# Set of Rules 2024


Contents

# I. Preface

The ChemCar–competition has been carried out by the “kreative junge Verfahrensingenieure” (kjVI) of the VDI-GVC in co-operation with DECHEMA e.V. since 2006. In 2024, the competition will take place at the Jahrestreffen “Prozess-, Apparate- und Anlagentechnik” (PAAT) in Frankfurt am Main. Aim of this competition is the accurate design of the reaction to achieve a certain distance, for example by adjustment of a specific reactant.

Students of chemical and process engineering, chemistry and further study courses are invited to contribute their know-how, creativity and ability to work in a team to succeed in the provided task. The ChemCar–competition consists of two parts; the poster presentation and the race. This set of rules describes the competition procedure and outlines the determination of the winning team. To base the project on the chemical reaction, several technical requirements and restrictions on the model car have been placed. In case of non-compliance with the rules, either points may be deducted, or the team may be disqualified by the jury or the host.

# II. Overview: Deadlines

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| Registration | 02.04.2024 |
| ChemCar Concept submission: | 12.04.2024 |
| Notification of the concept selection: | 26.04.2024 |
| Submission of the safety concept: | 10.06.2024 |
| Submission of the revised safety concept: | 30.09.2024 |
| Presentation to the Jury and the race: | 11.11.2024 |

## III. Prerequisites

For the main competition seven teams will be selected from the participants who submit their ChemCar concepts by the jury. Only one team from the non-EU countries can be selected for the competition. Creative and original concepts will be favored. Concepts which show a significant lack of safety aspects will be rejected. The following points should be considered when registering:

1. Correct and punctual registration (see point 4)

2. Applied chemical reaction contains neither safety nor environmental risks (see point 6)

3. Members have signed that they read, understood and are willing to follow the rules and regulations

4. A team may consist of five students at maximum, who shall not have any master's or diploma degree. The students may be enrolled in different study courses. One member must be appointed as contact person or team leader

5. The teams must be supervised by one qualified person from the university, who has a degree in the following or comparable courses of studies: process engineering, mechanical engineering, chemistry

6. At least 2 team members, including the team leader, must attend the competition and the poster presentation on 11.11.2024

7. Due to space limitations at the competition's location, the number of team members allowed in the preparation room may be limited

8. A participant shall not take part in more than two ChemCar competitions

# IV. Registration and concept submission

The registration and the concept submission have to be done by 02.04.2024 and 12.04.2024 by email at chemcar@vdi.de, respectively. A template for the concept can be found at www.chemcar.de. Registrations beyond the deadline will not be considered.

With your participation, you agree that your personal data will be stored in an automated file. Name, address, telephone number and email address will be registered. By submitting the competition documents, each German participant will be admitted to the VDI as a free student member for the competition year 2024. The VDI membership is renewed automatically, however, a timely termination is possible. You can find more information about the VDI membership on: https://www.vdi.de/mitgliedschaft

By participating in the competition, each participant declares their agreement with the competition's conditions.

The concept must contain the following information:

1. Description of the functionality of the car model including a sketch. Description of the chemical reaction and the conversion of chemical energy to kinetic energy must be technically comprehensible. Furthermore, all used chemicals must be enlisted, their required input must be notified, expected pressures and temperatures upon working with the chemicals must be described (this information will be used to determine the risk potential of your ChemCar)

2. A working description of how the motive reaction/ChemCar will be initated using the starting mechanism (agreeable with point V.4. of the rules)

3. First estimation of possible emissions and how those may be avoided

4. The first registration must include a process flow diagram (PFD) of the supposed process to be used in the ChemCar

5. The registration must contain the complete contact information of the qualified supervisor from the university (name, university, address, phone number, e-mail) and the contact information of the team members (name, e-mail, studies, semester, university, address, phone number)

# V. Rules

The compliance with the regulations will be verified by members of the kjVI right before the competition.

**If you have any questions regarding the rules, please contact the kjVI by email at chemcar@vdi.de.**

1. The energy source for running the ChemCar must be based on a chemical reaction. The powering of the ChemCar's engine must be stopped by the exhaustion of the main reaction (energy source), by an additional chemical reaction (stop reaction) or a mechanical or an electrical switch (please see rule 2 for further information).

2. The use of mechanical or electrical switches for the stopping mechanism is allowed, in case it is directly connected to a chemical reaction (e.g. diodes which detect a color change). Please mind that Microcontrollers (e.g. Raspberry Pi) are not allowed. Any devices or physical principles for stopping the ChemCar after a certain distance is not allowed. This includes mechanical brakes, any electronic or mechanical device for measuring the distance travelled. In case of doubts, please refer to the organizers **before** submitting your concept.

3. The run of the ChemCar must be started by performing a starting mechanism, which is based on **pushing a button/switch or similar *single-action* mechanism**. It should theoretically be possible for every person to carry out this action. In addition, it is not allowed to carry anything else than the ChemCar to the starting line, hence it is not allowed to change parts of or add something to the ChemCar. For example, manual mixing (shaking) as well as addition of chemicals or a partial assembly of the ChemCar directly before the start are absolutely prohibited. The only reason why a component could first be fixed near the starting line, is due to a higher safety consideration during transport (if this is the case, you have to clearly describe the reasons to the safety inspectors and the kjVI). As a result, a proper starting mechanism must be conceived to take part in the

competition. The starting procedure will be strictly controlled by the kjVI during the race.

4. Commercial acquirable batteries or fuel cells must not be used to power the ChemCar. Excluded are energy sources for secondary equipment (i.e. mixers).

5. Any material or electrical circuit in the “ChemCar-System” must not be manipulated during the race. This means that any electrical switches, relays or similar components and material connections (wires, valves, tube, electrolytes…) must not be manipulated for controlling the distance or time travelled by the ChemCar. In case of uncertainties or questions, do not hesitate to ask the kjVI.

6. Operating the ChemCars by remote controls is not allowed.

7. It must be possible to transport the ChemCar to the starting line in a trough of the size 900 mm x 550 mm at the top (360 mm depth and 570 mm x 280 mm at the bottom (see Figure 1). It must be possible to transport the ChemCar securely without any additional transport device. **Non-fulfillment will exclude the ChemCar from the race!**

Figure 1: Transport box.

8. The ChemCar must weigh at least 2 kg but not more than 30 kg. If the ChemCar’s weight is below 2 kg, additional weight has to be attached. The non-observance of the upper limit of 30 kg results in disqualification. During the race an additional weight of up to 30 % of the ChemCar’s empty weight must be carried.

9. In addition to the safety review on the day of competition, the kjVI will check if your car matches your concept and if the concept follows the rules. Please make sure

that every team member is able to explain your concept and to answer the questions of the kjVI.

# VI. Safety

As a result of the increased demands concerning the operational safety of the ChemCars, revised safety rules including a guideline for the safety analysis will be published. The safety rules are published on www.chemcar.de. All requirements described in the file “ChemCar Safety Rules 2024.pdf” are part of the official rules and must be strictly adhered to. To create the safety concept, the guideline for the safety analysis must be strictly followed (see file “Safety guideline”). Non-fulfillment of the requirements will lead to point deduction. All questions of this safety guideline must be answered when preparing the safety concepts of the ChemCar.

Three main rules should be noted as an essential requirement at this point to enter the competition at the early stage:

1. The registration must contain a list of **all** chemicals used (including a valid Material Safety Data Sheet) with the following minimum requirements:
    - Name of substance, CAS-number & name of supplier
    - Hazardous classification (H & P- statements according to GHS)
    - Intended use
    - Total amount of substance for the competition
    - Operating conditions (temperatures, pressures…)

    This information will be used to determine the risk potential of your ChemCar.

2. Changes to the safety-relevant equipment are strictly prohibited after the safety revision by the official technical partner. Neglect leads to the immediate disqualification from the competition.

3. The safety documentation needs to be signed by an official safety inspector from your university. The safety inspector must not be the supervisor of the ChemCar team. Also, the contact data and the safety inspector's full name must be attached to this document. Further instructions will be included in the safety documentary.

# VII. Competition Instructions

The competition consists of four parts: the poster presentation, the race, the safety concept and the rule validation by the kjVI.

## *Poster*

Based on a poster in DIN A0 format, the concept of the model car should be illustrated to the jury and the audience. The poster presentation takes place on 11.11.2024. The exact time will be announced beforehand. The presentation time is limited to five minutes. If the given space is sufficient, it is possible to present the ChemCar as well. Every team has to provide a copy of the poster. It is proposed that the poster contains the following information:

1. Name of the team and its members
2. An image of the model car
3. Technical description of the chemical reaction (How is the car powered? How is the distance determined which must be run?
4. If tested, a diagram of the route dimensioning
5. The originality of the concept
6. Abstract of the constructional processing including a process flow sheet

## *Race*

1. Goal of the race is to reach the finishing line as close as possible under the conditions drawn by the jury (specified distance with additional weight). The distance between finishing line and the leading edge of the model car will be measured. Winner of the race is the team with the smallest distance to the finishing line.

2. The model cars must not leave the track or touch the track's boundaries. In this case, the run is evaluated as not driven. The dimensions of the track are 14 m in length and 3 m in width.

3. One hour before starting, the jury will announce the conditions of additional load (5-30 % of ChemCars mass) as well as the range (6-12 meter). Both parameters will be drawn, whereas the additional mass will be rounded down at full 100 g. These weights with a maximum diameter of 80 mm and a bore with a diameter of 8 mm will be provided by the kjVI. Figure 2 shows the various weights. Sufficient space for the weights needs to be considered designing the ChemCar. The weights have to be returned to the kjVI after each run.


Figure 2: Used weights provided by the kjVI.

4. The starting order of the teams will be drawn after their nomination by the kjVI and will be the same in both attempts. The starting order will be communicated to the team leaders.

5. The first three starting teams must be ready five minutes before the start. After the first team finished the run, the fourth team needs to be ready and so on. This means that starting times are flexible and no explicit starting times will be assigned to the teams.

**6.** To protect sensitive parts of the ChemCar or to increase safety during transport of the ChemCar to the start line, parts of the ChemCar may be supported, temporarily removed or disconnected from each other. Removing supports or connecting parts may be done at the start line. Important note: This must not trigger either the driving or the stop reaction! The start of all reactions may only be triggered by the single-action mechanism! In addition, the preparation of the ChemCar at the start line must not take longer than 30s and must be explicitly described in the safety concept under section "Safety Analysis Form - Safe Operating Procedures Page”

7. Each team has five minutes to carry out its attempt. The run starts when the starting mechanism is activated and ends when the car stops. If the time exceeds the time limit, the attempt will be invalid.

8. **After the starting mechanism is activated, the ChemCar must not be touched by anybody until the run is completed.** Otherwise, the team will be disqualified for this run.

9. At start, no part of the car may stick out beyond the starting line.

10. To determine the distance travelled, the leading edge of the car will be used.

11. Each team has two attempts. The superior run will count for the final result. Additionally, a bonus of five points will be given to those teams who are able to finish within a margin of maximum 10 % (with regards to the distance travelled) from the finishing line in both of their runs.

12. Each team has at least 15 minutes preparation time for the second run.

13. The teams must use personal protective equipment (especially safety goggles) during preparation and running of the model cars. Lab coats, safety goggles and gloves must be organized by the teams. Also refer to the additional safety rules.

14. The safety representatives, the jury or the host have the right to refuse the start of any team due to safety doubts at any time of the competition. The cleaning after the race is part of the competition and has the same safety standard as before and during the race. Unsafe behavior will exclude the team even after the race. Disregarding the safety instructions will result in a disqualification from the complete competition.

15. If the ChemCar does not start in both runs, the team will not get any points for the race.

## *Safety concept*

A seamless safety concept minimizes the danger of a possible fault or malfunction and therefore potential risks for humans and the environment. The fulfilment of the safety requirements (please refer to file “ChemCar Safety Rules 2024.pdf”) will not be evaluated. Safety is viewed as an integral component of this project and upon negligence of safety rules your ChemCar team will be immediately disqualified.

In this part of the competition following issues will be evaluated:

1. Safety inspection (7 points): You will have to explain your ChemCar to a safety consulting company. These inspectors will analyze whether you understand the risks and dangers of your ChemCar.

2. Safety documents (4 point): You will have to bring all safety documents to the competition in printed form (material safety data sheets, operating instructions etc.). If you forget to bring those safety documents, you will not get these points.

3. Responsible behavior (4 point): You need to declare all your carried chemicals in an appropriate way, wear safety goggles and needed all the time during the ChemCar preparation and keep your ‘table’ clean and safe, even after the competition. If you follow this ‘good safety practice’ you will get these points.

4. For the disposal of chemicals and materials, every team must bring sufficiently large disposal bins. The disposal of chemicals in the provided garbage bags is not allowed and will disqualify the ChemCar subsequently and any entitlement to a placement or prize will be rescinded.

## *Points allocation – Overview*

The maximum available number of points is 65, which is composed of the following parts (Figure 3):

- maximum 25 points for the concept & its presentation
- maximum 25 points for the race
- maximum 15 points for the safety concept

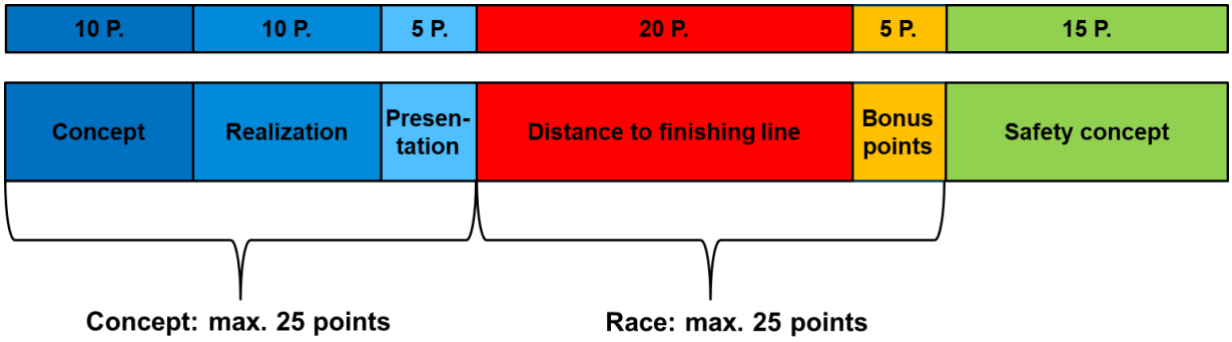


Figure 3: Overview over point allocation.

The 25 points for the poster presentation comprise the following parts:

1. **Concept (10 Points)**

   Innovation & originality

2. **Realization (10 Points)**

   Technical/scientific challenge

3. **Presentation (5 Points)**

Keep in mind that a good evaluation requires either a new concept or an interesting technical realization of a known reaction.

The 25 points from the race are distributed as followed:

1. The race points will be allocated relative to the deviation from the finish line after the ChemCar has stopped (no deviation = 20 points, maximum possible deviation = 0 points). The allocated points will be rounded to one decimal.

2. If a car accomplishes to finish within a distance of ±10 % of the finishing line in both attempts, the team will obtain 5 extra points.
3. If two or more teams achieve the same distance to the finishing line in their superior attempt, their second-best attempt will be counted for the comparison of both teams. If there is no difference as well, both teams obtain the same score.

The team with the most points in total (presentation, safety and race) will win the competition. In the event of a tie, the result of the race decides the ranking.

Please keep in mind that immediate disqualification occurs at:

- neglecting safety rules
- smoke emission (ChemCar Safety Rules 2024.pdf)
- loss of any liquids (including water!)
- safety doubts by safety representatives, jury or host
- gross discrepancies between the concept and the ChemCar
- non-compliance of any rules

## VIII. Prizes

The winners of the overall ChemCar competition will receive the following prizes:

1st place: 2000 € and the ChemCar - trophy

2nd place: 1000 €

3rd place: 500 €

Furthermore, the team that placed first in the race, as well as the team that won the poster presentation will receive an award for their respective accomplishment. There will not be an additional monetary reward for placing first in the individual disciplines of the ChemCar competition.

## IX. Contact

- Current information: www.chemcar.de
- Registration and questions regarding the competition: chemcar@vdi.de
- General requests: kjVI@vdi.de