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2024 Engineering Design Package (EDP)

**University**:       **Vehicle Name:**

**Team Captain Name**:       **Team Captain Email:**

**Faculty Supervisor:**       **Supervisor Email:**

**Revision #**:       **Revision Date**:

**\*Onsite Safety Judge\*:**       (Virtual Only)

**\*Onsite Track Length\*:**      (Virtual Only) \***Onsite Track Width\***:      (Virtual Only)

**Instructions for Chem-E-Car Team:**

* All Chem-E-Car Teams competing in an AIChE Chem-E-Car Competition must complete and submit and Engineering Design Package by the posted deadline.
* Failure to meet the posted deadline will result in exclusion from the competition.
* Please complete all the applicable sections of this document, and save in PDF format. If your EDP is incomplete, AIChE cannot guarantee that it will be reviewed.
* Please rename the title of the document using the format University Name EDP.
* Additional information including Safety Data Sheets (SDS), Manufacturer’s specification documents or specifications for custom-built components should be compiled and saved as another single PDF titled “University Name EDP Supplement”.
* All teams will receive EDP Feedback with any suggested changes from AIChE Chem-E-Car Competition Safety Judges.
* Please use the MOC Form document to document changes made to the EDP after receiving EDP feedback from your online review.
* Each team must bring a printed copy of final EDP, EDP Supplement, EDP feedback and MOC Form in a folder or binder. This will help streamline the Onsite Safety Inspection on competition day.
* \*Please review the AIChE [Code of Conduct](https://www.aiche.org/about/governance/policies/code-ethics) and [Code of Ethics](https://www.aiche.org/about/governance/policies/code-ethics).\*

For more information, visit [www.aiche.org/chemecar](http://www.aiche.org/chemecar).

## **Job Safety Assessment Form**

**Car operation, hazards, and safety:** Describe your Chem-E-Car’s design, intended mode of operation (propulsion system), intended mode of control (stopping mechanism), auxiliary processes, major hazards and their control.

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| --- |
| **Describe your car’s design:** |
| **Power source (propulsion system):** |
| **Auxiliary processes including synthesized fuel production, battery charging, hydrogen production, etc. (if applicable):** |
| **Stopping mechanism:** |
| **Hazards inherent in design (for car & auxiliary processes, if applicable):** |
| **Safety measures to prevent and mitigate hazards. Every hazard identified above must be addressed here**: |
| **Please list any major design changes for your car, and how the reaction chemistry of the propulsion and stopping mechanism has been changed from the car used in the previous year**: |
| **For car & also for auxiliary processes if applicable**  **Expected Operating Conditions :**  **Temperature**:  **If your car generates pressure above 5 psig, please list the Maximum Operating Pressure (MOP) and the Maximum Allowable Working Pressure (MAWP):** |

**Photos of Completed Vehicle:**

Please add photos of your vehicle after construction has been completed. These pictures must be current. The entire car must be visible in at least one picture. Remove the top to expose electrical controls if necessary. You must include multiple (at least 6) views of the car **(top, bottom, left, right, front and back**). Please adjust the following cells to fit *A drawing or AutoCAD document will NOT be accepted*

|  |
| --- |
| Top View |
| Bottom View |
| Left View |
| Right View |
| Front View |
| Back View |

**Request for Power Outlet at Competition Site (requirement for in-person competition):** If your team requires a power outlet at your table at the competition, please provide reasoning here. *Please note that outlets requested to plug in laptops at your table will not be granted*.

|  |
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**Safety Training and Rules Certifications**

**University**:       **Vehicle Name:**

1. **Briefly describe the propulsion system (reaction/mechanism) of your vehicle.**

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1. **Briefly describe the reaction that your vehicle uses to stop at the designated finish line.**

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1. **Provide a precise answer to the following question: If your vehicle is 3 m short of the designated finish line on the first run, what specific changes will your team make to the stopping reaction to correct the shortfall?**

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1. **Required Safety Training:**

All participants must take and pass the AIChE Chem-E-Car Safety Training Course with a minimum score of 80%. For information on the Safety Training Course, please visit [www.aiche.org/chemecar](http://www.aiche.org/chemecar).

Please list the date that the required Chem-E-Car safety training that was completed by the faculty advisor:

**Advisor Name Date**

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Please list the date the required Chem-E-Car safety training that was completed by each team member:

**Team Member Name Date**

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1. Faculty Safety Rules Certification:

I certify that this student team has followed all of the safety and competition rules, has completed an engineering documentation package, has completed a safety review under my supervision or with an outside expert, and has at least ten hours of operating experience beyond the time required to design and assemble the car:

Faculty Advisor Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Faculty Advisor Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_

Outside Expert Name\* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Outside Expert Signature\* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_

\**Note that this section must be signed by (1) Chem E Car Faculty advisor at a minimum. Having a signature from another outside expert is not required but recommended if you are getting support from another faculty member or safety professional on this project.*

1. Student Safety Rules Certification:

We certify that we have followed all of the safety and competition rules, have completed an engineering documentation package, have completed a safety review with our faculty supervisor or with an outside expert, and have at least ten hours of operating experience beyond the time required to design and assemble the car. We understand and agree that we will not be allowed to compete in the Chem-E-Car Competition if our completed EDP package is not resubmitted by the posted deadline:

Team Member Signature Date

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***\*Please include a copy of the Safety Training Course Certificate for each Team Member + Advisor in your EDP Supplement Document; Certificates should have a completion date of on or after January 1st 2023\****

**Hazards Analysis**

This analysis is for your home institution, not the competition site. Please attach a floor diagram of the laboratory where you will be building and testing your vehicle on the following page. List the location of available safety equipment and spill response supplies on this diagram.

**Expected Operating Conditions:**

|  |  |
| --- | --- |
| **Temperature** | **Pressure** |
| Normal: | Normal: |
| Minimum: | Minimum: |
| Maximum: | Maximum: |

**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. **Answer all questions**. 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. **Answer all questions**. If not available, type “NA” in the field.

|  |  |
| --- | --- |
| **Item** | **Location** |
| Spill Kit: |  |
| Sorbent Powder: |  |
| Spill Dikes: |  |
| Acid and/or Base Neutralizers: |  |
| Drain Plugs: |  |
| Spill Pillows: |  |
| Mercury Spill Kit: |  |
| Other: |  |
| Other: |  |

**Laboratory Floor Plan/Diagram:** Please insert a floor plan diagram of the laboratory where you will be building and testing your vehicle on this page. List the location of available safety equipment and spill response supplies from the previous page on this diagram. Onsite Competition Fire & Safety Floor Plan showing the location of available fire and safety equipment as well as emergency exits in the performance competition venue will be provided to participating teams by the competition host.

**Vehicle Primary Hazards Checklist:** Check the box in the left hand column 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 5 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 the 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 or at all**  **Must have measurements or calculations to prove maximum operating pressure. Max allowable pressure this year is 200 psig.**  **See ChemE car rules for more details on these requirements.** |
| (b) Hazardous Materials | Are any chemicals with a GHS hazard rating present (i.e., toxicity, flammability, corrosivity)?  Doubly contained and handled properly.  Team has properly filled out Team Waste Tags |
| (c) Temperature | Any exposed surface greater than 150 deg. F or under 32 deg F.  Insulation or barrier to prevent contact. |
| (d) 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. |
| (e) Electro Chemical (Battery) | Any student fabricated electrochemical devices (batteries) used on the car?  Electrochemical device to be fully disassembled into original components and individual components made safe (pH=6-8) and disposed of separately. Team shall explain process in detail.  Team has properly filled out Team Waste Tags |
| (f) Mechanical | Any parts (meshing gears, belts or chains) that are pinch hazards.  Guards present and adequate. |
| (g) Oxygen | All components exposed to oxygen. These must be  certified for oxygen service.  thoroughly cleaned of contaminants as per instructions in rules.  not used previously for other types of service. |
| (h) Biohazards | No biohazards that require handling in a laboratory greater than Biosafety Level 1 (BSL-1) are permittedbiohazard level 1 either during the design, development, preparation, or competition phases of your car. |

**Additional Fabrication & Operation Hazard Detail Check List:** Check all hazards that are likely to be encountered during your Chem-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.

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| **Hazard** | **Present During** | | **Control Method(s)1** | **PPE Required1** |
| **Construction?** | **Operation?** |
| Pressure |  |  |  |  |
| Hazardous materials |  |  |  |  |
| Hot Surfaces/High Temp > 150 F (65 C) |  |  |  |  |
| Cold Surfaces/Low Temp < 32 F (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**

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

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**Table 1:** Please list all chemicals, concentrations and quantities that will be shipped to competition site. Concentration MUST be that of the raw material being shipped, not your race day solutions.

This is so the Host can prepare to receive, store and transport your chemicals.

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| --- | --- | --- | --- |
| **Chemical Name** | **Chemical State**  **(Solid, Liquid, Gas)** | **Concentration**  **(MUST include units!)** | **Amount Sent To Competition Site (for an in-person Competition only)** |
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**Note:**  Please include any special storage requests that the Host should be aware of for your chemicals.

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**Table 2:** Please list all chemicals that you expect to generate and dispose of during the competition. This should be WASTE/USED chemicals only. Chemicals must be made safe by the team for disposal in one of the listed waste classifications on the Team Waste Tag form. Team Waste Tags must be present to race and completed to be allowed to dispose of chemicals. See Team Waste Tags section of EDP.

|  |  |  |  |
| --- | --- | --- | --- |
| **Chemical Name** | **Concentration**  **(Include units!)** | **Amount**  **(MUST include units!)** | **Waste Classification (Acid, Base, Organic, Aqueous, Solid Waste, Other\*)**  **\*If other, classification must be specified** |
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**Chemical Hazards and Disposal**

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

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| --- | --- | --- | --- | --- | --- | --- |
| **Chemical Name** | **Physical State**  **(S, L, G)** | **GHS Hazard Classifications\*** | **Incompatible Chemicals**  List chemicals present within the laboratory | **Flash Point**  **Temp.** | **Flammability Limits** | |
| **LFL** | **UFL** |
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**\***Complete this section of the EDP using the Globally Harmonized System (GHS) hazard classifications that are indicated on Section 2 of your chemical's SDS. This is NOT the same hazard ranking system as the National Fire Protection Association (NFPA) "Fire Diamond". Note that the GHS hazard ranking system runs opposite to the NFPA "Fire Diamond" system. For example, a Category 4 NFPA hazard is the highest in severity, while a Category 4 GHS hazard is the lowest in severity. For example, for acetic acid (SDS [here](https://www.sigmaaldrich.com/US/en/sds/aldrich/w200603)) you would write in: Flammable Liquid (Category 3), Skin Corrosion (Category 1A), and Serious Eye Damage (Category 1).

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Chemical Name** | **Toxicology** | | | **Waste Classification for Disposal** | **Personal Protective Equipment**  **Specific to this Chemical** |
| **8-Hour TWA** | **STEL** | **Ceiling** |
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**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.

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**Standard / 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 at your preparation table. This must include procedures for making each solution required for your car to operate.

The **Run Time Procedure** should describe all steps to operate your vehicle at the competition starting line, including activation of any switches, valves, etc.

The **Shutdown Procedure** should describe the steps normally taken to shut down your vehicle at the end of your competitive run. This cannot involve disconnecting tubing, removing components of the car, or cutting electrical connections on the race floor.

The **Cleanup / Waste Disposal** section should list all the steps required to clean your vehicle of all chemicals and proper chemical disposal. Please keep in mind that at the competition, you most likely will not be working in a chemistry laboratory or have access to a sink. You should consider what additional supplies and steps will be needed when you are doing clean up at your table at the competition site. Please also list which waste bucket you will be using to dispose of the waste (example: Acids, Bases, Organic, Aqueous, Inert Solid Waste). This must include steps of how any student made electro chemical (battery) devices will be separated, neutralized and made safe prior to disposal in solid waste streams.

Team must also remember that all glassware must be clearly labeled at the competition site. Unlabeled chemicals at the tableside is grounds for disqualification.

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

* Please list every piece of equipment on the car.
* Please include all manufacturer’s specification documents or specifications for custom-built components in the EDP Supplement document.

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| **Equipment** | **Manufacturer** | **Operating Limits: Temperature** | **Operating Limits: Pressure** | **Materials incompatible with chemicals?** |
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Note: It is highly recommended that you include a CAD or other diagram indicating where each piece of equipment is located within the design of your car. Use the same naming scheme in the diagram as in the equipment list.”

**Discharged Hydrogen (or other flammable chemicals) Calculations**

If your car will include a small amount of hydrogen discharge, please use this space to provide calculations to prove to the reviewer that any discharged hydrogen is well below the Lower Flammable Limit (LFL)/Lower Explosive Limit (LEL) of hydrogen for the given volume of the reactor, chamber or fuel cell in which hydrogen is stored. *If your car does not use hydrogen, then this section should be left blank.*

**Pressure Calculations**

For all cars with pressure greater than 5psig, please complete the following in this section. The textbook “Chemical Process Safety” by Crowl and Louvar can be used as reference. Please see Appendix A of the Safety Rules for full instructions on what is required for Pressure Testing. *If your car does not generate pressure above 5 psig, you may leave this section blank.*

* List of potential credible overpressure scenario(s) (i.e., too much reactant added, blocked valve, etc.)
* Sizing calculations for a pressure relief device. You must calculate both the appropriate pressure relief set point and orifice size/device capacity based on the worst-case overpressure scenario identified above;
* Test procedure and results for a pressure relief.

**Capital Cost of Vehicle Calculations**

Referencing the competition rule surrounding Capital Cost of Vehicle, use the space below to show the capital cost of your vehicle and all related calculations.

**Team Waste Tags**

Please fill out a waste tag fully describing each of your competition day waste streams, using the form below. This must be completed and included with your EDP. You must print and bring enough copies to accommodate all the waste you might generate. A completely filled out waste tag will be required before any team is allowed to dispose of waste into an AIChE waste collection system.

**ALL SOLID WASTE MUST BE DISASSEMBLED, MADE SAFE AND BE LIQUID FREE**

**Team Name:**  **No.:**

**Waste Description:**

**Composition:**

|  |  |
| --- | --- |
| **Amount (ml/g)** | **Description** |
|  |  |
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|  |  |
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|  |  |

**Disposal Waste Stream:**

Flammable  Organic

Acid  Base

Aqueous (pH 6-9)  Solids (pH 6-9)

**Notes:**

**Team Name:**  **No.:**

**Waste Description:**

**Composition:**

|  |  |
| --- | --- |
| **Amount (ml/g)** | **Description** |
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**Disposal Waste Stream:**

Flammable  Organic

Acid  Base

Aqueous (pH 6-9)  Solids (pH 6-9)

**Notes:**

**Team Name:**  **No.:**

**Waste Description:**

**Composition:**

|  |  |
| --- | --- |
| **Amount (ml/g)** | **Description** |
|  |  |
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**Disposal Waste Stream:**

Flammable  Organic

Acid  Base

Aqueous (pH 6-9)  Solids (pH 6-9)

**Notes:**

**Team Name:**  **No.:**

**Waste Description:**

**Composition:**

|  |  |
| --- | --- |
| **Amount (ml/g)** | **Description** |
|  |  |
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**Disposal Waste Stream:**

Flammable  Organic

Acid  Base

Aqueous (pH 6-9)  Solids (pH 6-9)

**Notes:**