2004 RULES AND GUIDELINES

FOR THE

FIRST ANNUAL UNIVERSITY STUDENT HYDROGEN DESIGN CONTEST:

HYDROGEN FUELING STATION

Presented by the National Hydrogen Association, U.S. Department of Energy and ChevronTexaco

1 Program Description

The first annual hydrogen design contest is intended to engage university students from a variety of disciplines in the design of a hydrogen fueling station. The contest aims to create a competitive academic forum for students to apply their academic learning and creativity in the areas of design, engineering, economics, environmental science, and business to the developing hydrogen infrastructure.

2 Contest Rules

2.1 Eligibility and Team Structure

- The contest is open to students of colleges and universities in North America.
- Teams can have up to 10 students, but only 5 students from each team are eligible for awards.
- Given the multi-disciplinary nature of this competition teams are recommended to include members from at least three of the following interdisciplinary fields: engineering (all types), economics, business, environmental science, policy, chemistry, architecture, industrial design, marketing, education or any other field of study relevant to the project.
- Team members must be enrolled in a college or university at the time of the contest but do not have to be full-time. Each member must be enrolled in the same university as other team members.
- Multiple teams from a single school are welcome, but each team must work independently.
- Each team must have a faculty advisor. The advisor must be a faculty member of the college or university of the students on the team. Adjunct or emeritus faculty are welcome to serve as advisors. Advisors may give guidance and suggestions but cannot perform actual design work.

2.2 Information Sourcing and Questions

- Teams may use any source of data or materials: journals, computers, software, references, web sites, books, etc. All sources **must** be credited.
- An electronic bulletin board is on the contest web site: http://www.hydrogenconference.org/bulletinboard.pdf. Teams may submit questions concerning the contest by email and they will be answered in a timely fashion by

hydrogen experts assembled by the NHA and DOE. Both questions and answers will be posted for the duration of the contest.

- Teams may contact by phone, fax, or email reference hydrogen professionals, as desired. Any and all contacts that provide information used within the report **must** be documented.

2.3 Report Format and Scoring

- Entries will take the form of a proposal responding to the attached mock RFP. The proposal will be submitted to the judging panel electronically by sending a *.pdf file. Pages should have 1" margins and should utilize Times 12 point font.
- The following page limits and weights will be assigned to sections of the design:

Section	Page Limit	Points
Executive Summary	1	--
Technical Design	10	30
Safety Analysis	6	20
Economic Analysis	6	20
Environmental Analysis	5	15
Marketing/Education	2+1(ad)	10
Appendix	10	--
References	as necessary	--
Entry Form	1	--

In addition to the total of 95 points assigned above, teams that utilize renewable (for example, solar, wind, hydro, geothermal, etc.) energy in the production of hydrogen will receive a bonus of up to 5 points.

- The executive summary should summarize the main features and operation of station.
- An appendix of up to 10 additional pages is allowed for teams to include information, calculations and background material.
- Entries will receive a 3 point penalty for each page submitted over the stated limit.
- Judging criteria include technical accuracy, completeness, clarity of writing and presentation, professionalism, economic viability, environmental performance, and realism of the design. The judging panel will judge each section based on the above criteria and awards points individually for each section.
- All teams must register online at: http://www.hydrogenconference.org/contest-team-reg.asp before submitting their design.
- The winning team (announced March 26, 2004) must submit a 20-minute PowerPoint presentation of their design to the NHA (see address in Section 3.2) by April 16, 2004.
- Teams are encouraged to copyright their designs. By submitting a design in this contest, however, teams agree to have their papers published; the National Hydrogen Association and the U.S. Department of Energy assert the right to publicize the design concepts for their own purposes. All work will be given due credit to its authors.

2.4 Prizes

One winning team and four honorable mention teams are expected to be selected. The winning team will receive a trip to Hollywood, CA to present its winning design at a plenary session of the 2004 NHA Annual Conference. Meals, hotel, airfare and conference registration expenses for the 5-person winning team will also be paid by the NHA. The Annual Conference will be held April 27-30, 2004 with accommodations at the Renaissance Hollywood Hotel (for more information on the conference, visit www.hydrogenconference.org). In addition, the four honorable mention teams will be invited to give poster presentations. Five team members from each honorable mention team will receive free conference registration and materials (some meals will be provided as a part of the conference registration). All five winning teams will receive awards at a ceremony preceding the presentation of the winning entry and will have their winning designs published in the 15th Annual U.S. Hydrogen Conference Proceedings. (Note: all designs will be published in a separate compendium).

2.5 Contest Schedule

- Early announcement to alert universities: **Sep 30, 2003**
- Draft Guidelines and Rules released to interested universities: **Oct. 15**
- Open meeting to review Draft Rules and Guidelines **Nov 5**
- Final contest rules and guidelines released: **Nov 15**
- **DUE:** Team registration: **Dec 15**
- **DUE:** All final entries at NHA offices: **Mar 3, 2004**
- Selection of winning teams: **Mar 3-Mar 23**
- Winners announced: **Mar 26**
- **DUE: Winning team submits presentation to NHA** **Apr 16**
- Awards ceremony, plenary and poster presentations **Apr 28-30**

3 Request for Proposals

The NHA and the US DOE request proposals for the design of a public hydrogen fueling station serving light duty hydrogen fuel cell vehicles. The proposals must also include details of the hydrogen production and distribution (if necessary). The designs may utilize any technology, but the proposals must conform to the station requirements listed below.

3.1 General requirements of the hydrogen station:

- The station will have the capacity to refuel a minimum of 50 vehicles/day. Each vehicle has a storage capacity of 4 kg of hydrogen. Assume that vehicles refuel when the storage is one quarter full, and therefore, refuel using 3 kg of hydrogen.
- The station must be designed to be able to handle a single peak fueling period of 20 kg in 1 hour.
- Hydrogen is carried on board the vehicle as a high pressure gas at 5000 psig.
- The maximum footprint for the station must not exceed 14,440 square feet.
- The station is accessible to the general public (not fleet service only).

- Dispensing of hydrogen fuel is the primary commercial purpose of the station. Generation of grid power is not an option.
- As a part of the design, teams should plan to open their fueling station for service in March 2006.

3.2 Submission guidelines:

All entries are due by 5:00 PM EST on March 3, 2004. Entries will be submitted in hardcopy and on disk/CD to the National Hydrogen Association:

Hydrogen Design Contest Committee
ATTN: Patrick Serfass
National Hydrogen Association
1800 M Street, NW Suite 300
Washington, DC 20036-5802

4 Judging Criteria

Judging criteria include technical accuracy, completeness, clarity of writing and presentation, professionalism, economic viability, environmental performance, and realism of the design.

4.1 H2 Station Technical Design

The station design can be based on either on-site production or centralized production and distribution. In either case the project team must provide a detailed description of the hydrogen production and distribution technologies used to deliver hydrogen to the station. In the case of on-site production, the project team must describe the hydrogen production equipment as part of the station. In the case of centralized production, the project team would need to describe the centralized production (e.g. large-scale SMR, bio-mass, electrolysis, etc.) and distribution mechanism (LH_2 tanker, pipeline, tube trailer, etc.) used to deliver hydrogen to the station. The environmental and economic impact of these elements must be included in the final report.

The technical design will include:

- Site (plot) plan. The plot plan should include a diagram of the location and number of re-fueling pumps, re-fueling island design, canopy (if included), any buildings (e.g. mini-mart), ingress/egress, any auxiliary equipment and any other items the project team wishes to include.
- Detailed three-dimensional drawing or computer rendering of the station design including all major hardware and structures.
- Description of major components with specifications and rationale for their choice. The description must include off-site production and delivery components (if necessary). Whenever possible, teams will select commercially available equipment.
- Process schematic, including the source of hydrogen and all major equipment and flow paths. The schematic should include items such as valves and PRDs but not individual fittings.
- Accounting of anticipated energy use (electricity, natural gas, etc.) for station operation.
- Explanation of the fueling process including how long it will take to refuel a car.

- Explanation of the control of major components and processes (e.g. when the compressor turns on and off).

4.2 Safety Analysis:

Currently, although some codes and standards for fueling stations exist, they are largely in a developmental stage. In their station design, students must insure that safety is comprehensively addressed as a paramount issue during station operation. In the case where the student's design is actually constructed, officials (for ex., the fire marshal, chief fire inspector, insurance providers) will have to be convinced, in addition to the general public, that the station will be able to operate safely with an acceptable level of risk to rogue events (like terrorism, explosives, large vehicle collision, etc.). This section will be judged on the safety of the entire design and the documentation provided to prove that the station will operate safely. Due to time and page limitations, the following requirements are listed to assist the design team in making their case.

To document the ability of the students' fueling station to address safety, the following ***minimum*** requirements must be met in this section:

- Students must identify at least eight major failure modes (leakage, rupture, accidents, equipment failure, etc.).
- The eight failure modes must be ranked from highest probability (#1) to lowest probability (#8).
- The top three (highest probability) failure modes must be analyzed. Students will explain how their design will either mitigate the risk of failure or cope with the result.
- Students must design their station to address the other five failure modes in addition to any other major anticipated risks. (The goal of this section is to prove that the station will be able to operate safely.)

4.3 Economic Analysis

The project team will complete a detailed economic analysis of the station including hydrogen production, distribution, compression (if necessary), storage, and dispensing. The economic analysis should include capital costs, operational and maintenance costs and return on investment (ROI). The project team should determine the selling price of dispensed hydrogen ($/kg) based on the economic analysis. The analysis should include:

- Capital costs for all equipment sited at station.
- Operating costs of all fuel, power, water or other resources necessary for station operation (i.e., water for electrolysis, natural gas for reformers, LH_2 supply, electricity for compressors and controls). Justify costs for water, natural gas and electricity (when needed) using relevant local utilities prices.
- Costs for delivered hydrogen justified with a cost analysis of production and delivery systems.
- Costs of natural gas, electricity, and water, documented for the region and for any special prices (time of day or volume sales).
- Maintenance requirements and costs.
- Selling price of hydrogen, based on a discounted cash flow analysis with an after-tax internal rate of return of 10% for a 10-year analysis.

- A comparision of the cost in $/mile of hydrogen fuel for the fuel cell vehicle compared to the $/mile for comparable conventional vehicle using gasoline. Assume the fuel cell vehicle fuel economy is 60 mile/kg of hydrogen. Assume the cost per mile for conventional vehicles is $0.058/mile.
- For all costing analyses, teams must use documented sources.

4.4 Environmental Analysis

Each team will perform a well-to-tank energy and emissions (CO_2 only) analysis. The analysis should include:

- An energy balance for all major components (production, delivery, compression, etc.) of the system. The well-to-tank analysis should show the grams CO_2/ kg hydrogen produced compared to the amount of CO_2/gal gasoline produced.
- An example of such a standard analysis for a baseline vehicle is the MIT study entitled "On the Road in 2020." (http://lfee.mit.edu/publications/reports)
- An estimation of the well-to-wheels emissions savings for one year based on replacing the 50 conventional vehicles with 50 fuel cell vehicles. Assume the fuel cell vehicle gets 60 mile/kg H_2 and the 50 conventional vehicles get 27.5 mpg gasoline.
- For all emissions analyses, teams must use documented sources.

4.5 Public Awareness/Marketing and Education Plan

Public acceptance of hydrogen is a challenge and needs to be overcome through long term education and outreach efforts, just like introduction of other fuels. How will you build support for your planned station, allay public safety fears, and raise community awareness of the benefits of hydrogen technologies? For this section, teams must produce a public awareness plan to support the planned hydrogen fueling station. The plan must include a one-page (8.5" x 11") advertisement that will be distributed through media local to the station's location. Costs for materials and services to carry out this plan must be noted and summarized.