Part 1 of the ChemE Car Training Program presented a brief history of the safety program, an introduction to the Engineering Documentation Package (EDP), and a partial discussion of the Job Safety Assessment (JSA) form.

Part 2 will complete the discussion of the Job Safety Assessment (JSA) Form, and will provide final details on the Engineering Documentation Package (EDP).

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**JSA – Page 5: Additional Hazard Detail**

Fabrication & Operation Additional Hazard Detail Check List: construction and operation. List the major source(s) of the hazard an hazard columns are checked in an individual row, then the hazards of Pressure, Toxicity, Flammability, Reactivity, Instability, Base Surface High Pressure. Please check hazards that are present and how they will be controlled.

**JSA – Page 6: Chem. Quantities**

Chemical Information Page

List the chemical name, state, concentration, and total quantity of chemical required for the competition.

**JSA – Page 6: Chem. Props.**

Chemical Information Page

Chemical Properties and Hazards

Complete for ALL chemicals, including reactants, intermediates and products.
**JSA – Page 7: Toxicology**

**Chemical Information Page**

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Toxicity</th>
<th>TWA</th>
<th>PEL</th>
<th>Other</th>
</tr>
</thead>
</table>

TWA: Threshold Limit Value, Time weighted average

PEL: Permissible exposure limit (OSHA)

These can usually be found on the MSDS.

**JSA – Page 7: Toxicology**

The Threshold Limit Value (TLV) is the maximum exposure limit to humans for 8 hours a day, 40 hours per week, that does not cause any noticeable effect.

The TWA is the time weighted average.

The TLVs are promulgated by the American Conference of Governmental Industrial Hygienists (ACGIH), a professional society.

The Permissible Exposure Limit (PEL) is the same thing, but is promulgated by OSHA, a government organization.

**JSA – Page 7: Toxicology**

**Chemical Information Page**

<table>
<thead>
<tr>
<th>Chemical Name</th>
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<th>TWA</th>
<th>PEL</th>
<th>Other</th>
</tr>
</thead>
</table>

**JSA – Page 7: Chemical Reactions**

Chemical Reactions: Provide details on any chemical reaction(s) that occur on your car. 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.

**JSA – Page 7: Biohazards**

Biohazards: Provide additional detail on the biohazards involved. List the name of the organism used, the biohazard level for this organism, and a description of how these organisms will be handled safely.

**JSA – Page 8: Safe Operations**

Sequence of Steps

- Emergency Shutdown
- Start-up Procedure
- Run Time Procedure
- Shutdown Procedure
- Cleanup/Waste Disposal
JSA – Page 8: Safe Operations

Emergency Shutdown:
List a few things you can do prior to evacuating the laboratory.

Start-Up Procedure:
List the steps to get ready to operate your vehicle.

Run Time Procedure:
Steps required to operate the vehicle.

Shut-down Procedure:
Steps required to normally stop the vehicle and return it to a safe state.

Clean-up / Waste Disposal:
Steps required to clean the equipment and dispose of all chemical wastes.

Potential Hazards Procedure to Control PPE

<table>
<thead>
<tr>
<th>Potential Hazards</th>
<th>Procedure to Control Hazard</th>
<th>PPE Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

JSA Application

The JSA is best applied during the conceptual design and construction of the vehicle. It is very useful for identifying the hazards in your design and developing methods to control those hazards.

Engineering Documentation Package (EDP)

1. Job Safety Analysis (JSA)
2. Flow diagram of car
3. Design basis for maximum operating pressure
4. Design basis for estimating relieving mass flow rate
5. Equipment specifications summary table and equipment specification data
6. Pressure certification of vessel
7. Standard operating procedures
8. Test Data
9. Car experimentation area floor plan
10. Management system for vehicle modifications
11. Management system for chemical use and disposal
12. Pictures of vehicle, as it would appear on starting line
13. Material Safety Data Sheets (MSDS)

Engineering Documentation Package (EDP)

An example engineering documentation package is available on the AICHE ChemE car web site.

Please consult for details.
Flow Diagram of Car

Diagram should label and provide identifiers for all major equipment items. Refer to these in JSA and other discussion.

Design Basis for Maximum Operating Pressure

Use reaction stoichiometry, vessel volumes, equipment consumption specifications, etc., to calculate maximum pressure required to drive your car the maximum distance (100 ft) with the maximum weight (500 ml).

Design Basis for Estimating Relieving Mass Flow Rate

The relief device protects your vehicle from high pressure by relieving mass from your ChemE car process.

Your required relief device is only capable of expelling material at a fixed max. rate. This information is available from the vendor’s equipment specifications.

The relief device must be capable of discharging mass as fast as it is being produced by your chemical reaction.

However, information on the reaction rate is not usually available unless extensive experiments are done.

Thus, your only approach is to prevent excessive pressures by stoichiometric control. Must convince reviewers that you have achieved this.

Equipment Specifications Summary Table / Data

Provide a summary table listing each major piece of equipment. Include valves, tubing, pipes, vessels, regulators, turbines, etc. List important specs, such as temperature and pressure, material of construction, etc.

Provide copies of the vendor’s equipment specification sheets for all equipment.
Pressure Certification of Vessel(s)

See Appendix A in the Safety Rules and also the example Engineering Documentation package.

A new vessel can be certified by the original vendor, but if over 5 years old, or damaged or corroded, it must be recertified. This can be done by your team, or by an outside vendor.

Standard Operating Procedures (SOPs)

These can be developed directly from the Safe Operating Procedures Page of the JSA. Include only the steps, not the hazards and controls.

Start-up Procedure

1. Prime PHE, checking safety glasses and gloves.
2. Place bottle on split tray.
3. Weigh out the designated mass of sodium bicarbonate into a beaker using the scale.
4. Place graduated cylinder on split tray.
5. Measure designated volume of glacial acetic acid using a graduated cylinder. Leave in graduated cylinder.
6. Measure out in graduated cylinders required some based on sodium bicarbonate solubility. Add 20% excess to ensure all dissolved.
7. Place plug in place of container.
8. Connect a four sodium bicarbonate powder to bottle.
9. Close N 1 prior sodium bicarbonate powder then bottle.
10. Close valve V2 to ensure that liquid does not enter regulator.

Test Data

Need some indication that you have run the vehicle and have some data.

Car Experimentation Area Floor Plan

Provide a layout of the area you will be testing your vehicle at your home institution. Show location of safety equipment:

- Fire extinguisher
- Safety shower / eyewash
- Spill kit
- Fire alarm
- First aid kit

Management System for Vehicle Modifications

This section applies to changes done after your engineering documentation package as been reviewed. The purpose of this is to inform the inspectors of the changes that have been made since the EDP was reviewed and to insure that any new hazards have been identified and addressed.

See the example EDP.

Management System for Chemical Use and Disposal

This applies to chemical storage, use and disposal at your home institution and also the competition.

See example Engineering Documentation Package.
Pictures of Vehicle

The picture must show exactly how the vehicle will look at the starting line of the competition.

Material Safety Data Sheets

Provide vendor supplied MSD sheets for all reactants, products and intermediate chemicals. Include any solvents or other utility chemicals that are used.

BOC GASES

PRODUCT NAME: CARBON DIOXIDE, GAS

1. Chemical Product and Company Identification

BOC Geest
Division of
The BOC Group, Inc.
The Oyster House
Shoreham, West Sussex

BOC Canada Limited
1900 Sheppard Avenue East
Mississauga, Ontario L5A 219

Summary of Workshop

You need to identify the hazards on your ChemE car, control or eliminate these hazards, and then convince the EDP reviewers and the inspectors that this has been done successfully.

You also need to follow the management procedures outlined in the rules: JSA preparation, EDP submission, and car inspection.

ChemE Car Qualification Test

Now that you have viewed the Chem-E-Car Safety Training presentation, please access www.aiche.org/chemecartest to take the required qualification test.

Simply watching the video WILL NOT qualify you to compete. As of January 2010, each team member of a NEW Chem-E-Car team or a team that was not qualified to compete at past competitions MUST pass the test to compete at a Chem-E-Car competition.

Once you pass the test with an 80% or higher score, your name will be added to the list of qualifiers maintained at AIChE headquarters.

If you fail the test, you will be given another opportunity to pass.

Please write down this website, as it is not on the public AIChE student website - www.aiche.org/chemecartest. This is where you will go to access the test and receive more details.

Good luck for your competition!

Have a safe experience!