AIChE Chem-E-Car Competition Official Rules WCCE 2017

The objectives of the AIChE Chem-E-Car Competition® are:

- To provide chemical engineering students with the opportunity to participate in a team- oriented hands-on design and construction of a small chemical powered model car;
- To demonstrate the ability to safely control a chemical reaction by changing a chemical reactant(s);
- To design and construct a car that is powered with a chemical energy source that will carry a specified load over a given distance and stop;
- To encourage students to become actively involved in their professional society;
- To increase awareness of the chemical engineering discipline among the general public, industry leaders, educators and other students.

AIChE holds annual competitions at regional conferences and at the AIChE Annual Meeting in the United States. Each year, the annual competition is held in conjunction with the Annual Student Conference at the site of the AIChE Annual Meeting. A host AIChE chapter, along with the AIChE staff and the competition sub-committee from the Student Chapters Committee, and SACHE, provides support for the annual competition. Please note that these Regional Competitions and Annual Competitions are separate competitions from the competition to be held at the WCCE. Passing the safety inspection at the Regional Chem-E-Car Competition does not guarantee that your team will automatically pass the safety inspection at the WCCE Chem-E-Car Competition.

There is a poster session, and a distance/performance session at each competition, as detailed below.

Each year the rules may be modified to address concerns that have developed at the past regional and annual competitions. These may have been significantly modified, so be sure to read the entire document carefully.

Competitions

A) Competition Notes

1. Students should contact studentchapters@aiche.org with questions or for clarification on the competition rules.
2. An AIChE appointed safety coordinator will be in attendance at the competition. This coordinator is the final authority regarding Chem-E-Car Competition® rules, safety concerns, violations, disqualifications, and the like, for that Competition only. This coordinator may be in contact with other members of the SCC Chem-E-Car Competition® sub-committee. The coordinator's judgment applies only to that competition and is not binding on judgments at other Chem –E-Car Competitions.
3. This competition at the WCCE is not a Regional Competition, and winning this competition does not guarantee your team a slot at any other AIChE Chem-E-Car Competitions.
4. A $200 entrance fee will be charged for each competing team. This entry fee will cover the disposal of chemicals and waste at the competition site.

Chem-E-Car Competition® Rules

There will be two events at a Chem-E-Car Competition®: a poster competition, and a car performance competition.

Poster Competition

a. A poster board must be displayed with the autonomous vehicle on the day of the competition. This poster should describe how the car is powered by the chemical reaction, the unique features of the car, and environmental and safety features in the design. Appropriate documentation on the design and testing of your vehicle must be available for inspection by the judges at the poster competition. This documentation must include:

- vehicle design description, drawings and testing results;
- complete Engineering Design Documentation package described in the Safety rules;
- proof that the team has all of its required PPE (personal protective equipment);
- evidence, if any, of creativity in the propulsion system design and the appearance of the vehicle.

b. The poster competition and judging will occur prior to the Chem-E-Car Performance Competition. Team members must be present during judging to answer questions from the judges.

c. A team must achieve a minimum score of 70% in the poster competition to be able to advance to the Chem-E-Car Performance Competition. Posters will be judged according to the following criteria:

- Description of the chemical reaction / power source (20%)
- Design creativity and unique features of the vehicle (20%)
- Environmental and safety features (40%)
- Quality of the poster and team member presentations (20%)

d. Winners of the poster competition will be announced at the end of the performance competition:

- 1st, 2nd and 3rd place certificates will be awarded;
- A certificate will be awarded for Most Creative Drive System;
- A Golden Tire certificate will be awarded for the Most Creative Vehicle Design;

Chem-E-Car Competition® Performance Competition:

1. **Load and Distance:**
   Each car will be given two opportunities to traverse a specified distance carrying a certain additional load. The required load and distance will be given to each team one hour prior to the start of the performance competition. The distance will be between 15 and 30 m ± 0.005 m and the load will be between 0 and 500 ml of water. Teams may not add or remove any "load" (or other inert items) to adjust their vehicle weight once the poster session has concluded. Teams are only allowed to adjust "fuel" or chemical reactants used in the car's chemical reaction.

2. **Course Layout and Distance Measurement:**
   The car will start with its front end just touching the designated starting line. There will be a

designated finish line. The distance will be measured with respect to the front most point of the car. The goal of the competition is to have your car stop closest to the specified finish line (in bounds) while carrying the specified load. The course should be wedge-shaped with a starting line and the prescribed distance clearly marked in an arc of constant distance from the starting point. The physical site will dictate the exact course layout. See Figure 1 for an example of the course layout. A vehicle that goes outside the course will have its distance measured to where it went out of bounds, and a penalty of 3.0 m will be added to the measured distance. "Outside the course" is defined as having the entire vehicle outside the side tape boundaries of the course. The tape is considered as part of the course. When measuring the distance from the finish line it does not matter if the car goes longer or shorter than the prescribed distance. Note: 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.

3. Race Logistics:

A Chem-E-Car Competition® judge (or MC) will announce each team just prior to the start of their run. Each team will be asked to introduce its entry to the audience, giving the school name and briefly mentioning the propulsion system. Each car will have two (2) attempts to complete the course, each attempt lasting no more than two (2) minutes. The best score of these two attempts will be used in the judging. 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. The order of the teams in the first round of competition will be determined by random drawing. There will be a short break at the completion of the first round before the second round begins. The competition order in the second round will be determined by the 1st round standings, beginning with the team that is farthest from the prescribed distance and ending with the team that was closest.

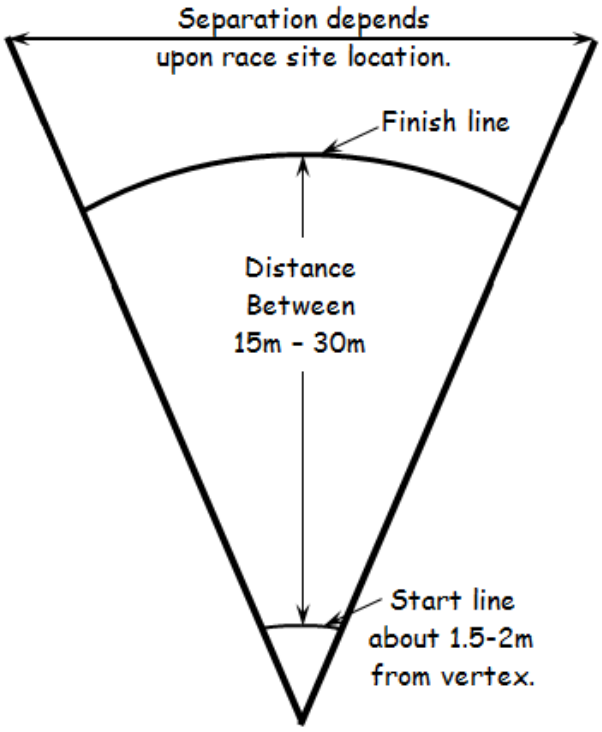

Figure 1. Sketch of typical performance course layout

4. **Starting Procedure:**
Each car is guaranteed a maximum competition time of two (2) minutes. The car must start moving, traverse the distance, and come to a stop within this time interval. If the car goes out of bounds, the next team must be ready to start its run as soon as the MC invites the team to the starting line. Since the run time of cars that run, go out of bounds, or do not start may be less than two minutes, the next car in the order of the competition must always be ready to run at a moment's notice. Please note that this is a design criterion. The MC will not guarantee a specific starting time or delay your teams start. If a car does not stop within the 2-minute period, then it is disqualified from that round of the competition.

5. **Competition Order Logistics:**
The purpose of the time restrictions is to allowcars to compete at the **Annual Student Conference** competition within the period allotted for the event.

5.1. Team start order is determined 1 hour before the competition start time.

5.2. The order for the first round may change because of disqualifications (rules violations, poster problems, or safety issues, for example). If a car is disqualified that was scheduled to start before your car, then you will move-up one position in the start order earlier than was originally scheduled.

5.3. The load and distance are announced one hour before the competition starts.

5.4. Five (5) minutes before the start of the competition, the first three (3) teams are called to the start. The first team will be at the start line, the second team at ready, and the third team beginning to move to the "at ready" position.

5.5. The first team is given a one-minute warning before the competition starts.

5.6. The competition starts when the MC signals the timing to begin. The first team is given 2 minutes for the car to start moving, traverse the distance and stop. When the car stops, the timer is reset for the next competitor. The timing will also stop if the car travels out of bounds. If the car does not stop within the 2-minute period, then it is disqualified from that round of the competition.

5.7. After the car for team 1 stops, the distance traveled is measured. During the distance measurement, team 4 is called and each team moves up one position. Team 1 should take their car directly to the chemical disposal station to dispose of their spent chemicals. This disposal process is repeated for each car upon completion of its run.

5.8. After the measurement is completed, team 2 is told to start their car, and has 2 minutes to complete the run. When the car stops, the timer is reset for the next competitor. The timing will also stop if the car travels out of bounds. If the car does not stop within the 2-minute period, then it is disqualified from that round of the competition.

5.9. During the distance measurement of team 2, team 5 is called and each team moves up one position. The process is continued until all qualified cars have competed once in the competition.

6. **Vehicle Drive System:**

An objective of this contest is a demonstration of the ability to control a chemical reaction. The only energy source for the propulsion of the car is a chemical reaction. The distance a vehicle travels must be based on a quantifiable change and direct control of the concentration of a chemical species. This chemical reactant species must be a solid, liquid, or vapor.

6.1. Vehicle Design Component: Vehicles entered into the competition must have a significant and demonstrable student design component, particularly with respect to the vehicle drive system, and the starting and stopping mechanisms. Both the chemical reaction driving the vehicle and the start/stop reaction (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). The vehicle must be powered by a chemical reaction and must be stopped by a quantifiable change, and direct control, of the concentration of a chemical species. This chemical reactant species must be a solid, liquid, or vapor.

Any vehicle that is purchased from a vendor without major modifications to its operation will be disqualified. For example a team could not purchase a fuel cell car and race this car without any modifications.

6.2. Commercial batteries: No commercial batteries (for example, AA batteries) are allowed as the power source. Commercial batteries are allowed for specialized instrumentation (e.g. detectors, sensors).

6.3. Autonomous vehicle: The car must be an autonomous vehicle and cannot be controlled remotely. Pushing to start the vehicle or using a mechanical starting device is not allowed. "Bleeding" the time off at the starting line or prior to the starting line is prohibited. Check with the Rules Coordinators (see below, item **12.)** if you have a specific question concerning your vehicle.

On-board computer control or programmable controllers are allowed but must not in any way control or measure the distance traveled. The program must be loaded onto the controller/computer/processor prior to the competition and may not be changed or communicated with after the competition begins. Wired or wireless communication with the on-board computer/controller is not allowed once the competition begins and during the competition. Teams may be asked to provide a copy of their complete programs to the rules committee on the competition day. Examples of an on-board programmable system might be an Arduino or Raspberry Pi unit.

6.4. No brakes: No mechanical force can be applied to the wheel, gears, driveshaft, etc., or ground to slow or stop the car (e.g. no brakes).

6.5. Mechanical or electronic timing devices: There can be no mechanical or electronic timing device(s) to stop the chemical reaction or stop the car. In addition, a timing device cannot utilize what is normally considered as an instantaneous reaction. For example, a constant or draining liquid feed to a sensing cell that employs an instantaneous reaction (acid-base or precipitation) would not be allowed. Another example would be a liquid draining out of a vessel to serve as a stop switch. This would be considered a mechanical timing device and would not be allowed. If there are questions whether an entry has a "mechanical or electrical" versus a chemical reaction stopping mechanism, the **Annual Student Conference** Rules Coordinators/judges have final say, regardless of prior rulings at regionals. Check with the **Annual Student Conference** Rules Coordinators (see item **12** below) if you have a specific question concerning your vehicle.

6.6. ICE: Internal combustion engines using an alternative fuel (e.g., biodiesel, ethanol, etc.) are allowed. The fuel MUST be completely synthesized by the students (no additive blending is allowed). Succinct safety procedures for the maintenance and operation of this engine must be demonstrated by

the team with considerations to indoor operation. If the fuel deviates in any way from those typically used, you should submit a description to the Chem-E-Car Competition® Rules Committee (see item **12** below), which will evaluate its acceptability. Note: Internal combustion engines are not allowed to emit visible combustion smoke to the competition space and are subject to sound restrictions. See the Safety Rules for a more complete discussion.

7. **Size of Car:**
   All components of the car must fit into a box of dimensions no larger than 40 cm x 30 cm x 20 cm. The car may be disassembled to meet this requirement. If the judges are uncertain whether the car will fit inside the box when dissembled, they may request that the team demonstrate that they can do this.

8. **Water Load Container:**
   The car must carry a container that holds up to 500 mL of water without spilling. An example container is a Nalgene Low-Density Polyethylene Narrow-Mouth Bottles (500 mL). At the competition, only the water will be supplied, thus each car must already have its own container.

9. **Capital Cost of Vehicle:**
   The cost of the contents of the "shoe box" and the chemicals must not exceed $2000. The vehicle cost includes the donated cost of any equipment. The time donated by university machine shops and other personnel will not be included in the total price of the car. It is expected that every university has equal access to these resources. The cost of pressure testing is also not included in the capital cost of the car. The method used to estimate the donated cost of the equipment must be shown. It is expected that standard financial procedures will be used to estimate this cost. **The same car cannot be reused from year to year.** Substantial changes must be made and indicated in the poster presentation.

10. **Team Member Status and Conduct:**

    10.1. All team members attending the Chem-E-Car Competition® must be registered attendees for the WCCE 10.

    10.2. Faculty and graduate students can only act as sounding boards to the student queries. The faculty cannot be idea generators for the project. There is no restriction on requesting assistance on vehicle safety – teams may request safety assistance from their faculty advisor, other faculty members, other universities, and professional practitioners in industry and elsewhere.

    10.3. The students working on the project must sign a statement saying they have read, understand, and abided by the rules. This statement must be included in the EDP and must be available at the poster competition.

    10.4. The minimum team size is five (5) participants. All team members do not have to be present at the Chem-E-Car Competition®; however, all are encouraged to attend, if possible. During the performance competition, only five (5) team members are allowed in the pit area at once. Team members can be swapped out during the competition, but only 5 are allowed in the area at a time.

    10.5. All team members and the faculty advisor MUST have completed the required safety training as outlined in the Chem-E-Car Competition® Safety Rules.

11. Winning Team

11.1 The winning team is the car that stops closest to the finish line. This is defined as the absolute value of the distance between the front most part of the car and the finish line. In case of ties, at the discretion of the Chem-E-Car Competition® judges, the team with the best average from the two runs may be declared the winner. Winners of the Chem-E-Car Performance Competition will be recognized immediately following the performance competition.

12. **Rules Coordinators:** If there is any uncertainty on an issue of safety or other judging criteria, please contact studentchapters@aiche.org.