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|-----------------------------------|----------------------------|
| Team Affiliation: | Team #/Name: |
| Author/ Team Captain Name: | Team Captain Email: |
| Faculty Supervisor: | Supervisor Email: |
| Revision #: | Revision Date: |

1.0 Product Description

Please describe the cube, include a description of the processes (absorption, adsorption, membrane separation, etc.), capabilities and limitations. This should be similar but not identical to your product pitch.

2.0 User Operating Instructions

Explain how the cube operates, and if maintenance is required (meter calibration, etc.). Be brief, this is for a potential future user, not for your use on competition day. How will the user introduce ambient air into the cube and how does it capture CO₂ before exiting the cube?

3.0 Ambient air CO₂ concentration

List the expected level of CO₂ in the inlet ambient air.

| | | | |
|----------------------------------|--|--|--|
| CO₂ (ppm) low | | | |
| CO₂ (ppm) high | | | |



4.0 Outlet air CO₂ concentration

List the CO₂ concentration that your cube achieves, not just competition requirements.

| | | | |
|----------------------------|--|--|--|
| CO ₂ (ppm) low | | | |
| CO ₂ (ppm) high | | | |

5.0 Technical Specifications data sheet

Isometric drawing of Cube (enlarge space as needed)

Product Details

| | | | | |
|---------------------------------|--|--|------------------------|---------------------|
| Height/length/width (ft) | Operating Pressure range (psig) | Operating T range (°F)/ Operating RH% range | Flow rate (lpm) | Capacity (L) |
| | | | | |
| Clearance required (in) | Inlet (in) | Outlet (in) | Power req'd | |
| | | | | |

Bill of materials (label on isometric drawing)

| Item # (isometric) | Description | Material | Cost (\$) |
|--------------------|-------------|----------|-----------|
| | | | |
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Stacking instructions:



6.0 Photos

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7.0 Safety Assessment

This section of the EDP will be used to identify the hazards present with the manufacturing and operation of the cube.

Product description: Briefly describe how you plan to design the cube (3D printing, etc.), the technology option chosen for the DAC challenge, the operating instructions, the source of power, the activation mode (switch, continuous operation), any hazards associated with the design and their control mechanisms. Please list any chemicals and concentrations present within the cube (amines, caustic, etc.).

| |
|---|
| Describe how to manufacture the cube: Hazards: Safeguards: |
| Describe the CO ₂ capture method used in your cube: Hazards: Safeguards: |
| Power requirements: Request for power on competition day? (Y/N) |
| Competition day operating instructions: Hazards: Safeguards: |
| List any chemicals used : |
| List safeguards and additional protective measures: |



8.0 Laboratory floor plan

This page applies to your home institution – not the competition site. Please provide a floor diagram of the laboratory where you will be building and testing your cube. List the location of available safety equipment and spill response supplies on this diagram.

Available Safety Equipment – Provide the location of each item shown below at the institution where the cube will be manufactured and tested. Show the location of this equipment on the floor plan above. If not available, type “NA” in the field.

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



Spill Response Supplies - Provide the location of each item shown below at the institution where the cube 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: | |

Personal Protective Equipment (PPE)

Check all PPE that will be worn during the development/operation of this ChemE Cube in the lab.

| | | | |
|---|---|---|---|
| <input type="checkbox"/> Long Pants | <input type="checkbox"/> Safety Glasses | <input type="checkbox"/> Hard Hat | <input type="checkbox"/> Apron |
| <input type="checkbox"/> Long Sleeves | <input type="checkbox"/> Splash Goggles | <input type="checkbox"/> Insulated Gloves | <input type="checkbox"/> Ear Protection |
| <input type="checkbox"/> Non-porous Shoes | <input type="checkbox"/> Face Shield | <input type="checkbox"/> Chemical Gloves | <input type="checkbox"/> Respirator |
| <input type="checkbox"/> Other | | | |

9.0 Cube Hazard Analysis

Primary Hazards Checklist: Consider each treatment process within the cube, and indicate whether a hazard is present. Check the left hand column box if the hazards listed below will be present during operation of the cube.

| Hazard (check if present) | Control mechanism |
|--|--|
| <input type="checkbox"/> Pressure: Do any processes generate pressure above 1 psig? If so, check the pressure hazard box above. | Any equipment within the cube (tubing, etc.) operating above 1 psig should include a certification from the manufacturer that it can safely operate at that pressure. If gas is generated within the cube, indicate how it will be vented safely. <input type="checkbox"/> All components exposed to pressure are certified to operate at this pressure. Provide a copy of the manufacturer’s pressure specifications in the appendix. <input type="checkbox"/> There is a vent present to relieve gases. <input type="checkbox"/> No gas under pressure above 1 psig will be vented. <input type="checkbox"/> Cube does not operate above 5 psig. |
| <input type="checkbox"/> Toxicity: Check this box if any chemicals with a GHS acute toxicity of 3 or lower. | <input type="checkbox"/> Doubly contained and handled properly. <input type="checkbox"/> Appropriate PPE will be worn at all times. |



| | |
|---|---|
| <input type="checkbox"/> Flammable: Check this box if any chemicals with a GHS flammability rating of 3 or lower. | <input type="checkbox"/> Doubly contained and handled properly <input type="checkbox"/> Appropriate PPE will be worn at all times. |
| <input type="checkbox"/> Temperature: If the exterior surface of the cube is below 32°F or above 90°F, check this box. If interior components operate above a temperature of 90°F, check this box. | <input type="checkbox"/> Cube may not operate with an exterior surface temperature above 120°F. Burns are unlikely below this temperature. <input type="checkbox"/> Insulation or barriers on internal components are present to prevent accidental contact with hot or cold surfaces/components outside the range 32°F–90°F. |
| <input type="checkbox"/> Electrical: If electricity is used within your cube, check this box above. | Exposed wiring and electrically energized components are ignition, electrocution, and a shorting / fire hazard. Alligator clips and twisted wire connections are not allowed – use terminal connections, binding posts or banana plugs for a more secure connection. <input type="checkbox"/> Proper electrical insulation and connections provided. |
| <input type="checkbox"/> Mechanical: Check this box if there are any fast moving parts (meshing gears, belts or chains) that are pinch hazards. | <input type="checkbox"/> Guards present and adequate. |
| <input type="checkbox"/> Oxygen: Check this box if you are using oxygen or generating oxygen during processing. | All components exposed to oxygen must be <input type="checkbox"/> certified for oxygen service. <input type="checkbox"/> thoroughly cleaned of contaminants as per instructions in rules. <input type="checkbox"/> not used previously for other types of service. |
| <input type="checkbox"/> Biohazards: Check this box if biohazards are listed on the SDS for any treatment or challenge water chemicals. | <input type="checkbox"/> No biohazards greater than biosafety level (BSL) 1 either during the design, development, preparation or competition phase. <input type="checkbox"/> Appropriate PPE will be worn at all times. |



10.0 Fabrication Hazard Analysis

Check all hazards that may be encountered during your ChemE Cube construction. 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. Consider 3D printing, and other construction methods that may be needed.

| Hazard | Present During Construction? | Control Method(s) ¹ | PPE Required ¹ |
|---------------------------------|------------------------------|--------------------------------|---------------------------|
| Pressure | <input type="checkbox"/> | | |
| Toxicity | <input type="checkbox"/> | | |
| Flammability | <input type="checkbox"/> | | |
| Reactivity / Instability | <input type="checkbox"/> | | |
| Hot Surfaces/ High Temp > 130°F | <input type="checkbox"/> | | |
| Cold Surfaces/ Low Temp < 32°F | <input type="checkbox"/> | | |
| Electrical | <input type="checkbox"/> | | |
| Arc welding | <input type="checkbox"/> | | |
| Gas welding | <input type="checkbox"/> | | |
| Lathe | <input type="checkbox"/> | | |
| Milling machine | <input type="checkbox"/> | | |
| Handheld power tools | <input type="checkbox"/> | | |
| Drill press | <input type="checkbox"/> | | |
| Other mechanical hazards | <input type="checkbox"/> | | |
| Paint spraying | <input type="checkbox"/> | | |
| Ionizing radiation | <input type="checkbox"/> | | |
| Laser radiation | <input type="checkbox"/> | | |
| Asphyxiates | <input type="checkbox"/> | | |
| Open flames | <input type="checkbox"/> | | |
| Potential Spills | <input type="checkbox"/> | | |
| Biohazards: | <input type="checkbox"/> | | |



11.0 Chemical Information

Description of Chemistry/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.

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Table 1: Please list all Chemicals, concentrations and quantities that will be shipped to competition site. This is so the Host can prepare to receive, store and transport your chemicals.

| Chemical Name | Chemical State Solid, Liquid, Gas | Concentration Be sure to list units! | Amount Sending To Competition Site |
|---------------|--------------------------------------|---|------------------------------------|
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Notes: Please include any special storage requests that the Host should be aware of, and how many boxes you expect to ship.

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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.

| Chemical Name | Concentration Be sure to list units! | Amount | Waste Classification (Acid, Base, Organic, Metal, Oxidizer, Other) |
|---------------|---|--------|--|
| | | | |



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Table 3: Please list any unused chemicals that you expect to have leftover after the competition is done. These will be donated to the Host University. These should NOT be waste/ used chemicals.

| Chemical Name | Chemical State Solid, Liquid, Gas | Concentration Be sure to list units! | Amount Expected to be Leftover |
|----------------------|--|---|---------------------------------------|
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12.0 Treatment Chemical Hazard Documentation (attach SDS to this EDP)

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

| Chemical Name | Physical State (S, L, G) | GHS Ratings* | | | Incompatible Chemicals List chemicals present within the laboratory | Flash Point Temp. | Flammability Limits | |
|---------------|-----------------------------|--------------|---|---|--|----------------------|---------------------|-----|
| | | P | H | E | | | LFL | UFL |
| | | | | | | | | |
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*GHS Ratings: **P** – Physical, **H** – Health, **E** – Environmental

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 | | | |
| | | | | | <input type="checkbox"/> | |
| | | | | | <input type="checkbox"/> | |
| | | | | | <input type="checkbox"/> | |
| | | | | | <input type="checkbox"/> | |
| | | | | | <input type="checkbox"/> | |
| | | | | | <input type="checkbox"/> | |
| | | | | | <input type="checkbox"/> | |
| | | | | | <input type="checkbox"/> | |



13.0 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 the cube.

The **Start-Up Procedure** section should list all the steps required to prepare your cube for DAC of CO₂. Example: prepare absorbent/adsorbent check electrical connections, etc.

The **Operating Procedure** should describe all steps to operate your cube for the DAC of CO₂. Example: Flip exterior switch to ‘ON.’

The **Shutdown Procedure** should describe the steps normally taken to shut down your cube at the end of CO₂ capture. Example: Flip exterior switch to ‘OFF.’

The **Cleanup / Waste Disposal** section should list all the steps required to clean the cube of all chemicals and proper chemical disposal, if necessary. Example: Remove filter and rinse under clean water for 30 seconds. Empty trap.

The **Emergency Shutdown** section should have only one or two steps required to stop your cube and bring it to a safe state. Example: In the event of overheating, unplug power from wall receptacle.

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



14.0 Safety Rules

Safety rules for the competition are listed below. Failure to follow these rules will result in a multi-year disqualification of your university from competition and possible fines.

| 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 testing in hotel or dorm hallways, warehouses, or other facilities that are not designed for chemical handling. This includes at 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 be provided by the host site. |
| (e) No use of regulated chemicals, highly reactive or unstable chemicals. See your faculty advisor if you are uncertain. |
| (f) Only air may exit the cube during the competition. No other liquid, or gas under pressure may be released. |
| (g) The exterior temperature of the cube must remain below 120°F. |
| (h) Cube must work autonomously. Cube may not be opened during the DAC challenge. When the competition begins, students will only be permitted to establish air flow with the starting of a fan and monitor instrumentation. |
| (i) All interior components must be sealed such that challenge water does not build up inside the cube. Cube interior should be dry at the start of the competition, so that leaks can be observed. |
| (j) All wiring and electrical components must be covered to prevent the possibility of electrical shock or ignition of any component. No alligator clips may be used, banana plugs and binding posts are acceptable. |
| (k) Guards must be present to protect operators from mechanical hazards (if any). |
| (l) No biological organisms with a biohazard greater than level 1 may be used. |
| (m) No chemicals with any of these GHS hazards may be used: explosives, flammable gases, flammable aerosols, oxidizing gases/liquids, flammable solids, flammable liquids, self-reactive substances, pyrophoric solids or liquids, self-heating substances, substances which on contact with water emit flammable substances, organic peroxides, or radioactive substances. |





15.0 Safety Certifications

| | |
|--------------------------------------|---------------------|
| Team Affiliation: | Team #/Name: |
| Primary Student Contact Name: | Email: |
| Faculty Supervisor: | Email: |

Required 3D printer/fabrication/laboratory safety training:

Each student team is expected to have completed a safety training at their university regarding the use of the 3D printing equipment, other fabrication methods, and use of the laboratory.

Below, please record the date and location of required safety training for each team member.

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

| Team Member Name | Training type (3DP/fab/lab) | Date |
|------------------|-----------------------------|-------|
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

Faculty Certification:

I certify I have reviewed the safety rules, that this student team has completed the above safety training, has completed an engineering documentation package detailing their design, and has completed an internal product safety review under my supervision or with an outside expert.

Faculty Advisor Name _____

Faculty Advisor Signature _____ Date _____

Outside Expert Name _____

Outside Expert Signature _____ Date _____



16.0 Management of Change Form

Person requesting change: _____ **Date:** _____

Summary /Description of Change:

Reason for Change:

Signature of Requestor: _____ **Date:** _____

APPROVAL

Ensure that the EDP documentation has been revised and the implication of the change to safety has been reviewed and approved by the supervising faculty.

Signature of Advisor: _____ **Date:** _____

Signature of Team Member: _____ **Date:** _____

Signature of Team Member: _____ **Date:** _____

Signature of Team Member: _____ **Date:** _____

Signature of Team Member: _____ **Date:** _____



Signature of Team Member: _____ **Date:** _____