



SAE Brasil & BALLARD Student H2 Challenge 2023

Piracicaba/SP - August 2nd to 6th - 2023

COMPETITION ORGANIZATION

Competition location:

- ▶ ECPA - Piracicaba – SP - Brasil



Events Master Schedule

| SAE Brasil & BALLARD Student H2 Challenge 2023 - SCHEDULE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------------------------------------|----------------------------------|-------------|-------------|-------------|--------------------------------|-------------|-------------|-------------|--------------------------------------------------------------|-------------|-------------|-------------|--------------------------------|-------------|-------------|-------------|--------------------------------------------|-------------|-------------|-------------|--------------------|-------------|-------------|-------------|----------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|--|--|--|--|--|
| EVENT | WEDNESDAY 2nd | | | | THURSDAY 3rd | | | | | | | | FRIDAY 4th | | | | | | | | SATURDAY 5th | | | | | | | | SUNDAY 6th | | | | | | | |
| | 13:00-14:00 | 14:00-15:00 | 15:00-16:00 | 16:00-17:00 | 08:00-09:00 | 09:00-10:00 | 10:00-11:00 | 11:00-12:00 | 12:00-13:00 | 13:00-14:00 | 14:00-15:00 | 15:00-16:00 | 16:00-17:00 | 08:00-09:00 | 09:00-10:00 | 10:00-11:00 | 11:00-12:00 | 12:00-13:00 | 13:00-14:00 | 14:00-15:00 | 15:00-16:00 | 16:00-17:00 | 08:00-09:00 | 09:00-10:00 | 10:00-11:00 | 11:00-12:00 | 12:00-13:00 | 13:00-14:00 | 14:00-15:00 | 15:00-16:00 | 16:00-17:00 | | | | | |
| PROJECT REPORT | DELIVERY ONLINE DUE ON JULY 17th | | | | | | | | | | | | | | | | | | | | Release of results | | | | | | | | | | | | | | | |
| REGISTERING | Upon arrival | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BOX INSTALLATION | | | | | ALL TEAMS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SAFETY SCRUTINY | | | | | Unicamp Baja SAE Mauá Racing | | | | Team - UFABC Minerva Baja | | | | TEC H2-Racing Cheetah E-Racing | | | | | | | | | | | | | | | | | | | | | | | |
| DESIGN PRESENTATION | | | | | | | | | Unicamp Baja SAE Tech H2 Racing Cheetah E-Racing Maua Racing | | | | Team - UFABC Minerva Baja | | | | Hybrid Formula Kariri Kratos H2 LHMT - UFC | | | | | | | | | | | | | | | | | | | |
| FUNCTIONAL TESTS | | | | | | | | | | | | | | | | | Order per approval at safety scrutiny | | | | | | | | | | | | | | | | | | | |
| ENDURANCE | | | | | | | | | | | | | | | | | | | | | | | | | Order per approval on functional tests | | | | | | | | | | | |
| DESIGN SHOWCASE | | | | | Continuous event for all teams | | | | Continuous event for all teams | | | | | | | | Continuous event for all teams | | | | | | | | Continuous event for all teams | | | | | | | | | | | |
| WINNERS AWARD EVENT | | | | | | | | | | | | | | | | | | | | | | | | | ALL TEAMS | | | | | | | | | | | |

Note: Safety scrutiny order was defined based on the ranking from 2022

Project report – Due on July 17th – Online deliveries

Teams from 2020

- Template from June 22 th, 2023: *[H2challenge] Design Report - V2023_06_21_rev01.*
- Reference track for performance evaluation according to file: *H2 Challenge 2023 - Racetrack Parameters* – Released of June 22 th, 2023.
- Maximum 15 pages – 10 pages for Text and 5 for annexes.
- **Score: 100 points**
- Results to be released on August 5th – 14:00 H
- SAE Brasil did not define the list of topics.
- Evaluation per experts selected between sponsors and H2 community.

Teams from 2023

- Template from June 27 th, 2023: *Template para o relatório - Etapas Digitais - Novas Equipes.*
- Reference track for performance evaluation according to file: *Pista de Referência – Etapas digitais – Novas equipes* – Released of June 27 th, 2023.
- Maximum 15 pages – 10 pages for Text and 5 for annexes.
- **Score: 500 points** – Delivery on 3 parts:
 - **17.07.2023** Especificações técnicas , **24.07.2023** Detalhes do desempenho do powertrain híbrido elétrico com célula à combustível, **31.07.2023** Sistema segurança para o hidrogênio e protocolos de segurança.
- Results to be released on August 5th – 14:00 H

Registration – August 2nd – 13:00 H to 17:00 H

- Registration is free of charge for all teams.
- 20 members per team at ECPA.
- SAE membership required.
- Documents: Personal ID, Driving License for Drivers.
- Health Insurance Plan: Required for all members (SUS or Private). For Pilots only private accepted. All plans must be valid during the competition time and the team member shall present the list of service places available in Piracicaba. All members shall carry the Health Insurance Card during the competition.
- Team numbers: Defined according to 2022 ranking:
 1. Unicamp Baja SAE
 2. Maua Racing
 3. Team UFABC
 4. Minerva Baja
 5. Tech H2 Racing
 6. Cheetah E-Racing
- ***Once there will be electricity and H2 at the competition, team members shall not use any jewelry or metallic wearables during all days.***

Maps

General View



Maps



Box + Dynamic tests area



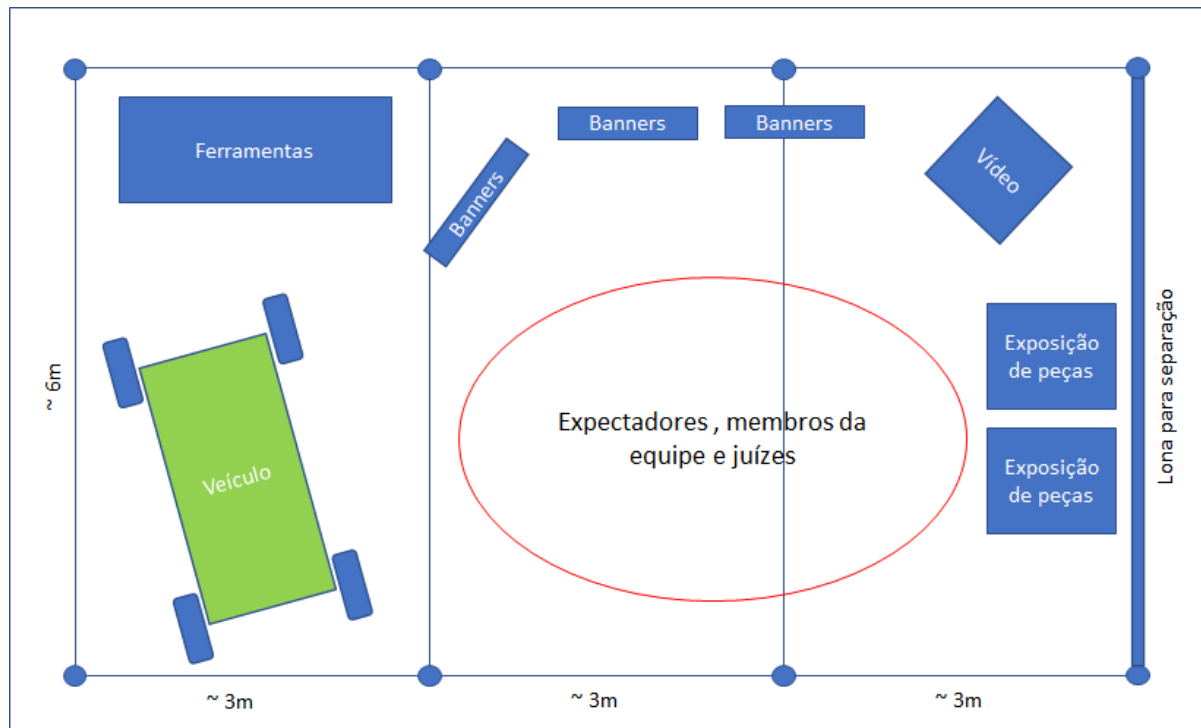
Endurance event track



Auditorium

Installations - August 3rd – 8:00 H to 12:00 H

- The team box shall be installed early on August 3rd and shall be kept active up to the Winners award on August 6th.
- *The boxes will be used on almost all events. They must have space for the vehicle, maintenance tools, project parts and rigs showcase, marketing and video displays.*



ECPA box installations

- Each team will have the space equivalent to three boxes at ECPA (Estimated 6m x 9m – 54 m2).
- Electric energy supply will be available. The teams should bring extensions and additional electrical plugs.
- The teams shall bring a plastic wall (lona) to separate the boxes and means to tie the plastic wall in place. The teams may opt to close one (minimum) or the 3 sides.
- All events will happen under sunlight! Use TV sets to present video or printed banners is recommended.

Installations - August 3rd – 8:00 H to 12:00 H

- The teams shall bring tables to expose the parts and place the presentation means.
- *Hydrogen tank can only be used installed at the vehicle, away from sunlight, only after approval on safety scrutineering, or over a bench during design presentation event.*
- Team sponsors can expose their marks and be present at the box.
- Restrooms and restaurants will be available close to the boxes.

Safety Scrutineering and Minimum design requirements verification event August 3rd 13:00 H to 17:00 H and August 4th 8:00 H to 17:00 H

- To be performed by specialized judges. The team may be requested to correct discrepant items so that it can be able to participate on the dynamic events.
- The vehicle shall be transported without the H2 cylinder which will be only installed after clearance and under supervision of the competition organization.
- The cylinder shall be identified with labels with the number of the team and the name of the team´s university.
- The checklist for the safety scrutineering event (See example on next page) will be released by the organization on the week before the competition and shall be fulfilled carefully and presented by the team upon arrival to this event under the risk of losing 15 points. The version applicable is the one from 2023.

Safety Scrutineering and Minimum design requirements verification event August 3rd 13:00 H to 17:00 H and August 4th 8:00 H to 17:00 H

CHECKLIST - HYBRID H2 POWERTRAIN specs & Safety rules - SAE Brasil & BALLARD Student H2 Challenge 2022 - VIRTUAL EVENT REPORT - TEAM: **XXFRED-ASTAIREXX**

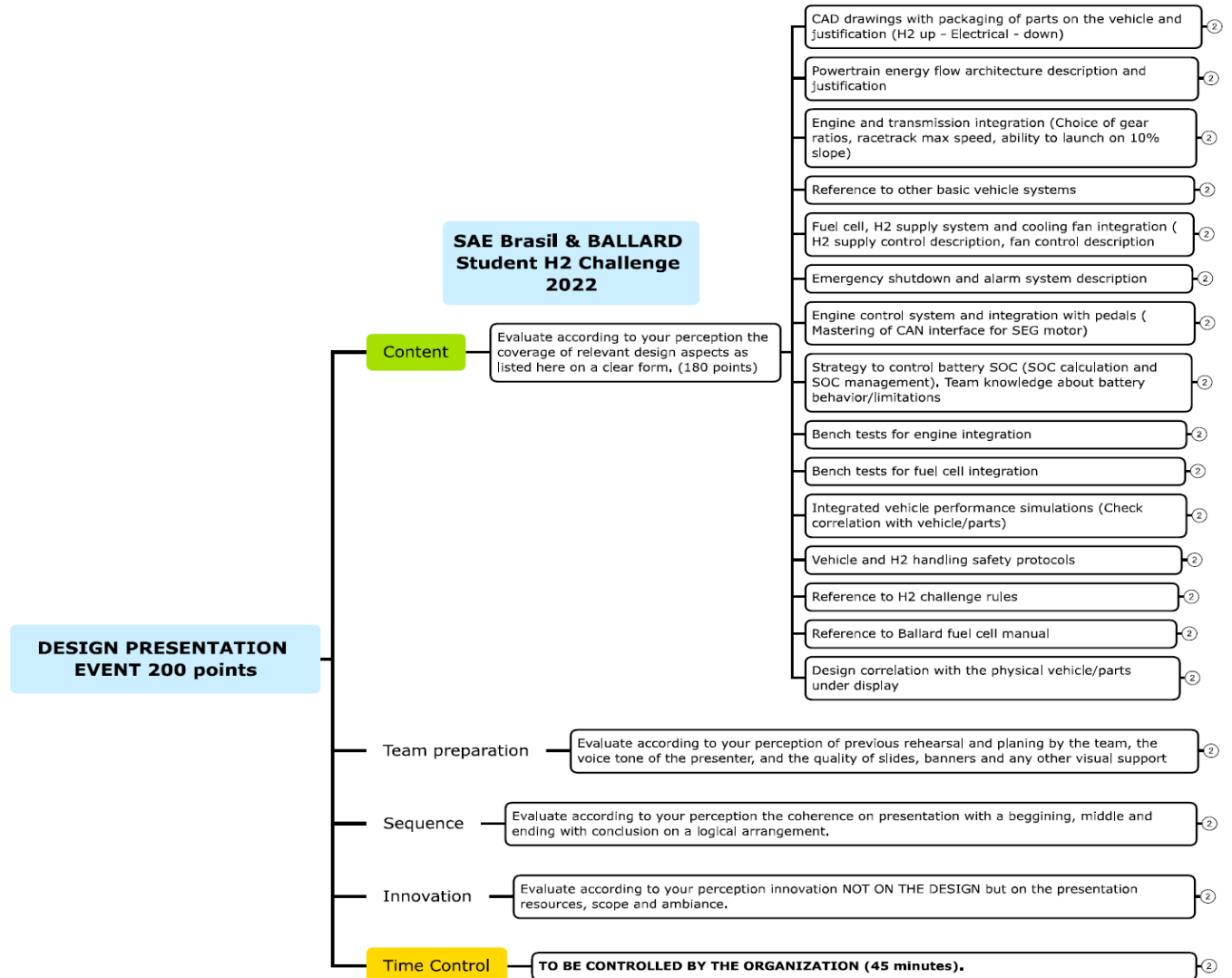
| LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 | LEVEL 5 | LEVEL 6 | REQUIREMENTS | TEAM CHECK | INSPECTOR'S CHECK | | |
|------------------------|----------------------------------------|----------------------------|---------|-------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|
| 1 HYBRID H2 POWERTRAIN | 1.1 H2 System Integration Requirements | 1.1.1 General Requirements | | | | The basic design of Baja SAE BRASIL series vehicles shall follow as reference the Baja SAE BRASIL 2020 - RATBSB_emenda_03 rules | NOT REQUIRED | NOT REQUIRED | | |
| | | | | | | The basic design of Formula SAE BRASIL series vehicles shall follow the Formula SAE Rules 2019 or Formula SAE Rules 2020 | NOT REQUIRED | NOT REQUIRED | | |
| | | | | | | When applicable, this requirement defines the powertrain and shall prevail over original rules. | NOT REQUIRED | NOT REQUIRED | | |
| | | | | | | To participate at SAE Brasil & BALLARD Student H2 Challenge 2020 the vehicle hybrid powertrain shall use a fuel cell stack from Ballard Power Systems FCgen®-1020ACS series (see Figure 1), assembled with 46 cells, and Part Number 5127057. | | | | |
| | | | | | | The hybrid powertrain shall have the minimum components described on Section 1.2 | | | | |
| | | | | | | Unless otherwise specified, the system components integrated with the fuel cell stack shall follow strictly the design and function requirements as defined by Ballard Power Systems Inc. for FCgen®-1020ACS fuel cell stack. | | | | |
| | | | | | | All system components shall meet certification and specifications required to be used with Hydrogen gas as defined at fuel cell stack documentation. | | | | |
| | | | | | To develop correctly the hardware and software and take credit of full performance of fuel cell stack the requirements from Ballard Power Systems Inc. shall be observed, unless otherwise specified. | | | | | |
| | | | | 1.1.2 Differences on basic vehicle design | | | | Although the basic vehicle design (chassis, suspension, cockpit, etc.) shall follow the basic rules as per section 1.1.1, some small changes will be required due to the electrical nature of the powertrain which will affect all Baja and Combustion based Formula SAE vehicles. | NOT REQUIRED | NOT REQUIRED |
| | | | | | 1.1.2.1 Firewall | | | A firewall shall separate the driver compartment and any portion of the driver harness from all components of the fuel supply, cooling systems, any lithium batteries, fuel cell stack, tractive system, electrical system and wiring and all tractive system components that are not located at the wheels. | | |
| | | | | | | The Firewall shall extend sufficiently far upwards and/or rearwards and/or sideways such that any point on the driver's body less than 100 mm above the bottom of the helmet of the tallest driver shall not be in direct line of sight with any part mentioned above. | NOT REQUIRED | NOT REQUIRED | | |
| | | | | | | The firewall shall be a non-permeable surface made from a rigid, nonflammable material. | NOT REQUIRED | NOT REQUIRED | | |

Safety Scrutineering and Minimum design requirements verification event **August 3rd 13:00 H to 17:00 H and August 4th 8:00 H to 17:00 H**

- The checklist shall be fulfilled by the team for the items available at the vehicle on column “Team Check” with “OK or “NOK” or even “NA” for “not applicable” based on team judgement referring to the compliance or not with the requirement. The team shall use “ND” in case the vehicle is not complete, and the item is not available for verification.
- Only after approval of all items except those related to H2 leakage will the vehicle be release for the installation of the H2 cylinder, and this can only be made at the area designated for that.
- The leakage check for tubes, connections and parts shall be made by the team before the competition using inert gases. All passed connections shall be labeled with visible marks. During the competition H2 sniffers will be used to detect leakage.
- The basic chassis and mechanical parts of the vehicle will be evaluated according to Baja and Formula SAE Brasil rules.
- The teams shall bring to BC class fire extinguishers. One of them shall follow the vehicle all times and the other shall be left visible at the box.
- **Score:** This event will not be scored but the team may be penalized with 15 points in case of not bringing the checklist fulfilled.
- This event is a classifying one. The teams will not be allowed to proceed in the competition dynamic events if not approved.

Design presentation event – Teams from 2020 - August 4th 8:00 H to 17:00 H

- Presentation order according to the schedule.
- Each team will have one hour to present its design, being 45 minutes for the presentation itself and 15 minutes for questions to be posed by the judges.
- Evaluation will be performed by specialized judges selected between the sponsors and H2 community.
- SAE Brasil does not impose the format or topics of the presentation and the team shall propose this.
- The topics presented here are only for guidance.
- Different from 2022 the presentation will be performed on a dedicated room reserved for that. *The team shall be on time at the room indicated carrying all presentation material and the vehicle.*
- **Score: 200 points.**



Design presentation event – Teams from 2023 - August 5th 8:00 H to 17:00 H

- Presentation order according to the schedule.
- Each team will have one hour to present its design, being 45 minutes for the presentation itself and 15 minutes for questions to be posed by the judges.
- Evaluation will be performed by specialized judges selected between the sponsors and H2 community.
- SAE Brasil does not impose the format or topics of the presentation and the team shall propose this.
- The topics presented for are according to document “Etapas Digitais e Critérios 2023” from June 27th, 2023.
- The presentation will be performed on a dedicated room reserved for that. *The team shall be on time at the room indicated carrying all presentation material.*
- **Score: 200 points.**



Student H2 Challenge 2023

Etapas Digitais Classificatórias para as novas equipes

Powertrain and vehicle systems functional check - August 5th 8:00 H to 17:00 H

- No battery charging will be allowed during the competition.
- Teams should administrate so that the batteries would be between 50 and 70 % state of charge before starting this event.
- First test will be performed with the vehicle over jacks. Teams to bring the jacks.
- This test will evaluate the starting sequence of H2 powertrain, the operation of the emergency shut-down system, the stability of controllers, variation and control of operation temperatures, vibration levels, heating of cables, plausibility between brake and accelerator pedals, and existence of H2 leakage. Also, the sequence of powertrain stop will be checked.
- At the second test the vehicle will be at the ground and will put on movement.
- ***Under no circumstance any vehicle will be allowed to operate at pure electrical mode (no fuel cell operating).***
- Pilots shall use fireproof clothes (Nomex), helmet suitable for the category of the vehicle, socks, gloves, balaclava, and shoes all fireproof.
- Two runs will be performed at the test track.
 - The first includes a soft acceleration up to 10 km/h and the demonstration of braking capacity.
 - The second will check maximum acceleration and braking performance.
- Components temperatures will be checked at the end and the H2 sniffer will be applied.
- **Score:** This event will not be scored but is classifying for the endurance event.



Dynamic tests area

Warning: Even after approved the vehicle shall be pushed always with powertrain off, unless when on the endurance track. H2 mechanical shut-off and cylinder valves shall be closed.

Endurance event - August 6th 10:00 H to 14:00 H

- This event will be only for approved vehicles.
- Pilots shall use fireproof clothes (Nomex), helmet suitable for the category of the vehicle, socks, gloves, balaclava, and shoes all fireproof.
- The event will occur at ECPA go-Kart area on the portion of the track selected.
- The vehicle shall be pushed from the box to the entrance of the go-Kart area with powertrain off, shut-off and H2 cylinder valves closed. Starting procedures can only be initiated if the team desire after entering the track.
- The vehicle shall be positioned at the top part of the track close to the tent designated for preparation, start and stop procedures. Pilots exchange will be performed there also.
- The endurance event will feature two heats on closed loop of 10 minutes each, when the two pilots shall drive the vehicle. A complete procedure of powertrain start, and stop shall be performed during the pilot exchange.



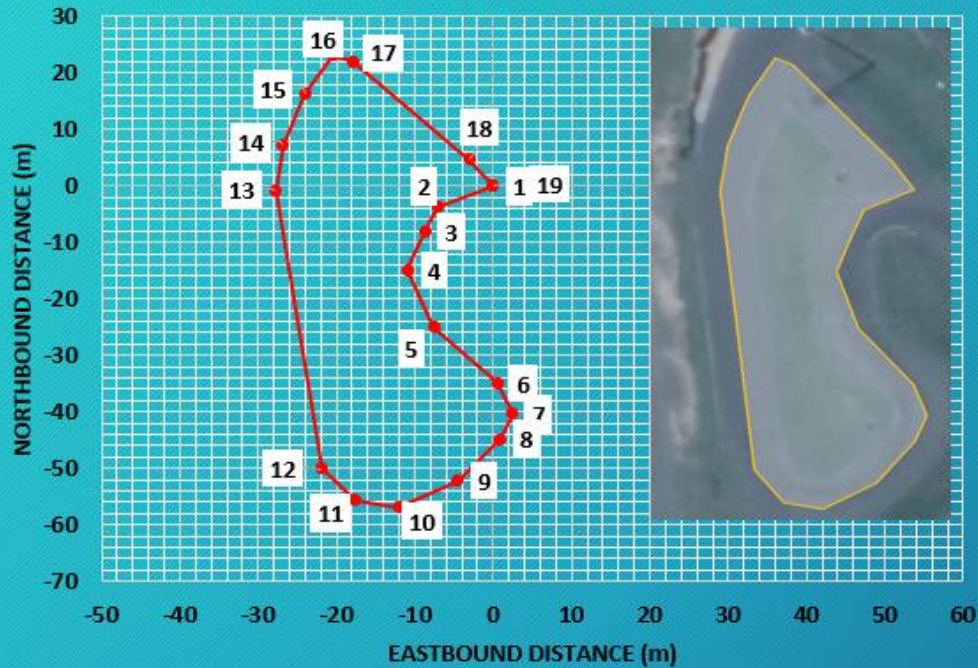
Path to endurance event

Endurance event - August 6th 10:00 H to 14:00 H

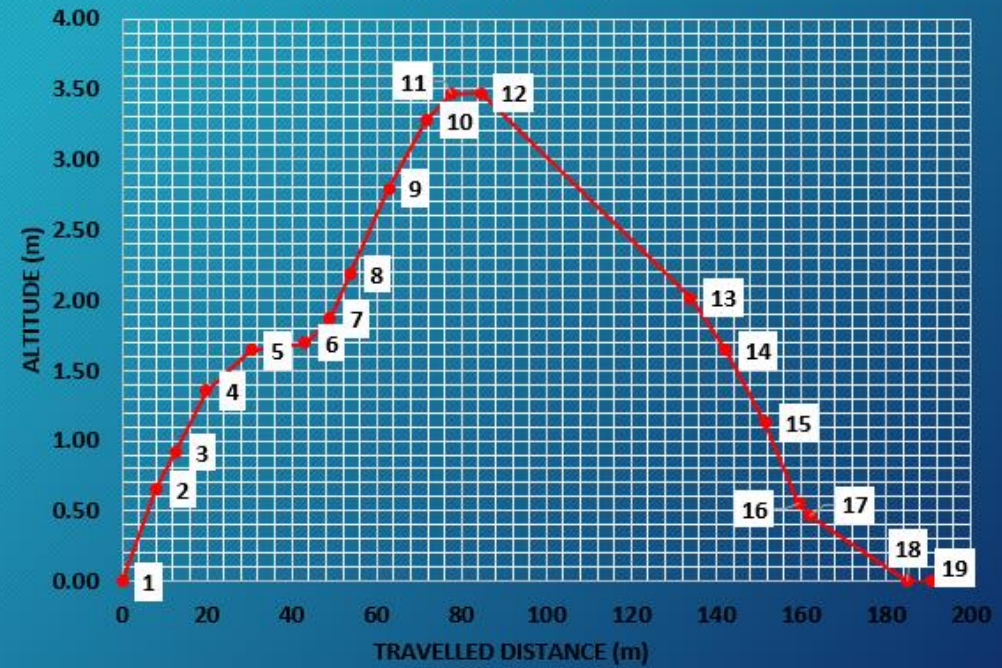
Racetrack Parameters

| | | | | |
|--------------------|-------|------|------|-----|
| Lap Distance | 191 | m | | |
| Average speed | 20 | Km/h | 5.6 | m/s |
| Estimated lap time | 34.7 | Secs | | |
| 10 Laps (1st heat) | 347.4 | Secs | 5.79 | Min |
| 10 Laps (2nd heat) | 347.4 | Secs | 5.79 | Min |
| Altitude variation | 3.5 | m | | |

RACETRACK PLAN



ALTIMETRY

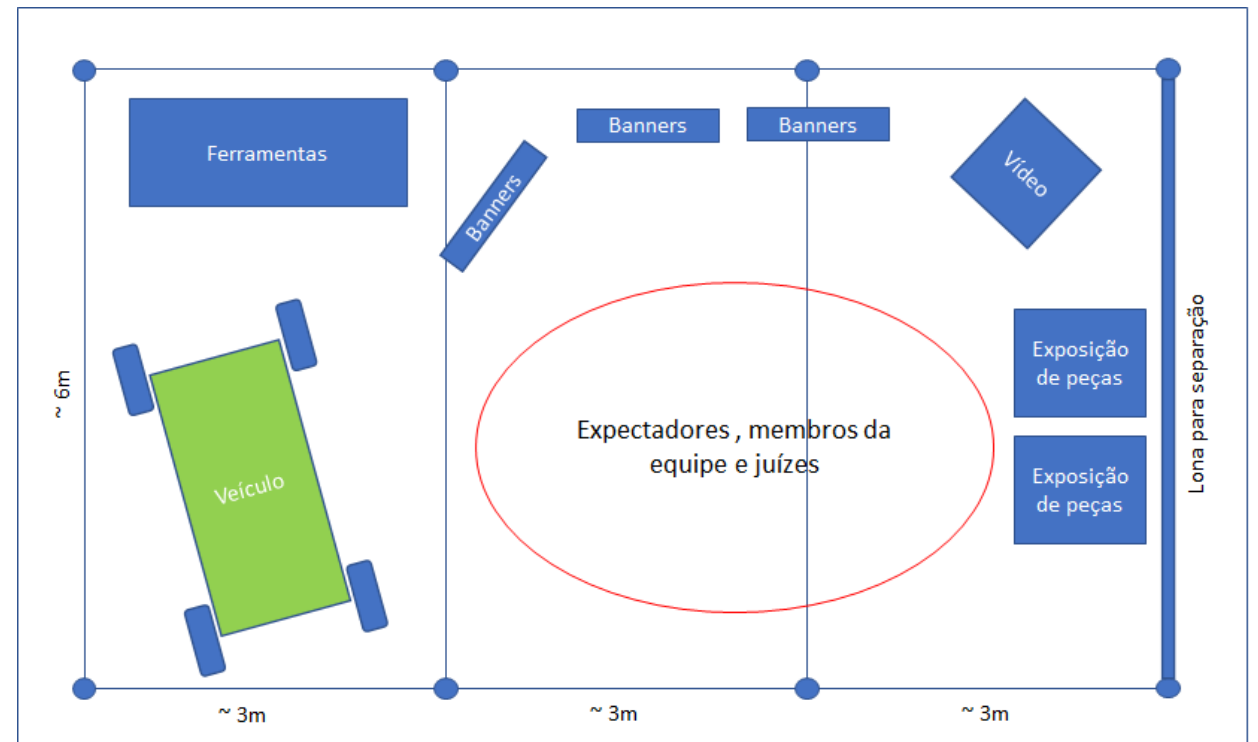


Endurance event - August 6th 10:00 H to 14:00 He

- The vehicle can not loose fluids, contaminate the track, loose parts or present signs of operation under risk during the event. In case that occurs, it will be forced to stop, and the endurance will be over for the team.
- For the sake of experimentation, it will be measured the battery state of charge and the H2 pressure at the beginning and at the end of the trial. That will be used to estimate the vehicle consumption.
- **Score : 400 points.**

Project showcase event From August 3rd 13:00 H to August 6th 12:00 H

- This will be a continuous event during the whole competition.
- The team shall design and assemble the box as a marketing showcase for the product like it would be done in an Automotive Trade Fair.
- It is suggested the presentation of videos showing the product, the team, and the development milestones (Sketches, rig tests, simulations, etc.) to be presented the whole time.



Suggested layout

Project showcase event - From August 3rd 13:00 H to August 6th 12:00 Hb

- The banners used on the design presentation can be left exposed.
- Spare parts, test parts and specially those provided by the sponsors, if not installed yet at the vehicle shall be exposed.
- The vehicle, even if not complete shall be exposed, and if it will participate of other events it should be exposed whenever available.
- It is suggested that the futurist sketches presented on the shape design, color and trim event of 2020 are also exposed.
- The team shall train members to be able to explain the technology used, show the parts on the vehicle and their functions on the system to the visitors of the event.
- The sponsors may also expose their brands and keep representatives.
- **Score: 300 points.** The evaluation will be performed by selected persons between the those present.

Winners award event - August 6th 14:00 H

- This event will award the winners of both competitions.
- It will take place at the auditorium of ECPA.



Auditorium