

AIChE Chem-E-Car Competition™ 2016

Updated–December 2015

Regional Chem-E-Car Competition™ Checklist

Done	Deadline Dates	Item
☐	See AIChE website for various regional deadlines and instructions.	<ul style="list-style-type: none"> • Design Chem-E-Car using approved safety procedures • Inform regional host of your team’s intention to participate by the deadline they assign.
☐	See AIChE website for various regional deadlines and instructions.	<ul style="list-style-type: none"> • An Engineering Documentation Package (EDP) must be filled out and appropriate approvals obtained. Each EDP must include the following: JSA Form, Safety Verification Form and the Certifications Form. • Comply with all Chem-E-Car Competition™ rules and safety rules. All team members and the team advisor must sign and submit the rules verification page to the Chem-E-Car Competition™ Committee. This must be submitted with your EDP packet.
☐	Month before competition day.	<ul style="list-style-type: none"> • Create a plan to transport vehicle and chemicals in coordination with the regional host. Note: teams will be disqualified for not transporting chemicals in accordance with the regional host’s rules.
	Week before competition day.	<ul style="list-style-type: none"> • Hold a team meeting to review the rules and to make sure that everyone has their safety glasses and coats to bring to the competition.
☐	Week before competition day.	<ul style="list-style-type: none"> • Inform your team that each region has a Safety Coordinator who is the <i>final authority on safety issues, disqualifications, and rules issues.</i>
		<ul style="list-style-type: none"> • NOTE: a pressure cylinder of hydrogen gas will not be allowed to be used as a H₂ source for filling at the 2016 regional or Annual Student Chapter competitions. See the Chem-E-Car Competition™ safety rules for more information.

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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.

There are two general competitions. The first is held at spring regional conferences and the second is held at the AIChE Annual Meeting. 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.

There is a poster session, a video competition and a distance/performance session at each competition, as detailed below. For 2016, the video competition at the regional meetings will not be formally held, but may be held for fun at the discretion of the host organizers.

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) Regional Conference Competitions

1. In general, a school may have any number of entries at the Regional Conference. However, the Host School has the right to set a limit, should the need arise.
2. The rules listed under the **Annual Student Conference** Competition shall apply for the regional conference competition.
3. Regional conference host school organizers should contact studentchapters@aiiche.org with questions or for clarification on the competition rules.
4. An AIChE appointed safety coordinator will be in attendance at each regional competition. This coordinator is the final authority regarding Chem-E-Car Competition™ rules, safety concerns, violations, disqualifications, and the like, for that Regional 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 the regional competition and is not binding on judgments at the **Annual Student Conference** level competition.

For more information on this competition, contact AIChE at (646) 495-1364 or studentchapters@aiiche.org.

Regional Conference Awards:

Poster Competition:

- 1st place: \$200 and Ribbon
- 2nd place: \$100 and Ribbon
- 3rd place: \$50 and Ribbon
- Ribbon for Most Creative Vehicle Design

Performance Competition:

- 1st place: \$200 and Ribbon
- 2nd place: \$100 and Ribbon
- 3rd place: Honorable mention and Ribbon
- Ribbons for 4th and 5th place finishers
- Ribbon for Spirit of Competition

B) Annual Student Conference Competition

There will be a maximum of 31 regional car entries at the 2016 **Annual Student Conference**. The list of **Annual Student Conference** entries is drawn from the regional winners, based on the size of each region. The number of qualification slots reserved for each region is shown below:

- | | | | |
|----------------------|--------------|-------------------|--------------|
| • Mid-America: | 3 qualifiers | • Rocky Mountain: | 3 qualifiers |
| • Mid-Atlantic: | 5 qualifiers | • Southern: | 5 qualifiers |
| • North Central: | 5 qualifiers | • Southwest: | 2 qualifiers |
| • Northeast: | 3 qualifiers | • Western: | 3 qualifiers |
| • Pacific Northwest: | 2 qualifiers | | |

Multiple entries from a single school may be permitted at the regional competitions, with permission from the regional host school. **However, only one entry per school, via this qualifying procedure, will be allowed at the Annual Student Conference competition.**

NOTES:

- **To be eligible to apply** for the 2016 **Annual Student Conference** competition, **your team must have had a team entry, and participated**, in your normal region (or in an AIChE approved alternative region). **If your team did not compete in your normal region (or AIChE approved alternative), you cannot participate in the 2016 Annual Student Conference Chem-E-Car Competition™.**
- If your team participated in a regional conference, but did not qualify, you may email Sarah Ewing at sarae@aiche.org to be added to the waitlist. Waitlist submissions will be accepted until May 29, 2016.
- Teams who have failed the safety inspection at regionals will be required to provide documentation (signed by their faculty advisor) to the Chem-E-Car Competition™ Committee (attn: **Dr. David Dixon**, david.dixon@sdsmt.edu) that they have corrected the safety violations.
- For the 2016 **Annual Student Conference** competition, 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.
- In May of 2016, the Chem-E-Car Competition™ Rules Committee will evaluate all of the regional qualified teams to determine if their entry meets the **Annual Student Conference** Competition rules. If a team's entry is determined to not meet the **Annual Student Conference** Competition rules, that team will be disqualified and will not be able to compete at the 2016 **Annual Student Conference** Competition. Their slot will open up to the next team on the

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waiting list.

Chem-E-Car Competition™ Rules

There are three events at a Chem-E-Car Competition™: a poster competition, a video 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 plaques will be awarded;
 - A plaque will be awarded for Most Creative Drive System;
 - A Golden Tire plaque will be awarded for the Most Creative Vehicle Design;
 - Society of Biological Engineers Award for Best Use of a Biological Reaction to Power a Car;
 - SACHÉ Safety Award for the best application of the principles of chemical process safety to the Chem-E-Car Competition™.

Video Competition (Optional at Regional Competitions)

Build excitement for your participation in the Annual Student Conference Chem-E-Car Competition™ by submitting a quick intro video, profiling your team, your car and your participation in the competition.

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- Videos will be broadcast at the Chem-E-Car Competition™.
- Videos will be featured on ChEnected, the AIChE student page, shown on the ChEnected YouTube Channel, tweeted, and shown on Facebook.

Instructions:

- Videos should be no longer than 60 seconds
- Videos should be a quick, fun introduction to your car, your team and your school. What makes your car special?
- Be creative and get people excited about your participation in the competition
- Videos must show your school and car name
- Videos should be submitted in an .mp4 YouTube-friendly
- Videos submitted must comply with Youtube copyright policies.

If you submit a video that does not follow what is outlined above, it cannot be used or considered for the competition.

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 \pm 0.005 m and the load will be between 0 and 500 ml of water. A judge from the student host chapter will measure out the prescribed water for each team. 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 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

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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.

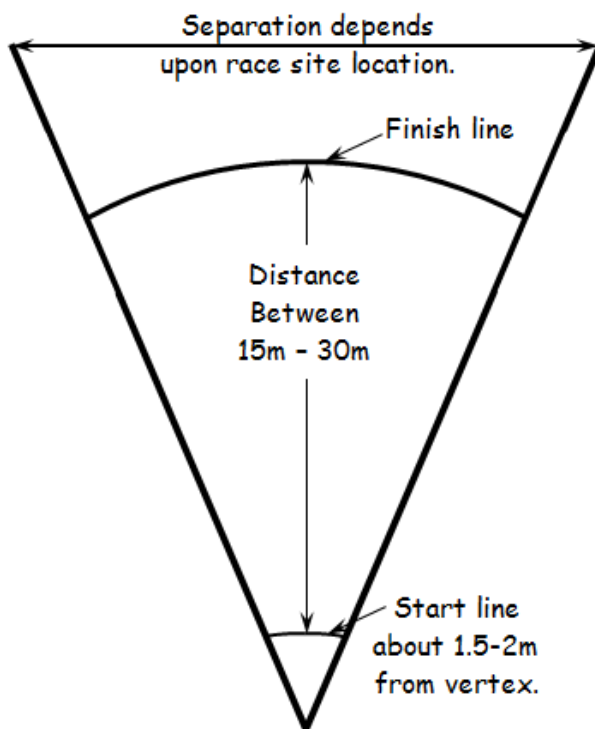


Figure 1. Sketch of typical performance course layout

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 allow 31 cars to compete at the **Annual Student Conference** competition within the period allotted for the event. Note: at the regional competition, the host may allow a more generous time allotment, however, the Annual Student Conference competition must follow the rigid time restrictions.

5.1. Team start order is determined during the poster competition.

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

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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.

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.

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

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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 **Annual Student Conference 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 disassembled, 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

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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 **Annual Student Conference** Competition must be active AIChE members.

10.2. The competition will be conducted on the honor system. 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 **Annual Student Conference Chem-E-Car Competition™**; however, all are encouraged to attend, if possible.

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.

10.6. All student chapters that are competing in the **Annual Student Conference** Competition must have submitted a Student Chapters Annual Report online to AIChE following the submission deadline.

11. Winning Team and Awards, **Sponsored by Chevron**

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 Annual Student Conference judges, the team with the best average from the two runs may be declared the winner. Winners of the **Annual Student Conference Chem-E-Car Performance Competition** will be recognized immediately following the performance competition.

11.2 The **Annual Student Conference** Performance and associated awards are:

- **1st place:** \$2000 and a trophy
- **2nd place:** \$1000 and a trophy
- **3rd place:** \$500 and a trophy
- **Best Use of a Biological Reaction to Power a Car - \$1,000 Prize:** Sponsored by the Society

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- for Biological Engineering
- **SACHE Safety Award** for the best application of the principles of chemical process safety to the Chem-E-Car Competition™.
- **Most Consistent Performance** - This award is based on the best average score for the two runs that the vehicle makes. It has been created to recognize the team that has designed and most understands the performance of the reaction that powers the vehicle. Award consists of a plaque.
- **Spirit of the Competition** - This award is given to the team displaying the most team spirit as decided by a panel of judges. Award consists of a plaque.
- **Most Creative Drive System** - Recognition is awarded to the team that has designed and installed the most creative propulsion system. The winner is decided by a panel of judges during the poster competition. Award consists of a plaque.
- **Golden Tire Award** - In 2002, Northeastern University team members created this award to recognize the team with the most creative vehicle design. The committee has adopted this as an annual award. The winning entry is decided by a ballot cast by each team entered in the competition. Award consists of a plaque.

12. Rules Coordinators: If there is any uncertainty on an issue of safety or other judging criteria, please contact the following people first:

The decisions of the rules and safety judges are final.

Dr. Skip Rochefort
Oregon State Univ.
Chemical Engineering
103 Gleeson Hall
Corvallis, OR 97331
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skip.rochefort@oregonstate.edu

Dr. Robert Ofoli
Michigan State Univ.
Chemical Engineering
East Lansing, MI 48824
517-432-1575
ofoli@egr.msu.edu

Dr. James Smith
Univ. of Alabama, Huntsville
Chemical & Materials Engineering
130 Engineering Building
Huntsville, AL 35899
256-824-6439
jesmith@che.uah.edu

Questions regarding decisions may be addressed to:

- Dr. Rochefort (skip.rochefort@oregonstate.edu), Dr. Dixon (david.dixon@sdsmt.edu), and Ms. Ewing (sarae@aiche.org).

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