

Competition rules



**14th International
AVENTICS Pneumobile Competition**



Competition rules

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A. Vehicle specification

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General vehicle specification and safety requirements

1.1 Construction of vehicle

- a. The driver has to stay inside the vehicle.
- b. The driver has to be in a sitting position in the vehicle and the frame has to enclose the seat.
- c. Recommended number of wheels for the competition in 2021 is 4, which has to be arranged at least in 2 wheel-tracks.
- d. New vehicles must be built with 4 wheels. In 2022, most likely only vehicles with 4 wheels will be allowed to race.

1.2 Dimensions

Maximum allowed dimensions of vehicle are

- a. Length: 2500 mm
- b. Width: 1700 mm
- c. The height is the 90% of the width.
- d. The clearance between the bottom of the vehicle and the ground surface must be at least 70 mm

Dimension related rules

- a. Tank and pressure reducer cannot be higher than 50% of vehicle wheelbase.
- b. The highest point of the buffer tank and the engine cannot be higher than 60% of the width (max.1020 mm)
- c. If a vehicle has 4 wheels, the the wheel base of the axle with the smaller wheel base must be at least 60% of the other wheel base.
- d. 3-wheeled vehicles: the angle of the wheels is min 30 degree
- e. The engine must be placed in the vehicle so that its parts extend maximum 200 mm from the farthermost points of the front and back wheels.

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General vehicle specification and safety requirements

1.3 Frame and body

1.3.1 General information

- Vehicle frame must protect the driver, the compressed air tank and pressure reducer, which means that the tank together with pressure reducer must be placed inside the vehicle frame.
- It is not obligatory to design and build complete car body, but driver must be protected by shields from moving elements of motor and drive chain.
- Two separated even surfaces with size of A3 shall be provided on the front and on the left side of the vehicle for the start number plates.

Vehicle that does not meet this request will be, for safety reason, disqualified from all races.

1.3.2 Structural shaping/forming

Bodywork must follow these rules:

- Minimum 6 points type cage is allowed.

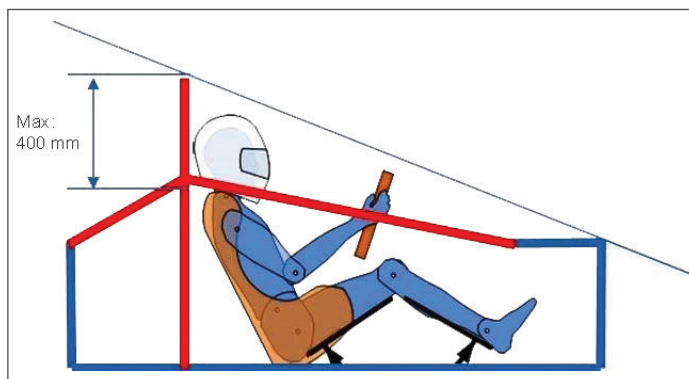


Figure 1 Protection of the driver.

- Steel or aluminum must be used as material of main rollbar. If it is made of steel, the tube diameter must be at least 25 mm, and the wall thickness must be min. 2 mm. If the rollbar is made of aluminum its diameter must be at least 32 mm and the wall thickness min. 2 mm
- The frame must be stiff enough to ensure head-protection for the driver too, so a headrest or a seat with headrest must be built in the vehicle.
- The highest point of the rollbar must be placed in line with the headrest, and it must be 5 cm higher than the helmet-level of the driver in driving position.

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- e. The backups of the roll cage must be inside 400 mm from the highest point of the rollbar.
- f. At shoulder height, roll bar must be min. 700 mm wide.
- g. The side bar must be in muster height.
- h. The vehicle frame has to provide the protection of the leg space.
- i. The roll cage and the sitting position must be formed according to Fig 1. illustration- the driver' body parts must not reach above the line which is fitted to the frame.

1.3.3 Fixing and position of main pressure tank

- a. Compressed air tank must be placed within the vehicle frame that way that assures protection against impact during a crash.
- b. Special attention must be pay on position and protection of pressure reducer.
- c. Any parts of the tank must not be lower that bottom of a frame.
- d. The position of the tank could be fixed inside or besides/outside the frame (Fig. 2 illustration).
- e. If it is placed outside, a subframe has to cover it which has to be made of the same material as the roll cage.

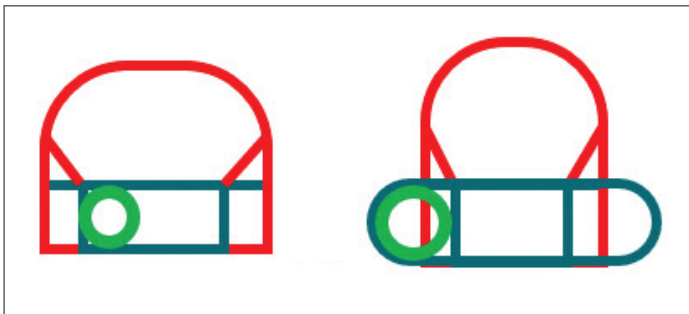


Figure 2

- f. Tank must be fixed with stable way that avoids slipping and moving during race in any direction (tank is not allowed to move neither to the sides, nor forwards/backwards).
- g. It is not allowed to use rubber band to fix the tank.
- h. Tank and pressure reducer cannot be higher than 50% of vehicle wheelbase. Tank cannot be in standing position.
- i. Easy access to closing valve must be assured.
- j. Easy tank exchange must be considered.
- k. It is mandatory to ensure the visibility of the pressure reducer.

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General vehicle specification and safety requirements

1.3.4 Fixing and position of buffer tank

- a. Buffer tank must be placed within the vehicle frame that way that assures protection against impact during a crash.
- b. Puffer container must be fasten to the frame with the appropriate strap or the welded feet of the container with at least M8 screws.
- c. The connection(s) of the buffer tank must be inside of the frame, protection against crash is mandatory.

1.4 Safety Rules

- a. It is mandatory to wear safety motorbike helmet (fulfilling the requirements of the ECE 22.05 standards) by the drivers and the passengers of the vehicles during different races. Use of other safety helmets (e.g. bicycle helmet) is not permitted.
- b. If the helmet does not have plexi to protect the face, it is obligatory to wear goggles.
- c. Drivers have to wear closed shoes and gloves.
- d. Drivers must wear long sleeve clothing (tops/shirts) and long trousers during all races.
- e. All equipment needed for vehicle control, especially safety equipment, must be easy accessible by driver.
- f. Drivers have to be able to leave the car within 15 seconds and they have to be able cut off the voltage and compressed air supply of the vehicle.
- g. Driver must sit in a seat equipped with a four fixing position belt, that is able to fasten the driver so that the shifting is prevented.
- h. Vehicle must be equipped with two rear-view mirrors.
- i. The vehicle must be equipped with minimum 1 brake light.
- j. The vehicle has to have an electrical emergency stop switch, which is easily accessible from the outside.
- k. The electrical emergency swith must be marked with red-white triangle (red frame, white inside).
- l. The battery must be placed in an IP54 protection class casing, which prevents the batteries from moving.
- m. Using of the predesigned pneumatic safety circuit is obligatory.
- n. Safety circuit must be mounted on red plate and placed in such place that allows easy access to it for driver and from outside of vehicle.
- o. The frame must protect the driver's leg.
- p. The driver must be separated from all moving parts.
- q. The roll cage is according to 1.3.2.

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General vehicle specification and safety requirements

1.5 Pneumatic control system and parts

1.5.1 Main pressure tank

- a. The source of energy is a 10 litre pressure-tank filled with air, nominal pressure of 200 bars.
- b. Training pressure tank: diameter 140 mm, total length of the tank: 1300 mm
- c. Race pressure tank: diameter 140 mm, total length of the tank: 900 mm
- d. The tank has a pressure-reducer. Type: Messer FC-2000
- e. Connection of pressure-reducer: Plastic pipe: Ø 12 mm
- f. More detailed data can be downloaded from site <http://www.pneumobil.hu> in download section.

1.5.2 Puffer Containers

- a. Only buffer containers qualified by the manufacturer can be applied on the vehicle.
- b. Qualification must be proved with certificate (type 3.1) or based on the technical data available on the container during the vehicle check.
- c. Plastic tank (neither PET) can't be built in any way as puffer.
- d. Sum volume of all puffers can't be more than 60 liters.
- e. Puffer containers must be installed that way that they are unpressurized by activation of safety stop circuit.
- f. Puffer container must be connected to a circuit by 3/2 valve. Turning off a valve will exhaust air from puffer container. (Example of possible puffer containers connection is given on figures 3-4.)

1.5.2 Buffer Tank

Puffer tartály bekötése megkerülő ággal
Conenction of puffer container with by-passing

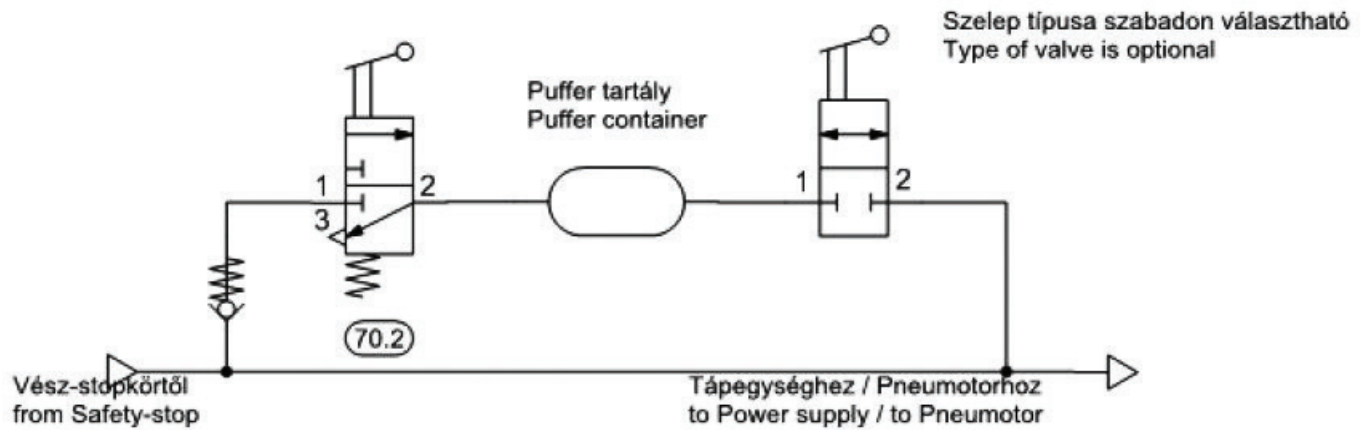


Figure 3

1.5.2 Buffer Tank

Puffer tartály bekötése megkerülő ág nélkül
Connection of puffer container without by-passing

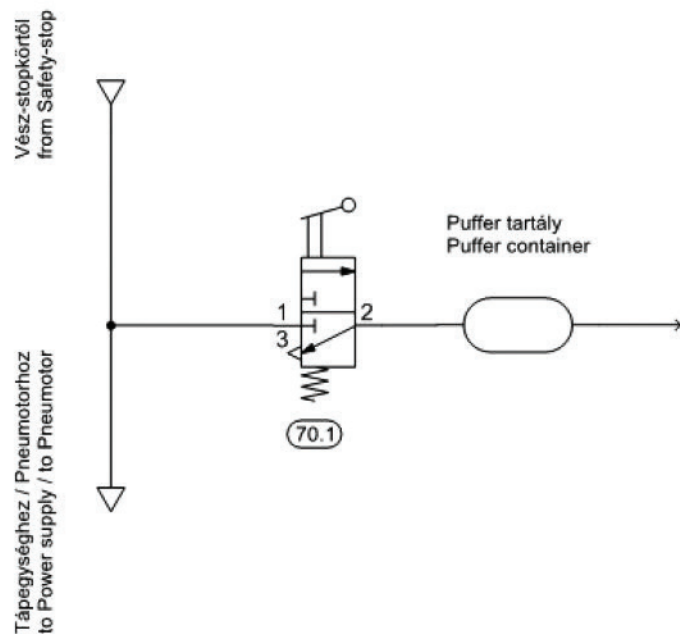


Figure 4

Chapter 1.

General vehicle specification and safety requirements

1.5.3 Safety stop circuit

Using of pneumatic safety circuit on air pressure input is obligatory.

- Safety circuit is given and cannot be changed.
- Safety circuit must be mounted on red plate and placed in such place that allows easy access to it for driver and from outside of vehicle.
- Technical specification of safety circuit is presented on figure 5.

1.5.3 Safety stop circuit

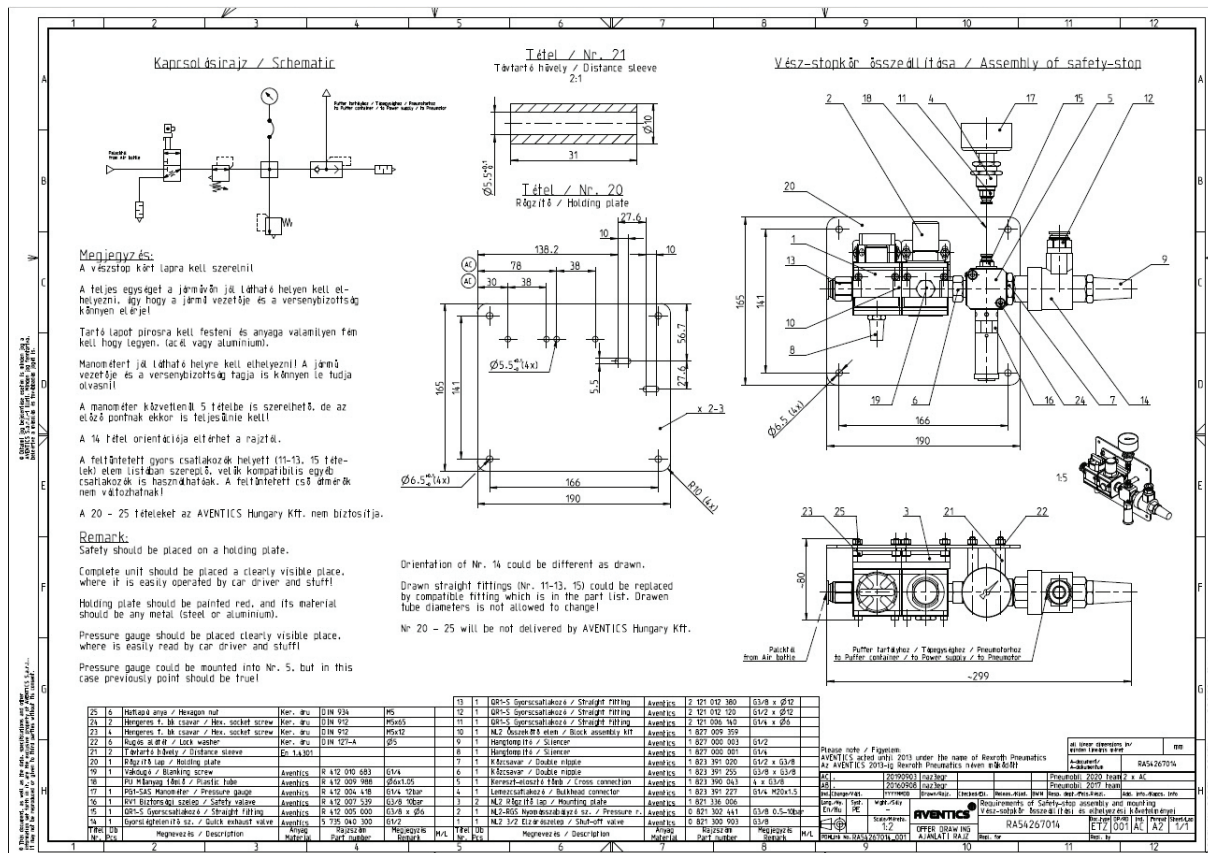


Figure 5 Pneumatic safety circuit. (See : http://pneumobil.hu/pneumobil_2019/letoltesek)

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General vehicle specification and safety requirements

1.5.4 Air supply

- Air supply unit must be placed after safety stop circuit.
- Supply units examples are shown on figures 6-9: solutions differ from it have to be approved by the jury.
- The free exhaust of air must be ensured.

1.5.4 Air supply

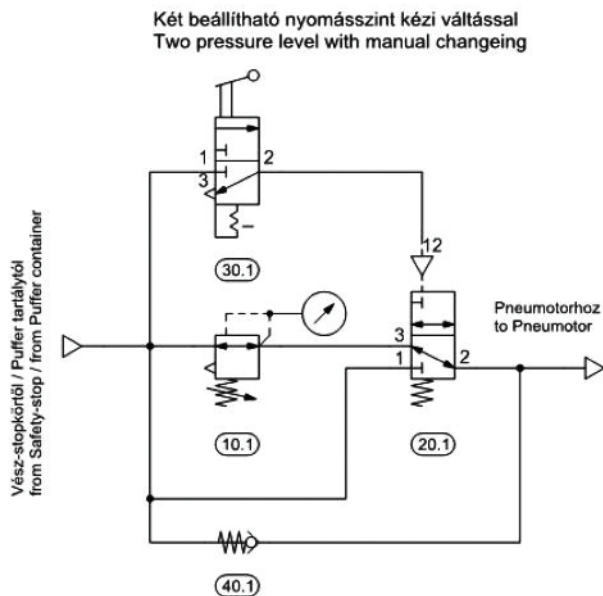


Figure 6

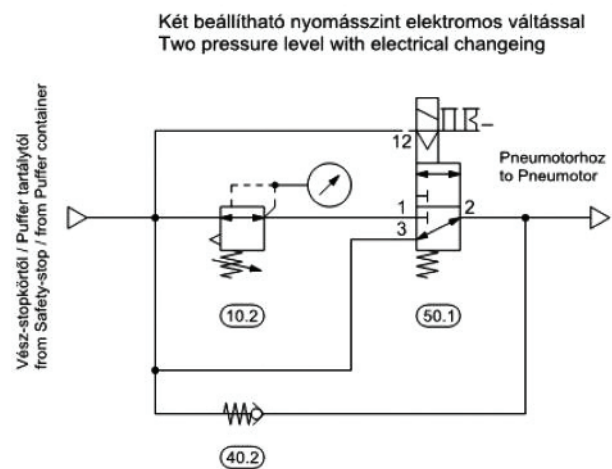


Figure 7

1.5.4 Air supply

Manuálisan fokozatmentesen beállítható üzemi nyomás
Manuali infinitely setupable working pressure

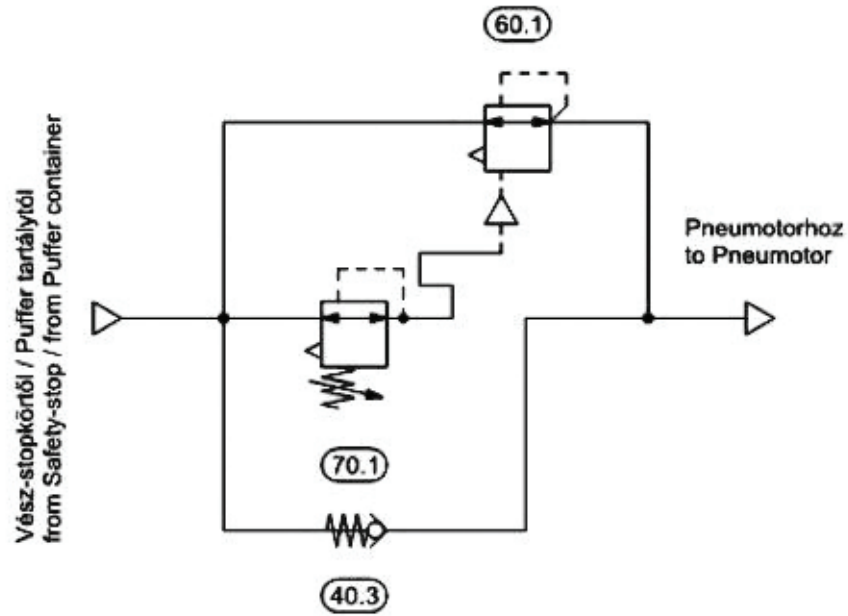


Figure 8 Mechanical accelerator pedal

1.5.4 Air supply

Elektromosan fokozatmentesen beállítható üzemi nyomás
Electrically infinitely setupable working pressure

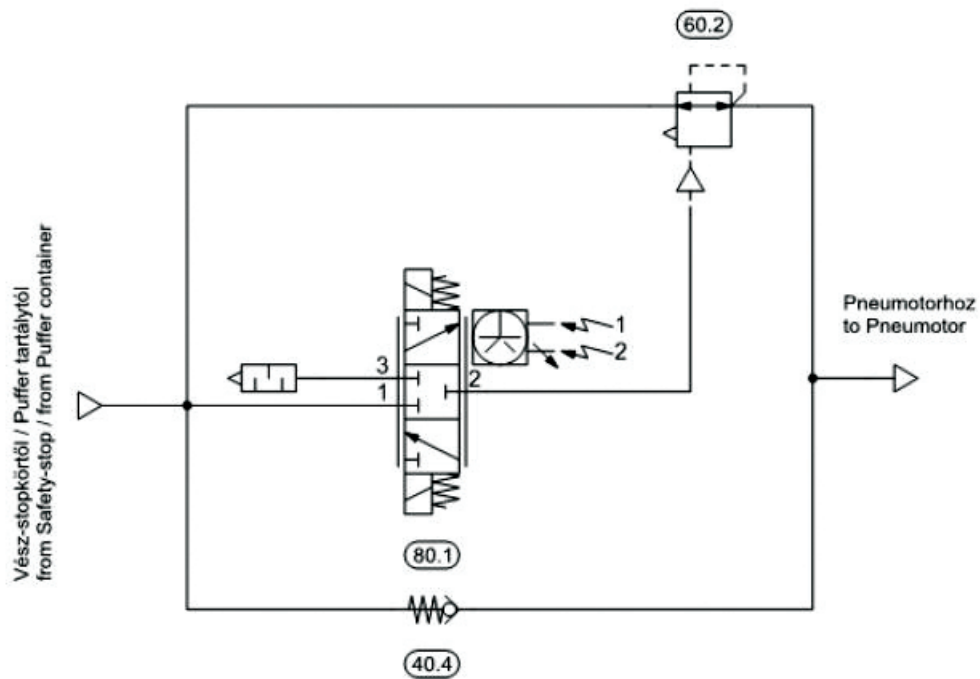


Figure 9 Electrical accelerator gas pedal

Chapter 1.

General vehicle specification and safety requirements

1.5.5 Pneumatic system

- a. Pneumatic system must only contain Emerson's AVENTICSTM products. Using other brand product is prohibited.
- b. Emerson is supporting the teams with the pneumatic elements needed to prepare vehicle for competition.
- c. Complete list of elements that can be used for vehicle design can be found in the PneuShop on the PneuReg website.
- d. To select the pneumatic elements and their accessories use the following link:
http://en.pneumobil.hu/pneumobile_2019/downloads/demand_of_elements

AV valve system application

- a. The catalog page is available here:
<https://www.aventics.com/de/en/pneumatics-shop/pgr.256256>
- b. Valve system allows piloting of pneumatic elements.
- c. Bus control (protocols available on catalog page).
- d. No separate application is required, the use of the valve island must be described in the technical documentation.
- e. The best 5 of the presented solutions will be accepted, and these teams will be provided with free valve island.
- f. The valve island configuration page must be uploaded to PneuReg.
- g. Further information: Zsolt Piukovics - zsolt.piukovics@emerson.com

Presenting of the pneumatic circuit is mandatory

- a. Pneumatic schematic must contain one of standardized safety stop circuits. Modification of stop circuits is prohibited.
- b. Pneumatic schematics must be prepared in D&C scheme editor software that is available in the following link: [Scheme editor software download:](https://www.aventics.com/hu/service/engineering-tools/circuit-diagram-software/)
<https://www.aventics.com/hu/service/engineering-tools/circuit-diagram-software/>
- c. All elements on the drawing must be indexed with individual index number for easy identification, and the index numbers must be in accordance with the PneuShop Order List.

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General vehicle specification and safety requirements

1.6 Electronic system

1.6.1. General information

- a. Power supply device will not be supplied by Emerson.
- b. All electrical equipment delivered by organizer are designed for industrial 24 VDC control system and because of that 24 DC power supply voltage is preferred. Usage of power supply voltage higher than 48 V DC is prohibited.
- c. Electrical control elements must be protected from harmful atmospheric conditions by electrical cabinet with insulation class not lower than IP54 according to IEC standard 60529.

1.6.2 Electronic control system

Rules regarding the control system:

- a. Vehicles from previous races may use their old control system (Rexroth PLC, PIC, Rasberry PI, own microcontroller, etc.)
- b. Emerson's Machine Automation Solution products must be used to control the pneumatic engine of **ALL THE NEW VEHICLES** - see section 1.6.3
- c. Auxilary control may be used on the vehicle (telemetry, shift control, etc.)

1.6.3 Using Emerson PACSystems Controller/IPC and I/O

NEW

General rules:

- a. There are two options available: PACSystem Controller or IPC and I/O
- b. The description of the control system must be included in the technical documentation in english
- c. An ideal system description should be no more than 5 pages, will contain a detailed explanation on what sensors and actuators the team will pair with the system given and what are the most important measured and controlled properties of the vehicle.
- d. The application could include details of electrical and pneumatic control schemes along with information regarding any algorithms and diagnostics to be implemented. Electrical and machine safety could also be considered.
- e. The documentation should contain a list of the products to be used, along with the product name (Part Number).

Products offered for the competition (Option 1 and 2):

Option 1: PACSystems RSTi-EP Programmable Automation Controller And I/O

This option combines a PACSystems RSTi-EP Programmable Automation Controller (PAC or PLC) CPU along with I/O, software and an optional operator interface. These components can be combined to create a high performance control system to allow control and monitoring of the Pneumobil.

PACSystems RSTi-EP Controller

RSTi-EP CPUs provide real time control, taking user setpoints and inputs and processing them via the user's application to write outputs to perform the required control function.

Main features:

- a. Supports IEC 61131-3 programming including ladder logic, structured text and function block diagram; C subroutines are also supported
- b. Supports real-time application status and remote diagnostics
- c. Dual LAN interfaces with four Ethernet ports and built-in RS-232 serial port
- d. Support for a range of communications protocols, including OPC UA, Modbus TCP and PROFINET
- e. 1 MB of non-volatile user memory
- f. DIN-rail or panel mount
- g. Scan times would be expected to be in the order of 20ms

Available components:

- a. EPSCPE100 PACSystems RSTi-EP CPU with 1Mb memory

Further information: <https://www.emerson.com/en-us/catalog/automation-solutions/control-safety-systems/programmable-automation-control-systems-plc-pac/emerson-epscep100>

RSTi EP High Density, High Performance I/O:

RSTi-EP I/O is a powerful combination of clean layout, high density, and small footprint. It can accommodate up to 64 I/O modules and 1,024 I/O points per drop.

Main features:

- a. Network adapter support for PROFINET IRT over Ethernet at 100 Mbps for communication with the CPE100 controller
- b. GSDML support for configuration via controller software
- c. Built-in web server for configuration and diagnostics
- d. Hot-swap IO and inputs and outputs to enable service activities to be performed while the system is active

- e. Easy error diagnosis allows errors to be localized instantly with an LED directly on the channel and status indicators on every module
- f. High speed system bus communicates up to 1,024 discrete inputs or outputs and 256 analogue inputs and outputs
- g. Optional safe feed input for EN ISO 13849 machine safety
- h. DIN-rail mount

Available components:

- a. EPXPNS001 PROFINET IRT Network Adapter
- b. EP-1218 Digital Input, 8 Points, Positive Logic, 24VDC 2 Wire
- c. EP-2218 Digital Output, 8 Points, Positive Logic, 24VDC, 0.5A, 2 Wire
- d. EP-3164 Analog Input, 4 Channels Voltage/Current 16 Bits 2, 3, or 4 Wire
- e. EP-3704 4 Channels RTD 16 Bits with Diagnostics 2, 3, or 4 Wire (for temperature sensors)
- f. EP-4164 Analog Output 4 Channels Voltage/Current 16 Bits 2, 3, or 4 Wire
- g. EP-7641 1 Channel 24VDC Input Flow 10A for extra current needs
- h. EP-1901 Safe feed input module, single channel (SIL3)

Further information: <https://www.emerson.com/en-us/catalog/industrial-i-o/distributed-slice-i-o>

PAC Machine Edition software tool:

PAC Machine Edition (PME) is used to develop, configure and diagnose the system.

Main features:

- a. Supports configuring and programming of the PACSystems controller range using IEC61131-3 languages including ladder logic (LD), structured text (ST) and function block diagram (FBD)
- b. Supports object oriented (OO) programming with User Defined Function Blocks (UDFBs) and User Defined Data types (UDTs)
- c. Supports C subroutines with C programmer's toolkit (free download)
- d. PROFINET discovery tool (DCP) is used to discover and configure PROFINET IO devices
- e. Supports configuration of QuickPanel+ screens and scripts

Available components:

- a. MEMBL001 PAC Machine Edition Lite Development Suite

Further information: <https://www.emerson.com/en-us/catalog/automation-solutions/control-safety-systems/machine-edition-pps/emerson-membl001>

Optional accessory: QuickPanel+ Operator Interface

QuickPanel+ is a modern, high performance operator interface featuring a Human Machine Interface (HMI) with a scripting engine for custom functions.

The QuickPanel+ includes various graphic objects to create screens which are animated from variables obtained from the controller. Other capabilities include security, alarming and trending.

The scripting engine supports VB .NET to allow data manipulation and analysis and data logging to local storage or to a cloud-based server.

Main features:

- a. 7" wide screen TFT display (800x480 pixels) with PCAP touch input
- b. 1 GHz ARM CPU
- c. 512Mb memory for storage of application, screens and data
- d. Ethernet interface and serial interface
- e. SD card slot for local data storage and application backup
- f. VESA or panel mount

Available components:

- a. IC755CSW07CDA QuickPanel+ 7"

Larger display sizes could be made available.

Further information: <https://www.emerson.com/en-us/catalog/automation-solutions/control-safety-systems/human-machine-interfaces-hmi/emerson-ic755ckw07cdmep>

Option 2: RXi Panel PC Incorporating Industrial PC, display and RSTi-EP I/O

This option combines an RXi Panel PC incorporating an Industrial PC (IPC) with RSTi-EP I/O. These components can be combined to create a high performance control system to allow control and monitoring of the Pneumobil.

EMERSON will provide Windows 10, pre-installed on the IPC. This allows the team to create their own application to perform the required control function. As an alternative to Windows 10, the IPC could run Linux which would allow the use of programming languages such as Python and packages such as Node-RED, InfluxDB, Grafana etc.

RXi Panel PC Incorporating Industrial PC And Display

The RXi Panel PC modular display portfolio combines multiple options of separable screens and computing units to maximize flexibility, performance and durability.

Main features:

- a. 7" wide screen TFT display (1024x600 pixels) with PCAP touch input

- b. Dual Core 1 GHz AMD (x86/x64 compatible) CPU (GX-210HL)
- c. 8Gb RAM
- d. 128Gb SSD
- e. 2x Ethernet interface, 2x USB interface and 2x serial interface
- f. uSD card slot
- g. Windows 10 OS (Linux could also be installed)
- h. VESA or panel mount
- i. Scan times would be expected to be in the order of 50-100ms

Available components:

- a. IC758CSWB07PC128 7" RXi - Panel PC, 8Gb RAM, 128Gb SSD, Windows 10 IOT Enterprise LTSB, Widescreen
Larger display sizes and sunlight readable (SLR) displays could be made available.

Further information: <https://www.emerson.com/en-us/catalog/automation-solutions/control-safety-systems/programmable-automation-control-systems-plc-pac/emerson-ic758cswb07pc128>

RSTi EP High Density, High Performance I/O:

The innovative RSTi-EP I/O is a powerful combination of clean layout, high density, and small footprint. It can accommodate up to 64 I/O modules and 1,024 I/O points per drop.

Main features:

- a. Network adapter support for Modbus TCP over Ethernet at 100 Mbps for communication with the IPC
- b. Built-in web server for configuration and diagnostics
- c. Hot-swap IO and inputs and outputs to enable service activities to be performed while the system is active
- d. Easy error diagnosis allows errors to be localized instantly with an LED directly on the channel and status indicators on every module
- e. High speed system bus communicates up to 1,024 discrete inputs or outputs and 256 analogue inputs and outputs
- f. Optional safe feed input for EN ISO 13849 machine safety
- g. DIN-rail mount

Available components:

- a. EPXMBE001 Modbus TCP Network Adapter
- b. EP-1218 Digital Input, 8 Points, Positive Logic, 24VDC 2 Wire
- c. EP-2218 Digital Output, 8 Points, Positive Logic, 24VDC, 0.5A, 2 Wire

- d. EP-3164 Analog Input, 4 Channels Voltage/Current 16 Bits 2, 3, or 4 Wire
- e. EP-3704 4 Channels RTD 16 Bits with Diagnostics 2, 3, or 4 Wire (for temp. sensors)
- f. EP-4164 Analog Output 4 Channels Voltage/Current 16 Bits 2, 3, or 4 Wire
- g. EP-7641 1 Channel 24VDC Input Flow 10A for extra current needs
- h. EP-1901 Safe feed input module, single channel (SIL3)

Further information: <https://www.emerson.com/en-us/catalog/industrial-i-o/distributed-slice-i-o>

Technical support

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Chapter 1.

General vehicle specification and safety requirements

1.7 Engine

1.7.1 Input energy

- a. Engine must use energy of compressed air. Input of any other energy used to drive engine is not allowed.
- b. Mixing of system air with external air is allowed. In case of using any equipment that pumps back air to the system this equipment must be driven by compressed air.
- c. Using of heat exchanger is allowed. Both free and driven air flow heat exchangers are enabled. In case of using fan it must be driven by compressed air.

1.7.2 Construction

- a. The conversion of energy of compressed air to mechanical energy must be performed by pneumatic cylinders and valves by Emerson's AVENTICSTM brand. Using of pneumatics components provided by other companies is strictly prohibited.
- b. Allowed cylinders:
 - Type: PRA series
 - Quantity max 4 pcs
 - Diameter: Ø50 - Ø100
 - Stroke: 200...500 mm, in standard steps
- c. To select the pneumatic elements and their accessories use the following link:
http://en.pneumobil.hu/pneumobile_2019/downloads/demand_of_elements
- d. Only one engine can be used in the vehicle, which makes up one mechanical unit (there is only one turn-out main axle).
- e. When the engine works, the working cylinders rotating the main axle are only allowed to be disconnected without changes in the drive-chain, only by pneumatic (electro-pneumatic) switching.

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General vehicle specification and safety requirements

1.7.3 Redesign of AVENTICS™ pneumatic components

Teams have the opportunity to redesign Emerson's AVENTICS™ products.

Possible components: cylinders, valves.

Authorization of the conversion is subject to a separate application, which includes the following steps:

- a. By 1 December 2020, the intention to convert shall be notified to the appointed consultant
- b. By 31.12.2020, the application must be submitted together with the design documentation, including a brief description of the conversion, calculations and technical drawings

Possible conversions, **redesings**:

- a. Integration of cylinder parts in the drive chain
- b. Reducing the frictional resistance of a cylinder
- c. Optimization of flow

1.7.4 Placement in vehicle

- a. The engine must be placed in the vehicle so that its parts extend maximum 200 mm from the farthermost points of the front and back wheels. However, the extended parts have to be protected with a frame which is welded to the vehicle frame and on which there is also a cover.
- b. Parts not belonging to the engine may extend longer.
- c. The engine must be visible for the jury.

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General vehicle specification and safety requirements

1.8 Drive chain

- a. The drive chain can be optionally built with geared or direct transmission.
- b. Electric or hybrid drive is not allowed!
- c. The drive-chain must contain a free-wheel (compulsory) and/or clutch (optional).
- d. The vehicle have to be moveable forwards and backwards.
- e. Modification in the drive chain (adjustment) is allowed between the races under condition that all the engine components are used during all modes; no parts can be added or removed.
- f. Adjustments can be made only on the existing functional parts of the drive chain.

1.9 Suspension/Wheel fixing

- a. Any kind of wheel suspension principle is applicable.
- b. The diameter of wheels is min. 16"
- c. Front wheels cannot be bigger than 26", with at least 28 spoke of wheel and min. double-wall rim.
- d. Plastic elements at the suspension are not allowed..
- e. The pavement of runway is asphalt.

1.10 Steering gear

- a. The vehicle can be equipped with any kind of steering gear.
- b. The vehicle must be easily steered, the driver must be able to drive easily straight and take a bend, by normal force.
- c. Maximal allowed play in a steering gear system is 10 degree measured on with fixed wheels steering wheel.
- d. Plastic elements at the steering gear are not allowed.
- e. The vehicle must be able to turn around on the 8 m wide speedway.

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General vehicle specification and safety requirements

1.11 Brakes

- a. Every wheel of the vehicle must be equipped with an operating brake system.
- b. Brakes must be built in two independent cycles in order to guarantee efficient speed reduction of the vehicle and to stop the car. (e.g.: in case of a 4-wheel vehicle with a mechanic brake system (with bowdens) two bowdens are requested to be connected to the pedal one to the front and one to the back wheels. If one of the cycles (bowdens) gets damaged the other one must still work.
- c. Vehicles must be equipped with a hand/parking brake (it can be also a mechanical lock of one of the brake-circles).
- d. Settings of the brake will be checked with a brake-test during technical-check. While braking, both brakes must work on the same efficiency level (“wandering of the steering-gear” is not admitted).

1.12 Starting plates

The vehicle must be provided with two separate A3 flat surfaces to accommodate the number plate (front and left, in a conspicuous position), which may be on the bodywork or on a separate board for this purpose. In the absence of a suitable surface, the vehicle could not participate.

B. Technical documentation and demand of elements

Chapter 2.

Technical documentation – evaluation and rating rules

- a. Documentation has to be submitted in a „pdf” document.
- b. Every attachment, figures, drawings, simulations have to be pasted into this file (the whole content).
- c. Documentations arriving in more files will be rejected (for supplement) before evaluating.
- d. Each page of documentation must contain page number and documentation version number. In case of documentation modification version number must be increased and new complete documentation must be uploaded to a server. .
- e. Documentation must be prepared in Hungarian or English language.
- f. Documentation must be checked and approved by supporting teacher, who confirms approval with signature.
- g. Jury checks documentation point by point and gives points to each chapter.
- h. Maximum number of points for each section is listened on the right side. Each section contains also explanation what must be presented in given section and what will jury evaluate.
- i. Maximum 100 points can be reached by team. Table below presents rules of documentation evaluation.

Description	Documentation Max Point	Delay Factor	Summary
Documentation sent and accepted for first deadline	100	1	100
Documentation sent and accepted for second deadline or fixed after jury comments	100	0,9	90
Documentation sent and accepted for third deadline or fixed twice after jury comments	100	0,7	70

Chapter 2.

Technical documentation – evaluation and rating rules

Detailed requirements and responding points assigned to it are presented in tables below.

Compliance with safety rules

Safety regulations	
Accepting the general safety rules	
Presentation of the dimension-related rules	
Tank and pressure reducer cannot be higher than 50% of vehicle wheelbase.	
The highest point of the buffer tank cannot be higher than 60% of the width (max.1020 mm)	
The engine's highest mechanical element point is 60% of the vehicle width. (Max:1020 mm)	
Presenting the wheel base (4 wheeled vehicles)	
Presenting the angle of wheel positin (3 wheeled vehicle)	
Mounting and position of main pressure tank	
Compressed air tank must be placed within the vehicle frame that way that assures protection against impact during a crash.	
Presenting the protection of pressure tank (training and race tank as well)	
Presenting the protection of pressure reducer	
Presenting the visibility of pressure reducer	
Pressure tank mounting	
Mounting and protection of buffer tank	
Buffer tank must be placed within the vehicle frame that way that assures protection against impact during a crash.	
Presenting the protection of the connection of buffer tank	
Pressure tank mounting	
Engine placement	
Drawing, that shows the position of the engine inside the vehicle. The engine must be inside the vehicle chassis, taking into account the technical requirements.	
The driver must be separated from moving parts of the engine and gear unit by a protective wall.	
Brakes	
Dual brake system (figures, remark)	
Calculation of brake distance	
Parking brake	
Brake light	
Turning radius	
Showing, that the turning radius is less than 8m	

Chapter 2.

Technical documentation – evaluation and rating rules

Presentation of vehicle

General presentation of the design and construction of the vehicle	Points
A brief description of the vehicle.	5
Presenting the unique features to the jury.	
If the vehicle was not manufactured this year, a presentation of previous years' experience and results	
3D model of the vehicle	Points
Image of a 3D model showing a general view of the entire vehicle.	2
Presentation of vehicle dimensions	3
The plane projections of the vehicle (top view, front view, side view) by specifying the main dimensions and marking the center of gravity.	
The total length, width and maximum height shall be indicated.	
Indication of wheel diameter	
Indication of ground clearance	3
Frame presentation, CAD model	
Description of materials used and execution.	
Description of the fasteners used.	
3D or 2D CAD model about the vehicle chassis	3
Demonstration of the mechanical strength of the frame by calculation or simulation.	
Vehicle Starting Plates	3
Description of the vehicle body, materials used.	
Indication of the position of the start plates on the body	

Engine and drive chain presentation

A detailed description of the engine structure	Points
Drawings showing the structure of the engine in detail.	10
The cylinders and mountings purchased from AVENTICS™ and the linear actuators should be marked on the drawings.	
Kinematic diagram and description of the movement of the engine from the cylinders to the crankshaft.	
Drive Chain Introduction	
Kinematic sketch of the drive train from crankshaft to driven wheel (s).	
Calculations	5
Calculations of:	
a. Calculation of the total volume of the cylinders.	
b. Nominal speed of the piston rod at 6.3 bar.	
c. Crankshaft speed and torque per minute.	
e. Torque and speed calculations on wheel at 6.3 bar supply.	
f. A description of the maximum speed of the vehicle is required.	

Chapter 2.

Technical documentation – evaluation and rating rules

Presentation of control system

Schematic diagram of pneumatics	Points
Schematic diagram of pneumatics made with D&C scheme editor.	12
The schematic drawing must include all cylinders, valves, air preparation elements and pressure sensors. It is not necessary to present the connectors.	
Description of the standard emergency stop system used.	
The item numbers must match those of PneuShop.	
Pneumatic drawing element list	
Elements list of pneumatic drawing elements (cylinders, valves, sensors) - item number, material number, designation, quantity	3
The item numbers must match those of PneuShop.	
Schematic diagram of electronics	
To present a schematic diagram of electronics on one or more A4 pages.	10
The electronic circuit must include all electronic components, with particular regard to the sensors, electropneumatic valves required.	
* Teams that do not use electronics will automatically receive a maximum score of 8.2.	
Description of the control system	
Detailed description of control functions: speed control, operating modes	20
The description must include all the elements (primarily valves) in the drawings, with the item number shown on the drawings.	
The function of all pneumatic elements (valves, flow regulators, pressure regulators, sensors) must be indicated	
At this point, the control system used must be specified.	
If the team applies for the AV Valve Island, this section should explain its intended use	

Suspension and steering wheel presentation

Front wheels	Points
Diagram and description of the front wheel suspension.	3
Description of the braking system used.	
Rear wheels	
Diagram and description of rear wheel suspension.	3
Description of the braking system used.	
Introduction of the steering gear	
Diagram and description of used steering gear and operation.	3
Ackermann's Trapeze Drawing (Preferred)	

Innovation

Innovation	Points
High efficiency and innovative use of pneumatic components used in the engine.	10
New and innovative solutions in the vehicle, taking into account the structure and function.	
Application of new solutions and / or technologies.	
Other innovation results	

Chapter 3.

Parts acceptance and delivery

3.1 Parts Acceptance

- a. Parts acceptance is done by jury after evaluation of documentation.
- b. Based on functionality of designed vehicle and quality of presented documentation jury will make decision about acceptance of requested parts.
- c. Accepted parts will be confirmed and delivered to teams according to delivery schedule. .

Parts acceptance will be done based on following rules:

- a. Only parts that usage is presented in documentation can be accepted,
- b. Teams participating in the competition in the earlier years are requested to use the existing pneumatic and control components for construction of vehicles, and to order only the missing elements and accessories.
- c. Jury reserve rights to reject some parts that are not important for vehicle functionality and have significant influence on price of project. In this case jury will consult with teams and try to make decision that is satisfying for both sides.

3.2 Parts delivery

- a. After acceptance of the list of elements by jury, parts will be delivered to teams until 24.03.2021.
- b. Transportation of the elements will be completed by BDI Hungary Kft.
- c. BDI Hungary Kft handles the delivery of other (beside pneumatics) parts for the competition in 2021 with great discount and favourable terms of payment.
- d. In case of interest BDI Hungary Kft will send an offer and specify the order details.
 - 1. E-mail: PneumobilSupport@bdi.hu
 - 2. More information about the company can be found at <https://new.bdiexpress.com/hu/hu/>

Chapter 3.

Parts acceptance and delivery

3.3 Claims and reclamation

Our goal, as organizers of competition is to give all teams equivalent chance to develop, prepare and check performance of vehicle during the races. Therefore we will do all what we can to solve problem caused by parts supplied by Emerson Claims handling will be done according to following rules.

3.3.1 Based rules

- a. All parts delivered by Emerson are covered with guarantee service.
- b. Reclamation will be handled according to standard procedures. Part complaint notification must contain part type, order code and description of problem.
- c. Failures caused by improper handling or use will be rejected.

3.3.2 Reclamation before competition

- a. In case of product failure organizer will replace broken part.
- b. Because of complain check process broken part must be noticed not later than **3 weeks** before competition.
- c. Parts that are destroyed by not proper handling or usage not according to user manual are not covered by guarantee, but still can be replaced on cost of teams.

Chapter 3.

Parts acceptance and delivery

3.3.3 Reclamation on the day of competition

Parts covered by reclamation service.

In case of failures with the AVENTICS™ elements, happening during the event program, organizer provides limited quantity of connectors, standard valves, and plastic tubes for using as spare parts. Spare parts will be provided with following rules:

- a. All parts will be provided in limited quantity.
- b. Broken part must be replaced with same type if available.
- c. Only in case of lack of original part replacement can be offered.

Claims procedure

- a. Broken part must be reported to jury before race.
- b. Defects that happen during a race do not give possibility for re-start in the same race.
- c. Member of jury will check broken part and make decision about replacement.
- d. Part must be replaced by team members.
- e. Maximum reparation duration will be discussed in accordance to actual time schedule
- f. After discussed time team and vehicle must be ready to race. In case unsuccessful reparation and vehicle cannot start on time team will be disqualified from given race.

C. Technical and vehicle check

Chapter 4.

Vehicle check

- During vehicle check members of jury inspect if vehicle is compliant with technical specification and safety rules.
- The checklist can be downloaded from www.pneumobil.hu
- The check procedure is explained in the following points

4.1 Dimensions and construction check

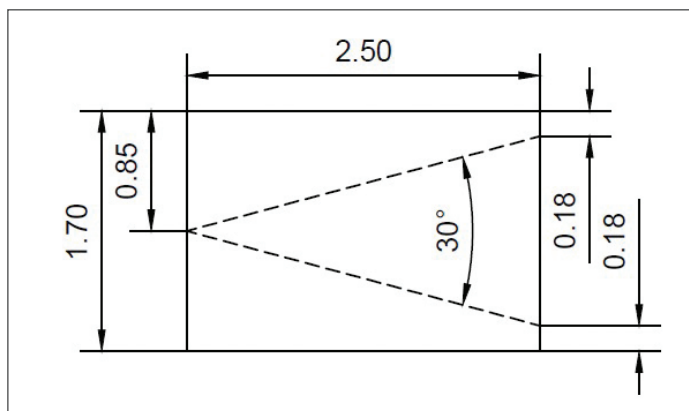


Figure 10 Dimensions check template

4.1.1 Four wheel vehicle check

- Vehicle must drive inside a rest rectangle.
- Every part of the vehicle must be in the rectangle.
- If any part of vehicle is out of rectangle, vehicle will be disqualified

Chapter 4.

Vehicle check

4.1.2 Three wheel vehicle check

- a. Vehicle must drive inside a test rectangle.
- b. Every part of the vehicle must be in the rectangle .
- c. Vehicle must stay that way that one wheel stand on a top of triangle shown on drawing above. Two wheels of vehicle must be outside of triangle.

4.1.3 Ground clearance check

- a. The clearance between the bottom of the vehicle and the ground surface must be at least 70 mm, which will be checked with a 70 mm high bumper on the ground.

4.2 Steering check

- a. The jury will check if steering system is working easy and the vehicle can be controlled without difficulties
- b. Play on steering wheel – jury will check a play on steering wheel. Maximum accessible play is 10 degree (measured from maximal left position to maximal right position).
- c. Play between wheels – member of jury will check stability of steering system by moving free wheel left and right. No play between wheels is allowed. In case of one wheel steered this check will not be performed.

4.3 Checking the compliance of safety regulations

- a. According to 1.4 point, all safety features must be presented.

Chapter 4. Vehicle check

4.4 Brake check

- a. Driver with his vehicle have to stand on a tiltable motherboard. Under the vehicle wheels there is a glued emery cloth with 80 grit size.
- b. Service breaks have to be operating, then the board has to be raised to 20°.
- c. In the case of operating service breaks at 20°, the car has to stay in standing position or it can only slip with standing wheels.

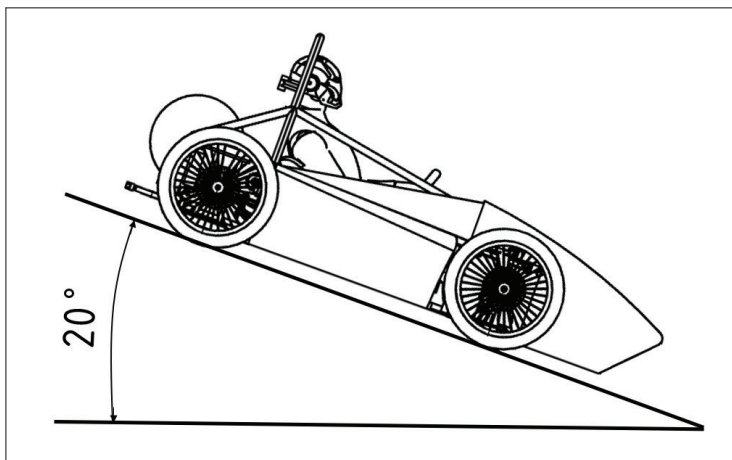


Figure 11 Checking the service breaks

4.5 Parking brake check

- a. The jury will check if parking brake is working properly.
- b. At the actuated position of the parking brake, the vehicle must be able to move (can be pushed away) so that the braked wheels will not turn.

4.6 Checking the stability of the vehicle

- a. Driver with his vehicle have to stand on a tiltable board (Figure 12.). Under the vehicle wheels there is a glued emery cloth with 80 grit size.
- b. Drivers have to be in the car, he has to wear the prescribed protection equipment and he also has to fasten the seat belts tightly.

Chapter 4. Vehicle check

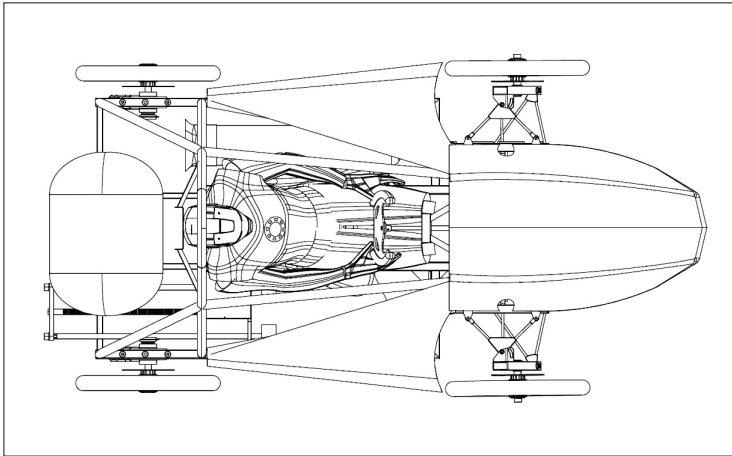


Figure 12 Placement of the car on the board

- c. Then the board has to be raised to 25° (Figure 13).
- d. None of the vehicle wheels are allowed to rise before reaching the 25° and they are also not allowed to rise in the 25° final situation.
- e. If the jury realise that the quantity of the vehicle is not even (for ex. the bigger mass on its right side), the vehicle must be turned over and they also must check it in this way.
- f. The driver can balance the car but if he fails to do it and the vehicle tilts, then the car failed the checking.

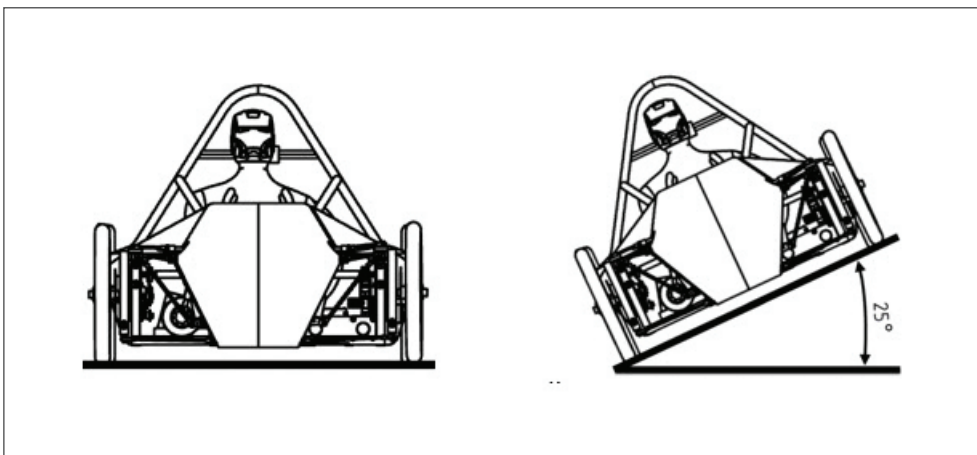


Figure 13 Tipping the motherboards

D. Race categories, rules and program

Chapter 5.

Race categories and rules

5.1 Race categories

1. Technical evaluation
2. Project evaluation
3. Long-distance race
4. Slalom track
5. Acceleration race

5.2 Technical evaluation

- a. In this race category, the design documentation will be evaluated by the jury and based on this evaluation, the list of requested elements will be accepted or refused.
- b. On the competition days the vehicles will be checked, if they are built according to the rules and submitted design documentation, and the applied innovation of design and building will also be evaluated.
- c. In this category the reliability of the vehicle and its run results (during the physical races) will be evaluated too.
- d. The first three prizes can be given only to teams, who has finished all physical races.

Chapter 5.

Race categories and rules

5.2.1 Elaborate the documentation and compile the list of required components

- a. Evaluation will be done based on the criteria defined in the chapter nr. 2.
- b. The maximum score of this segment can be 25% of the total points of Technical evaluation.

5.2.2 Vehicle check

- a. Vehicle check will be done by the jury based on the criteria defined in chapter nr. 4.
- b. Allowance for participating on one or all of the races depends on the result of the vehicle check.
- c. Decision will be taken by the jury, who has the right to refuse the allowance in case of not fulfilling all requirements.

5.2.3 Technical check

- a. Evaluation of the vehicle from the aspect of technical level and comparing it with the other vehicles registered for the competition. The team presents the vehicle according to the following points:
 - 1. Solutions of the pneumatic circuit
 - 2. Innovative content, inventive solutions
 - 3. Applied materials
 - 4. Quality of the construction, appearance, design
- b. Comparison of the documentation with the finished vehicle:
 - 1. Does the of number of wheels fit to the documentation?
 - 2. Does the construction of the engine fit to the documentation?
 - 3. Does the place of the engine in the vehicle fit to the documentation?
 - 4. Does the place of the tank in the vehicle fit to the documentation?
- c. The maximum score of this segment can be 75% of the total points of Technical evaluation. The “Vehicle check” belongs to this evaluation.

Chapter 5.

Race categories and rules

5.3 Evaluation of project management

- a. The organizers will not only evaluate the technical competences but other important skills too.
- b. In order to be successful, it is important to work in team, define and keep deadlines, furthermore to be cost effective.
- c. In this competition category the process of vehicle building must be presented, as well as the connecting activities.
- d. It is mandatory to present all the milestones during construction. Failing to do so can result in disqualification from the competition.
- e. In the project management category, max. 50 points can be achieved.

5.3.1 Time plan, milestones

1. Submitting of design and project documentation until 01.10.2021

Teams, not having an approved design documentation and approved list of elements until 12.02.2021, will not be allowed to participate in the competition!

2. Presentation of the vehicle's complete frame until 28.02.2021.

Presenting the vehicle's complete frame is mandatory, in case of missing presentation the participation is not allowed.

3. Fulfill the proof of the knowledge of the competition deadline 06.04.2021

If any of the teams hasn't got accepted test until 07.04.2021 the team will be disqualified.

4. Prove with video, that the vehicle is able to move by itself (functioning) until 30.04.2021

Teams, not proving that their vehicle is able to move by itself (functioning) until the deadline of 30.04.2021, will not be allowed to participate in the competition!

Chapter 5.

Race categories and rules

5.3.2 Project documentation

- a. The documentation must be supplied in the desired format, in one PDF file.
- b. Language: only in English
- c. Deadline: 01.10.2021
- d. Aspects of evaluation: see the table below, max. 20 points can be achieved:

1. Short introduction of the project	Points
Short overview, why the team has applied for the competition, and which kind of expectations do they have	2
2. Project organization	
Introduction of the project participants in an organigram with responsibilities (may contain "supporters" too, who are not team members, but take part in the vehicle-building)	4
3. Planned budget of the vehicle	Points
The total budget of the vehicle must be presented, and the cost of pneumatic elements must also be calculated based on the list prices from the list of elements.	4
4. Time plan of the project	
Teams must submit a time plan (milestone plan), containing the project stages, with the 5 main fixed milestones according to followings:	6
1. Deadline for application: 31.10.2020	
2. Submitting of the design documentation: 01.10.2021	
3. Presentation of the vehicle's complete frame 28.02.2021 (photo or video)	
4. Successful exam of the competition rules: 06.04.2021	
5. Prove, if the vehicle is able to move by itself (video) 30.04.2021	
5. Video about the preparation ("werkfilm")	
Teams, preparing a werkfilm about the preparations and send it to the Jury, will receive extra points in this category. Deadline for submitting: 20.04.2021	4

Chapter 5.

Race categories and rules

5.3.3 Project presentation

- a. All teams must present the results of the project for the jury and for invited experts, managers and press (Board) on the day of the competition.
- b. Required format of the presentation: Power Point presentation
- c. Template for the slides can be downloaded from www.pneumobil.hu. The use of this template is recommended, but not mandatory.
- d. Slides of the presentation have to be prepared in English.
- e. Max. time frame for the presentation: 10 min. + 2 min. (for questions coming from the Board), and the presentation must contain the following points.
 1. Short introduction of the team and the project
 2. Project organization with responsibilities
 3. Planned and real budget of the vehicle
 4. Time plan of the project and fulfillment of the defined milestones
 5. Innovative solutions of the vehicle
 6. Experience gathered during construction
- f. Language of the presentation: English in front of the Board
- g. Time slot and place of the presentations will be published by the organizers on the day of the presentation.
- h. Teams can achieve max. 30 points for the presentation from the Board according to following evaluation aspects:
 1. Presentation techniques/methods (keeping the time frame, structure of the presentation, each team member must present, being able to keep interest from the audience)
 2. Content of the presentation (presenting the technical solutions, as well as the planning and building process)

Chapter 5.

Race categories and rules

5.4 Physical race categories

5.4.1 General information

- a. Teams, who has not attended the technical check, and received racing permit and start number cannot enter the race. Only the driver is allowed to sit in the vehicle in the starting area and on the race track.
- b. “Acrobatic stunts” (dangerous movements) performed in the pit lane and the starting zone as well as exceeding the speed limit of 5 km/h will result in a disqualification.
- c. The jury can call out the team for mechanical checking in any time, which will be fulfill in part or in whole according to the rules of the Vehicle Check. If there is a difference discovered by the examination , the team will be disqualified from the previous races (races which took place before).

5.4.2 Motorhome

- a. Organizers provide teams with the opportunity to create motorhomes where they can welcome non-racing team members, supporters, guests, and sponsors. Each team can claim an area the same size as the box on the outside of the box street behind their box. Teams from the same institution (based on the traditions so far) are placed side by side, so it is possible to consolidate the area.
- b. Request for motorhomes must be registered at PneuReg until 31st December 2020. The request must be in the appendix of the Technical Documentation, and must contain a draft layout and a description of the planned activities.
- c. Due to security reasons motorhomes are a closed area, where the entrance is restricted and requires a registration. Teams are allowed to have max. 12 guests (including all the – non-racer – team members too), who must be registered at PneuReg until 20th April 2021 (guests, who are not team members, must be registered as Fans). Organizers will hand-over the licences for motorhome entrance for all the guests to the captain of team during the team registration.
- d. Setting up of motorhomes is only possible on the day of competition, 15th May 2021 between 6 and 8 a.m. For the time of setting up, vehicles are not allowed to enter the pit lane or the event area. Vehicles may only be parked in the parking lot designated by the organizers, and loading and unloading must be carried out by the team using only their own hand-held transport equipment. The disassembly of the motor home can begin only after the results announcement has been completed.
- e. Please consider the „Responsibility” and „Placing of start number and advertisements” chapters of the Competition Rules, which are also valid for motorhomes.

Chapter 5.

Race categories and rules

5.4.3 Parc ferme

- a. Parc ferme is a closed parking space for the competitors and pneumobiles.
- b. The car park is closed according to the race programs, in this time, vehicles have to be in there and members of the team cannot approach it.
- c. The opening times will be presented on the racing site.
- d. Only one operation is allowed with jury supervision: charging the battery of the pneumobile.
- e. It is forbidden to carry out fire hazard activities (eg grinding, welding) even during the opening hours of the parc ferme.

5.4.4 Flag signs

- a. Waved **red** flag: interruption of the race or training. The vehicles have to return to the pit lane with reduced speed.
- b. Waved **yellow** flag: danger in front of the vehicle. The vehicles have to slow down and be prepared to stop. During the flag signal overtaking is prohibited. The yellow flag valid until the next judge member waving a green flag.
- c. Waved **blue** flag: there is a faster vehicle behind you, which shall be safely let go at the closest suitable track section.

Chapter 5.

Race categories and rules

5.4.5 Policy for start line up

Lining up takes place on the basis of the start-list handed out for each category. Teams have to line up in the starting lane according to the mentors' instructions. The start lane consists of three stations:

Start office

- a. Vehicles classified to the starting lane according to the start list, get to the start here at the steward.
- b. In case of a technical problem here you can ask for a later start position. A team member has to indicate it when the team is called to line up.
- c. All "racing team members" and the instructor can be present at the start office.

Checkpoint

- a. At this point the pneumatic system can be pressurized in the presence of a steward.
- b. The buffer tank filling rules are checked here.
- c. The driver has to sit in the vehicle latest here, and he has to prove that all the safety requirements are met (seat belt is fastened, protective cloth is suitable etc.).
- d. The "racing team members" and the supporting instructor can be present at the checkpoint.

Start zone

- a. Here the vehicle and its driver have to be ready for starting the race.
- b. Start will be done from here with the help of the sign of a steward or a starting light.
- c. In the start zone only the driver is allowed to stay.

Chapter 5.

Race categories and rules

5.4.7 In case of an accident

- a. If there is no personal injury and the driver can continue the race by putting the vehicle back to the track without or with the help of stewards, the race can be continued (the used time is included in the race time).
- b. If there is a personal injury the race shall be stopped and the place has to be secured until the further decision of jury.

5.4.8 In case of technical problems

- a. If the vehicle has already started the race, but it is not able to finish it without external support due to a technical problem, the team has no further chances in that race category (no new start is allowed), even if the problem occurs due to a failure of element provided by the organizers on the day of competition (e.g. pressure reducer, tank).

5.4.9 Free Practice

Purpose of the practice: teams can test their vehicles and change their setups.

Procedure of the practice: Starting order depends on the arrival to the starting zone and it will start on the jury's mark. 3-5 vehicles can be on the track at the same time with delayed start. 2 laps can be done on the marked track (qualification 1 track) and there is no recorder laptime. After crossing the finishline, teams must leave the track on a shortened in-lap based on the jury's marks. One team can start many times, but they have to get in lane again in the startzone.

Rules of free practice race:

- a. It is prohibited to drive in the opposite direction.
- b. Smaller technical problems can be repaired only by the driver on the track.
- c. Requesting help from the stewards is allowed only from a standing vehicle by raising a hand.

Chapter 5.

Race categories and rules

5.4.10 Qualifying race I. (pressure drop measuring)

The purpose of the race: to get qualified for the long-distance race and its race order will be defined based on the results of the qualification race I.

Teams can get starting allowance for the long-distance race, if the **average speed is above 15,00 km/h during the qualification race I., and pressure drop is not more than 70 bar**. If the qualification race I. is not completed by the team, they are allowed to participate on the long-distance race only if they got the permission from the jury with the acceptance of the determined supplied regulations. The starting place for the start order is a calculated value:

$$\text{Qualifying degree} = \frac{\text{Pressure drop (bar)}}{\text{Average speed} \left(\frac{\text{km}}{\text{h}} \right)}$$

Arrangement of the race: The jury reads the pressure value of the air tank of the vehicle which is ready for race in the starting zone. The vehicle can start after this. Two rounds must be finished on the track and then the actual value of tank's pressure will be read again by the stewards at a designated checkpoint. If the team has completed the race and achieved a result for the starting allowance for the long-distance race, it is not allowed to run more times, but if the first try was not successful, the team might race again. The total time frame for the qualification is 2 hours from the starting of the first vehicle.

Results of the qualification will be published within 2 hours from the finish of the last vehicle's run.

Rules of the race:

- a. It is prohibited to drive in the opposite direction.
- b. All kinds of stopping the vehicle will be counted into the circle time (average speed).
- c. Smaller technical problems can be repaired only by the driver on the track.
- d. Requesting help from the stewards is allowed only from a standing vehicle by raising a hand.

Chapter 5.

Race categories and rules

5.4.11 Qualifying race II. (time measuring)

The purpose of the race: get qualified for the arcade race and its race order will be defined based on the results of the qualification race II.

Teams can get starting allowance for the arcade race, if their time result is less than 200% of the best achieved time during the qualification race II. If the qualification race II. is not completed or the team do not fulfill the requirements, they can only take part on the arcade race with the separate decision made by the jury with the acceptance of the determined supplied regulations.

Arrangement of the race: Starting order of the race is based on the arrival to the starting zone, but the alignment is free choice of the teams, starting is possible according to the signals of the jury. 2-3 vehicles might be on the race track in the same time, but with postponed starting. 2 laps must be finished on the defined race track (see the track of arcade race Q1), the final result is the sum run time of the 2 laps. After crossing the finish line, the track must be left on a shortened lap according to the signals of the jury. Each team can run the qualification race II. (time measuring) several times, but must always get in lane to the starting zone/order.

Results of the qualification will be published within 1 hour from the finish of the last vehicle's run.

Rules of the race:

- a. It is prohibited to drive in the opposite direction.
- b. All kinds of stopping the vehicle will be counted into the circle time (average speed).
- c. Smaller technical problems can be repaired only by the driver on the track.
- d. Requesting help from the stewards is allowed only from a standing vehicle by lifting a hand.

Chapter 5.

Race categories and rules

5.4.12 Long-distance race

Aim of the race: drive the longest possible distance with one filled tank.

Planned length of the race track: ~580 meter

Arrangement of the race: Lining up in the starting lane must be done on the basis of the issued starting order. A maximum of 10 vehicles can run on the track and the next start is done when a vehicle finishes the race and leaves the track. The vehicle has to take as many rounds on the determined track as possible until it runs out of pressed air. During the race **drivers shall change 3 times**, it takes place off the track in a given “pit stop” zone. The “racing team members” are allowed to stay and to carry out repairs only here. Technical problems arising in other areas of the track can be repaired only by the driver. If the vehicle is not able to pass on by its own, the driver has to indicate it by raising his hand, but he cannot leave the vehicle. The stewards will make a record of the position of the vehicle (the outermost point of its front) and will help to move the vehicle into the pit stop. From the pit stop the “racing team members” can push out the vehicle.

Rules of the race:

- a. Deviation from the starting order can be made only once, this means a subordination by 5 positions. If the second start is not successful the vehicle is not allowed to fulfill that race category.
- b. The achieved distance is measured from the outermost point of the vehicle's front.
- c. Maximum of working pressure: 10 bar
- d. Required minimum of average speed is 15 km/h taking all full rounds into consideration.
- e. The average speed within one round is not compulsory, as the average counts. The average speed of the last broken round doesn't count. It is possible to go slowly. If the finish line is not crossed it is not counted in the average speed.
- f. Attention! All finished rounds will be counted in the average speed.

Chapter 5.

Race categories and rules

Rules of driver change

- a. Minimum 3 driver exchanges are compulsory.
- b. It is considered a driver change, if the vehicle stops at the traffic cone, the two driver swap places, and the vehicle starts moving.
- c. The vehicle is standing still until the driver gets out, passes the safety-helmet over, another driver takes it on, and fastens the safety belt.
- d. First change can already be done in the first round.
- e. Minimum one round between two changes is compulsory.
- f. Time of the change counts into the average speed.

5.4.13 Arcade race

Purpose of the race: Take the determined slalom track in the shortest possible time by using one tank.

Planned length of the race track: Race 1= 700 m; Race 2= 900 m; Race 3= 1100 m

Arrangement of the race:

The race will have 3 sessions based on qualifying system. Method of the race is the same in each session, but (the length of) the race will change. Vehicles must line up at starting zone according to the defined starting order and they will be released separately. Deviating from the defined starting order will generate a position change to the last place of the starting order.

For the signal of the stewards, the vehicles must line up at the defined place at the end of the pit line where drivers must wait for the starting signal in/on the vehicles then they start for that signal. Maximum 3 vehicles are allowed to stay on track side by side (at the same time), overtaking is possible. Taking these conditions into consideration, the sum race time of 2 laps will be rated. After passing the finish line, the track must be left in a shortened returning lap in accordance with the signal of stewards

Chapter 5.

Race categories and rules

Rules of the race:

- a. All teams get the opportunity to run in the first session (Race 1). Teams with the first 18 best lap time of the Race 1 will qualify for Race2. The best 6 from Race 2 can enter the Race 3 session, on which they match their performances, and the first 3 of them will be awarded.
- b. Maximum working pressure: 10 bar
- c. Any stop during the race will be counted into the round time.
- d. Sum race time of the 2 laps is the achieved result in each phase.

5.4.14 Acceleration race

Purpose of the race: Take the determined section of the track in the shortest possible time

Planned length of the race track: ~ 220 meters.

Arrangement of the race: Lining up in the starting lane must be done parallel in pairs on the basis of the issued starting order. The start lamp will give the sign to start from here. Running over from the own lane to the competitor's lane is prohibited. The race must be done by following the path of the track and after the finish slow down according to the stewards' signs. After the finish line, there is a determined waiting zone which is an open area. Drivers shall be waiting here until the stewards open the closed section to the boxes.

Rules of the race:

- a. Sides of the parallel track are chosen by a coin-flip
- b. Best time is the winner, highest speed will be measured as well
- c. Operation of the start lamp:
 - 1. Every yellow lamp is on (Prepare!)
 - 2. Green lamp turns on in 3 seconds (Start!)
- d. Reaction time is included
- e. Jump start is prohibited, vehicles jumped-out or not starting will be disqualified
- f. Maximum working pressure: 10 bar

Chapter 6.

Race program

6.1 Registration

- a. After arrival (before anything else) all team members have to go to the registration desk of the competition office where they receive the wristbands and the badges required for entry.
- b. Every team member has to understand, accept and sign the Declaration of responsibility.
- c. After the registration the team members can take the pressed air tank provided for the vehicle acceptance check at the service point.

6.2 Vehicle check

- a. Station 1: First, every team member have to go the acceptance check station established in the competition centre together with their prepared vehicle and all safety accessories (safety-helmet, protective clothing).
- b. The inspection takes place according to the checking list published on the official website of the competition. Every team gets their own safety data sheet, on which the stewards register the evaluation.
- c. Station 2: is the test track in the Érsekkert where the stability, steering and the brake system will be inspected.

The teams can repair the noted deficiencies but in this case the acceptance check procedure has to be repeated.

6.3 Free practice training

- a. Teams that have successfully completed the vehicle check can go to free training.

6.4 Evaluation of technical content of the vehicle

- a. The vehicle must be presented to the jury at a defined check point in the competition center.
- b. Every team will be given a **time slot**, when they need to appear in front of the jury.

Chapter 6.

Race program

6.5 Project presentation

- a. All teams must present the results of the project for the jury and for invited experts, managers and press people (Board) on the competition.
- b. Every team will be given a time slot and place, when and where they need to appear in front of the Board.

6.6 Competition briefing

- a. After the acceptance check the organizers will inform the participants about the further program.
- b. During the presentation the rules of the competition and the most important behavior rules will be explained.
- c. All team members and supporting teachers shall be present at the briefing.

6.7 City parade

- a. After the briefing the teams together with their vehicles are lining up according to the instructions of the stewards.
- b. The parade is an organized vehicle presentation with police lead.
- c. By the end of the program teams go back to the competition centre led by the police.

6.8 Qualification race I. (pressure drop measuring)

- a. Qualifying race is compulsory for every team.
- b. Starting order of the race is determined by the arrival to the starting lane.

6.9 Qualification race II. (time measuring)

- a. Teams must participate on a qualification race for time measuring in a defined time frame.
- b. Starting order of the race is based on the arrival to the starting zone.
- c. Each team can run the qualification race II. (time measuring) several times, but must always get in lane to the starting zone/order.
- d. The tank remained from the qualification can be used and one more tank will be provided by the organizers.

Chapter 6.

Race program

6.10 Long-distance race

- a. Aim of the race is to take the longest possible distance with one charged tank.
- b. Starting order is according to the pressure drop registered Friday.

6.11 Arcade race

- a. Aim of the race is to run the slalom track in the shortest time.
- b. Starting order according to the Qualifying session.

6.12 Acceleration race

- a. Aim of the race is to run the determined section of the track in the shortest possible time competing in parallel pairs.
- b. Due to the track length the result is very much depending on the acceleration of the vehicle.

6.13 Closing ceremony and announcement of result

- a. Following the instructions of the stewards every team and their vehicle shall line up around the podium.
- b. Returning to the boxes takes place after the ceremony following the instructions of the stewards.

E. Important information

Chapter 7-8.

Chapter 7. Responsibility

- a. Race participants release the organizer, the authorized event officials, their employees and representatives from every liability related to any damages caused by the participants jointly or separately to assets or third persons during the competition.
- b. The organizers are not responsible for supplies and objects left unattended in the depot.
- c. When racers are away, team members must take care of the items left in the depot and motorhome.

Chapter 8. Placing of advertisements

- a. Logo and name of the university or college must be placed on the vehicle in an A4 size.
- b. Sponsor advertisements can be placed on the vehicle in max. size of 0,5*A4 (210*148 mm or 297*105 mm). Maximum two copies of the same advertisement. Advertisements of competitors of Emerson are not allowed to place on the vehicles. In case of doubts the team has to clarify the matter with the organizing committee prior to the race. Stickers from previous races must be removed before the race.
- c. At the parade and on Saturday the “racing team members” must wear the T-shirt provided by the organizers.
- d. No advertisements can be placed on or around the race track or in the depot. Exceptions to this prohibition are the advertisements and logos which are painted on the transport vehicles of the teams furthermore on external race cars, on the team member’s clothes, and on other devices of the event (signboards, umbrellas etc.).
- e. The advertisements of competitors of Emerson are not allowed to place even on the above equipment.
- f. Any prohibited advertisements will be removed by the organizers.

Eger, 29th September, 2020

Emerson's International AVENTICS Pneumobile Competition equals engineering excellence, fun and ingenuity.



Compressed-air-powered vehicles - known as “pneumobiles” - designed and created by engineering students are competing at the annual event. The vehicles, which are based on Emerson's AVENTICS™ pneumatics components, are tested for endurance, manoeuvrability and speed. This competition further demonstrates Emerson's long-standing commitment to STEM programs that support the future workforce, including supporting over 350 academic institutions globally.

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