

IN TECHNICAL INSPECTIONS

IN 1 GENERAL

IN 1.1 Technical Inspection Process

IN 1.1.1 The technical inspection is divided into the following parts:

- Pre-Inspection
- [EV ONLY] Accumulator Inspection
- [EV ONLY] Electrical Inspection
- Mechanical Inspection
- Autonomous System Inspection
- Tilt Test
- Vehicle Weighing
- [CV ONLY] Noise Test
- [EV ONLY] Rain Test
- Brake Test
- EBS Test

IN 1.2 General Rules

- IN 1.2.1 Each vehicle must pass all parts of technical inspection except Autonomous System Inspection and EBS Test before it may participate in any dynamic event.
- IN 1.2.2 Each vehicle must pass Autonomous System Inspection and EBS Test before it may participate in any Driverless (DV) dynamic event.
- IN 1.2.3 Passing the technical inspections is not a certification of complete rules compliance of the vehicle.
- IN 1.2.4 The technical inspection sheet includes several inspection points and will be provided on the competition website before the competition. It must always stay with the push bar.
- IN 1.2.5 The officials may inspect other points not mentioned on the technical inspection sheet to ensure compliance with the rules.
- IN 1.2.6 Teams are responsible for confirming that their vehicle and the required equipment satisfies the requirements and restrictions of the rules before presenting it for technical inspection.
- IN 1.2.7 Vehicles must be presented for technical inspection in ready-to-race condition.

IN1 General

- IN 1.2.8 Safety uncritical rule violations without a benefit to the team that cannot be changed at the event may result in at least 20 penalty points for the teams, depending on officials' decision. Safety uncritical violations with a minor benefit to the team that cannot be changed at the event may result in at least 40 penalty points for the team. The penalty points will be deducted from the team's overall score.
- IN 1.2.9 All items on the inspection sheet must be clearly visible for the officials without using instruments such as endoscopes or mirrors. Visible access may be provided by removing body panels or by providing removable access panels.
- IN 1.2.10 The vehicle must maintain all required specifications throughout the competition.
- IN 1.2.11 Officials reserve the right to ask the team for drilling of additional inspection holes to check the chassis for compliance with the rules.
- IN 1.2.12 Officials will mark or seal various different approved parts. Removal of or damage to the seals will void the inspection approval.
- IN 1.2.13 Once the vehicle is approved for competition, any damage to the vehicle that requires repair(s) will void the inspection approval. After completion of the repair(s), the vehicle must be re-submitted to technical inspection for re-approval.
- IN 1.2.14 The officials reserve the right to prohibit the use of parts that could pose a safety risk to drivers, track marshals or the environment.

IN 1.3 Technical Inspection Sticker

- IN 1.3.1 The competition technical inspection stickers will be placed on the nose of the vehicle.
- IN 1.3.2 If a vehicle is no longer in compliance with the rules, the officials will set the vehicle's technical inspection status to fail, remove the respective inspection sticker(s) from the vehicle and note the reason for revoking the technical inspection approval in the technical inspection sheet.

IN 1.4 Inspection Responsible Person

- IN 1.4.1 To accelerate the technical inspection process, the team must appoint one team member as inspection responsible person. For vehicles that have an autonomous system, see T 14, implemented, this has to be an ASR. [EV ONLY] For electrical inspection and accumulator inspection this has to be an ESO.
- IN 1.4.2 This inspection responsible person must be:
- Familiar with the vehicle.
 - Able to show compliance of the vehicle with all points mentioned on the technical inspection sheet.
 - Able to perform the technical inspection autonomously observed by the officials, when asked.

IN2 Pre-Inspection

- IN 1.4.3 Should the inspection responsible person be unable to perform one of these requirements, or the vehicle and all necessary items are not ready, the technical inspection will be aborted and the team will be asked to leave the technical inspection area.

IN 1.5 Modifications and Repairs

- IN 1.5.1 After technical inspection, the only modifications allowed to the vehicle are:
- Adjustment of belts, chains and clutches
 - Adjustment of the brake bias
 - Adjustment of the driver restraint system, head restraint, seat and pedal assembly
 - Substitution of the head restraint or seat insert for different drivers
 - Adjustment to engine operating parameters, e.g. fuel mixture and ignition timing
 - Adjustment of mirrors
 - Adjustment of the suspension where no part substitution, other than springs, sway bars and shims, is required
 - Adjustment of tire pressure
 - Adjustment of winglet angles, but not the position of the complete aerodynamic device in relation to the vehicle
 - Replenishment of fluids
 - Replacement of defective tires or brake pads. Replacement tires and brake pads must be identical in material/composition/size to those presented and approved at technical inspection.
 - Changing wheels and tires for “wet” or “damp” conditions as allowed in D3.2 and D7.6
 - Software calibration changes
 - Recharging LV batteries
 - Recharging TS accumulators
 - Adjustments of AS sensors
 - (De-)Coupling of actuators as allowed in T 14.7
 - Installing and removing protective sensor covers, if approved during technical inspection

IN 2 PRE-INSPECTION

IN 2.1 Pre-Inspection Required Items

- IN 2.1.1 The following items must be presented for pre-inspection:
- All helmets
 - All driver’s equipment and other safety gear

IN3 [EV ONLY] Accumulator Inspection

- Two unused and in date fire extinguishers
- One set of four tires on rims for wet conditions
- One set of four tires on rims for dry conditions

The tire type/rim type combination presented during pre-inspection must be the same during the whole competition. The rims for dry tires and wet tires may be different, but for all dry tire sets and all wet tire sets the same.

IN3 [EV ONLY] ACCUMULATOR INSPECTION

IN3.1 Accumulator Inspection General Definitions

- IN3.1.1 Cell modules or stacks do not need to be disassembled when AIRs, fuses, pre- and discharge circuit and positive locking mechanism of the maintenance plugs are reachable and visible for the officials.
- IN3.1.2 An official temperature logging device must be installed if used by the competition, see EV 5.8.6.
- IN3.1.3 The accumulator charger will be inspected and sealed.
- IN3.1.4 The set of basic tools will be checked.

IN3.2 Accumulator Inspection Required Items

- IN3.2.1 The following items must be presented at accumulator inspection:
- All TS accumulators
 - Accumulator hand cart
 - Accumulator charger
 - Basic Tools, see IN 3.2.2
 - Tools needed for the (dis)assembly of parts
 - Samples of self designed PCBs that are part of the TS and inside the TSAC, see EV 4.3.7
 - Data sheets for all parts used in the accumulator
 - Original delivery notes for material without serial number printed on according to T 1.2.1
 - Print-outs of rule questions (if applicable)
 - Print-out or digital version of ASES
- IN3.2.2 The following basic tools in good condition must be presented:
- Insulated cable shears
 - Insulated screw drivers
 - Multimeter with protected probe tips and two 4 mm banana plug test leads rated for 600 V CAT III or better

IN4 [EV ONLY] Electrical Inspection

- Insulated tools, if bolted connections are used in the TS
- Face shield
- at least two pairs of HV insulating gloves (not expired)
- Two HV insulating blankets of at least 1.0 m² each
- Safety glasses with side shields for all team members that might work on the TS or accumulator

All electrical safety items must be rated for at least the maximum TS voltage.

IN 4 [EV ONLY] ELECTRICAL INSPECTION

IN4.1 Electrical Inspection General Definitions

IN4.1.1 The insulation resistance between the TS and LVS ground will be measured. Vehicles with a maximum TS voltage less than or equal to 250 V will be probed with 250 V and vehicles with a maximum TS voltage greater than 250 V with 500 V.

To pass this test, the measured insulation resistance must be at least 500 Ω/V related to the maximum TS voltage of the vehicle.

IN4.1.2 The IMD will be tested by connecting a resistor between the TSMP, see EV 4.7 and LVS ground connector, see EV 4.7.8.

The test is passed if the IMD shuts down the TS within 30 s at a fault resistance of 50 % below the response value which corresponds to 250 Ω/V .

IN4.1.3 The BSPD will be tested by sending an appropriate signal that represents the current, to achieve ≤ 5 kW whilst pressing the brake pedal. This test must prove the functionality of the complete BSPD except for any commercially available current sensors. Ends of a current transducer's auxiliary winding must be insulated.

IN4.2 Electrical Inspection Required Items

IN4.2.1 The following items must be presented at electrical inspection:

- Vehicle with mounted TS accumulator
- Jacks and push bar
- Samples of self designed PCBs that are part of the TS and are outside of the TSAC, see EV 4.3.7
- Tools needed for the BSPD check, see IN4.1.3
- Data sheets for all parts used in the TS
- Original delivery notes for material without serial number printed on according to T 1.2.1
- Tools needed for the (dis)assembly of parts for electrical inspection
- Print-outs of rule questions (if applicable)
- The connectors needed

IN5 Mechanical Inspection

- to safely close the SDC while the HVD is removed and
- to safely supply the TS using the same shrouded receptacles as used for TSMP when the TS accumulator is unconnected

IN 5 MECHANICAL INSPECTION

IN5.1 Mechanical Inspection Required Items

IN 5.1.1 The following items must be presented at mechanical inspection:

- Jacks and push bar
- The tallest driver of the team
- Copies of any safety structure equivalency forms
- Copies of any impact attenuator data requirement
- Print-outs of rule questions (if applicable)
- Physically tested IA assembly, including (representative) test fixture (if applicable)
- Teams with a monocoque: laminate test specimen(s)
- Teams using alloyed steel: test specimen(s)
- Only tools needed for the (dis)assembly of parts for mechanical inspection
- [HY ONLY] Copies of the HSF
- [HY ONLY] HSC and any tools and/or materials needed to determine the weight limit as per CV 5.2.3

IN 6 AUTONOMOUS SYSTEM INSPECTION

IN 6.1 Autonomous System Inspection Required Items

IN 6.1.1 The following items are required:

- Data sheets for all perception sensors
- Documents which proof that all perception sensors meet local legislation
- RES remote control
- ASF
- Tools needed for the (dis)assembly of parts for autonomous system inspection
- Print-outs of rule questions (if applicable)

IN 7 TILT TEST

IN 7.1 Tilt Test Procedure

IN 7.1.1 The tilt test will be conducted with the tallest driver fully strapped in normal driving position.

IN8 Vehicle Weighing

- IN7.1.2 The tilt test will be conducted with all vehicle fluids at their maximum fill level.
- IN7.1.3 The vehicle will be placed upon the tilt table and to an angle of 60°. There must be no fluid leaks and all wheels must remain in contact with the tilt table surface.

IN 8 VEHICLE WEIGHING

IN8.1 Vehicle Weighing Procedure

- IN8.1.1 All vehicles must be weighed in ready-to-race condition.
- IN8.1.2 All fluids must be at their maximum fill level for weighing.

IN 9 [EV ONLY] RAIN TEST

IN9.1 Rain Test General Definitions

- IN9.1.1 Vehicles must have passed electrical inspection, see IN4, to attempt the rain test.

IN9.2 Rain Test Procedure

- IN9.2.1 The vehicle must be in ready-to-race condition. All components and constructions used to protect the vehicle from water during the rain test must be used during the entire competition.
- IN9.2.2 The TS must be active during the rain test.
- IN9.2.3 The vehicle must be jacked up using the jacks, see T 13.2, and all driven wheels must be removed.
- IN9.2.4 The vehicle must not be in R2D mode, see EV 4.11.
- IN9.2.5 The test will be conducted without a driver.
- IN9.2.6 Water will be sprayed at the vehicle from any possible direction. The water spray is similar to a vehicle driving in rain and not a direct high-pressure stream of water.
- IN9.2.7 The test is passed if the IMD is not triggered while water is sprayed at the vehicle for 120 s and 120 s after the water spray has stopped.

IN 10 [CV ONLY] NOISE TEST

IN10.1 Noise Test Procedure

- IN10.1.1 The sound level will be measured during a static test.
- IN10.1.2 The vehicle must be compliant at all engine speeds up to the maximum test speed, see CV 3.2.1.
- IN10.1.3 Teams must bring a laptop to indicate the engine speed measured by the engine control unit.

IN11 Brake Test

- IN 10.1.4 Measurements will be made with a free-field microphone placed free from obstructions at the exhaust outlet level, 0.5 m from the end of the exhaust outlet, at an angle of 45° with the outlet in the horizontal plane.
- IN 10.1.5 Where more than one exhaust outlet is present, the test will be repeated for each exhaust and the highest reading will be used.
- IN 10.1.6 If the exhaust has any form of active tuning or throttling device or system, it must be compliant with the rules in all positions. Manually adjustable tuning devices must require tools to change them and must not be moved or modified after the noise test is passed. The position of the device must be visible to the officials and manually operable by the officials during the noise test.
- IN 10.1.7 The test will be run with the gearbox in neutral. During this test the vehicle must be jacked up using the jacks, see T 13.2.
- IN 10.1.8 After passing the noise test the function of the master switch, the cockpit-mounted shutdown button and the inertia switch will be tested.
- IN 10.1.9 After passing IN 10.1.8 the air tightness of the intake system will be tested by closing off the inlet after which the engine must stall.

IN 11 BRAKE TEST

IN 11.1 Brake Test Procedure

- IN 11.1.1 Lock all four wheels and stop the vehicle in a straight line at the end of an acceleration run specified by the officials.
- IN 11.1.2 [CV ONLY] The vehicle must come to standstill without stalling the engine.
- IN 11.1.3 [EV ONLY] After accelerating, the TS must be switched off by the driver, using the cockpit-mounted shutdown button, and the driver must brake using only the mechanical brakes.
- IN 11.1.4 After the brake test, the vehicle must be able to continue driving under its own power without external assistance.
- IN 11.1.5 The brake light, [EV ONLY] and TSAL, illumination will be checked and the officials will verify if the illumination is satisfactory for external observation.
- IN 11.1.6 [EV ONLY] The R2D sound will be checked and the officials will verify if the sound level is satisfactory.

IN 11.2 EBS Test

- IN 11.2.1 The EBS performance will be tested dynamically and must demonstrate the performance described in T 15.4.
- IN 11.2.2 The test will be performed in a straight line marked with cones similar to acceleration.

IN 12 Post Inspection

- IN 11.2.3 During the brake test, the vehicle must accelerate in autonomous mode up to at least 40 km/h within 20 m. From the point where the RES is triggered, the vehicle must come to a safe stop within a maximum distance of 8.5 m.
- IN 11.2.4 In case of wet track conditions, the stopping distance will be scaled by the officials dependent on the friction level of the track.
- IN 11.2.5 The EBS test is conducted after all other elements of IN 11 have been passed.

IN 12 POST INSPECTION

IN 12.1 Post Inspection Procedure

- IN 12.1.1 The officials reserve the right to impound any vehicle at any time during or after any of the dynamic events to check for compliance with the rules. If necessary, the vehicle will remain with the officials until the violation of the rule was discussed with the team.
- IN 12.1.2 After the endurance and trackdrive event, the vehicle must be placed in parc fermé where no team member may access the vehicle.
- IN 12.1.3 During and after any dynamic event, the vehicle must be in compliance with the rules.
- IN 12.1.4 For each violation of the rules, the team receives a separate penalty as follows:
- Group A: Violation of the rules without advantage for the team
 - Group B: Violation of the rules with advantage for the team (e.g. aerodynamics)

	Acceleration	Skidpad	Autocross	Endurance	Trackdrive
Group A	0.3 s	0.2 s	2 s	30 s	30 s
Group B	1 s	0.6 s	5 s	2 min	2 min

The penalty applies to all runs since the vehicle entered the dynamic area the last time.

- IN 12.1.5 Violation of the rules concerning safety or the environment (e.g. BOTS, safety harness issues, ground clearance, fluid leaks other than plain water, noise) results in DQ since entering the dynamic area.
- IN 12.1.6 Losing a part of the vehicle on the track will result in DQ for that particular run.
- IN 12.1.7 Changes in vehicle weight of more than ± 5 kg compared to the official technical inspection weight, see IN 8, results in a 20 point penalty for each kg the tolerance is exceeded by. E.g. a weight difference of ± 6.2 kg results in a 40 point penalty.
- IN 12.1.8 [EV ONLY] The vehicle must be able to enter R2D mode, see EV 4.11, during post inspection process for all tests requiring this mode. Violation will result in DQ.
- IN 12.1.9 [EV ONLY] Directly after endurance and leaving parc fermé, every team must come back to the charging area to disassemble the temperature logging device (if used by the competition) from the TS accumulator, see EV 5.8.6.
- IN 12.1.10 Directly after the last dynamic discipline and leaving parc fermé, the data logger (if installed), see EV 4.6 or T 14.2, will be disassembled from the vehicle.

S STATIC EVENTS

S 1 GENERAL RULES

S 1.1 Vehicle Condition

- S 1.1.1 Vehicles must be presented for judging in finished condition, fully assembled, complete and ready-to-race.
- S 1.1.2 The judges will not evaluate any vehicle that is presented in what they consider to be an unfinished state.
- S 1.1.3 Vehicles may be presented for judging without having passed technical inspection, even if final tuning and setup is in progress.
- S 1.1.4 Covers and/or parts may be removed during the judging to facilitate access and presentation of components or concepts.

S 2 BUSINESS PLAN PRESENTATION EVENT

S 2.1 Business Plan Presentation Objective

- S 2.1.1 The objective of the BPP is to assess the team's ability to develop and present a comprehensive business model. This business model must offer a product or a service based on the team's specific prototype vehicle or a specific component of it, providing a rewarding business opportunity that creates a monetary profit. The vehicle or component must be an essential part of the value proposition.
- S 2.1.2 The judges should be treated as if they were potential investors or partners for the presented business model.
- S 2.1.3 The quality of the actual prototype will not be considered as part of the BPP judging, therefore S 1.1 does not apply.

S 2.2 Business Plan Presentation Procedure

- S 2.2.1 Presentations are limited to a maximum of 10 min. The judges will stop any presentation exceeding 10 min.
- S 2.2.2 The presentation will not be interrupted by questions. Immediately following the presentation there will be a question and answer session.
- S 2.2.3 One or more team members may present the business plan.

S2 Business Plan Presentation Event

- S2.2.4 All team members involved in the BPP must be in the podium area and must be introduced to the judges at the beginning of the presentation. The team members who have been introduced may answer the judges' questions even if they were not actually presenting.
- S2.2.5 Teams that fail to make their presentation within their assigned time period will receive zero points for the BPP.
- S2.2.6 Before the competition a specific deep dive topic, which has to be part of the 10 min presentation, will be published on the competition website.

S2.3 Pitch Video

- S2.3.1 To convince the potential investors or partners that the team's presentation is worthy of their time, it is required that a Business Plan Pitch Video (BPPV) is submitted before the competition. The pitch video should be considered as the first impression of the business idea and has to contain the relevant investment figures.
- S2.3.2 The BPPV must be submitted online via the competition website, not later than the deadline specified in the competition handbook.
- S2.3.3 The BPPV must not exceed a length of 30 s and must be in a common video format, e.g. avi, mpg, mp4, wmv.

S2.4 Business Plan Presentation Scoring

- S2.4.1 The BPP will be evaluated on the categories specified in table 6.

Category	Points
Pitch Video	10
Content	20
Finances	10
Deep Dive Topic	10
Demonstration and Structure	15
Delivery	10
Questions	10
General Impression	15
Total	100

Table 6: BPP evaluation categories

- S2.4.2 If the business model presented does not relate to one of the areas listed within S2.1.1, 15 penalty points will be deducted from the team's BPP scoring.
- S2.4.3 The judging at the competition will start with an initial judging, where all teams are judged by different judging groups.
- S2.4.4 Some teams may be chosen to participate in the BPP finals to determine the BPP winner. The BPP finals will be held separately from the initial judging and teams will be informed about their participation during the event.
- S2.4.5 The scoring of the BPP is based on the average of the scores given by each of the judges.

S3 Cost and Manufacturing Event

S2.4.6 The scoring for the non-finalist is calculated as followed:

$$BPP_SCORE = 70 \left(\frac{P_{team}}{P_{max}} \right)$$

P_{team} is the score awarded to the team

P_{max} is the highest score awarded to any team not participating in the finals

S2.4.7 The scoring of the BPP finalists will vary from 75 to 71 points and is scored immediately after the BPP finals by all judges.

S3 COST AND MANUFACTURING EVENT

S3.1 Cost and Manufacturing Objective

S3.1.1 The objective of the cost and manufacturing event is to evaluate the team's understanding of the manufacturing processes, costs and greenhouse gas emissions associated with the construction of a prototype vehicle. This includes trade off decisions between content and cost, make or buy decisions and understanding the differences between prototype and mass production.

S3.2 Cost and Manufacturing Procedure

S3.2.1 Prior to the competition, three Cost Report Documents (CRD), see S3.3, must be submitted to the competition website by the deadline specified in the competition handbook.

S3.2.2 During the competition, a discussion with the judges will take place, next to the team's vehicle. The discussion is split into three parts:

S3.2.3 Part 1 "Bill of Material (BOM) Discussion":

A discussion to evaluate the team's ability to prepare an accurate engineering and manufacturing BOM for the complete vehicle. The team must prove the following:

- The specification of the vehicle in the CRD accurately reflects the vehicle brought to the competition.
- The costs and emissions within the Costed Carbonized Bill of Material (CCBOM) part of the BOM are correct and realistic.
- The manufacturing feasibility of the vehicle.

S3.2.4 Part 2 "Cost Understanding":

A discussion to evaluate the general cost and manufacturing knowledge of the team.

S3.2.5 Part 3 "Real Case":

A specific task to evaluate the cost and manufacturing knowledge in a certain field. The real case task will be published on the competition website before the competition.

S3.2.6 The teams must present their vehicle to the judges at the designated time. Teams that miss their time slot will score 0 points.

S3.2.7 Teams are allowed to bring electronic, handwritten or printed handouts, flip charts or similar to the event, but the space available may be limited.

S3 Cost and Manufacturing Event

S3.3 Cost Report Documents

- S3.3.1 The CRD consist of the following documents:
- The BOM, including CCBOM, created and submitted online on the competition website
 - The supporting material file, submitted as a pdf file to the competition website
 - The cost and emissions explanation file, submitted as a pdf file to to the competition website
- S3.3.2 A changelog of the changes on the vehicle since the submission deadline of the CRD can be presented to the judges at the BOM discussion. Missing parts of the BOM cannot be part of the changelog.
- S3.3.3 All CRD must be brought to the event discussion either as hard copy or as digital version.
- S3.3.4 The website tool will provide a printable pdf version of the BOM.
- S3.3.5 The team must ensure that at least two judges are able to review the CRD independently.
- S3.3.6 The presented CRD must be identical to the submitted versions, otherwise 0 points will be scored for the “BOM Discussion” part.

S3.4 Bill of Material

- S3.4.1 The BOM is a sorted list of all vehicle parts.
- S3.4.2 The BOM is structured as follows:
- The BOM is broken down into “systems”, see S3.4.7.
 - Each “system” is broken down into “assemblies”, which are defined by the website tool.
 - Each “assembly” can optionally be broken down into “sub-assemblies”, which must be defined by the team.
 - Each “assembly” or “sub-assembly” is broken down into “parts”, which must be defined by the team.
- S3.4.3 The BOM must list all parts fitted to the prototype vehicle at any time during the competition.
- S3.4.4 Only dry tires and wheels per T2.7.1 need to be included in the BOM.
- S3.4.5 “Fasteners” are additional items necessary to assemble a “part” or “(sub-)assembly” and should not be listed (e.g. DIN-931 hexagon screw, glue, tape, zip-tie, ...).
- S3.4.6 A self-manufactured “fastener” is considered a “part”.
- S3.4.7 The “systems” are:
- Autonomous System
 - Brake System
 - Chassis and Body
 - Drivetrain

S3 Cost and Manufacturing Event

- Engine and Tractive System
- Grounded Low Voltage System
- Miscellaneous, Fit and Finish
- Steering System
- Suspension System
- Wheels, Wheel Bearings and Tires

S3.4.8 When adding “parts” to the BOM, the comments section should be reviewed thoroughly. The chosen part name must clearly describe what is included. For example, if a spring is included, the “part” should not be called “damper”.

S3.4.9 Only metric units must be used within the BOM.

S3.5 Costed Carbonized Bill of Material

S3.5.1 The manufacturing and assembly processes, actual costs and greenhouse gas emissions of all parts from one or two systems of the BOM must be listed in the CCBOM.

S3.5.2 For 2025, a CCBOM for the “Steering System” must be submitted.

S3.5.3 Additional to the BOM, the CCBOM must:

- Include the actual associated manufacturing processes for each part as used for the prototype vehicle.
- Include tooling (e.g. welding jigs, molds, patterns and dies).
- Include the actual costs of materials, fabrication, bought parts and assembly for each part as used for the prototype vehicle.
- Include the system’s carbon footprint for each part, manufacturing and assembly process of the prototype vehicle in Carbon Dioxide Equivalents (CO₂e).

S3.5.4 Each constituent “part” of an “assembly” must be classified as “bought” or “made”.

S3.5.5 Additional to the structure of the BOM, in the CCBOM each “part” is broken down into

- “materials” used (e.g. aluminium)
- “processes” that describe the necessary steps for manufacturing
- “fasteners” used to assemble the part (if applicable)
- “tooling” required for manufacturing (if applicable)

S3.5.6 “Tooling” is the necessary tools used for transforming the “material” into the desired shape. If production tooling is associated with processes that are specific to the part geometry, it must be included. For example the dies to stamp out a chassis bracket are tooling.

S3.5.7 Hand or power tools must not be included.

S3.5.8 For “bought parts”, only fasteners have to be included (if applicable). If the part was modified, the associated “processes” and “tooling” (if applicable) for this modification must also be included.

S3 Cost and Manufacturing Event

- S3.5.9 Only parts that can be bought from a catalog may be designated as “bought parts”.
- S3.5.10 The cost calculations must be completed as realistically as possible and exclude research, development and capital expenditures for real estates (e.g. plant or development hours of the team).
- S3.5.11 All costs must be displayed in EUR. For calculating the prices in EUR from other currencies, the team must provide the exchange rates used.
- S3.5.12 There is no maximum cost. Receipts are not required for any items.
- S3.5.13 The calculations for machine hourly rates, wages (including overheads) etc. must be shown.
- S3.5.14 The “carbon footprint” is calculated in CO₂e based on a “Cradle-to-Gate” Life Cycle Assessment (LCA) of the selected “system(s)”.
- S3.5.15 The “Cradle-to-Gate” analysis includes extraction of raw materials needed, manufacturing of “made parts”, “sub-assemblies” and “assemblies” as well as manufacturing of the “system” (ready to be mounted into the final prototype vehicle).
- S3.5.16 For “bought parts”, only the “carbon footprint” of modifications has to be included.
- S3.5.17 The “carbon footprint” for the the transportation between the steps must be included.
- S3.5.18 The “carbon footprint” must exclude research and development.

S3.6 Supporting Material File

- S3.6.1 The supporting material file is a document containing additional information which allows the judges to understand the BOM. It should include drawings, exploded view drawings and/or pictures of the vehicle and the parts included in the BOM.

S3.7 Cost and Emissions Explanation File

- S3.7.1 The cost and emissions explanation file is a document which allows the judges to understand the costs and greenhouse gas emissions within the CCBOM part of the BOM.
- S3.7.2 The cost model used must be pointed out, especially which specific costs are included, e.g. machine operation costs.
- S3.7.3 The methodology used for determining the Global Warming Potential (GWP) in CO₂e also needs to be explained. The specific carbon emission factors associates with e.g one material type need to be included.

S3.8 Cost and Manufacturing Scoring

- S3.8.1 The team must present their vehicle according to S1.1 to score points in the cost and manufacturing event.
- S3.8.2 The cost and manufacturing event will be evaluated on the categories specified in the following table:

S4 Engineering Design Event

Category	Points
Part 1 “BOM Discussion”	50
Part 2 “Cost Understanding”	25
Part 3 “Real Case”	25
Total	100

- S 3.8.3 If items are missing from the BOM, points are deducted until 0 points are scored for “BOM Discussion”.
- S 3.8.4 Some teams may be chosen to participate in the cost and manufacturing finals to determine the cost and manufacturing event winner. The cost and manufacturing finals will be held separately from the initial judging and teams will be informed about their participation during the event.
- S 3.8.5 In case of finals the highest achievable scoring for the non-finalists is 80 points.

S4 ENGINEERING DESIGN EVENT

S4.1 Engineering Design Objective

- S 4.1.1 The concept of the design event is to evaluate the student’s engineering process and effort that went into the design of a vehicle, meeting the intent of the competition.
- S 4.1.2 Proprietary components and systems that are incorporated into the vehicle design as finished items are not evaluated as a student designed unit, but are only assessed on the team’s selection and application of that unit.
- S 4.1.3 An evaluation concerning the capability of the vehicle to drive autonomously will also be part of this event. Therefore, all systems that are required to drive autonomously will be investigated. This also includes a discussion about the hardware and the software used in the AS.

S4.2 Engineering Design Report

- S 4.2.1 The EDR should contain a brief description of the overall vehicle including the AS with a review and derivation of the team’s design objectives. Any information to scope, explain or highlight design features, concepts, methods or objectives to express the value and performance of the vehicle to the judges should be included at the teams’ discretion.
- S 4.2.2 The EDR must not exceed ten pages, consisting of not more than seven pages of content (text, which may include pictures and graphs) and three pages of drawings.
- S 4.2.3 The three EDR drawings (no renderings) must show the vehicle from the front, the top and the side. Each drawing must appear on a separate page.
- S 4.2.4 Any measures to facilitate reviewing the drawings (e.g. measurements, details, colors) may be utilized at the teams’ discretion.
- S 4.2.5 Any portions of the EDR that exceeds seven pages of content and/or three pages of drawings will not be evaluated.

S4 Engineering Design Event

- S4.2.6 If included, cover sheets and tables of contents will count as text pages.
- S4.2.7 The EDR will be used to sort the teams into appropriate design queues based on the quality of its review.
- S4.2.8 Evidence of information mentioned in the EDR should be brought to the competition and be available, on request, for review by the judges.

S4.3 Design Spec Sheet

- S4.3.1 A completed DSS must be submitted online on the competition website.

S4.4 Engineering Design Procedure

- S4.4.1 The design event starts with the submission of the DSS and the EDR and their review respectively.
- S4.4.2 At the competition, teams will present their knowledge and their vehicle to the judges, which will evaluate the teams' performance following the design objectives stated in chapter S4.1.
- S4.4.3 Some teams may be chosen to participate in the design finals to determine the engineering design event winner. The design finals will be held separately from the initial judging and teams will be informed about their participation during the event.
- S4.4.4 Teams may bring any photographs, drawings, charts, spare parts or other material that they believe are supportive to the design event, but the space provided for design judging may be limited.
- S4.4.5 [EV ONLY] Only sealed TSACs which passed the accumulator inspection may be presented or mounted in the vehicle. They must not be opened.
- S4.4.6 [EV ONLY] Only discharged, below 5 % State of Charge, accumulator cells each having all terminals electrically isolated may be presented.
- S4.4.7 [DC ONLY] There is no extra design presentation for the DC, however scoring will be adapted, see table 8, and there will be more judges during the normal presentation focusing on the AS.
- S4.4.8 [DC ONLY] There will be separate design finals for the DC.

S4.5 Engineering Design Judging Criteria

- S4.5.1 The judges will evaluate the engineering effort based upon the teams' DSS and EDR, responses to questions and an inspection of the vehicle.
- S4.5.2 The judges will inspect the vehicle to determine if the design concepts are adequate and appropriate for the application (relative to the objectives set forth in the rules).
- S4.5.3 The judges may deduct points if the team cannot adequately explain the engineering and construction of the vehicle.

S4 Engineering Design Event

S4.6 Engineering Design Scoring

- S4.6.1 The team must present their vehicle according to S 1.1 to score points in the engineering design event.
- S4.6.2 The overall engineering design event maximum scoring is 150 points.
- S4.6.3 The maximum scores listed in table 7 apply for the engineering design event.

Category	Points
Overall Vehicle Concept	20
Software	10
Vehicle Performance	30
Mechanical / Structural	15
Tractive System / Powertrain	25
LV-Electrics / Electronics	10
Autonomous Functionality	20
Driver Interface	10
Engineering Design Report (EDR)	10

Table 7: Maximum scores in engineering design event

Category	Points
Overall Vehicle Concept	20
Software / Compute	30
Vehicle Performance	30
Autonomous Functionality	70

Table 8: [DC ONLY] Maximum scores in engineering design event

D DYNAMIC EVENTS

D1 DYNAMIC EVENTS GENERAL

D1.1 Definitions

- D 1.1.1 Starting – crossing the light barrier at the starting line starts a lap.
- D 1.1.2 Finishing – crossing the light barrier at the finish line ends a lap. Can be the same as the starting line.
- D 1.1.3 Lap – a complete trip on a defined track, beginning at the start line and ending at the finish line.
- D 1.1.4 Run – a single attempt to compete in a dynamic event. Runs consist of one or more lap(s). A run is started when receiving a GREEN FLAG or the go-signal by the officials.
- D 1.1.5 Did Not Finish (DNF) – starting a run without finishing it. For the purpose of scoring, a DNF is treated as a DQ.
- D 1.1.6 Disqualified (DQ) – being removed from the scoring due to a rule violation.
- D 1.1.7 Valid Run – a run that is neither DNF nor DQ.
- D 1.1.8 Running Order – the sequence in which teams take part in a dynamic event. If not defined otherwise, the running order is queue based and teams on their first run receive priority.
- D 1.1.9 To score points in any dynamic event, a team must have at least one valid run in that event.

D1.2 Driver Limitations

- D 1.2.1 In total, a minimum of three and a maximum of four drivers are allowed for each team.
- D 1.2.2 An individual driver must not drive in more than two dynamic events.
- D 1.2.3 The endurance and efficiency event is considered a single event.
- D 1.2.4 An individual driver must not drive more than two runs in each dynamic event.
- D 1.2.5 No more than two drivers are allowed to drive in each dynamic event.

D1.3 Number of Runs in the Dynamic Events

- D 1.3.1 Table 9 defines the number of runs for each dynamic event.

D2 Driving Rules

Dynamic Event	Runs in Manual Mode	Runs in Autonomous Mode
Acceleration	2	-
DV Acceleration	-	2
Autocross	4	-
[DC ONLY] DV Autocross	-	2
Endurance	1	-
Skidpad	2	-
DV Skidpad	-	2
[DC ONLY] Trackdrive	-	1

Table 9: Number of runs for each dynamic event

D1.4 Dynamic Area and Dynamic Vests

- D 1.4.1 The technical inspections and all dynamic events are held in the dynamic area.
- D 1.4.2 Four dynamic vests are handed out to each team by the officials and must be worn in the dynamic area.
- D 1.4.3 Only four members per team, including the driver, may enter the dynamic area at one time.
- D 1.4.4 Drivers must not wear the dynamic vest when sitting in the vehicle. The driver's vest must be attached to the pushbar.
- D 1.4.5 The number of tools that may be used in this area is restricted to those which can be safely carried by the four team members in one trip.

D1.5 Track Walks

- D 1.5.1 There will be track walks before the Autocross, Endurance and [DC ONLY] Trackdrive event.
- D 1.5.2 During the track walk only analogue measurement devices may be used.

D2 DRIVING RULES

D2.1 Flags

- D2.1.1 Flag signals are commands that must be obeyed immediately and without question.
- D2.1.2 There will be no flag signs for vehicles in autonomous mode.
- D2.1.3 BLACK FLAG – the driver must pull into the driver change area for discussion with the officials concerning an incident. A time penalty may be assessed.
- D2.1.4 BLACK FLAG WITH ORANGE DOT / MECHANICAL BLACK FLAG – the driver must pull into the driver change area for a mechanical inspection of the vehicle, something has been observed that requires a closer inspection.
- D2.1.5 BLUE FLAG – the driver must pull into the designated passing zone to be passed by a faster competitor. The driver must obey the track marshals' signals at the end of the passing zone.

D2 Driving Rules

- D2.1.6 CHEQUERED FLAG – the session has been completed. The driver must exit the track at the first opportunity.
- D2.1.7 GREEN FLAG
- The session has started, the driver may enter the track under direction of the track marshals. In case of stalling, the vehicle can be restarted, but the driver has to await another GREEN FLAG as the opening in traffic may have closed.
 - The driver is clear to re-enter the track after using the slow lane to let a faster vehicle pass.
 - The driver may pick up speed again after a YELLOW FLAG was displayed.
- D2.1.8 RED FLAG – the driver must come to an immediate safe and controlled stop on the track and must follow track marshals' directions.
- D2.1.9 YELLOW FLAG – danger, the driver must slow down, something has happened beyond the flag station, no overtaking unless directed by the track marshals.
- D2.1.10 RED AND YELLOW STRIPED FLAG – the track is slippery or something is on the racing surface that should not be there. The driver must be prepared for evasive manoeuvres to avoid the situation.

D2.2 Teleoperated Driving

- D2.2.1 After the vehicle has crossed the starting line it is prohibited to change parameters, send commands or perform any software changes by wireless communication until the vehicle has crossed the finish line. Receiving information from the vehicle via one-way-telemetry is allowed.
- D2.2.2 The only device that is allowed to send commands by wireless communication at all times is the RES described in T 14.3.

D2.3 Driving Under Power

- D2.3.1 During driving, the mechanical integrity of the vehicle must be maintained.
- D2.3.2 Vehicles must not be driven in reverse.
- D2.3.3 The vehicle must be capable of starting and restarting without external assistance/batteries at all times.
- D2.3.4 Push starts are prohibited.
- D2.3.5 Burnouts before and during the events are prohibited.
- D2.3.6 When driving in autonomous mode, an ASR has to be present at the race control with the RES. Additionally, a single monitoring device (laptop, tablet, ...) may be brought (no complicated antenna construction or similar!).

D2 Driving Rules

D2.4 Practice Track

- D2.4.1 A practice track for testing and tuning vehicles is available.
- D2.4.2 To use the practice track, vehicles must have passed all technical inspections.
- D2.4.3 Practice or testing at any location other than the practice track is absolutely forbidden.

D2.5 Cones & Markings for Autonomous Running

- D2.5.1 Details of the cones used and more detailed track layout figures can be found in the competition handbook.

D2.6 Start-up Procedure for Autonomous Running

- D2.6.1 No additional equipment (e.g. laptop, jack-up device, pressure tank, etc.) is allowed to start up the vehicle at the staging/starting line.
- D2.6.2 If the vehicle does not enter “AS Ready” state within 1 min after being staged, the team may be sent back to the preparation area by the officials. In this case any priority is lost.
- D2.6.3 The vehicle may only be staged with the steering system in straight position.
- D2.6.4 The ASMS may only be switched on by the ASR after approval from an official at the starting line.

D2.7 Vehicle Break Downs and Usage of RES during Autonomous Running

- D2.7.1 If a vehicle comes to standstill for any reason, it may have up to 30 s to attempt to continue to drive. If the vehicle doesn't restart within 30 s, it will be disqualified.
- D2.7.2 If the average speed of the first three laps in trackdrive (after completing the third lap) is below 2.5 m/s or the average speed of any of the following laps is below 3.5 m/s, the vehicle will be disqualified.
- D2.7.3 If a traceable signal loss of the RES appears and doubtless proof can be brought by the team that it was not self-inflicted, a re-run may be granted for the respective autonomous run, if the officials are notified before the affected dynamic event closes. The data logger data must be uploaded before notifying the officials.
- D2.7.4 At the direction of the officials, team members may be instructed to retrieve broken-down vehicles. This recovery may only be done under the control of the officials.

D2.8 Procedure After Completing a Driverless (DV) Dynamic Event

- D2.8.1 After approval from the officials the ASR has to deactivate the vehicle using the RES.
- D2.8.2 The vehicle must be collected by the ASR and an additional team member immediately after approval from the officials.

D3 Weather Conditions

D2.9 Handling of Re-Runs

- D2.9.1 A re-run may be granted in following cases:
- Usage of YELLOW FLAG in Autocross.
 - Usage of RED FLAG.
 - Usage of RES to ensure safe conditions on the track or traceable signal loss of the RES according to D2.7.
 - After official's decision due to technical or organizational issues.
- D2.9.2 The team will be informed about a granted re-run either by a sign at the exit or by direct communication through an official.
- D2.9.3 It is at the discretion of the team whether they accept the re-run. If the re-run is accepted, it must be executed immediately and the corresponding initial run is removed from the scoring.

D3 WEATHER CONDITIONS

D3.1 Operating Conditions

- D3.1.1 The following track conditions are recognized:
- Dry
 - Damp
 - Wet
- D3.1.2 The operating condition are decided by the officials and may change at any time.
- D3.1.3 The current operating condition will be prominently displayed at the dynamic area.

D3.2 Tires Allowed

- D3.2.1 Teams must run the tires allowed for each operating condition:

Operating Condition	Tires allowed
Dry	Dry
Damp	Dry or Wet
Wet	Wet

- D3.2.2 When the operating condition is damp, teams may change between dry tires and wet tires:
- Any time during the acceleration, skidpad, and autocross events.
 - Any time before taking the GREEN FLAG to start endurance and according to D7.6.
- D3.2.3 If an event had varied operating conditions, the minimum performance levels to score points may be adjusted if deemed appropriate by the officials.
- D3.2.4 Only one set of tires per type (dry/wet) may be used during all the dynamic events. The brake test, practice area, [DC ONLY] driverless autocross, [DC ONLY] trackdrive and the static events are excluded from this regulation.

D4 SKIDPAD EVENT

D4.1 Skidpad Track Layout

- D4.1.1 The skidpad track consists of two pairs of concentric circles in a figure of eight patterns.
- D4.1.2 The centers of these circles are 18.25 m apart. The inner circles are 15.25 m in diameter and the outer circles are 21.25 m in diameter.
- D4.1.3 17 cones are placed around the inside of each inner circle. 13 cones are positioned around the outside of each outer circle, in the pattern shown in the skidpad layout diagram.
- D4.1.4 Each circle is marked with a line, outside the inner circle and inside the outer circle.
- D4.1.5 The driving path is the 3 m wide path between the inner and outer circles. The vehicles enter and exit through gates on a 3 m wide path that is tangent to the circles where they meet.
- D4.1.6 The line between the centers of the circles defines the start/finish line. A lap is defined as traveling around one of the circles, starting and ending at the start/finish line.

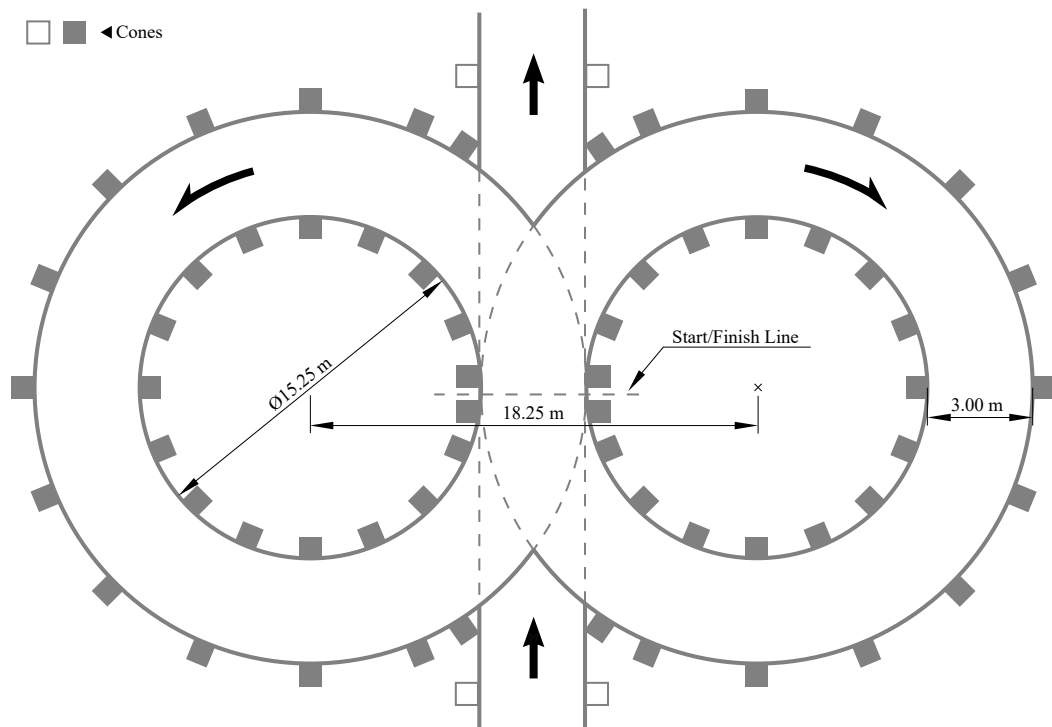


Figure 21: Skidpad Track Layout

D4.2 Skidpad Procedure

- D4.2.1 A run consists of a sequence of laps in exactly the following order. The vehicle must enter perpendicular to the figure of eight and must take one full lap on the right circle to establish the turn. The next lap must be on the right circle and will be timed. Immediately following the second lap, the vehicle must enter the left circle for the third lap. The fourth lap must be

D4 Skidpad Event

on the left circle and will be timed. Immediately upon finishing the fourth lap, the vehicle must exit the track perpendicular to the figure of eight and moving in the same direction as entered.

- D4.2.2 [MANUAL MODE ONLY] The driver has the option to make the second run immediately after their first run.
- D4.2.3 [AUTONOMOUS MODE ONLY] The foremost part of the vehicle is staged 15 m in front of the starting line.
- D4.2.4 [AUTONOMOUS MODE ONLY] After exiting the track the vehicle must come to a full stop within 25 m behind the finish line, inside the marked exit lane and enter the finish-state described in T 14.8.

D4.3 Skidpad Scoring

- D4.3.1 The run time is the average time of the timed left and the timed right circle plus penalties which are added after the averaging.
- D4.3.2 [AUTONOMOUS MODE ONLY] Runs with a run time without penalties >25 s will be disqualified.
- D4.3.3 [MANUAL MODE ONLY] Points are given based on the following formula:

$$M_SKIDPAD_SCORE = 0.95 P_{\max} \left(\frac{\left(\frac{T_{\max}}{T_{\text{team}}} \right)^2 - 1}{0.5625} \right) + 0.05 P_{\max}$$

with

P_{\max} is the maximum points for the event according to table 3

T_{team} is the team's best manual mode time including penalties. T_{team} is capped to T_{\max} .

T_{\max} is 1.25 times the time of the fastest manual mode vehicle including penalties.

- D4.3.4 [AUTONOMOUS MODE ONLY] Points are given based on the following formula:

$$DV_SKIDPAD_SCORE = P_{\max} \frac{N_{\text{all}} + 1 - R_{\text{DV,team}}}{N_{\text{all}}}$$

with

P_{\max} is the maximum points for the event according to table 3

$R_{\text{DV,team}}$ is the ranking of team's best autonomous mode time including penalties within the best autonomous mode times including penalties of all other teams

N_{all} is the number of teams who have at least one valid manual mode or autonomous mode run

D5 Acceleration Event

D4.3.5 [DC ONLY] Points are given based on the following formula:

$$DC_SKIDPAD_SCORE = 0.95 P_{\max} \left(\frac{\left(\frac{T_{\max}}{T_{\text{team}}} \right)^2 - 1}{1.25} \right) + 0.05 P_{\max}$$

with

P_{\max} is the maximum points for the event according to table 3

T_{team} is the team's best autonomous mode time including penalties. T_{team} is capped to T_{\max} .

T_{\max} is 1.5 times the time of the fastest autonomous mode vehicle including penalties.

D5 ACCELERATION EVENT

D5.1 Acceleration Track Layout

D5.1.1 The acceleration track is a straight line with a length of 75 m from starting line to finish line. The track is at least 3 m wide. Cones are placed along the track at intervals of about 5 m.

D5.2 Acceleration Procedure

D5.2.1 A run consists of a single lap.

D5.2.2 [MANUAL MODE ONLY] The driver has the option to make the second run immediately after their first run.

D5.2.3 The foremost part of the vehicle is staged 0.30 m behind the starting line.

D5.2.4 [AUTONOMOUS MODE ONLY] After the finish line, the vehicle must come to a full stop within 75 m behind the finish line inside the marked exit lane and enter the finish-state described in T 14.8.

D5.3 Acceleration Scoring

D5.3.1 [AUTONOMOUS MODE ONLY] Runs with a time without penalties > 25 s will be disqualified.

D5.3.2 [MANUAL MODE ONLY] Points are given based on the following formula:

$$M_ACCELERATION_SCORE = 0.95 P_{\max} \left(\frac{\frac{T_{\max}}{T_{\text{team}}} - 1}{0.5} \right) + 0.05 P_{\max}$$

with

P_{\max} is the maximum points for the event according to table 3

T_{team} is the team's best manual mode time including penalties. T_{team} is capped to T_{\max} .

T_{\max} is 1.5 times the time of the fastest manual mode vehicle including penalties.

D6 Autocross Event

D5.3.3 [AUTONOMOUS MODE ONLY] Points are given based on the following formula:

$$DV_ACCELERATION_SCORE = P_{\max} \frac{N_{\text{all}} + 1 - R_{\text{DV,team}}}{N_{\text{all}}}$$

with

P_{\max} is the maximum points for the event according to table 3

$R_{\text{DV,team}}$ is the ranking of team's best autonomous mode time including penalties within the best autonomous mode times including penalties of all other teams

N_{all} is the number of teams who have at least one valid manual mode or autonomous mode run

D5.3.4 [DC ONLY] Points are given based on the following formula:

$$DC_ACCELERATION_SCORE = 0.95 P_{\max} \left(\frac{T_{\max}}{T_{\text{team}}} - 1 \right) + 0.05 P_{\max}$$

with

P_{\max} is the maximum points for the event according to table 3

T_{team} is the team's best autonomous mode time including penalties. T_{team} is capped to T_{\max} .

T_{\max} is 2 times the time of the fastest autonomous mode vehicle including penalties.

D6 AUTOCROSS EVENT

D6.1 Autocross Track Layout

D6.1.1 The autocross track layout is a handling track built to the following guidelines:

- Straights: No longer than 80 m
- Slaloms: Cones in a straight line with 7.5 m to 12 m spacing
- Miscellaneous: Chicanes, multiple turns, decreasing radius turns, hairpin turns, etc.
- The minimum track width is 3 m
- The minimum required turning diameter is 9 m

D6.1.2 The length of the autocross track is less than 1.5 km.

D6.1.3 [DC ONLY] The autocross track layout is instead built to the guidelines defined in D8.1.

D6.2 Autocross Procedure

D6.2.1 A run consists of a single lap.

D6.2.2 [MANUAL MODE ONLY] Each driver has the option to make the second run immediately after their first run.

D6.2.3 [AUTONOMOUS MODE ONLY] The vehicle is staged such that the front wheels are 6 m in front of the starting line on the track.

D7 Endurance and Efficiency Event

- D6.2.4 [AUTONOMOUS MODE ONLY] After the run the vehicle must come to a full stop within 30 m behind the finish line on the track and enter the finish-state described in T 14.8.

D6.3 Autocross Scoring

- D6.3.1 [MANUAL MODE ONLY] Points are given based on the following formula:

$$AUTOCROSS_SCORE = 0.95 P_{\max} \left(\frac{\frac{T_{\max}}{T_{\text{team}}} - 1}{0.25} \right) + 0.05 P_{\max}$$

P_{\max} is the maximum points for the event according to table 3.

T_{team} is the team's best manual mode time including penalties. T_{team} is capped at T_{\max}

T_{\max} is 1.25 times the time of the fastest manual mode vehicle including penalties.

- D6.3.2 [DC ONLY] Points are given based on the following formula:

$$AUTOCROSS_SCORE = 0.9 P_{\max} \left(\frac{T_{\max} - T_{\text{team},\text{total}}}{T_{\max} - T_{\min}} \right) + 0.1 P_{\max}$$
$$T_{\text{team},\text{total}} = \min(T_{\text{team},1}, \text{avg}(T_{\text{team},1}, T_{\text{team},2}))$$

P_{\max} is the maximum points for the event according to table 3.

$T_{\text{team},1}$ is the team's autonomous mode time including penalties of run 1.

$T_{\text{team},2}$ is the team's autonomous mode time including penalties of run 2.

T_{\max} is the time for driving the lap with 6 m/s.

T_{\min} is the fastest autonomous mode $T_{\text{team},\text{total}}$ of all teams.

For runs that are DNF or DQ or for runs with a $T_{\text{team},i}$ above T_{\max} , $T_{\text{team},i}$ is set to T_{\max} .

D7 ENDURANCE AND EFFICIENCY EVENT

D7.1 Endurance Track Layout

- D7.1.1 The endurance track layout is a closed lap circuit built to the following guidelines:

- Straights: No longer than 80 m
- Slaloms: Cones in a straight line with 9 m to 15 m spacing
- Miscellaneous: Chicanes, multiple turns, decreasing radius turns, hairpin turns, etc.
- The minimum track width is 3 m
- The minimum required turning diameter is 9 m

- D7.1.2 The length of one lap of the endurance track is approximately 1 km.

- D7.1.3 The length of the complete endurance is approximately 22 km.

D7.2 Endurance Procedure

- D7.2.1 Before entering the event, each CV's fuel tank must be filled to the fuel level line, see CV 2.6.4, at the fueling station. During fueling, once filled to the scribe line, no shaking or tilting of the tank, the fuel system or the entire vehicle is allowed.

D7 Endurance and Efficiency Event

- D7.2.2 A run consists of a multiple laps driven by two different drivers.
- D7.2.3 The first driver will drive for 11 km and will then be signaled into the driver change area.
- D7.2.4 After the driver change specified in D 7.5, the second driver will drive for an additional 11 km and will be signaled to exit the track after crossing the finish line.
- D7.2.5 [CV ONLY] The second driver will proceed directly to the fueling station. The tank will be filled to the refill mark and the amount of fuel will be recorded.

D7.3 Endurance Running Order

- D7.3.1 The running order for the endurance will be established in a way that vehicles with similar speeds are on the track together.
- D7.3.2 The running order will be published according to the competition handbook.
- D7.3.3 The procedure for handling the running order is defined in the competition handbook.

D7.4 Passing

- D7.4.1 During the endurance event, overtaking is only permissible in the designated passing zones and under the control of the track marshals.
- D7.4.2 Passing zones have two parallel lanes, a slow lane only used by the vehicles that are being overtaken and a fast lane for the vehicles that are overtaking.
- D7.4.3 Passing zones may be situated on either the left or right of the fast lane.
- D7.4.4 The passing zone procedure will be as follows:
- A slower leading vehicle will be shown the BLUE FLAG and must drive into the slow lane and decelerate.
 - The following faster vehicle will continue in the fast lane to pass the slow vehicle.
 - The vehicle that has been overtaken may re-enter the track when the track marshal who is in charge of that passing zone is showing the GREEN FLAG.
- D7.4.5 The passing rules do not apply to vehicles that are stopped on track or vehicles that have spun out and are not moving. When passing a stationary vehicle, it is critical to slow down, drive cautiously and to follow the instructions from the track marshals.

D7.5 Endurance Driver Change Procedure

- D7.5.1 Only three team members including the drivers may enter the driver change area. They may only bring the tools required to adjust the vehicle to accommodate the second driver and/or change tires.
- D7.5.2 [EV ONLY] One team member must be an ESO.
- D7.5.3 During the driver change, the team may:
- perform changes to accommodate the second driver

D7 Endurance and Efficiency Event

- operate the master switch(es)
- change tires as per D7.6.

No other work may be performed during the driver change.

- D7.5.4 Each team is given 3 min to change their driver.
- D7.5.5 The driver change time will start once the vehicle is stopped in the driver change area and the first driver has turned off the [CV ONLY] engine / [EV ONLY] TS.
- D7.5.6 [EV ONLY] The TSMS must be switched off by the ESO and the TSAL must have changed to green color, before anyone is allowed to touch the vehicle or to climb out of the vehicle.
- D7.5.7 The first driver will climb out of the vehicle and any necessary adjustments will be made to the vehicle to fit the second driver (seat cushions, head restraint, pedal position, etc.). The second driver will then be secured in the vehicle.
- D7.5.8 When the second driver is fully secured in the vehicle, the vehicle has restarted and is R2D again, the driver change time is stopped.
- D7.5.9 If the driver change takes longer than 3 min, the extra time is included in the final time.

D7.6 Endurance Event Tire Changes

- D7.6.1 All tire changes after a vehicle has received the GREEN FLAG to start the endurance event must take place in the driver change area.
- D7.6.2 If the operating condition changes to wet during endurance, the track will be RED FLAGGED or vehicles will be BLACK FLAGGED and brought into the driver change area.
- D7.6.3 If a team wants to change tires, the officials must be informed beforehand.
- D7.6.4 Tire changes can be carried out during the driver change or during an extra stop.
- D7.6.5 If the tire change is carried out during the driver change, in deviation from D7.5, four team members may enter the driver change area.
- D7.6.6 The allowed tire changes and associated conditions are given in table 10.
- D7.6.7 Teams that have incurred a puncture during the endurance event due to external factors (e.g. debris on track) may change the tire with no time penalty, if the vehicle reaches the driver change area under its own power without external assistance.
- D7.6.8 The wheel will be inspected by the officials. If the deflation was not caused by external factors, the vehicle will be disqualified.
- D7.6.9 Deflation caused by running Off-Course (OC) or impacting barriers or other objects due to driver error will not be regarded as external factors.

D7.7 Endurance Specific Regulations

- D7.7.1 Teams are prohibited from working on or fueling their vehicles during the run.
- D7.7.2 Wheel-to-wheel racing is prohibited.

D7 Endurance and Efficiency Event

Existing Operating Condition	Currently running on	Condition changes to Dry	Condition changes to Damp	Condition changes to Wet
Dry	Dry Tires	–	A	B
Damp	Dry Tires	–	A	B
Damp	Wet Tires	C	–	–
Wet	Wet Tires	C	C	–

	Requirement	Time Allowed
A	may change from dry to wet	Note 1
B	must change from dry to wet	Note 1
C	may change from wet to dry	Note 2

Note 1: Any time in excess of 10 min without driver change, or 13 min with driver change, is added to the team's total time for endurance.

Note 2: The time used to change to dry tires is added to the team's total time for endurance.

Table 10: Endurance event tire change

- D7.7.3 If a vehicle stalls out on the track, it is allowed one lap by the vehicle that is following it (approximately one minute) to restart.
- D7.7.4 If a vehicle has a restart problem at the driver change or after a RED FLAG, it is allowed 2 min to restart the engine or to enter R2D. The 2 min start from the time the driver first tries to restart the engine or to enter R2D. The time is added to the endurance time.
- D7.7.5 If restarts are not accomplished within the above times, the vehicle is disqualified for the run.
- D7.7.6 If a vehicle breaks down it will be removed from the track and will not be allowed to re-enter the track.
- D7.7.7 Team members may be instructed by the officials to retrieve broken down vehicles. This recovery may only be carried out under the control of the officials.

D7.8 Endurance Restart Procedure After Red Flag

- D7.8.1 When the cause of the RED FLAG has been rectified, all vehicles on the track will be guided to the driver change area under YELLOW FLAG in order to receive further instructions from the officials.
- D7.8.2 The lap in which the RED FLAG occurred is completely ignored for endurance and efficiency scoring and repeated after the restart.

D7.9 Endurance Scoring

- D7.9.1 Each lap of the endurance event is individually timed. The corrected elapsed time is determined by subtracting the extra-long lap for the driver change from the total time and adding any penalty times.

D7 Endurance and Efficiency Event

D7.9.2 Points are given based on the following formula:

$$ENDURANCE_SCORE = 0.9 P_{\max} \left(\frac{\frac{T_{\max}}{T_{\text{team}}} - 1}{0.333} \right) + 0.1 P_{\max}$$

P_{\max} is the maximum points for the event according to table 3.

T_{team} is the team's corrected elapsed time. T_{team} is capped at T_{\max} .

T_{\max} is 1.333 times of the corrected elapsed time of the fastest vehicle.

D7.10 Efficiency Scoring

D7.10.1 Efficiency is measured during the endurance event.

D7.10.2 Only vehicles which meet all of the following requirements are considered for efficiency scoring:

- the vehicle received points for the endurance event
- the uncorrected elapsed endurance time does not exceed 1.333 times the uncorrected elapsed time of the fastest vehicle
- [CV ONLY] the consumed fuel mass does not exceed 15 kg/100 km 98 RON or 21.75 kg/100 km E85

D7.10.3 [CV ONLY] Fuel pumps must be on and fuel valves must be opened during refueling.

D7.10.4 [CV ONLY] The measured fuel mass of vehicles using E85 fuel is divided by 1.45 to be comparable to the vehicles using 98 RON.

D7.10.5 [EV ONLY] The endurance energy is calculated as the time integrated value of the measured voltage multiplied by the measured current logged by the data logger, see EV 4.6. Regenerated energy is multiplied by 0.9 and subtracted from the used energy.

D7.10.6 Efficiency points based on the following formula are given:

$$EFFICIENCY_SCORE = P_{\max} \left(\frac{EF_{\max} - EF_{\text{team}}}{EF_{\max} - EF_{\min}} \right)$$

with

P_{\max} is the maximum points for the event according to table 3

EF_{team} the team's efficiency factor

EF_{\min} the lowest efficiency factor of all teams which were considered for efficiency

EF_{\max} is defined as $1.5 \cdot EF_{\min}$

D7.10.7 The efficiency factor is calculated based on the following formula:

$$EF = T^2 \cdot E$$

with

T uncorrected elapsed driving time

E [CV ONLY] corrected used fuel mass / [EV ONLY] used energy

D8 [DC ONLY] TRACKDRIVE EVENT

D8.1 Trackdrive Tracklayout

D8.1.1 The trackdrive layout is a closed loop circuit built to the following guidelines:

- Straights: No longer than 80 m
- Miscellaneous: Chicanes, multiple turns, decreasing radius turns, hairpin turns, etc.
- The minimum track width is 3 m
- The minimum required turning diameter is 9 m

D8.1.2 The length of one lap is approximately 200 m to 500 m.

D8.2 Trackdrive Running Order

D8.2.1 The running order will be defined by the officials, based on previous dynamic event results.

D8.2.2 The running order will be published according to the competition handbook.

D8.2.3 The procedure for handling the running order is defined in the competition handbook.

D8.3 Trackdrive Procedure

D8.3.1 A run consists of ten laps.

D8.3.2 The vehicle is staged such that the front wheels are 6 m in front of the starting line on the track.

D8.3.3 After ten laps the vehicle must come to a full stop within 30 m behind the finish line on the track and enter the finish-state described in T 14.8.

D8.3.4 There will be no last lap signal i.e. the vehicle should count laps itself.

D8.4 Trackdrive Scoring

D8.4.1 Each lap of the trackdrive event is individually timed. The corrected elapsed time is determined by adding any penalty times.

D8.4.2 Points are given based on the following formula:

$$TRACKDRIVE_SCORE = 0.75 P_{\max} \left(\frac{T_{\max}}{T_{\text{team}}} - 1 \right)$$

P_{\max} is the maximum points for the event according to table 3.

T_{team} is the team's corrected elapsed time. T_{team} is capped at T_{\max} .

T_{\max} is 2 times of the corrected elapsed time of the fastest vehicle.

D8.4.3 In deviation of D 1.1.9, an additional 2.5 % of the maximum points for the event according to table 3 are given for every completed lap.

D9 DYNAMIC EVENTS PENALTIES

D9.1 General Penalties

- D9.1.1 Penalties will not be assessed for accident avoidance or other reasons deemed sufficient by the officials.
- D9.1.2 A cone is Down or Out (DOO) if the cone has been knocked over or the entire base of the cone lies outside the box marked around the cone in its undisturbed position.
- D9.1.3 Cones that are DOO are not replaced/reset during autonomous running. There will be no re-run due to cones in the driving path or disorientation due to missing cones.
- D9.1.4 The DOO penalty, see D9.1.7, is added for each DOO including entry and exit gate cones before the start and after the finish line, that occur on that particular run.
- D9.1.5 Off-Course (OC)
- An OC occurs when the vehicle has all four wheels outside the track boundary as indicated by edge marking.
 - Missing one or more gates of a given slalom at autocross or endurance is counted as one OC per occurrence.
 - When an OC occurs, the driver must re-enter the track at the next possible point.
 - When re-entering the driver needs to wait for a gap and follow the instructions of the track marshals.
- D9.1.6 An Unsafe Stop (USS) is defined as not stopping within the specified area and/or not entering the finish-state described in T 14.8 within 30 s after stopping during autonomous running.
- D9.1.7
- | | Acceleration | Skidpad | Autocross | Endurance | Trackdrive |
|-----|--------------|---------|-----------|-----------|------------|
| DOO | 2 s | 0.2 s | 2 s | 2 s | 2 s |
| OC | DQ | DQ | 10 s | 10 s | 10 s |
| USS | DQ | DQ | DQ | n/a | –50 points |
- D9.1.8 Failure to obey a flag: 1 min time penalty.
- D9.1.9 Reckless or aggressive driving or “Over Driving”: BLACK FLAG, see D 2.1.2.
- D9.1.10 Vehicle to vehicle contact: 2 min up to DQ depending on the nature of the incident.
- D9.1.11 If a vehicle is not able to start the run, within 30 s after receiving a GREEN FLAG or go-signal, the vehicle is DQ for that run.

D9.2 Endurance Penalties

- D9.2.1 Teams that are running out-of-order as defined in the competition handbook, are penalized by 2 min and may then run at the discretion of the officials.
- D9.2.2 Mechanical Problem: The time taken for mechanical inspection under a BLACK FLAG WITH ORANGE DOT, see D 2.1.3, is considered officials’ time and is not included in the team’s total time. If the inspection reveals a mechanical integrity problem the vehicle is disqualified.

D9 Dynamic Events Penalties

- D9.2.3 If it is impossible to impose a penalty by a stop under a BLACK FLAG, e.g. not enough laps left, the officials may add an appropriate time penalty to the team's elapsed time.
- D9.2.4 A team may be disqualified if their vehicle is too slow or being driven without proper control. A vehicle is considered to be too slow if the average speed, based on lap times, for two consecutive laps is below 8 m/s in dry conditions or below 5 m/s in wet or damp conditions.
- D9.2.5 Any violation to the procedure of driver change, see D 7.5.3, will lead to a time penalty of up to 2 min.
- D9.2.6 All rules and penalties from IN 12 are also applicable during driver change.

D9.3 [CV ONLY] Efficiency Penalties

- D9.3.1 Should the fuel level change after refueling due to effects such as described in CV 2.7.1, the difference in fuel level will be measured and twice the amount will be added to the official fuel consumption figure.

D9.4 [EV ONLY] Power and Voltage Violation Penalties

- D9.4.1 A violation is defined as using more than the maximum power, see EV 2.2, or exceeding the specified voltage, see EV 4.1.1, after a moving average over 500 ms is applied to the respective data logger signal, see EV 4.6.
- D9.4.2 Each violation will result in the team being disqualified for the fastest valid run of the event.. If a violation occurred during two runs, the two fastest valid runs will be disqualified etc. .
- D9.4.3 The respective data and the resulting decision of violations may be made public.
- D9.4.4 Non-availability of data logger data will be treated as a violation.