

Official Rules

Chem-E-Car

*some parts of this document are adapted from <https://www.aiche.org/chem-e-car-competitionr-rules>

1. VEHICLE DESIGN GUIDELINES AND RESTRICTIONS

1.1. The propelling energy force of the car must *only* come from a controlled chemical reaction.

The distance traveled by the car must solely be based on a chemical reaction controlled by direct and quantifiable changes in concentration of the chemical species. The chemical species involved must be a solid, liquid or vapor.

1.2. All design components must be physically on the vehicle.

The driving system (chemical reaction) and starting/stopping mechanisms (if there is one) must be physically on the vehicle during the competition (i.e. pre-loading of a drive system such as a capacitor assembly is not allowed).

1.3. The vehicle must not employ commercial batteries.

Batteries cannot be used as the source of power for the vehicles. However, its use in specialized instrumentation such as sensors and detectors can be given permission.

1.4. The vehicle must be an autonomous car.

Remote control of the car, pushing or using of mechanical starting devices and any other methods outside the drive system that can influence the travel distance during the competition are prohibited.

On-board computers and programmable controllers such as Arduino or Raspberry Pi unit can be given permission if and only if it does not affect or measure the distance traveled by the car. Programs for the on-board computers/controllers can only be loaded before the competition and cannot be changed or communicated with (wired or wireless) during the competition. A copy of the complete programs must be provided to the rules committee on the competition day.

1.5. The vehicle must not have any brakes or brake-like features.

The car must not feature any kind of brakes or any form of mechanical force that can be used to stop or slow the car the down.

1.6. The vehicle must not utilize timing devices.

The use of mechanical and electronic timing devices to stop the chemical reaction of the drive system or to stop the car itself is not allowed.

Timing devices also cannot utilize reactions that are normally considered instantaneous. For example, a draining liquid being fed to a sensing cell that uses instantaneous reactions (e.g. acid-base or precipitation) or a draining liquid out of a vessel serving as a stop switch are not allowed as these are considered mechanical timing devices. Should there be any ambiguity regarding "mechanical or electrical" timing devices versus chemical reaction stopping mechanism, coordinators/judges will have the final say regardless of prior rulings at regionals. Consult the Annual Student Conference Rules coordinators if there are any concerns with your vehicle.

1.7. Internal combustion engines (ICE) using alternative fuel are allowed.

The alternative fuel (e.g. biodiesel, ethanol, etc.) used for the ICE must be completely synthesized by the students and no additive blending is allowed. For fuels that are less common or not typically used, a detailed description must be submitted to the rules committee and have its acceptability assessed.

Teams must consider indoor operating conditions (e.g. visible smoke emissions and sound) for the ICE and provide demonstration for the safety procedures, maintenance and operation. Refer to the safety rules for a more detailed description.

1.8. All of the vehicle parts and components must fit inside 40cm x 30cm x 20cm box.

The car may be disassembled to meet this requirement. The teams must be able to demonstrate that their car is able to fit inside the box when disassembled should the judges request.

1.9. The vehicle must have a container that can hold up to 500mL of water.

The car must have its own container and must be able to support and carry the water without spilling. Only water will be supplied at the competition. An example container is Nalgene Low-Density Polyethylene Narrow-mouth Bottles (500mL).

1.10. The maximum cost of the vehicle, contents of the box and the chemicals used is \$2000.

The cost of any donated equipment will be counted. Time allotted by university machine shops and personnel will not be counted in overall price as it is expected that these are equally available resources in every university. The cost of pressure testing will also not be included in the capital cost of the car. Breakdown and the method used to estimate costs must be shown according to standard financial procedures.

1.11. Reusing vehicles from previous competitions is not acceptable.

The same car cannot be used again unless a substantial amount of modifications has been made. These changes must be elaborated in the poster presentation.

2. TEAM MEMBER STATUS AND CONDUCT

2.1. All participating team members must be active AIChE members and must be registered for the Annual Student Conference.

2.2. The roles of faculty and graduate students are limited to student inquiries and consultations.

Faculty cannot be the source of idea for the project. However, teams are allowed to request assistance regarding safety from their advisers, other faculty members, other universities, professional practitioners in the industry and elsewhere.

2.3. All students involved on the project must sign a statement declaring they have read, understood and abided by the rules.

The signed statement must be included in the EDP and must be available at the poster competition.

2.4. The participating teams must be composed of a minimum of five (5) members.

It is encouraged that all members attend the event, however, all team members are not required to be present. During the performance competition, only five (5) representatives from the team will be allowed to stay in the pit area. Team members can be swapped out during that time as long as only five members are present in the area at a time.

2.5. All team members and faculty must have completed the required safety training.

The required safety training is outlined in the Chem-E-Car competition safety rules.

2.6. All competing student chapter teams must submit a Student Chapter Annual Report Online to AIChE before the deadline.

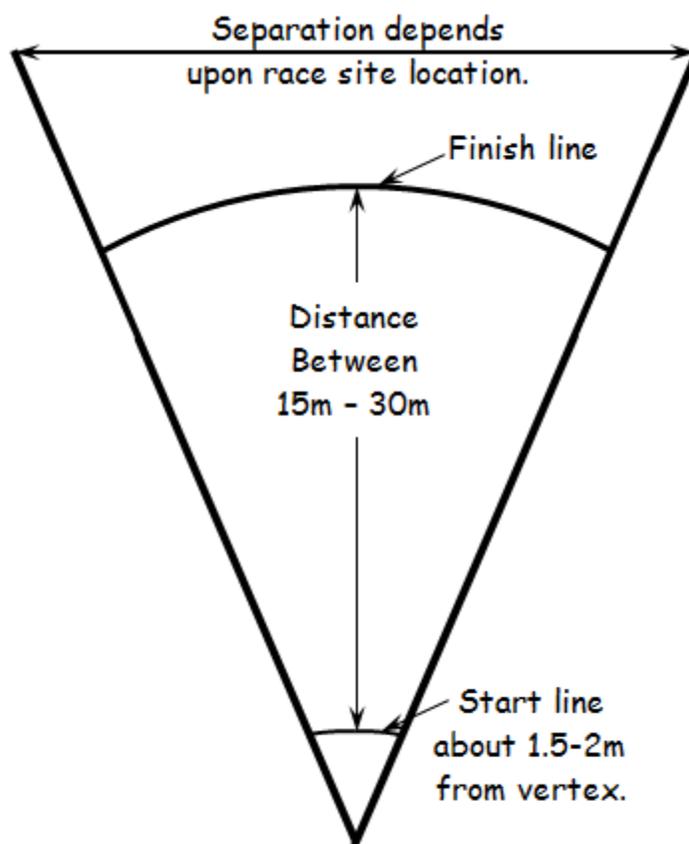
All teams that will participate in the Regional Conference Competitions and the Annual Student Conference Competitions must submit their reports following the submission deadline. Teams who have failed to submit according to the deadline will not be allowed to compete.

3. LOAD AND DISTANCE

The distance that each car needs to travel will be between 15m and 30m ($\pm 0.005\text{m}$), and the load that each car needs to carry will be between 0mL and 500mL of water. The specific load and distance will be given to each team 1 hour prior to the start of the performance competition. The prescribed amount of water for each team will be measured by a judge from the student host chapter. Each car will be given 2 attempts to accomplish traversing the specified distance while carrying the assigned load. Teams are not allowed to add or remove any "load" (or other inert items) to adjust their vehicle weight once the poster session has ended. Teams are allowed to adjust "fuel" or chemical reactants used in the car's chemical reaction.

4. COURSE LAYOUT AND DISTANCE MEASUREMENT

4.1. The figure below shows a schematic diagram of the course layout. There will be a designated starting and finish line where the finish line is marked in an arc of constant distance from the starting point. The course will be wedge-shaped with bounds defined by the finish line arc. The boundaries will be defined using side tapes, and the tapes are considered part of the course.



4.2. The front most point of the car will be used as a reference point for measuring distance. At the start, the car will be positioned with its front end just touching the starting line.

4.3. The goal of the competition is to transport the car with its specified load from the starting line and stop at the finish line (or somewhere closest) while remaining within bounds. Should the

vehicle go outside the course boundaries, the point where it went out of bound will be designated as its stopping point for measurement. A penalty of 3.0m will be added to the measurement of cars that went “outside the course”. A car is considered outside the course when its entire body is past the tape boundaries. When measuring the distance from the finish line it does not matter if the car goes longer or shorter than the prescribed distance. It is important to note that the site location may dictate an out-of-bounds region past the finish line. Vehicles traveling past this out-of-bounds region will be treated as disqualified for that run.

5. RACE LOGISTICS

- 5.1.** Just prior to the start of a run, a judge or MC will announce each team. The team will then introduce their represented school name and entry to the audience and then briefly describe the propulsion system used to drive their vehicle.
- 5.2.** There will be two (2) attempts given to the team to complete the course with each attempt consisting of two (2) minutes in duration. The higher score from the two attempts will be considered the final score for judging.
- 5.3.** In the event a team fails to show up on the starting line or the vehicle fails to start, the next team in the order of the competition will be announced and requested to proceed to the starting line.
- 5.4.** The order of the teams in the first round of the competition will be determined by a random draw. The order for the second round will then be determined according to the first round standings beginning with the team that achieved the farthest from the prescribed distance and ending with the one who is closest. There will be a short break in between the first and second round.

6. STARTING PROCEDURE

- 6.1.** A time of two (2) minutes is given for each car to complete the course. Within this time, the car must start moving, traverse the distance and finally come to a stop. If a car does not stop within the 2-minute period, then it is considered disqualified from that round of the competition.
- 6.2.** Teams, especially those who are next in order, should always be ready to start their run as it is expected that run times will be less than two minutes. Other cases that can cut the run time short include cars that go out of bounds and cars that fail to start at all. Thus, the next car must always be ready to start at a moment’s notice. The MC will not guarantee a specific starting time or delay a team’s start.

7. COMPETITION ORDER LOGISTICS

- 7.1.** Time restrictions are imposed to allow 31 cars to compete in the Annual Student Conference competition within the event period. At regional competition, the host may allocate a more generous time allotment, however the time restrictions are rigid for the Annual Student Conference.

- 7.2. The team start order will be determined during the poster presentation. In instances of disqualifications (e.g. rule violations, poster problems, safety issues), the order of the teams will be adjusted accordingly. For example, if a car which is supposedly scheduled to start before you is disqualified, then you will move up in order and start earlier than your original schedule.
- 7.3. The details regarding the specific load and distance will be announced one hour before the start of the competition.
- 7.4. Five (5) minutes before the start of the competition, the first three (3) teams will be called to the start. The first team will be at the start line; the second team will be at ready; and the third team will be standing by to move to the "at ready" position.
- 7.5. A one-minute warning will be given to the first team before the start of the competition.
- 7.6. The MC will signal the start of the competition by signaling the time to begin. The first team will then have 2 minutes to complete starting, traversing and stopping their cars. The timer is reset for the next competitor when the car has fully stopped or goes out of bounds. If a car does not stop after the 2-minute period, then it is disqualified from that round of the competition.
- 7.7. Once the car for team 1 stops, the distance traveled will be measured. While the distance is being measured, team 4 will be called and each team moves up one position. Team 1 is then urged to proceed with their car to the chemical disposal station where the spent chemicals are properly disposed. This disposal process will be repeated for each car upon completion of its run.
- 7.8. After the measurement is completed, team 2 will be advised to start their car and will similarly have 2 minutes to complete the run. The same procedure described above will be followed after which team 5 is called to move up one position during the distance measurement of team 2. The process will be continued until all qualified cars have competed once in the competition.

Note: If every car took two minutes to complete the course the competition for 31 cars would take a minimum of 124 minutes, which is more than the two hours allotted for the competition. To enable the competition to proceed in a timely fashion, it is recommended that the next team to compete should be ready and at the staging area at least five (5) minutes before their anticipated run time. Upon the completion of the run of the previous team, the next car should be ready to start.