

## The technical specification of task:



### General conditions

The object is the design and construction of a „pneumatic vehicle” – **PNEUMOBILE** – which is driven by compressed air. The transmission of torque onto the wheels shall be performed by pneumatic control and drive elements. The vehicle should race on the tracks with one driver on board.

### 1) Composition

- a) The driver has to stay (sit) on the vehicle (remote control is not permitted)
- b) Number of wheels: minimum 3, - arranged at least in 2 wheel-tracks, for safety reasons.
- c) According to the experiences of the competitions before, the vehicles were “cars” (with 3 or 4 wheels with driver seat inside) or “quads” (with 3 or 4 wheels with driver seat on the top). Different design is also allowed, if it fulfils the technical and safety requirements.

### 2) Mass and dimensions

- a) The maximum admitted length of the vehicle is 2.5 m, the maximum admitted width is 1.7 m, to be checked at the machine reception with a rectangular 2.5x1.7 m stuck on the ground. No part of the vehicle is allowed to hang out from this “box”.
- b) For stability reasons it is important to design the vehicle with the lowest possible centre of gravity. At the design following dimensions should be considered: driver’s shoulder-level must not be higher than the 75 % of the track gauge when driving, furthermore any part of the engine or the highest point of the bottle should not extend that level.  
Checking: during the vehicle-check the driver’s shoulder-level (both smartness- and acceleration races’ drivers) will be measured vertically from the ground.
- c) In case of 3-wheels vehicles, the smallest angle in the triangle, which is bordered by the wheels, should be at least 30° (see figure 1.)

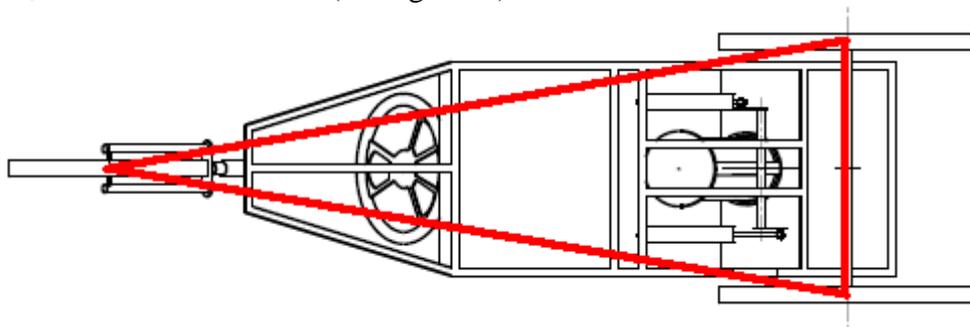


figure 1.

- d) The clearance between the bottom of the vehicle and the ground surface should be at least 70 mm, which will be checked with a 70 mm high bumper on the ground.
- e) No limit to the mass is defined (try to reach the lowest possible mass)

### 3) Framework, car-body

#### 3.1 “Car” character (with 3 or 4 wheels, with seat inside)

- a) The chassis shall be made of metal, for two reasons:
  1. Protect the driver from injuries in case of accident
  2. Carrying the pressure-bottle, the driving system and the driven wheels.
- b) Crash-tube (safety tube)



Building in of a safety tube is obligatory for every team. The tube has to be fixed to the chassis or to lattice frame on the side, and has to be bent from one piece material. Its material should be steel or aluminium. If it is made of steel, the tube diameter should be at least 25 mm, and the wall thickness should be min. 2 mm. If the tube is made of aluminium its diameter should be at least 35 mm and the wall thickness min. 2 mm. The frame-width has to be at least 700 mm at driver's shoulder-level . The frame should be stiff enough to ensure head-protection for the driver too, so a headrest or a seat with headrest should be built in the vehicle. The safety tube should be placed vertically in line with to the headrest, and it should be 5 cm higher than the helmet-level of the driver in driving position.

#### 3.2 “Quad” character (with 3 or 4 wheels, with seat on the top)

- a) The chassis shall be made of metal, carrying the pressure-bottle, the driving system and the driven wheels.
- b) The driver seat without back-rest should be built on the framework. The framework must not contain any extending parts which can cause injuries to the driver in case of accident or which can hinder the driver to leave or fall off the vehicle.

#### 3.3 General instructions for the framework and car-body

- a) The pressure (air) bottle and the pressure-reducer must be protected by the framework of vehicle, so **they should be placed inside the framework.** If the vehicle does not fulfil this requirement it **will not be allowed to take part in the race** (in any of the categories).

- b) The (air) bottle is not allowed to be mounted with suspension under the framework, directly above the road surface.
- c) Material and design of other components are not limited. (Composites can be used either.)
- d) Closed chassis is not required, but the driver must be separated from moving parts of drive system by a protection shield.
- e) Crush zone: At the front of the vehicle a deformable zone (“crush zone”) should be constructed which absorbs the shock in case of accident. Material is not defined but its part must not cause any injuries. If the front wheel is mounted in the middle building of a crush zone is not necessary.

#### 4) Engine

- a) The conversion of energy of compressed air to mechanical energy should be performed by pneumatic cylinders and valves of Rexroth.
- b) Number of applicable cylinders: maximum 4 (with max. diameter  $\varnothing 100$  mm, and standard strokes according to the catalogue).
- c) Only one engine can be used in the vehicle, which makes up one mechanical unit (there is only one turn-out main axle). 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 (electropneumatic) switching.
- d) The engine should be built in so that its construction is visible by the jury and visitors, or transparent cover can be used. Teams not fulfilling this criteria will be punished by 25 % points reduction in the technical category (category of creativity of design).
- e) The engine should be placed in the vehicle so that its parts extend max. 200 mm from the farthestmost points of the front and back wheels. (See figure 2.). Parts not belonging to the engine may extend longer.

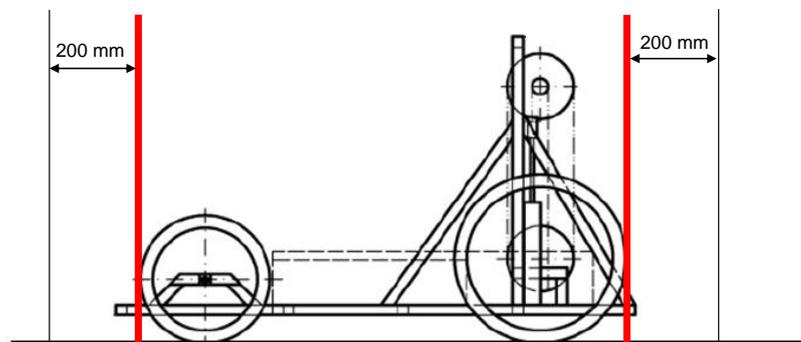


figure 2.

- f) Teams participating in the competition in the earlier years are requested to **use the existing pneumatic components** for construction of vehicles, and to order only the missing elements and accessories.
- g) The control system can be electro pneumatic as well. In this case the promoted voltage is 24V DC.
- h) The electric control unit, PLC should be protected from humidity (rain). This unit should be placed in a box with an insulation category IP54, and it should be transparent at least on one side.
- i) If there is a request for a PLC to construct the drive and control system, we can provide a basic PLC package. On the competition only the use of PLC type IndraControl L10 is admitted. (use of any other type of PLC is strictly prohibited!)
- j) Institutes participating in the competition in the earlier years are requested to **use the existing PLC** for construction of vehicles, and to order only the missing elements and accessories.

## 5) Input of external energy

- a) Air in the system can be heated with external environmental heat via heat-exchanger or by absorbing and mixing of environmental air. Heating is allowed before the races, after the mounting of the bottle. The heat-exchanger can be free or forced flow. In case of forced flow “ventilator” can only be driven by the energy of the bottle. In case of air absorbing the exhauster-compressive part can only work with the energy of the bottle.
- b) For driving the vehicle during the race it is not allowed to use other energy resource or heat energy in other form (except the directions at chapter 5a), or to use human force (except the battery used for the control system).

## 6) Puffer container:

Material of the puffer container and its clamping should fulfil the requirements for pressure-cabins.

## 7) 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 should contain a free-wheel (compulsory) and/or clutch (optional).
- d) Modification in the drive chain (adjustment) is allowed between the races under condition that all the engine components are used, no parts can be added or removed. Adjustments can be made only on the existing functional parts of the drive chain.

## 8) Suspension

- a) Any kind of wheel suspension principle is applicable.
- b) The diameter of wheels is min. 400 mm.
- c) The pavement of runway is bitumen.

## 9) 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) The vehicle should be able to turn around on the 8 m wide speedway.

## 10) Brake

- a) Every wheel of the vehicle should be equipped with an operating brake system. The brakes should 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 3-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 should still work.
- b) Vehicles should be equipped with a parking brake (it can be also a mechanical lock of one of the brake-circles).
- c) Settings of the brake will be checked with a brake-test at machine-check. While braking, both brakes should work on the same efficiency level (“wandering of the steering-gear” is not admitted).

## 11) Compressed air bottle:

- a) The source of energy is a 10 litre pressure-bottle filled with air, nominal pressure of 200 bar. The air bottle is equipped with a pressure-reducer.
- b) The bottle shall be fixed to the chassis, and locked against slipping. The pressure-reducer shall be protected against damage, in case of collision, accident or external objects (e.g. with protection cover). It is not allowed to use “shirrs” for that reason.
- c) Technical data of pressure-bottle:
  - 1) Dimensions: **The exact properties will be later before the nomination given!**
  - 2) Type of pressure-reducer: Messer FC-2000
  - 3) Connection of pressure-reducer: Plastic pipe: Ø 12 mm
  - 4) Maximal air flow of reducer: see on the home page of Pneumobil (download)

## 12) Safety prescriptions

- a) The driver must have a safe place in or on the vehicle.

- b) In case of a vehicle with car character the use of minimum three-point safety belt over the seat is obligatory.
- c) In case of a vehicle with quad character there is no requirement for a safety belt, but wearing protective clothing for motorcycling is obligatory, or you can use knee- and elbow-pads, as well as protecting vest (jacket) for the backbone. Wearing of protective clothing is not obligatory for every driver during the distance race.
- d) In case of a vehicle of quad character the “gas-pedal” should be always pressed down. When released the “gas-pedal” should go back to the start position. Goal: in case of an accident with the driver, the vehicle should not run longer.
- e) An emergency stop circle shall be used in the pneumatic system, for exhausting the air from drive chain. The operating lever or button shall be easily accessible by the driver or by other helping person. The circuit diagrams of compulsory emergency stop system are available on the [www.pneumobil.hu](http://www.pneumobil.hu) home page. Only the specified circles and pneumatic elements can be used for this purpose.
- f) The optional source of current (battery) shall be safely fixed, and the vehicle equipped with a main switch which should be easily accessible, similar to the emergency stop level.
- g) Actuators of the safety elements (current cutting and exhausting – see emergency stop) should be marked with red-bordered white triangle. (according to description on the home-page)
- h) Wearing motorcycle crash-helmet by the drivers and the passengers (if any) is compulsory during the events of competition. Use of other crash-helmet (e.g. helmet used at cycling) is not permitted.
- i) In case of accident:
  - if there is no personal injury and the competitor can continue the race (by himself/herself or by the help of staff) , the race can be evaluated (the used time is included in the race time)
  - if there is personal injury the race should be stopped and the place have to be ensured until the further decision of jury

### **13) Rexroth elements**

- a) The conversion of energy of compressed air to mechanical energy should be performed by pneumatic cylinders and control valves of firm Rexroth.
- b) The applicable Rexroth pneumatic components can be selected from the list on the home page of the competition.
- c) Besides the driving system the vehicle can have other pneumatically operated functions as well. In this case, special agreement about the financing of the elements is required.

## 14) Documentation

- a) The competing teams have to prepare the documentation of technical design considering the following points:
1. Technical documentation have to prepared **in 1 pc. pdf file** in the “Technical documentation” form which is available on the homepage (all technical information have to be documented in this file, attachments are not admitted).
  2. The list of needed pneumatic elements has to be prepared and sent in to us in the “Request of elements” chart.

Every part of the documentation should contain the datum and version number. Later, when modifications, changes or supplement come up, the version number should be changed and the whole documentation is to send in again.

**Documentation should only be sent to Bosch Rexroth after let it checked and signed by the supporting instructor.**

- b) Deadlines:

1.)Term of submitting of documentation	19.12.2011
2.)Reply (acceptance, further requirements) until	<b>20.01.2012</b>
3.)Deadline for correction or supplement	03.02.2012
4.)Reply and decision about the acceptance until	15.02.2012
(only for teams which had to correct the documentation)	

- c) In case of insufficient, perfunctory documentation the team will be punished with 50 % point reduction in the technical category. That will be communicated to the team according to “Deadlines” point nr. 4.
- d) Accepted languages of documentation: Hungarian or English

## 15) Start plates and publicity surfaces

- a) Two separated even surfaces with size of A3 shall be provided on the front and on the right or left side of the vehicle for the start plates.  
These surfaces can be directly on the chassis or on extra boards made for this purpose.  
Without these surfaces the vehicle cannot be approved for the competition.
- b) Logo and name of the university or college should be placed on the vehicle in an A4 size.
- c) Sponsor advertisements can be also placed on the vehicle, in a maximum size of A4 and max. two copies of each advertisement. Advertisements of Rexroth pneumatic competitors are not allowed to place on the vehicle.
- d) The members of competing teams shall wear the T-shirts of Rexroth, that will be provided in different colours to the team leaders one months before the competition.  
The logo of sponsors can be placed on the T-shirt.