary that the wheels of the vehicle do not rotate while it is being pushed. Brakes of a vehicle whose wheels rotate while being pushed are not suitable.

9.5. Connection Mechanisms

Heavy loads to be carried in the vehicle should be fixed in place tightly (e.g., spare tyre, recharging cable, tool bag).

9.6. Safety Belts

It is necessary to use a safety belt that is fixed at four or five points according to FIA standards (See Figure 3). Safety belts that do not meet FIA standards will be considered as a reason for disqualification due to violation of safety rules.

Safety belts could be any brand that has a FIA certificate. The passenger and the driver must have separate belts and the FIA certificate of both belts will be checked in technical inspections.

9.7. Helmet, Race Overalls, Gloves, and Shoes

Helmets with a closed front and circumference and open race helmets may be used in vehicles. It is obligatory to use a helmet.

Race overalls, gloves, and shoes that are FIA certificated and specially manufactured for races must be used to protect the driver in the case of any fire (See Figure 1 and Figure 2). Hardware not meeting these specifications is not acceptable. Please check the sample figures given in the Annex 1. In the case of overalls that are not race overalls but do meet the safety conditions, 150 Wh penalty shall be applied to that team. The overalls could be any brand having a FIA certificate.

9.8. Fire Extinguishers

It is obligatory to provide one 2 kg or two 1 kg fire extinguishers in the vehicles. The extinguishing substance should be dry chemical dust in accordance with type C fires.

In technical inspections, it shall be checked that the fire extinguishers are located somewhere easily reachable, that they are fixed but can be removed from their place, and that the expiry date has not passed.

9.9. Roll Bars and Roll Cages

a) Roll bars and roll cages must be made of material having a minimum yield strength of 200 MPa at each point.

b) The roll bars should be connected by bolts or welding at a minimum of four points on the roll cage or body and be perpendicular to the vehicle’s bottom.
c) The distance between bolts should be a minimum of 2.5 D, and they should be a minimum of 1.5 D from the sides.

d) The minimum welding thickness should be half of the body thickness of the thinner of the welded parts, provided that it not be less than 3 mm. Max (3 mm, 0.5 tmin), tmin: body thickness of the thinner of the welded parts.

e) Minimum welding length should be 5-fold the welding thickness provided that it not be less than 20 mm max (20 mm, 5 t): welding thickness. For example, if there is a welding thickness of 5 mm, 25 mm of uninterrupted welding should be used.

f) Profiles used for the roll bar and roll cage have to be closed and rolled pipe or box profiles. Open profiles and profiles closed with welding will not be accepted. Vehicle chassis made of carbon fibre and honeycomb material are not accepted as roll cages. Carbon fibre roll bars and roll cages independent of the body may be used if they meet the profile conditions defined above.

g) The box or pipe profiles to be used must have a minimum diameter of 3 cm and a thickness of 3 mm.

h) The profiles to be used must be h/t < 20. For example, the body thickness of a box profile having a side length of 8 cm or a pipe profile with a diameter of 8 cm must be 4 mm or more.

i) The bolts used must be minimum metric 8 and 8.8 grade.

j) The distance between bolts must be a minimum of 2.5 D and they must be a minimum of 1.5 D from the sides.

k) No bore shall be opened other than the points where roll cage elements are connected to one another on the roll cage, and no welding shall be done. Opening bores for decreasing the weight will be cause for disqualification due to violation of safety rules.

l) Roll bars are required to be supported at a minimum of 4 points. Unsupported roll bar designs longer than 50 cm shall be cause for disqualification due to violation of safety rules.

m) Roll bars and roll cages are independent from the chassis and must have closed cross-sections.

n) The front roll bar must start at least 3 cm above the top point of the steering wheel circle.

o) The rear roll bar must start a minimum of 5 cm above the helmet when the driver is sitting in the racing position.
p) The top point of the helmet when the driver is sitting in the racing position should remain below an imaginary line drawn between the tops of both roll bars.

q) If it is observed during the race that the helmet of the driver is above the roll bar, s/he will be disqualified from the race.

r) The feet gap of the roll bar must not be less than half of the vehicle width in the cross-section.

s) It is sufficient to provide a roll bar only for the driver’s seat.

t) Beams that provide sufficient resistance to be used in the side frames of the vehicle shall be accepted as roll bars (provided that an imaginary line between front and rear roll bars remains above the driver’s helmet).

u) It is expected that the vehicle has a profile or a strong body on the side plane so as to protect the vehicle from side impacts.

v) Sample designs are given in the Annex 1.

w) **Teams employing roll bar and roll cage practices that are not in compliance with the rules but are considered to be safe by the jury can participate in the race with a penalty of 150 Wh.** For example, even if the design of a team that uses a carbon-fibre vehicle chassis as a roll cage is found to be safe, the roll bar and roll cage will get a penalty score of 150 Wh since they violate the rule of creating a cage independent of the vehicle.

In technical inspections, the thickness of the material used for roll bars and roll cages, the places where they are fixed, the bolt or welding used for fixing, the distance between the place of fixing and the longest part, and the complete protection of the driver from outside impacts while in a sitting position will be examined.

In order for the profiles that pass through the vehicle’s bottom to be accepted as a roll cage, the distance between the closest part of the driver’s roll cage and the surface of the roll cage that looks inside the vehicle should be a minimum of 20 cm.

### 9.10. Rear View

It is necessary that on both sides of the cockpit, rear view mirrors with a minimum reflection area of 50 cm² each be provided. In the inspections, it will be expected that the text to be shown from behind the vehicle can be seen and read by the driver by means of the mirrors.

### 9.11. Tow Bars

One steel ring should be provided on the front and rear part of the vehicle with a minimum internal diameter of 20 mm, attached to the chassis, located in an easily...
accessible manner, painted red or yellow, and easily seen from outside.


Windows that do not shatter during collisions should be used (Plexiglas, polycarbonate, or metal mesh). If glass is used, it should be transparent and not obscure the sight of the driver.

Wipers should be provided for the windscreen. In technical inspections, it is expected that the wipers should perform the movement of cleaning the windscreen without any aid continuously a minimum of 5 times.

9.13. Cockpit

The cockpit should be designed so as not to cause any tiredness for the driver even during long drives. The main equipment required for driving the vehicle must be designed in such a way that the driver could use the vehicle without excessively moving his or her body or unfastening the safety belt. The cockpit should be designed to provide a sufficient amount of clean air inside the vehicle. Entry into and exit from the cockpit should be possible without the aid of any other person. In vehicles, the driver should be able to get out of the vehicle without any aid within a maximum of 20 seconds (See 9.21. Emergency Evacuation).


The seat must be fixed to the chassis in a safe manner. The back support should not be at an angle greater than 30 degrees to the perpendicular. When selecting the seat, it is obligatory to choose products having FIA certification that protect the driver and prevent drifting in both directions.

The same seat must be used for the driver and the passenger. Seats may be any brand that has a FIA certificate.

If seats that do not meet racing seat standards but do meet the safety conditions are used, a penalty of 150 Wh will be applied to those teams.

Seats created by shaping the bottom of the vehicle into a seat shape will not be accepted. An external seat is obligatory.

The passenger seat and the driver seat must be the same. The passenger seat and the driver seat must be on the same plane. A minimum knee distance of 10 cm must be used for back-to-back location designs.

The certificate for the seat will be checked in technical inspections. Certified seats are mono-block. Seats that fold are not suitable.

In the inspections, both the driver and one person from the team will be required to sit
in the seats and fasten their safety belts. Designs in which the passenger cannot fit into the seat will not be accepted.

9.15. **Steering Wheel**

The steering wheel must be in the form of a closed ring. Open handles, such as in the form of a joystick, are prohibited since these could create problems in the event of an emergency evacuation.

In technical inspections, the fixation of the steering wheel, its location under the front roll bar, and its capability to be easily rotated will be checked.

9.16. **Vehicle Parts with Fundamental Functions**

a) Braking and drive control devices.

b) Load carrying parts.

c) Wheel suspension.

d) Safety belt fixing points; attention should be paid to the quality of such parts. Registered standard parts should be used when possible.

e) Screws should be of sufficient length and should not loosen on their own.

The teams shall be requested to fix any problematic parts that are found during visual inspection. The fact that the vehicle passes the dynamic driving test demonstrates that it performs its basic functions.

9.17. **Mitigating the Risk of Injury**

It is inevitable that parts will protrude from inside the vehicle. Since sharp or protruding edges will not be permitted, these should be cushioned as much as possible. Sharp ends outside the vehicle should be sufficiently covered or cushioned. Parts of the vehicle that cannot be covered should be marked in yellow and black.

Elements that constitute a risk for the driver and other vehicles will be visually inspected.

9.18. **Horn**

The vehicle should have a certified acoustic horn that sounds continuously for three seconds at a sound level of **80 dB(A)**.

In technical inspections, the driver shall be requested to sound the horn for 3 seconds; it will be measured with a sound-level meter at a distance of 2 meters.
9.19. **Speedometer**

A speedometer should be installed within the driver’s field of vision. Mobile phones will not be accepted as speedometers. Devices such as tablet computers that record speed by GPS will also not be accepted as speedometers. A separate system must be provided that takes speed information from the wheel.

Teams that cannot meet this requirement can use a smart phone as speedometer with a 300 Wh penalty.

*In technical inspections, the speedometer will be tested by driving in the dynamic driving area.*

9.20. **Break Light and Headlights**

a) A brake light should be placed at the back of the vehicle that must be seen from a minimum distance of 25 m, emit a red light, and be activated in the case of full or half pressure on the brakes. In technical inspections, it shall be checked whether break lights are easily seen from a distance of 25 m.

b) In technical inspections, the driver will be requested to turn on and off the headlights using a button placed in the cockpit. Two headlights emitting white light should be placed on the front of the vehicle that can be seen from a minimum distance of 25 m. In technical inspections, it shall be checked whether the two headlights are easily seen from a distance of 25 m.

9.21. **Reversing**

The vehicle should be able to perform reverse movements with its own driving force. Reversing control shall be made in dynamic driving control.

9.22. **Emergency Evacuation**

Teams that pass the controls of door, seat, safety belt, helmet, race overalls, gloves, and shoes shall satisfy the emergency evacuation test in order to be sure that the driver can leave the vehicle in case of a dangerous situation during the training laps or the race.

In technical inspections; the driver dressed in full racing garments sitting in the driver seat with the safety belt fastened, hands on the steering wheel, and the reserve driver dressed in full racing garments sitting in the passenger seat with the safety belt fastened will both try to leave the vehicle upon a command simultaneously. The time between the command and the moment when the driver and reserve driver have completely exited the vehicle shall not be more than 20 seconds.
9.23. Flag

The flag shall be in the form of a hard plastic plate with a minimum thickness of 2 mm and a rectangular shape of a minimum of 20 × 30 cm, provided that the lowest point is not below the “visible point”, and it shall be attached to the vehicle by a non-deformable pole. In case where Logos to be attached to the flag and vehicle numbers shall be distributed by TÜBİTAK during registration.

Flags will be checked by visual inspection; the flag should be visible from a distance.
10. THE ELECTROMOBILE AND HYDROMOBILE RACE

10.1. Electromobile Final Race

In the race, every vehicle is expected to complete **30 laps** in a maximum of **65 minutes**. While evaluating vehicles with excessive laps, the distance travelled shall be considered as 30 laps.

It is not important in terms of final ranking at which rank the vehicle completed the race. The energy measuring device to be given by TÜBİTAK beforehand and attached to the vehicles before the race will be used for the evaluations.

During the race, teams can enter the pit area and make mechanical or electrical adjustments to their vehicles, excluding those that may affect the energy measuring device and battery.

The ranking at the end of the race shall be calculated based on the score received by teams according to the following formula:

\[
X = (Number \ of \ Laps) \times \left( \frac{4500}{30} \right) - (Energy \ Consumption \ Value + \ Penalty \ Wh - \ Award \ Wh)
\]

<table>
<thead>
<tr>
<th>Number of Laps</th>
<th>Time (min)</th>
<th>Energy (Wh)</th>
<th>Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>40</td>
<td>2650</td>
<td>1850</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>59</td>
<td>1950</td>
<td>2550</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
<td>55</td>
<td>2700</td>
<td>1800</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>60</td>
<td>1800</td>
<td>1200</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>60</td>
<td>600</td>
<td>900</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>58</td>
<td>2650</td>
<td>2600</td>
</tr>
</tbody>
</table>

**Table 3. Sample Calculation for Electromobile**

**Calculating the Score of Vehicle 3:**

\[
X = Number \ of \ Laps \times \left( \frac{4500}{30} \right) - (Energy \ Consumption \ Value + \ Penalty \ Wh - \ Award \ Wh)
\]

\[
X = (30) \times \left( \frac{4500}{30} \right) - 2700
\]

\[
X = 1800
\]

**Important Note:** The formula may change depending on the condition of the track where the race will take place.
In order to be eligible for the Performance Award in Electromobile category, a team’s race score must be at least 2000.

10.2. Hydromobile Final Race

During the race, every vehicle is expected to complete 30 laps in 65 minutes. It is not important in terms of final ranking at which rank a team completes the race. The ranking at the end of the race shall be calculated based on the score received by teams according to the following formula:

\[ X = \frac{4500 \times \text{Number of Laps of Team}}{30} - (\text{Energy Measuring Device Value} + \text{Hydrogen Consumption Value}) + |\text{Energy Measuring Device Value} - 3 \times \text{Hydrogen Consumption Value}| + \text{Penalty Wh} - \text{Award Wh} \]

Teams may maximise their scores by drawing balanced energy from the battery and fuel cell.

<table>
<thead>
<tr>
<th>Number of Laps</th>
<th>Number of Valid Laps</th>
<th>Time</th>
<th>Energy</th>
<th>Hydrogen</th>
<th>Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>#</td>
<td>min</td>
<td>Wh</td>
<td>L</td>
<td>#</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>30</td>
<td>60</td>
<td>30</td>
<td>1300</td>
<td>350</td>
<td>2600</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>64</td>
<td>30</td>
<td>650</td>
<td>200</td>
<td>3600</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
<td>64</td>
<td>30</td>
<td>1050</td>
<td>250</td>
<td>2900</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>66</td>
<td>14</td>
<td>600</td>
<td>205</td>
<td>1280</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>64</td>
<td>6</td>
<td>500</td>
<td>5</td>
<td>-90</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>64</td>
<td>30</td>
<td>0</td>
<td>1200</td>
<td>-300</td>
</tr>
</tbody>
</table>

Table 4. Example of calculation for Hydromobile

Important Note: The formula may change depending on the condition of the track where the race will take place.

In order to be eligible for the Performance Award in Hydromobile category, a team’s race score must be at least 2000,
10.3. Energy Consumption Measuring Device

Energy consumption will be measured with an energy measuring device to be given by TÜBİTAK. The specifications of the device are as follows:

a) The device supplies its own energy from an internal battery.

b) There is an LCD screen that displays the energy consumption and the measurement duration.

c) Current measurement range is 0–100 A and voltage measurement range is 24–200 V. Power measurement accuracy is less than ±1%.

d) If the measurement ranges are exceeded for current or voltage, two times the limit values will be used to calculate energy.

e) Dual way energy flow is considered while calculating the net energy. Therefore, regenerative energy will be discounted from the net energy.

f) A connection diagram between the device and the vehicle electric system is shown in Figure 9. In order to connect the device to the vehicle, power connectors will be supplied and installed in the vehicle by TÜBİTAK staff before the races. Connector codes are 6810G2 or SA120B6-H.

10.4. Hydrogen Consumption Measuring Device

Hydrogen consumption will be measured by a flow meter to be provided by TÜBİTAK 5 days in advance of the race in calibrated condition. The flow meter will be battery-powered and will have no electrical connection. The flow meter will be connected to the hydrogen line before the fuel cell with a 6-mm connection (or ¼ inch) in a direction suitable for the gas flow (Figure 12), and it will be returned after completion of the race. The flow meter must be located inside the vehicle where the driver cannot reach it and it must be easily readable from outside. The suitable location for integrating the flow meter into the vehicle will be determined based on advice from the Advisory and Evaluation Board.

10.5. Number and Time of Laps

In Electromobile and Hydromobile categories, it is expected to complete 30 laps in 65 minutes. Excessive laps will not be taken into consideration.

The number and time of laps of teams during the race are recorded by the transponders provided by TOSFED, who is responsible for sportive management of the race. The objections to the number and time of laps after the race shall be evaluated by TOSFED.

10.6. Determining the Ranking

The initial value of the energy measuring devices of all vehicles before the start of the race and the final values when the race is completed shall be read and recorded by the jury. If two teams have the same scores according to these values, the one with
the highest number of laps shall be ranked higher. In the event that the number of laps is the same, the vehicle that completed the race within the shortest time will be ranked higher.

The score received by the teams shall be used for the final ranking according to the formula explained above.
ANNEX 1: SAMPLE DRAWINGS AND FIGURES

Figure 1. Racing overalls

Figure 2. Racing gloves

Figure 3. Racing safety belt
Figure 4. Sitting position of driver inside the vehicle and position of roll bars and seat

a) Roll bars perpendicular to vehicle bottom
b) The front roll bar starts minimum 3 cm above the steering wheel ring
c) The rear roll bar starts minimum 5 cm above the helmet level of the seated driver
d) Driver seat fixed to the chassis is at a maximum angle of 30 degrees to the perpendicular
e) If there is a distance of more than 50 cm between the point where the roll bar connects with the roll cage and the highest point of the roll bar, a support should be welded between the front and rear roll bars.

Figure 5. Sample roll cage and roll bar designs

(Only a sample; the designs may be changed provided that the conditions specified in the rules are met.)
In Figure 5a, it is shown that a roll bar could be provided only for the driver’s seat in vehicles. A separate seat is required for the passengers. The seat in Figure 5a conforms with the competition’s rules. As can be seen above, a roll cage is provided that protects the vehicle against side impacts and will not block door entry. Designs similar to these will be accepted.

Sample drawings are for a single seat. Two seats must be provided in vehicles.

The design in Figure 5b conforms to the competition’s rules; however, the seat is not suitable since it does not protect the driver from the sides.
The design in Figure 5-c conforms to the competition’s rules; however, the seat is not suitable since it does not protect the driver from the sides.

The seat should protect the driver from the sides as shown in the first drawing.

![Figure 5-d](image)

The seat type in Figure 5-d is suitable as a race seat. However, the part at the top or similar additions will not be accepted as a roll bar.

![Figure 5-e.1](image)
Bolts and nuts must be grade 8.8 with a minimum diameter of 8 mm.

Figure 5-e.2

Figure 5-e provides technical drawings that demonstrate the minimum distance between the bolts and show how far the bolt should enter as a minimum in the case corresponding to the edge.

a) The diameter of the bolt is D, as indicated in the rules for roll bars and roll cages, and it should be a minimum of 8 mm.

b) There should be minimum of 2.5 D between two bolts; namely, it should be 25 mm for an M10 bolt.

c) The distance from the side should be a minimum of 1.5 D, or 15 mm for an M10 bolt.

Figure 5-f

If the roll bar does not have enough support or is longer than 50 cm from the support point, extra supports must be applied as seen.
The illustration in Figure 5-f is only for defining the measurements. There is no need to screw the roll bars to the roll cage if it is welded or bolted.

Figure 5-g

In Figure 5-g, a carbon-fibre roll bar used in a Formula G racing vehicle in 2014 is shown. According to 2015 rules, it cannot be used since it is not in a closed box or made of a milled pipe profile.

Figure 5-h
A honeycomb body shall not be accepted as a roll cage. It is required to use a separate suitable profile inside the vehicle in accordance with the rules.

**Figure 5i**
Use of aluminium sigma profiles as seen in Figure 5-i is not allowed according to the rules.

**Figure 5-j**
Roll bars and roll cages in Figure 5-j should be in accordance with the defined minimum thickness measurements.
The Toyota electric vehicle shown as an example in Figure 5-k is in compliance with the rules in terms of number of seats, shape of seats, and width of door.

<table>
<thead>
<tr>
<th>Rule</th>
<th>Min (cm)</th>
<th>Max (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1.c</td>
<td>A</td>
<td>120</td>
</tr>
<tr>
<td>7.1.f</td>
<td>B</td>
<td>130</td>
</tr>
<tr>
<td>7.1.h</td>
<td>C</td>
<td>10</td>
</tr>
<tr>
<td>7.1.a</td>
<td>H</td>
<td>100</td>
</tr>
<tr>
<td>7.1.d</td>
<td>L</td>
<td>200</td>
</tr>
<tr>
<td>7.1.b</td>
<td>W_tr</td>
<td>max(100, A/2)</td>
</tr>
<tr>
<td>7.1.b</td>
<td>W_back</td>
<td>max(60, A/2)</td>
</tr>
</tbody>
</table>

Figure 5-l. Vehicle dimensions

Figure 6. Sample race driver seats
Figure 7. Battery box and BMS

**Figure 7-a.** Sample drawing for battery box

**Figure 7-b.** Sample BMS for lithium-based batteries

**Figure 7-c.** Box and sample BMS for lithium-based batteries
Figure 8. Emergency stop switch

**Figure 8-a.** Sample breaker circuit with high-current emergency stop switch

**Figure 8-b.** Sample breaker circuit with low-current emergency stop switch

**Figure 8-c.** Emergency stop button examples
Figure 9. Energy consumption measuring device connection

**Figure 9-a.** The device connection to the vehicle electric system

**Figure 9-b.** Connection when the device is removed

**Figure 9-c.** Unacceptable connection

---

**Figure 10.** Vehicle control unit
- This schematic is a simple example for recommended power distribution diagram.

- Maximum cable RMS current (A) should not exceed 5 times the conductor cross-section in mm².

- It is recommended to use DC circuit breakers. If AC circuit breakers are used, DC breaking capacity should be suitable.

- Protective components should be used to feed loads.

- It is recommended to use different colour cables for different voltage levels.

Figure 11-a. Sample distribution diagram (Electromobile)
This schematic is a simple example for recommended power distribution diagram.

- Maximum cable RMS current (A) should not exceed 5 times the conductor cross-section in mm².
- It is recommended to use DC circuit breakers. If AC circuit breakers are used, DC breaking capacity should be suitable.
- Protective components should be used to feed loads.
- It is recommended to use different colour cables for different voltage levels.

**Figure 11-b. Sample distribution diagram (Hydromobile)**
Figure 12. Connection of the H₂ flow meter in the gas flow direction

Figure 13. Possible power sources connections
Supercapacitors can be used to store energy generated during deceleration and use it back for acceleration. The capacitors should not be connected to batteries or the fuel cell directly. Instead, dual way DC-DC converters should be used between the capacitors and main DC link. To measure the initial and final energy stored in the capacitors, the circuit in Figure 14a is advised. In Figure 14a, one of the connection circuits in Figure 11 is taken as an example. Super capacitor can be added to any of the examples in Figure 11 with an appropriate DC-DC converter.

If a super capacitor circuit is to be connected between the energy measurement device and the motor driver (Figure 14b), initial and final energy of the capacitor will be calculated by measuring the capacitor voltage and the energy will be included in total energy calculation. In this case, terminals should be placed at an accessible point in order to measure the capacitor voltage easily.
Figure 15. Dynamic testing control area measurements

Figure 16. Dimensions of the braking platform
### ANNEX 2: PENALTY LIST

<table>
<thead>
<tr>
<th>Violation</th>
<th>Electromobile</th>
<th>Hydromobile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Progress Report</strong></td>
<td><strong>150 Wh or Disqualification</strong></td>
<td><strong>150 Wh or Disqualification</strong></td>
</tr>
<tr>
<td>Failure to submit the progress report or missing parts in the report</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Technical Design Report</strong></td>
<td><strong>150 Wh</strong></td>
<td><strong>150 Wh</strong></td>
</tr>
<tr>
<td>Getting less than 300 points from the technical design report</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Being Domestic</strong></td>
<td><strong>Disqualification</strong></td>
<td><strong>Disqualification</strong></td>
</tr>
<tr>
<td>No mandatory domestic sub-part</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For every missing /not applied mandatory domestic sub-part</td>
<td><strong>400 Wh</strong></td>
<td><strong>400 Wh</strong></td>
</tr>
<tr>
<td><strong>Vehicle Measurements</strong></td>
<td><strong>violated cm x 10 Wh</strong></td>
<td><strong>violated cm x 10 Wh</strong></td>
</tr>
<tr>
<td>Do not comply with measurements specified in the rules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The height of the vehicle from the ground must be a minimum of 10 cm.</td>
<td><strong>violated cm x 100 Wh</strong></td>
<td><strong>violated cm x 100 Wh</strong></td>
</tr>
<tr>
<td>The height of the vehicle longer than 1.25 times the length of the vehicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The distance between wheels in the same axle less than half the width of the vehicle</td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td><strong>Cockpit</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td>Not enough space for driver, not safe</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vehicle Body</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td>From the top view of the car, there are open regions (holes) on the vehicle body and/or the wheels are totally outside of the vehicle body.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fragile windows / sharp ends / protruding edges etc.</td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td><strong>Door</strong></td>
<td><strong>300 Wh</strong></td>
<td><strong>300 Wh</strong></td>
</tr>
<tr>
<td>50 cm × 80 cm frame can’t pass through the door</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doors cannot open in case of turnover (driver cannot evacuate)</td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td><strong>Door Mechanism</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td>Does not comply with the rules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cannot be opened from outside/unintended opening of the doors during the race</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wheel width</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td>Less than 70 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Brake system</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td>Not dual-circuit or hydraulic</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety Belts</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
<td><strong>Disqualification Due To Safety</strong></td>
</tr>
<tr>
<td>Not fixed at four or five points or not compatible with FIA standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety belts</td>
<td>Passenger seat belt missing or not compatible with FIA standards</td>
<td>150 Wh</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Driver outfit and equipment</td>
<td>Not compatible with the rules</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safe, but not compatible with FIA standards</td>
<td>150 Wh</td>
</tr>
<tr>
<td>Fire extinguishers</td>
<td>Less than 2 kg</td>
<td></td>
</tr>
<tr>
<td>Roll bars</td>
<td>Missing any roll bars</td>
<td></td>
</tr>
<tr>
<td>Roll cage</td>
<td>Yield strength lower than 200 Mpa</td>
<td></td>
</tr>
<tr>
<td>Roll bar not perpendicular to bottom of the vehicle</td>
<td>Disqualification Due To Safety</td>
<td></td>
</tr>
<tr>
<td>Roll bar not perpendicular to bottom of the vehicle</td>
<td>Disqualification Due To Safety</td>
<td></td>
</tr>
<tr>
<td>Roll cage</td>
<td>The front roll bar doesn't start at least 3 cm above the steering wheel</td>
<td></td>
</tr>
<tr>
<td>Roll cage</td>
<td>The rear roll bar doesn't start at least 5 cm above the helmet</td>
<td></td>
</tr>
<tr>
<td>Roll cage</td>
<td>Profiles do not comply with the rules</td>
<td></td>
</tr>
<tr>
<td>Roll cage</td>
<td>Roll cage not independent from the chassis, and the vehicle is not safe</td>
<td></td>
</tr>
<tr>
<td>Roll cage</td>
<td>Roll cage not independent from the chassis, but the vehicle is safe</td>
<td>150 Wh</td>
</tr>
<tr>
<td>Roll cage</td>
<td>Welding/bolts not used according to specified rules</td>
<td></td>
</tr>
<tr>
<td>Vehicle body</td>
<td>No front/rear hood for access to battery package</td>
<td></td>
</tr>
<tr>
<td>Vehicle body</td>
<td>No front/rear hood for access to other components</td>
<td>150 Wh</td>
</tr>
<tr>
<td>Rearview mirrors</td>
<td><strong>Do not exist</strong> / Only one rearview mirror</td>
<td></td>
</tr>
<tr>
<td>Rearview mirrors</td>
<td>Reflection area less than 50 cm²</td>
<td></td>
</tr>
<tr>
<td>Rearview mirrors</td>
<td>Driver cannot see the text shown</td>
<td></td>
</tr>
<tr>
<td>Tow bar</td>
<td>No towing rings</td>
<td></td>
</tr>
<tr>
<td>Tow bar</td>
<td>Internal diameter less than 20 mm/not made of steel</td>
<td></td>
</tr>
<tr>
<td>Windscreen</td>
<td>Material does not comply with the rules, not transparent</td>
<td></td>
</tr>
<tr>
<td>Wiper</td>
<td><strong>Does not exist</strong></td>
<td></td>
</tr>
<tr>
<td>Wiper</td>
<td>Exists but not working properly</td>
<td>150 Wh</td>
</tr>
<tr>
<td>Seat</td>
<td>Makes an angle greater than 30 degrees with the normal axis of the chassis</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Seat</td>
<td>Only one seat, passenger seat missing</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Seat</td>
<td>Does not comply with FIA standards and not safe for racing</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Seat</td>
<td>Does not comply with FIA standards but safe for racing</td>
<td>150 Wh per seat</td>
</tr>
<tr>
<td>Steering Wheel</td>
<td>Not closed form</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Horn</td>
<td>Doesn't sound 3 second continuously</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Speedometer</td>
<td>Does not exist/not functional</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Speedometer</td>
<td>Phone or smart devices used</td>
<td>300 Wh</td>
</tr>
<tr>
<td>Break lights</td>
<td>Do not exist/not seen from a distance of 25 m</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Break lights</td>
<td>300 Wh</td>
<td>300 Wh</td>
</tr>
<tr>
<td>Headlights</td>
<td>Do not exist</td>
<td>150 Wh</td>
</tr>
<tr>
<td>Flag</td>
<td>Smaller than 20 cm x 30 cm/can't be attached to the vehicle properly</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Electrical cable connections</td>
<td>Bare conductors, no proper insulation</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Emergency stop button</td>
<td>Does not exist/ not functional</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Overcurrent breaker</td>
<td>Does not exist / design does not comply with the rules</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Battery</td>
<td>Missing</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Battery management system</td>
<td>Missing</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Battery temperature measurement</td>
<td>No flasher, buzzer and temperature indicator</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Battery box</td>
<td>Missing, material and/or design is not comply with the rules</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Fixing battery box</td>
<td>Not fixed, diameter of bolts smaller than 8 mm</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Safety wall</td>
<td>Protective shield not exist between driver seat and battery pack</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Joule meter connection</td>
<td>Extra battery apart from the main battery package</td>
<td>(Battery energy capacity) Wh</td>
</tr>
<tr>
<td>Joule meter</td>
<td>Voltage levels of the battery are out of joulemeter specifications</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>VIOLATION</td>
<td>ELECTROMOBILE</td>
<td>HYDROMOBILE</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Embedded recharging unit</td>
<td>No electrical isolation between grid and battery group</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Fuel cell</td>
<td><strong>Missing/not functional/higher than 3 kW</strong></td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Super capacitor</td>
<td>Higher than 110 kJ</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Pressure safety valve</td>
<td><strong>Missing / does not comply with the rules</strong></td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Gas flow safety valve</td>
<td><strong>Missing / does not comply with the rules</strong></td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Thermocouple</td>
<td><strong>Missing / does not comply with the rules</strong></td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Flasher</td>
<td><strong>Missing / does not comply with the rules</strong></td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Temperature indicator</td>
<td>Not connected to flasher</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Metal hydride cylinders</td>
<td>In the cockpit / does not comply with the rules</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Metal hydride cylinders</td>
<td>Protective shield does not exist</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Metal hydride cylinders</td>
<td>Not placed properly</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Hydrogen line</td>
<td>In the cockpit / does not comply with the rules</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Hydrogen line</td>
<td>Design does not comply with the rules</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Globe valve</td>
<td><strong>Does not exist / does not comply with the rules</strong></td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Globe valve</td>
<td>Material does not comply with the rules</td>
<td>Disqualification Due To Violation Of Rule</td>
</tr>
<tr>
<td>Hydrogen sensor</td>
<td><strong>Does not exist /does not comply with the rules</strong></td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Emergency Evacuation (driver and reserve driver)</td>
<td>Longer than 20 seconds/help required</td>
<td>Disqualification Due To Safety</td>
</tr>
<tr>
<td>Brake test</td>
<td>Not functional</td>
<td>Disqualification Due To Safety</td>
</tr>
</tbody>
</table>