

Set of Rules 2021

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I. Preface

The **ChemCar**-competition has been carried out by the “kreative junge Verfahreningenieure” (kjVI) of the VDI-GVC in co-working with DECHEMA e.V since 2006. In 2021, the competition will be held virtually at the respective universities of the participating teams and transferred to the virtual "European Congress of Chemical Engineering (ECCE)". 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 the provided task. The **ChemCar**-competition consists of two parts, the jury presentation and the race. This set of rules describes the procedure of the competition as well as the determination of the winning team. To focus the project on the chemical reaction, several technical requirements and restrictions to the model car have been imposed. In case of non-compliance to the rules in the following either points may be deducted or the team may be disqualified by the jury or the host.

II. Overview: Deadlines

Registration:	01.04.2021
Concept submission:	12.04.2021
Notification of nomination:	30.04.2021
Submission of safety concept:	14.06.2021
Submission of revised safety concept:	16.08.2021
Video footage submission:	06.09.2021
Safety discussions:	13.09.2021 – 17.09.2021
Jury presentation and race:	22.09.2021



III. Prerequisite

For the competition nine teams will be nominated at maximum by the jury. Creative and original concepts will be favored. Concepts which show a significant lack of safety aspects will be rejected. For the registration the following points should be considered:

1. Correct and punctual registration (see point 4).
2. Used 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 regulations.
4. The team may consist of 7 students at maximum, who all must not have any degree as master or diploma. The students may be enrolled in different study courses. One member must be announced as contact person / 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 jury presentation on 22.09.2021.
7. One participant must not take part at more than two competitions.



IV. Registration and concept submission

The registration and the concept submission have to be done until 12.04.2021 by email at chemcar@vdi.de. A template can be found at www.chemcar.de. Registrations after this deadline will not be taken into account.

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 2021.

The VDI membership is renewed automatically, 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 his or her agreement with the conditions of participation and competition.

The concept must contain the following information:

1. Description of the functionality of the model car including a sketch. The description has to be technical comprehensible – especially the chemical reaction and the conversion into kinetic energy. Furthermore a complete list of all used chemicals, their required input, expected pressures and temperatures has to be included (This information will be used to determine the risk potential of your ChemCar).
2. A first idea how the reaction/ChemCar will be started using the explained principle has to be provided. The starting mechanism has to be in agreement with point V.4. (see rules)
3. First estimation of possible emissions and how those may be avoided.



4. The first registration needs to contain a flowsheet (R&I) of the estimated process used in the ChemCar.

5. The registration has to contain the complete contact information of the qualified supervisor from the university (name, university, address, phone number, e-mail), 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 exhausting of the main reaction (energy source), by an additional chemical reaction (stop reaction) or a mechanical or 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 Microcontroller (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 electronical or mechanical device for measuring the traveled distance.
In case of doubts please refer to the organizers **before** submitting your concept.
3. The run of the ChemCar has to 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 a higher safety during transport (if this is the case, you have to clearly describe the reasons to the safety guides and the kjVI). As a result, a proper starting mechanism has to be constructed to take place in the competition. The starting procedure will be strictly controlled by the kjVI during the race. Due to the digital



competition, there will be a countdown by the hosts as soon as the ChemCar arrives at the starting line. After this countdown, the single-action mechanism must be carried out.

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 jury.
6. Operating the ChemCars by remote controls is not allowed.
7. The ChemCar must be able to be transported to the starting line in an open box of the size 900 mm x 550 mm at the top (360 mm height) 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
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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 has to be carried.

9. In addition to the safety revision on the competition day, the kjVI will check if your car match 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 from 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 2021.pdf” are part of the official rules and must be strictly adhered. To create the safety concept, the guideline for the safety analysis has to be strictly followed (see file “Safety guideline”). Non-fulfillment 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 noticed as an essential requirement at this point to enter the competition at this early stage:

10. The registration must contain a list of **all** used chemicals (including a valid Material Safety Data Sheet) with the following minimum requirements

- o name of substance
- o CAS-number
- o name of supplier
- o hazardous classification (H/ P-phrases according to GHS)
- o intended use
- o total amount of substance for the competition
- o operating conditions (temperatures, pressures...)

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

11. 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.

12. 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 full name of the safety inspector have to be attached to this document. Further instructions will be included in the safety documentary.

VII. Competition Instructions

The competition consists of five parts: the video footage, the jury presentation, the race, the safety concept and the rule validation by the jury.

Video footage

In preparation for the safety discussion, a 360° video of your ChemCar has to be created. This video must be sent by 06.09.2021 at the latest. It has to contain the construction and the individual components of the ChemCar. Please also explain the ChemCar verbally in this video. In addition, please send video material on the preparation of the ChemCar (e.g. laboratory work, filling, etc.) by the same date. These videos will also be taken into account for the awarding of points.

Presentation

On the basis of a PowerPoint presentation the concept of the model car should be illustrated to the jury, suitable slides must be created for this purpose. The jury presentation takes place on 22.09.2021. The exact time and the duration of the presentation will be announced beforehand. Furthermore, a DIN A0 poster must be prepared, which will be integrated into the official poster program of the conference.

It is proposed that both contain 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 has to 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

These documents must be sent to chemcar@vdi.de together with a copyright for publication before the competition.

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 20 m in length and 4 m in width. A suitable race location must be selected at your university for the competition. The safety of the venue must be ensured by the safety officer. If you cannot find a track with a width of 4 m, a narrower track is also possible, but the run is considered invalid if the ChemCar touches the track boundary. However, the track length of 20 m must be available in any case. When choosing the track, make sure that it has a suitable ground surface for the ChemCar.
3. One hour before starting the jury will announce the conditions of additional load (0-30 % of own mass) as well as the range (8-17 meter). Both parameters will be drawn, whereas the additional mass will be rounded down at full 100 g. These additional weights must be prepared by the teams for the competition. Every team is responsible for themselves to find and organize suitable objects for the competition which can be used as weights. The weight does not necessarily need



to involve a single object. A bunch of screws for example is compliant. Sufficient space for the weights needs to be considered designing the ChemCar.

4. The starting order of the teams will be drawn after their nomination by the jury and will be the same in both attempts. The starting order will be communicated to the team leaders.
5. The first three starting-teams have to be ready 5 min 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. Each team has 3 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, there will be a penalty of 1 meter for each started 10 seconds. From the beginning of the 4th minute the attempt will be invalid.
7. **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.
8. At the start no part of the car may stick out beyond the starting line.
9. To determine the traveled distance the leading edge of the car will be used.
10. Each team has two attempts. For the score the superior result will be counted.
11. Each team has at least 15 minutes preparation time at minimum for the 2nd run.



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

13. 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 complete disqualification of the complete competition

14. 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 see the file "ChemCar Safety Rules 2021.pdf") won't be evaluated. Safety is viewed as an integral component of this project and for 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 points). You will have to bring all relevant safety documents to the competition. If you forget to bring (for example) the material safety data sheets, you will not get this point.



3. Responsible behavior (4 points). You need to declare all your carried chemicals in an appropriate way, wear safety goggles as 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 praxis' you will get this point.

Points allocation – Overview

The maximum available number of points is 60, which is composed of the following parts (Figure 2):

- maximum 25 points for the jury presentation
- maximum 15 points for the race
- maximum 5 points for the video footage
- maximum 15 points for the safety concept

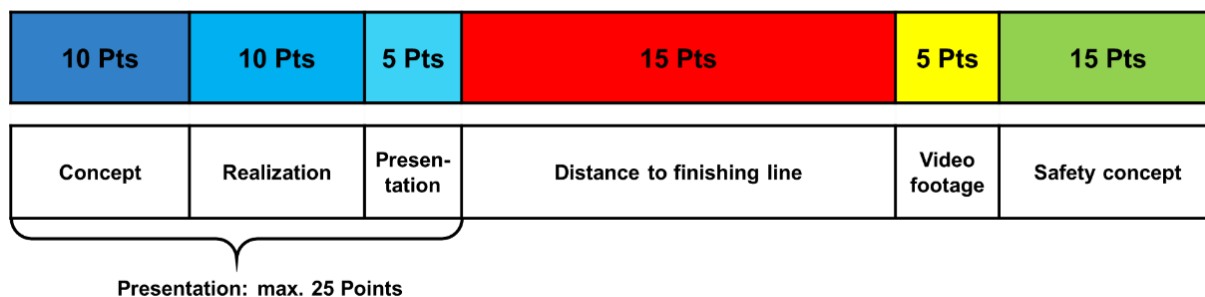


Figure 2: Overview over point allocation.

The 25 points for the jury presentation consist of following parts:

- 1. Concept (10 Points)**
 - a. Innovation (5 Points)
 - b. Originality (5 Points)
- 2. Realization (10 Points)**
 - a. Technical/scientific challenge (5 Points)
 - b. Energy conversion (5 Points)
- 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 15 points from the race are distributed as followed. The model car with smallest distance to the finishing line gains 15 points. Every following car obtains 2 points less. If two or more teams achieve the same distance to the finishing line in their superior attempt, their 2nd 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 (video footage, presentation, safety and race) will win the competition. At a tie, the result in the race decides about the ranking.

Please keep in mind that immediate disqualification occurs at:

- neglecting of safety rules
- smoke emission (ChemCar Safety Rules Rev 2021.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

A total of 3500 € is available. The money will be split evenly among all participating teams. The winning team will also receive the **ChemCar** trophy.

IX. Contact

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