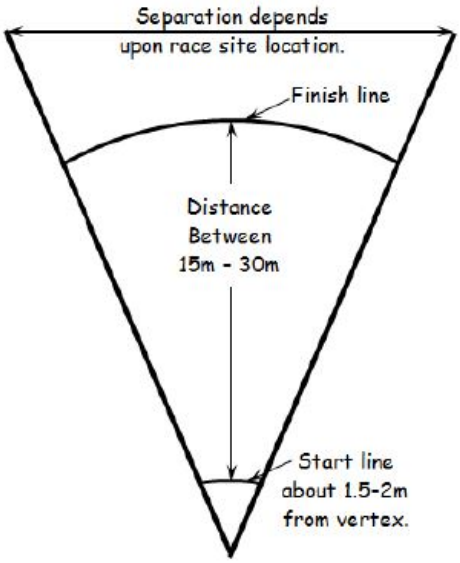
AIChE MIDDLE EAST REGIONAL CHEM-E CAR COMPETITION ®
2015 RULES

In order to create a safe and fun competition for all participants, all teams are required to follow the safety rules as described in this document. Safety for the competition means teams must follow safe laboratory procedures when designing, building, testing, and operating their car. Each team will design a car that starts using a chemical reaction and stops using a chemical reaction. A written design package, called an Engineering Design Package (EDP) will be created by each team and submitted to a team of safety professionals who will review it online. These professionals will review the EDP to check that all the rules pertaining to safety have been followed. Finally, the EDP and the car itself will be reviewed by the safety professionals at the competition site prior to the competition. Teams must pass both the EDP check which will occur online and the onsite EDP and car review.

COMPETITION INFORMATION

- **Each school may have only 3 car entries**
- **Each team may have a minimum of 5 and maximum of 12 team members, however, each team must have a minimum of 5 and a maximum of 6 team members on the floor at the time of the competition itself.**
- **One team per car**
- **A $200 USD entrance fee will be charged for each competing team. This entry fee will cover the disposal of chemicals and waste at the competition site.**
- **Each student can participate in designing and running only 1 car design**
- **Teams are required to create an Engineering design package (EDP)**
- **Teams are required to create a poster which explains design features, chemical reactions, safety features, etc.**
- **Each car will be given (2) opportunities to travel a specified distance while carrying a required load, the best score from the (2) runs will count for the overall team score**
- **The distance will be between 15 and 30 m and the load will be between 0 and 500 mL of water**
- **Cars will start with their front edge of the car in line with the start line**
- **Distance travelled by the car will be measured from the car's front wheel edge to the finish line**
- **The course will be wedge shaped with an arc of constant distance from the start point**
- **Any vehicle which travels outside of the arc will have the distance measured from the place it went out of bounds, and a penalty of 3 meters will be added to this distance. The car must be completely outside the boundary to be considered out of bounds. Merely touching the edge of the line does not constitute an out of bounds penalty.**
- **When measuring from the finish line it does not matter if the car goes longer or shorter than the finish line (i.e. a 'winning' car may cross the finish line)**

- **Any car traveling completely past the 33 meter line will receive a 'No score' for that run**
- **Cars must start running and complete the travel within 2 minutes**
- **An announcer will announce each team and provide a 2 minute warning to get the car to the start line**
- **A team member will describe the car on the microphone prior to the start of the run**
- **If a car fails to start, or does not complete a run within the 2 minute course time, that run will receive no score for that round.**
- **Each car will participate in the first round before the second round starts**
- **There is a 15 minute break after the first round**
- **The car which was furthest from the finish line will go first, and the car which was closest to the finish line in the first round will go last**
- **The car that finishes closest to the finish line WINS**



HOW TO PARTICIAPTE:

STEP 1: CREATE YOUR EDP

Please create your EDP by completing these items in this order. All forms needed to complete the EDP can be downloaded from the AIChE website.

1. **Product Hazard Analysis (PHA)** – This contains a summary of your car design, identifies the hazards, and identifies the means for protection. Please fill this form out completely.
2. **Diagram of car –** This is also called a Process Flow Diagram. Show the major parts of the car, including the pressure vessel, fuel cell, reaction container, motor, battery container, etc.
3. **Photograph of car** - The entire car must be visible in the picture. Remove the top to expose electrical controls if necessary. Multiple views of the car are encouraged.
4. **Table of car components -** A list of **every piece of equipment** on the car in **table format**. Include in the list the manufacturer of the equipment. List the maximum temperature and

pressure that each component on the car can withstand. For instance, if a fuel cell can only withstand a pressure of 0.48 bar (7 psig), please list that, even if you only plan to operate it at 0.07 bar (1 psig). Use the manufacturer specifications to obtain the information. For equipment that has no specification sheets, please use the material properties to estimate the operating limits related to max temperature and pressure.

5. **Standard operating procedures –** Explain how you will start the car, how you will clean up the car after a run is complete, and the emergency stop procedure for the car.
6. **Describe the chemistry –** Use stoichiometry to explain the chemical reactions within the car. Explain both the start and stop reactions. If you are letting the starting reaction run to completion, then list "limiting reactant" as your stopping chemistry.
7. **Explain pressure buildup in car –** If you are using a reaction that will create pressure, explain how you determined the maximum pressure that can be reached if the car must travel the maximum distance carrying the maximum load. Most students use PV = nRT to calculate this. In some cases, it may be necessary to test this.
8. **Attach certification for pressure vessel –** You can conduct this test yourself using the procedure in the Appendix, or you can provide a test certification from the manufacturer. If you are using the manufacturer certifications, you must prove your vessel has been in service less than 5 years.
9. **Use size calculations to select a Pressure Relief Valve (PRV)** – A pressure relief device is required to be installed on any car that operates using pressure above 0.07 bar (1 psig) for safety. If a pressure regulator is used, a total of (2) PRVs must be installed, **one on each side of the pressure regulator**. In order to select the appropriate PRV, calculations should be used to determine the correct orifice size to make sure pressure can be released fast enough. See API 520 Part 1 for an explanation of each variable and expected units for the equations, which is provided below.

$$A = \frac{W}{CK_dP_1K_bK_c}\sqrt{\frac{TZ}{M}}$$

Equation for determining the orifice area (in mm^2) of a PRV

10. **Test each PRV** – Please test the PRVs and make sure they operate when the pressure is above set point. Please explain how you tested the PRV and provide the results.
11. **Draw the laboratory test area** – label the location of the fire extinguishers and eye wash stations in the laboratory in which the car is constructed.
12. **Safe chemical disposal** – Explain how you will dispose of each chemical after your car is operated.
13. **Manage changes to car –** Describe the management system for approval of changes in your vehicle. There is a form for this posted on the AICHE website, called the management of change (MOC) form.
14. **Certification form signed by faculty member -** Have the engineering documentation package reviewed by your faculty advisor to insure that you have identified the major hazards and have controlled them properly.

15. **Chemistry use verification page -** Judges will use this page to determine whether or not the starting and stopping mechanism you have selected is compliant with the rules.
16. **Fill out the chemical order sheet –** make sure you order enough chemicals to run the car 3 times at maximum distance and load, to allow for mixing errors. Only the chemicals listed will be ordered. Chemicals will be shipped to the competition site in advance of the competition. All chemicals will likely arrive at the competition site several weeks in advance and will be inventoried prior to competition day. No chemicals will be provided to students prior to competition day.
17. **Material Safety Data Sheets for all chemicals** – should be included at the end of the EDP for quick reference.
18. **Put all the above documents into a single PDF.**
19. **Upload the EDP to the box.com website.**

STEP TWO: CREATE YOUR CAR

The following rules apply to the design and testing of the car.

- **Students are not allowed to bring any chemicals**

No chemicals may be transported in private, university or rental vehicles to and from the competition site, even for short distances. Students will be required to list the amount of chemicals needed in the EDP. All chemicals will shipped to the competition host prior to competition day.

- **Car start and stop system must be a chemical reaction that is onboard the car (no pre-loading of a drive system such as a capacitor assembly)**
- **Cars must be 'shoe box sized' in that they must fit into a standard size shoe box when completely disassembled**
- **Total cost of the vehicle material must be less than $2000 USD or the currency equivalent in participating countries at the time of the competition. (note that labor costs are not included)**
  Exchange rate as of 4/26/15:
  $2000 USD =
  - **= 754.14 Bahraini Dinars**
  - **= 15252.80 Egyptian Pounds**
  - **= 7281 Qatari Rials**
  - **= 7500 Saudi Arabian Riyals**
  - **= 7346.30 UAE Dirhams**
- **No commercial batteries can be used to drive car (batteries are ok to power specialized or auxiliary instrumentation)**
- **Car may not be remote controlled**
- **No one may 'push' the car to get it to start**
- **Computer controls or programmable controllers are allowed but must not be used to measure the distance travelled in any way**
- **Programmable controllers must be loaded prior to the first run and may not be changed once competition begins**
- **No brakes**

- **No mechanical or electrical timing devices are allowed (draining fluid to a sensing cell is not allowed)**
- **No titration reactions are allowed**
- **No flames**
- **No smoke from combustion**
- **No noise above 90 decibels (measured a 1 meter distance away)**
- **Students must make fuel if they use an internal combustion engine (no commercially purchased fuel such as gasoline or diesel)**
- **No liquid discharge – no liquid, not even water can escape the car**
- **All liquid reactions require double containment**
- **No chemicals with a** National Fire Protection Association (**NFPA) rating of 3 or 4 are allowed**
- **Insulation is required for any surface or container above a temperature of 70°C.**
- **No open containers – all containers must have a secure lid**
- **No unsecured syringes. All syringes must be attached to the car when walking to the starting line and remain attached to the car during the run.**
- **No exposed wiring connections (no twisted wires or alligator clips) - banana plugs ok.**
- **Maximum operating pressure (MOP) must be determined for the car to travel 30 meters (100 feet) carrying 500 mL of water**
- **Max operating pressure (MOP) in the car must be less than 35.4 bar (500 psig)**
- **No release of gas from a PRV- if your PRV functions as it must in an emergency your run will not count**
- **Cars with a pressure above 0.07 bar (1 psig) must have at least 1 PRV and 1 pressure gauge**
- **PRV and pressure gauge must be as close to the pressure vessel as possible**
- **Pressure containing vessel must be tested to ensure it can contain the MOP**
- **PRV must be set to operate at 1.1 times the MOP**
- **Pressure gauge must read 2 times the MOP**
- **No PVC, cPVC or polyethylene terephthalate (PETE or PET) vessels or piping used for pressurized gases**
- **No biohazards above biohazard level 1**
- **No hydrogen peroxide greater than 30%**
- **No plastic water or soda bottles can be used to contain chemical reactions**
- **Hydrogen gas must be generated by students** – students must create their own hydrogen
- **No chemicals can be poured at the starting line** – use an attached syringe or a valve to release chemicals from a holding tank
- **No highly reactive or unstable chemicals** – Chemicals with an NFPA rating of 4 are not allowed. NO acetyl peroxide, 3-bromopropyne, cumene hydroperoxide, di-tert-butyl-peroxide, diethyl peroxide, diisopropyl peroxydicarbonate, 0-dinitrobenzene, divinyl acetylene, ethyl nitrite, nitroglycerin, nitromethane, paracetic acid, and some high explosives.

- **No regulated chemicals** – Occupational Safety and Health Administration, (OSHA) regulated chemicals are not permitted. Here are some that are NOT permitted: Regulated chemicals include: asbestos, coal tar pitch volatiles, 4-nitrobiphenyl, alpha-napthylamine, methyl chloromethyl ether, 3,3'-dichlorobenzidine, bis-chloromethyl ether, beta-naphthylamine, benzidine, 4-aminodiphenyl, ethyleneimine, beta-propiolactone, 2-acetylaminofluorene, 4-dimethylaminoazo-benezene, n-nitrosodimethylamine, vinyl chloride, inorganic arsenic, benzene, 1,2-dibromo-3-chloropropane, acrylonitrile, ethylene oxide, formaldehyde, 4,4'-Methylenedianiline, 1,3-butadiene, methylene chloride.

STEP THREE: PACKING FOR THE COMPETITION

- If you are shipping your car, plan to ship your car to the competition at least 1 month in advance – the shipping address will be provided by AIChE in an email to the team captain. Declaration guidelines for country of destination customs information will be provided.
- Each team must bring their own personal protective equipment (PPE), such as gloves, goggles, safety glasses, lab coats
- Teams must bring their own glassware
- Weighing balances and hot plates will be provided by the conference organizers
- Bring extra glassware, pipettes, scoops and stirring rods in case they break
- Bring extra PPE
- Bring a copy of your EDP
- Bring a copy of the safety review form completed for your EDP safety review

STEP FOUR: ONSITE AUDIT

- All members of the team, including the team Advisor, will be present for safety review
- Bring the EDP, EDP review, and the car to the review session
- Be ready to answer questions about how the car operates

STEP FIVE: COMPETITION

- Chemicals will be provided to students at least 90 minutes prior to the start of the competition
- The distance and load will be announced 60 minutes prior to competition
- The order of the student teams will be announced at least 60 minutes prior to competition
- The order of teams will be selected at random by pulling team names from a container
- No testing is permitted on competition day
- Safe disposal of chemicals is required – disposal containers will be provided by competition organizers
- PPE must be worn in the chemical preparation area **at all times**
- All containers must be labeled in English to identify the chemicals within them and the school using the container

- All mixing will be done in the chemical prep area
- Any spills of chemicals will be reported to the conference organizers and cleaned up immediately

ASSISTANCE

Teams may request safety assistance from the Chem-E-Car car committee member Tara Henriksen (vbritelite@hotmail.com), Dave Dixon (David.Dixon@sdsmt.edu), Skip Rochefort (Skip.Rochefort@oregonstate.edu) or their faculty adviser. Webinars will be set up to provide access to these committee members for asking questions.

Additional Resources

The primary method for characterizing the hazardous properties of chemicals for the Chem-E car Competition® is by the National Fire Protection Association (NFPA) method. This method assigns a numerical value to the degree of hazard based on three major hazard groups: toxicity, flammability and instability / reactivity. The numerical values range from 0 to 4, with 0 representing the lowest degree of hazard and 4 representing the highest. See www.nfpa.org for more details on this.

An excellent source of information on the hazardous properties of chemicals is the National Institute for Occupational Safety and Health (NIOSH), www.cdc.gov/niosh. In particular, they support a free, on-line guide to chemical hazards call the *NIOSH Pocket Guide to Chemical Hazards*. This is available at http://www.cdc.gov/niosh/npg/default.html.

Appendix A: How to conduct a Pressure Vessel Test

The test pressure is the target pressure specified for the hydrotest. This specification depends on the maximum operating pressure (MOP) of the vessel. Note that this step is required for every container on the car that contains a pressure greater than 0.07 bar (1 psig).

A.2 Hydrotest Procedure

Hydrostatic testing (using water) is the standard for pressure vessel testing. Pneumatic tests using air, nitrogen, carbon dioxide or other gases are not permitted due to the explosive nature of rapidly expanding gases.

Pressure Gauge Requirements
The pressure gauge must read at least 4 times the MOP. The gauge must be able to be read to increments of at least 0.35 bar (5 psig).

Measurement of Vessel Deformation
During pressure testing a gauge must be configured to measure any deformation of the vessel. This gauge must be visible to the operator applying pressure. Use a dial gauge accurate to at least 0.0254 mm (1 inch). Insure that the dial gauge is in good working condition and properly calibrated.

To confirm that plastic yielding (expansion) has not occurred during pressurization, the vessel must be measured along its centerline in three directions (x, y, z) both before and after hydrostatic testing. Measurements shall be taken using a caliper or mechanical gauge accurate to 0.0254 mm (0.001 inch) or less.

Test Area
The test area should be restricted and barricaded. The vessel being pressure-tested should be oriented so that bolts, flanges, and other possible missiles point away from people and other equipment. All pressure tests must be conducted remotely. A barrier (sand bags, lumber) must be used to limit the potential from flying projectiles should the vessel fail the test. The barrier should be around all four sides of the vessel and should extend above the vessel.

Test Procedure

1. Provide a vent to allow air to leave the vessel while filling with water. You might consider providing a bottom drain to remove water when the testing is done.
2. Fill the vessel with water and remove the air. Make sure the vessel is completely filled with liquid prior to the test.
3. First, increase the pressure to a maximum of one-half of the test pressure. Then, raise the pressure in increments of 0.1 times the test pressure until the test pressure is reached. The final test pressure must be held for a minimum of 30 minutes. Pressure should hold steady and not change significantly during the test. A change of 10% of the test pressure or 0.35 bar (5 psig) is significant. No water leaks or drips should be observed.

4. The pressure should then be lowered to the operating pressure of the vessel and held for a visual inspection of all joints and connections. No water leaks or drips should be observed.
5. Take appropriate vessel measurements, accurate to within 0.0254mm (0.001 inch), both before and after testing to show that detectable plastic yielding has not occurred during pressurization.

Documentation of Test

Provide the following documentation in support of the hydrotest.

1. Identification of vessel(s) or system.
2. MAWP or test pressure of vessel(s) or system, if known.
3. Planned test pressure.
4. Supporting calculations.
5. Date and time that test started.
6. Date and time that test was completed or failed.
7. Maximum pressure attained.
8. Chart of test-pressure sequence (optional).
9. Test liquid.
10. External temperature of system.
11. Temperature of test liquid.
12. Organization conducting test.
13. Signature of Chem-E Car Advisor to certify the completion of the test.

Vessel Labeling

At the completion of the test a pressure test label must be affixed to the pressure vessel. Information on the label must include:

1. Identification of the Vessel (Car Name, Vessel Purpose)
2. MAWP or test pressure, and temperature
3. Working fluid
4. Test engineer
5. Test Date

Appendix B: Chemical Handling and Disposal

B.1 Introduction

All Chem-E-Car Competition® students who handle chemicals either at their host institution or at a regional competition, must understand the hazardous properties of these chemicals. Before using a specific chemical, safe handling methods must always be reviewed. Faculty advisers are responsible for ensuring that the equipment needed to work safely with chemicals is provided.

B.2 General Rules for Chemical Safety

A. Material Safety Data Sheets (MSDS) must be available in the laboratory for all chemicals, including those in storage in the laboratory.
B. When purchasing chemicals, purchase the smallest quantity necessary to complete the planned experiments. The cost of disposal of unused chemicals far exceeds the savings from quantity purchases.
C. Skin contact with chemicals must be generally avoided.
D. No more than 2-gallons /7.57 liters of flammable solvent should be out in the laboratory at any one time. Store bulk flammable containers in a flammable storage cabinet.
E. All containers (including those in storage) must be labeled – see the section on labeling below. Any unlabeled container must be treated as a hazardous substance.
F. Wear compatible gloves and apron when handling strong acids and bases.
G. Use a grounding strap and/or dip leg when transferring flammable chemicals into a storage tank.
H. Transport <u>all</u> chemicals using a safety carrier. The chemical must be in a closed container.
I. Chemical containers must be kept away from high temperatures, the edge of the lab bench, and other areas where an incident might lead to loss of containment.
J. Mouth suction for pipetting or starting a siphon is not allowed.
K. Unknown substances must be treated as toxic and flammable.
L. Do not taste or smell any chemicals.
M. Operations involving chemicals should generally be done in a laboratory hood.

B.3 Chemical Storage

A. MSDS's must be available for all chemicals stored.
B. ALL chemicals stored must be properly labelled see B.4 below.
C. No chemicals shall be stored on the top of lab benches or out in the open. Chemicals must not be stored over eye level height to prevent accidents from dropping containers.
D. Flammable and volatile chemicals must be stored in a cabinet designated for flammable storage. See the discussion of flammable storage cabinets in the Safety Equipment section. Refrigerated storage of these chemicals requires a refrigerator rated for storing flammables.
E. Acids and bases should be stored separately.
F. Acid-resistant trays shall be placed under stored acid containers.

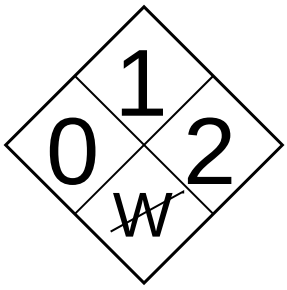
G. Acid-sensitive materials such as cyanides and sulfides must be separated from acids.
H. Oxidizers should be stored away from acids and bases.
I. Stored chemicals must be examined on a regular basis by the laboratory personnel (at least annually) to inspect for deterioration, container integrity, and expired dates. Chemicals which are not being used should be disposed of or returned to chemical stores for recycling.
J. An inventory of stored chemicals must be maintained by the laboratory owner at all times. Unneeded items shall be properly discarded or returned to Chemical Stores. Store only what you are using.

B.4 Chemical Labeling

All chemicals must be labeled, even during temporary transport at the competition site. This includes lab samples, temporary containers, etc. A proper chemical label must include:

- Identity of contents
- Date material was acquired
- Disposal date (for unstable chemicals)
- Responsible person
- Hazardous characteristics
- Other pertinent safety information

The hazardous characteristics are frequently denoted using an National Fire Protection Association (NFPA) diamond. A sample diamond is shown below:



The area with a “0" in the diamond denotes health hazard, the area with the “1" denotes fire hazard and the area with a “2" denotes reactivity hazards. The box at the bottom is used to denote special hazards, e.g. incompatible with water.

The hazards in the NFPA diamond are indicated by numbers 0 through 4. 0 means minimal hazard while 4 means extreme hazard.

B.5 Chemical Disposal

All chemicals must be disposed of in a safe and environmentally friendly manner. Any chemical substance which is corrosive, flammable, reactive, toxic, radioactive, infectious, phytotoxic, mutagenic, or acutely hazardous must be treated as hazardous waste. Do not dispose of chemicals by evaporation in a fume hood or in the sink! Do not hesitate to ask for help if any questions occur about the hazards of a material.

Collect and store chemical waste in containers which are clearly labeled. Do not combine containers unless the contents in each container is known, is compatible, and it is certain that it is safe to do so. Combined wastes are much more difficult and costly to dispose of properly.

Ordinary waste such as paper, cardboard, etc., may be placed in the wastebasket. However, contaminated waste must be disposed of separately in a labeled container.

Empty chemical containers must also be disposed of in an acceptable fashion. They must first be cleaned and then either returned to Chemical Stores or disposed through normal trash.

2015 AIChE MIDDLE EAST REGIONAL CHEM-E CAR COMPETITION ®

Product Hazard Assessment Form (PHA)

University:	**Vehicle Name:**
Author Contact Name:	**Author Email:**
Faculty Supervisor:	**Supervisor Email:**
Revision #:	**Revision Date**:

Purpose of Experiment / Equipment: Briefly describe your Chem-E-Car's design, intended mode for operation (source of power), intended mode for control (stopping), and major hazards and their control.

Describe your car's design:
Power source:
Stopping mechanism:
Hazards inherent in design:
Safety measures:

Expected Operating Conditions for starting reaction:

Temperature	Pressure
Normal:	Normal:
Minimum:	Minimum:
Maximum:	Maximum:

Expected Operating Conditions for stopping reaction:

Temperature	Pressure
Normal:	Normal:
Minimum:	Minimum:
Maximum:	Maximum:

This section applies to your home institution – not the competition site. List the location of available safety equipment and spill response supplies in your home laboratory.

Personal Protective Equipment (PPE): Check all PPE worn during operation of this Chem-E-Car. Do not list these in the procedure section.

☐ Long Pants	☐ Safety Glasses	☐ Hard Hat	☐ Apron
☐ Long Sleeves	☐ Splash Goggles	☐ Insulated Gloves	☐ Ear Protection
☐ Non-porous Shoes	☐ Face Shield	☐ Chemical Gloves	☐ Other:

Available Safety Equipment – Provide the location of each item shown below at your home institution where your vehicle will be operated and tested. Show the location of this equipment on your provided floor plan. If not available, type "NA" in the field.

Item	Location
Fire Extinguisher:	
Eyewash:	
Safety Shower:	
Telephone:	
First Aid Kit:	
Spill Containment	
Other:	

Spill Response Supplies - Provide the location of each item shown below at your home institution where your vehicle will be operated and tested. Show the location of this equipment on the attached floor plan. If not available, type "NA" in the field.

Item	Location
Spill Kit:	
Floor-Dri:	
Spill Dikes:	
Sodium Bicarbonate:	
Drain Plugs:	
Spill Pillows:	
Mercury Spill Kit:	
Other:	
Other:	

Disallowed Activities: All activities listed below are not allowed and will result in a multi-year disqualification of your university from Chem-E Car Competition®.

Item
(a) No transport of chemicals in private, university or rental vehicles either to or from the competition.
(b) Chemicals must not be stored in hotel rooms or other facilities not rated for chemical storage. Approved chemical storage will be provided at the host site.
(c) No vehicle testing in hotel or dorm hallways, warehouses, or other facilities that are not designed for chemical handling. This includes your university and the competition site.
(d) No improper disposal of chemicals at the conclusion of the competition. All chemicals shipped to the competition site must be disposed of in a safe and environmental fashion following all local, state and national regulatory measures. Chemical disposal will normally be provided by the host site.

Disallowed Designs: All of the items listed below are not allowed.

Item	Explanation
(a) Flames and/or smoke	Both inside and outside the vehicle, except for commercial internal combustion engines. See Chem-E Car Competition® rules for using commercial internal combustion engines. **Note that NO SMOKE is allowed from any vehicle, including those using internal combustion engines.**
(b) Liquid Discharge	Liquid may not be discharged under normal operating conditions.
(c) Open and/or improperly secured containers	Containing chemicals having an NFPA rating of 2 or greater. No open containers allowed at the starting line or during the operation of your vehicle. All containers with these chemicals must have secure lids and must be secured to the vehicle. All containers brought to the starting line must have lids, be properly labeled, and proper personal protective equipment must be used.
(d) Chemical pouring at starting line	Any chemicals with an NFPA rating of 2 or greater. Use a holding vessel on vehicle, with valve, to load starting chemicals.
(e) Regulated Chemicals	A number of chemicals are listed by OSHA as a special hazard. See list below. OSHA has a special regulation for each chemical. See www.osha.gov for details.
(f) Highly Reactive / Unstable Chemicals	Any chemical, raw material, intermediate or product with an NFPA reactivity / instability rating of 4.
(g) Hydrogen peroxide	Hydrogen peroxide at concentrations of greater than 30% are not allowed.

Regulated chemicals: asbestos, coal tar pitch volatiles, 4-nitrobiphenyl, alpha-napthylamine, methyl chloromethyl ether, 3,3'-dichlorobenzidine, bis-chloromethyl ether, beta-naphthylamine, benzidine, 4-aminodiphenyl, ethyleneimine, beta-propiolactone, 2-acetylaminofluorene, 4-dimethylaminoazo-benezene, n-nitrosodimethylamine, vinyl chloride, inorganic arsenic, benzene, 1,2-dibromo-3-chloropropane, acrylonitrile, ethylene oxide, formaldehyde, 4,4'-Methylenedianiline, 1,3-butadiene, methylene chloride.

Vehicle Primary Hazards Checklist: Check the left hand column box if the hazards listed below exist on the vehicle. Then check the applicable means of control for each hazard.

Hazard (check if present)	Control
☐ (a) Pressure	Anything greater than 0.07 bar (1 psig)? **Must meet all requirements below:** ☐ Pressure gauge (must read to 2x max. operating pressure) ☐ Emergency relief device set to no more than 1.1 times max. operating pressure. Relief sizing calculations must be provided. ☐ Emergency relief device in proper location. ☐ Pressure certification – see Pressure Vessel Testing Protocol ☐ Proper management system to prevent over or mis-charging. ☐ All car components exposed to pressure must be certified to operate at that pressure. Provide manufacturer's pressure specifications. ☐ No PVC, cPVC or polyethylene terephthalate (PETE or PET) plastics in pressure service **Must have measurements or calculations to prove maximum operating pressure. Max allowable pressure this year is 34.5 bar (500 psig).** **See Chem-E Car Competition® rules for more details on these requirements.**
☐ (b) Toxic	Any chemicals with an NFPA toxicity of 2 or greater? ☐ Doubly contained and handled properly.
☐ (c) Flammable	Any chemicals with an NFPA flammability rating of 2 or higher? ☐ Doubly contained and handled properly
☐ (d) Reactive	Any chemicals with an NFPA instability / reactivity rating of 2 or 3? **Chemicals with a 4 rating are not allowed.** ☐ Doubly contained and handled properly.
☐ (e) Temperature	Any exposed surface greater than 150 deg. F or under 32 deg F? ☐ Insulation or barrier to prevent contact.
☐ (f) Electrical	Exposed wiring and electrically energized components are ignition, electrocution, and a shorting / fire hazard. Alligator clips and twisted wire connections are not allowed – use binding posts or banana plugs for a more secure connection. ☐ Proper electrical insulation and connections provided.
☐ (g) Mechanical	Any fast moving parts (meshing gears, belts or chains) that are pinch hazards? ☐ Guards present and adequate.
☐ (h) Oxygen	All components exposed to oxygen must be ☐ certified for oxygen service. ☐ thoroughly cleaned of contaminants as per instructions in rules. ☐ not used previously for other types of service.
☐ (i) Biohazards	☐ No biohazards greater than biohazard level 1 either during the design, development, preparation or competition phases of your car.

Fabrication & Operation Additional Hazard Detail Check List: Check all hazards that are likely to be encountered during your Chem-E Car construction and operation. List the major source(s) of the hazard and describe how the hazard(s) will be controlled. If both construction and hazard columns are checked in an individual row, then the hazards should be identified separately for both the construction and operation.

Hazard	Present During		Control Method(s)[1]	PPE Required[1]
	Construction?	Operation?		
Pressure	☐	☐		
Toxicity	☐	☐		
Flammability	☐	☐		
Reactivity / Instability	☐	☐		
Hot Surfaces/ High Temp > 150 F	☐	☐		
Cold Surfaces/ Low Temp < 0 C	☐	☐		
Electrical	☐	☐		
Arc welding	☐	☐		
Gas welding	☐	☐		
Lathe	☐	☐		
Milling machine	☐	☐		
Handheld power tools	☐	☐		
Drill press	☐	☐		
Other mechanical hazards	☐	☐		
Paint spraying	☐	☐		
Ionizing radiation	☐	☐		
Laser radiation	☐	☐		
Asphyxiates	☐	☐		
Open flames	☐	☐		
Potential Spills	☐	☐		
Biohazards:	☐	☐		
Other:	☐	☐		

Other:	☐	☐		

Chemical Information Page

Fill in as much data below as available. If data are not available, leave the field blank.

Chemical Quantities: List below the chemical names, concentrations, and total quantity of chemical required for the competition.

Chemical Name	Chemical State Solid, Liquid, Gas	Concentration Required Be sure to list units!	Total Quantity Required for Competition Be sure to list the units!

Chemical Properties and Hazards for ALL CHEMICALS, including reactants, intermediates and products.

Chemical Name	Physical State S, L, G	NFPA Ratings*				Incompatible Chemicals List chemicals present within the laboratory, and any others that may come in contact.	Flash Point Temp.	Flammability Limits	
		H	F	S	Sp.			LFL	UFL

*NFPA Ratings: **H** – Health, **F** – Flammability, **S** – Stability, **Sp.** – Special

Chemical Toxicology, Regulation and Disposal: List the same chemicals that appear above, in the same order.

Chemical Name	Toxicology			Hazardous Waste Number	OSHA Regulated?	Personal Protective Equipment Specific to this Chemical
	TWA	PEL	Other			
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	

Chemical Reactions: Provide details below on any chemical reaction(s) that occur in your process. Please show the species involved, the stoichiometry and the heat of reaction, if available. Also list side reactions and any other reactions that may impact safety.

Biohazards: Provide details below on any biological hazards that may occur during the design, development, preparation or competition phases of your car. Please list the biological hazards, the biohazard level, and a description of how these agents will be safety handled.

Process Hazard Assessment Form
Safe Operating Procedures Page

Provide step-by-step details for each of the sections shown below. Identify the hazards, the control methods and the personal protective equipment (PPE) required. Provide adequate detail so that the reviewers of this document will have adequate understanding of your procedure to pass judgment on the safety of your vehicle.

The **Emergency Shutdown** section should have only one or two steps required to stop your vehicle and bring it to a safe state.
The **Start-Up Procedure** section should list all the steps required to prepare your chemicals and vehicle.
The **Run Time Procedure** should describe all steps to operate your vehicle at the starting line of the competition.
The **Shutdown Procedure** should describe the steps normally taken to shutdown your vehicle at the end of your competitive run.
The **Cleanup / Waste Disposal** section should list all the steps required to clean your vehicle of all chemicals and proper chemical disposal.

Sequence of Steps	Potential Hazards	Procedure to Control Hazard	PPE or Equipment Required
Emergency Shutdown			
Start-up Procedure			
Run Time Procedure			
Shutdown Procedure			
Cleanup / Waste Disposal			

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Chemical Order Form

Please use this form to allow the organizers of the Chem-E-Car Competition® event to understand the amount of chemicals your team will use at the competition. This information helps to forecast waste volume. Please make sure your order contains enough reactants to run the car at least 2 times at maximum distance and load. Each team is responsible for correctly identifying the chemicals needed, and the amount of each chemical needed. Extra chemicals will not be provided, so please be accurate and double check your reaction chemistry to make sure your chemical order is correct. Please go to the website of the vendor you plan to order chemicals from and find the SKU number and identify the correct package size the vendor sells this product in. This form must be submitted along with your EDP.

Starting reaction

Cost ($) USD	Vendor (Sigma, Fisher, etc.)	SKU / Package Size	Chemical Name	Amount of packages (1, 2 etc.)

Additional information for purchasers to consider:

Stopping reaction

Cost ($) USD	Vendor (Sigma, Fisher, etc.)	SKU / Package Size	Chemical Name	Amount of packages (1, 2 etc.)

Additional information for purchasers to consider:

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Chemistry Use Verification Page [Must Submit with Regional EDP]

1. Briefly describe the reaction / mechanism your vehicle uses to move.

2. Describe the reaction that your vehicle uses to stop at the designated finish line.

3. If your vehicle is 3 meters short of the designated finish line on the first run, what changes does your team make to the stopping reaction to adjust for the correct distance?

We, the undersigned team members, leaders and advisor of _____ (university) Chem-E Car Competition® team, do hereby verify that we have complied with all rules and safety requirements, as received from AICHE.

Team Members:

Printed Name	Signature	Date

Team Advisor:

Printed Name	Signature	Date

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MANAGEMENT OF CHANGE REQUEST FORM

Name of University: _____Car name: _____

Name of Person or Group Requesting Change: _____ Date: _____

Summary Description of Change:

Reason for Change:

Change is: ☐ permanent
☐ temporary Duration of change: _____

Signature or Requestor: _____

	Yes	N/A	
Attachment checklist:	☐	☐	Updated PHA pages, if changed
	☐	☐	Updated Process Flow Sheet, if changed
	☐	☐	Updated other Engineering documentation pages, if changed

Management of Change Request Form

PROCESS CHANGE REQUEST APPROVAL FORM

Type of Change: ☐ Major – Requires entire team and faculty adviser review
☐ Minor – Reviewed by team only

Description of Change as Approved:

Approved Duration of Change: _____

After a team meeting to discuss the effect of the potential change to safety system functionality, please sign below acknowledging the car is still safe to operate or has been modified to be safe to operate. Use as many copies of this form as needed to document each change to the car.

Signatures of Approval

Faculty Adviser: _____ Date: _____

Review Team Member: _____ Date: _____

Review Team Member: _____ Date: _____

Review Team Member: _____ Date: _____

Review Team Member: _____ Date: _____

Review Team Member: _____ Date: _____

Review Team Member: _____ Date: _____

Attach minutes and pertinent notes from review team meetings and place in permanent file.

Management of Change Request Form

SAFETY EVALUATION CHECKLIST

Complete this safety evaluation checklist, noting any conditions that apply to the proposed change. Attach a more detailed description of the change, if necessary, and all supporting materials.

Changes in Process Conditions/Materials:

- ☐ temperature
- ☐ pressure
- ☐ flow
- ☐ level
- ☐ composition
- ☐ chemical
- ☐ toxicity
- ☐ flash point
- ☐ reaction conditions
- ☐ biohazard
- ☐ use of regulated materials
- ☐ use of lasers/ change in class of lasers

Changes in Operating Conditions/ Procedures:

- ☐ startup
- ☐ normal operations
- ☐ abnormal operations
- ☐ shut down
- ☐ emergency shut down
- ☐ maintenance procedures
- ☐ lock-out
- ☐ tagging

Changes in Process Equipment:

- ☐ size or capacity
- ☐ materials of construction
- ☐ seals and gasket materials
- ☐ piping/ valving
- ☐ electrical system
- ☐ max./min. working pressure
- ☐ max./min. working temperature
- ☐ equipment guarding
- ☐ thermal insulation/insulation coverings
- ☐ filters
- ☐ support structures

Changes in Facilities:

- ☐ ventilation
- ☐ lighting
- ☐ utility services
- ☐ building modifications/renovations

Changes in Safety Equipment:

- ☐ containment
- ☐ guarding
- ☐ fire protection
- ☐ fire detection
- ☐ safety equipment location
- ☐ safety equipment type
- ☐ personal protective equipment
- ☐ grounding/bonding

Changes in Control Systems/ Elements:

- ☐ programming change
- ☐ controller action
- ☐ control valve trim/sizing
- ☐ instrument/transmitter
- ☐ sensing element
- ☐ graphically displayed information
- ☐ system response to alarm

Changes in Environmental Conditions:

- ☐ discharge air quality
- ☐ discharge water quality
- ☐ solid waste

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Certifications Page

University:	**Vehicle Name:**
Primary Student Contact Name:	**Email:**
Faculty Supervisor:	**Email:**

1. **Required Safety Training:**

   Required Chem-E-Car Competition® safety training for faculty advisor (online at http://www.aiche.org/community/students/chem-e-car-competition-rules/safety-training-test)

   Advisor Name _____ Safety Training Date_____

   List below each student team member and the date of safety training:

Team Member Name	Location	Date
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

2. **Faculty Certification:**
   I certify that this student team has followed all of the safety rules, has completed an engineering documentation package, has completed a safety review under my supervision and has at least ten hours of operating experience:

   Faculty Advisor Name _____

   Faculty Advisor Signature _____ Date _____

3. Student Certification:

We certify that we have followed all of the safety rules, have completed an engineering documentation package, have completed a safety review with my faculty supervisor or with an outside expert, and have at least ten hours of operating experience:

Team Member Signature	Date
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____