

# Hydrogen Today

"Clean Energy For A Better World"

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## How to Tank and Tube for Renewable Fuels

by Byron Anderson, editor

### STORAGE

Hydrogen can be stored in a gaseous, liquid or solid state. Each method has its advantages and disadvantages.

As a gas, Hydrogen is stored under high pressure in containers made of aluminum, steel or composites. A hydrogen container must be able to contain the gas at high pressure without leaking. High strength fibers (glass, carbon) are wound around the container to give it strength. Hydrogen emerges from the container, into the fuel line, under high pressure. Regulators are used to reduce the pressure before the fuel is admitted to the engine. The main drawback with gaseous storage is volumetric. That is, the density of Hydrogen being so low

great volumes need to be stored to make transportation applications viable.

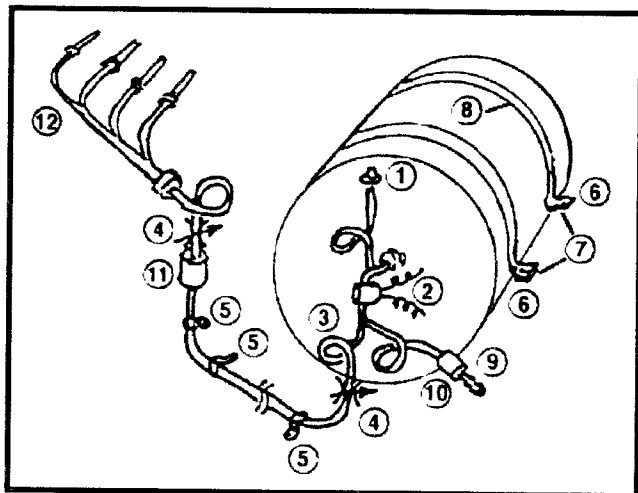
A second form of storage is liquid Hydrogen. As a liquid, Hydrogen has a temperature of  $-253^{\circ}\text{C}$  ( $-423^{\circ}\text{F}$ ). Storage containers must be highly insulated. Typical containers have double walls with a vacuum between the walls. In spite of good insulation 1 to 2 percent of the liquefied fuel is lost per day in evaporation. A specially designed pump is used to supply the engine with the fuel. Needless to say this type storage method requires significant technology and infrastructure support.

Thirdly, gaseous Hydrogen may also be stored inside a solid metal. The metal absorbs the Hydrogen gas at ambient temperature. Heat and/or lowering of pressure releases the Hydrogen from the metal. A typical configuration has hydride-containing tanks or tubes surrounded by water. Heating or cooling the water changes the temperature of the hydride regulating the release of gas. The main drawback of this system is weight.

Despite the problems, gaseous Hydrogen is the simplest and cheapest form of Hydrogen conversion. Its efficiency and range are sufficient for local round trips between 60 and 300 miles, depending on the vehicle and allocation of storage space. Hydrogen stored at 100 atm has about three times the energy density, and a thousand times the energy per unit weight than lead acid batteries.

The conversion of an automobile to gaseous Hydrogen is simple in concept. One or more gas cylinders are mounted in the trunk, behind seats, below or on top of the vehicle. Stainless steel fuel lines are typically used to prevent corrosion of the fuel line metal by corrosion from the outside environment. The fuel line circuit includes cut-off valves, pressure gauges, and regulators to monitor and control the fuel flow into the engine.

*Continued on next page.*



- |                          |                    |
|--------------------------|--------------------|
| 1 Dust Cap on PRD Vent   | 7 Rubber Cushions  |
| 2 Shut-off Valve         | 8 Tank straps      |
| 3 Vibration Loop         | 9 Refueling Nozzle |
| 4 Pressure Regulator     | 10 Primary Filter  |
| 5 Support on 24" Spacing | 11 Final Filter    |
| 6 Base Supports          | 12 Fuel Harness    |

## A GO-CART APPLICATION

Randy Olive recently built a couple of Hydrogen powered Go-Carts for the 1st ever alternative fuel race. Lets have a look at this application and review the components, cost and construction.

In the picture below we can see the main components of Randy's creation. The tank itself is similar to a SCUBA tank in size but is wrapped with carbon fibers embedded in epoxy resin. For the sake of simplicity,



pressure is regulated at the nozzle and flow is controlled by two in-line valves. A gauge monitors the line pressure. The upper valve is turned off to stop the fuel flow when the engine is shut off. Conventional carburation is non-existent because there is no intake manifold vacuum. The fuel delivery line is mounted into the metal housing of a filter covering the intake port.

Construction included tank mounting, tube bending, cutting, component assembly and testing. The fuel system components including the tank came to \$300. Randy was able to complete this project in a couple of weeks.

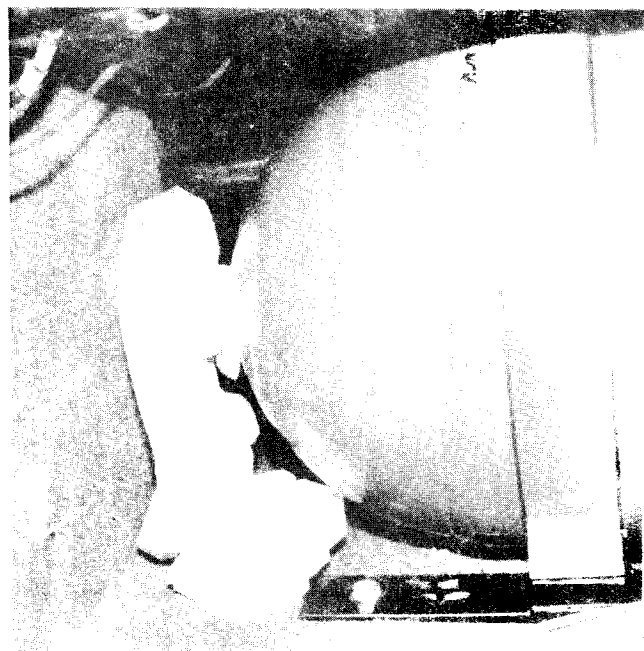
Conversion of a full sized car can be done by a skilled do-it-yourselfer, but it would be wise to have experts at your local natural gas utility or a propane installation specialist review your work.

## COMMERCIAL FLEET APPLICATION

AZStar is a Phoenix based company that does Natural Gas conversions for fleet vehicles. Though the fuels are different, the hardware necessary for Hydrogen and Natural Gas storage are virtually identical. Both fuels have similar requirements for high pressure regulated delivery systems and safety.



Above we see part of the engine compartment installation. To the left center is the pressure regulator. Note the pressure gauge on the firewall which monitors inline pressure from the storage tank below. A clean installation is not only aesthetically appealing but also eases servicing the vehicle.



The high pressure CNG tank is shown installed in the trunk of the vehicle. Note the plastic bag enclosing the valve stem. The tape adhered bag assures that leaks are safely contained and provides an immediate visual

check of any system malfunction. A mounting bracket firmly bolted to the trunk floor is one of two which secure the tank in place. It has been demonstrated in severe crash tests that well placed tank components remain virtually intact even though the vehicles were completely totaled.



There are many similarities in the go-cart and automotive application of tanking and tubing. The main differences are the pressure regulation sophistication and safety redundancy built into the automotive application.

It has been advised by Randy Olive and others that do-it-yourselfers start with a manageable project like a lawn mower or go-cart and learn the hands on basics. In doing so, you will find your needed component sources, machine shops etc. and can invest in tools gradually as you need them.

The natural gas industry as a whole, being a mature and growing industry, provides us an excellent example of safety practices, professional installation, and component vendor that bear examination by those wishing to learn more about gaseous alternative fuel conversion.

#### **SAFETY NOTES**

- 1 Select tanks, fittings, valves, etc., that do not leak!
- 2 Use fail-safe components such as the PRD system (pressure release device) and an excess flow shut-off valve.
- 3 Incorporate Hydrogen sensors in the instrumentation system to provide early warning and automatic tank shut-off

Many utilities have natural gas conversion classes (for AHA's classes see page 12) and there are several fine books available if you are serious about converting your car to alternative fuel: Propane Fuel Conversion for Automotive Engines by Jay Storer, Fuel From Water by Michael A. Peavy and The Philosopher Mechanic by AHA's own Roy Mcalister. The latter may be purchased directly from AHA for \$35.00

The internet is a rich source of free information and there are many forums to check out regarding Hydrogen and alternative fuels. Don't forget [www.clean-air.org](http://www.clean-air.org)!

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## **World's First Minus-Emissions Race Carts**

*by Misty Olive*

The world's first clean-air Go-CART (Go-Clean Air Racing Technology) race was held at South Mountain Park near Phoenix on April 18th. Hydrogen powered Go-Carts were joined by two methanol fueled Pro-Carts in runs around the track. For a small contribution many young passengers got race-track rides in the two-place Hydrogen cart. Many parents could not resist the urge to take a hydrogen Go-Cart around the track a few times. The Smog Dog mobile emissions van was on hand to measure the clean air capabilities of the entrants. Hydrogen powered carts scored minus emissions, in other words they emitted air cleaner than they took in! The

sophisticated methanol powered carts were very streamlined and had suspension systems carefully adapted to the track so they could run faster, but the owners revealed that racers and pit crew would often be sick after racing due to the noxious emissions from the methanol carts. Spectators in the grandstand complained about the methanol cart fumes and stated relief when the hydrogen go-carts cleaned the air.

Randy Olive won top honors for the day by accumulating far more points than all other entrants because his hydrogen go-cart cleaned the air.

The event provoked great interest for the racers and spectators alike. Roy McAlister had demonstrations of Hydrogen powered vehicles, quick and safe refueling techniques, including a hydrogen Cadillac and the world famous 1979 hydrogen pickup. AZStar was also on hand to talk about Natural Gas vehicle conversions. Hydrogen converted cars use many of the same components as Natural Gas vehicles.

The 1<sup>st</sup> annual Hydrogen Go-Cart race broke new ground by demonstrating how existing technology on a small scale can both provide fun and help to educate the public about the benefits of Hydrogen.

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## **SOLAR HYDROGEN FOR CHINA**

China is the most populated country on Earth. China burns more coal than any other country and nine out of the world's ten most polluted cities are in China. Further goals call for more than doubling the amount of coal burned in China. Currently economic growth is the paramount preoccupation in China at nearly any cost – including the environment.

Roy McAlister has been selected to lead a sustainable energy delegation to China. Our program will begin in Los Angeles on November 6, 1999. Following a briefing, we will depart for Beijing. After meetings and cultural activities in Beijing, we will fly to Chongqing, one of China's largest population centers. Chongqing is an industrial area, where pollution problems are particularly acute. From Chongqing, we will board the cruise ship *MV President 1*. For two days/three nights, we will sail down the Yangtze River and take in the famous three gorges. This scenery is particularly unique and made all the more so because in just three or four years, most of this river-front scenery will be submerged by the rising waters behind the new dam. We will dock in the restricted city of Sandouping, where we will visit the new dam site that is under construction.

*Continued on next page.*

*China con't.*

The Three Gorges Hydroelectric Project has been very controversial, because of the resettlement of 1.3 to 2 million people and the loss of natural river conditions. More than 150,000 people have already been moved to make —way for construction.

There are solutions to this and other looming problems. Our delegation will suggest ways to provide employment for uprooted citizens along with a program to greatly accelerate adoption of in-stream hydro, wind, wave, biomass and other forms of solar energy. Renewable energy resources far exceed coal and all other forms of fossil and nuclear energy. Solar Hydrogen is the common denominator to all forms of renewable energy.

AHA extends a personal invitation to you to join Roy McAlister on this exciting mission. This mission is an important step in advancing solar hydrogen and the goals of AHA. There is an optional Xp'an guided excursions to the terra cotta warriors and the Shaanxi Provincial Museum and one night in Hong Kong – with an additional cost of about \$590. The cost per delegate is US \$4550 based on double occupancy.

Please contact Jenifer Priest at People to People Ambassador Programs by 800-669-7882 or (509) 534-0430 extension 545... or by fax: (509) 532-3593.

These outreach programs are important steps in the development of solar hydrogen for a sustainable economy. Please join and make this your mission for worldwide prosperity without pollution.

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## STAR OF LIFE

Written by: Roy E. McAlister

Illustrated by Carolyn Presley

The coloring book – cartoon educational booklet explaining the problems and solution to cleaning our environment has caught the attention of international educators. This booklet has been translated into to 12 languages. The latest translation is in Swedish and has been distributed to many schools by the Scandanavian Hydrogen Association. (See [clean-air.org](http://clean-air.org) for a link.)

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## AHA T-SHIRTS

Back in stock by popular demand! This venerable AHA T-Shirt shows the Earth and an orbiting satellite when inspected up-close. This same AHA logo looks like the hydrogen atom when viewed from a distance. The Earth fades to look like the proton and the electron sweeps an infinity sign as it endlessly orbits the proton.

This T-Shirt has graced the backs of hydrogen race teams, students in design contests as they showed their

stuff, and has appeared at energy fairs all over the world. Get a new AHA T-Shirt (\$10.00 + \$2.00 shipping) and wear it out making the case for Solar Hydrogen.

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## Web Accessed Fuel Cell Conference

American Hydrogen Association is a sponsor of the first world wide web accessed fuel cell conference.

For more information please contact Mr. Harley Caperton, Executive Producer, Worldwide Corporate Network, Inc., 212-487-7777 or [www.hcaperton@wcnonline.com](http://www.hcaperton@wcnonline.com).

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## Local Chapter Initiative

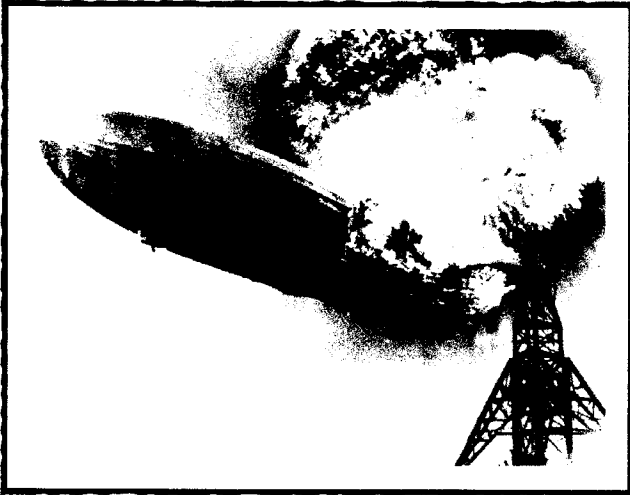
by Roy E. McAlister, President

Would you like to start a local AHA chapter in your area? Lets look as some of the implications of starting an AHA Chapter . How do you begin? How do you organize your chapter? How can you fund your chapter?

Certainly the first thing you need is enthusiastic people with synergistic goals to get any kind of initiative started. The greater number of interested parties, the greater the momentum to get something done. Start by locating like-minded people and announce a meeting. Locate an under-utilized building in your town, establish a class and meeting room for 30 students, a shop area for converting vehicles to minus-emissions operation. (AHA in Phoenix has located several used-equipment sources that can provide computers and office equipment. If needed AHA can arrange for local chapters to purchase such equipment and have it shipped to their location.) Ask members of your local community for office equipment and supplies. Remember the tax deduction that can be utilized in the scavenger hunt for equipment.

Monthly meetings will open the doors to people that will help your chapter flourish. Start with a brain storming session. This will provide a collection of ideas that can be sorted and prioritized for real accomplishments. Make contact with engineers, mechanics, suppliers, and interested resource people in your area. Develop a brochure. Many handouts and white sheets from AHA can be copied. Other materials are available at cost from AHA. Create a business plan and time line for progress by the new AHA Chapter.

Include yearly project goals. Let's say Agriculture might be the focus for year 2000 - Agricultural Sector Goals: with step-by-step actions to achieve a renewable economy in the farm communities *continue to page 10.*



## What caused the Hindenburg Disaster?

**'THE HINDENBURG FIRE IN 1937 PROVES THAT HYDROGEN IS TOO DANGEROUS FOR THE PUBLIC TO USE.'**

**(or does it prove how safe hydrogen is)**

*Excerpted from "The Philosopher Mechanic"*

*by Roy McAlister*

Often repeated remarks concerning the Hydrogen Economy go something like the following: *Hydrogen would answer the pollution question ... When hydrogen is produced in sufficient amounts to achieve the economies of scale it will be the cheapest renewable fuel ... But "Remember the Hindenburg" ...* It is often suggested that the Hindenburg disaster ended the chance for practical applications of hydrogen.

The Hindenburg was a rigid "airship" with a stretched outer shell of streamlined silver-colored fabric. It was lighter than air because it contained giant bags of hydrogen. Some 236 tons of air was displaced by the Hindenburg. This displaced air created a lifting force and buoyed the Hindenburg upward with a force of 236 tons.

Graf Zeppelin, a smaller hydrogen airship, had made 650 flights. More than 18,000 passengers were delivered safely during the nine years that the Graf Zeppelin flew. It flew 144 flights nonstop to and from Berlin across the Atlantic to Rio de Janeiro or New York.

The Graf Zeppelin traveled more than one million miles or 40 times around the world including a 20 day cruise around the world in 1929 on a publicity flight and it made a trip to the North Pole in 1931. This older Zeppelin, which was launched in 1928, carried sixteen giant

"sausage" casings filled with hydrogen. One of the better German technologies that had been years in development was sausage casings. German engineers expanded this technology to make gigantic light-weight lifting bags. These bags were reinforced with cotton fabric and filled with hydrogen to atmospheric pressure. Over 800,000 ox-guts were required for the liners of these lifting bags.

The newer Hindenburg had crossed the Atlantic 21 times and used a Goodyear-manufactured gelatin-latex membrane to contain the hydrogen in the gas cells. Much attention was paid to the silver airship image that displayed giant swastikas on the tail section. The silver appearance of the Hindenburg was due to a surface varnish of powdered aluminum in a paint formula that resembles the chemistry of modern solid booster rocket fuel.

In fact we should *remember* the Hindenburg and carefully study this mishap. An eye-witness passenger reported events as follows on the fateful evening that the Hindenburg burned while attempting to dock at an elevated altitude to a tall mast at Lakehurst, New Jersey: "With my wife I was leaning out of a window on the promenade deck. Suddenly there occurred a remarkable stillness. The motors were silent, and it seemed as



though the whole world was holding its breath. One heard no command, no call, no cry. The people we saw (on the ground) seemed suddenly stiffened. I could not account for this. Then I heard a light, dull detonation from above, no louder than the sound of a beer bottle being opened. I turned my gaze toward the bow and noticed a delicate rose glow, as though the sun were about to rise. I understood immediately that the airship was aflame ...

For a moment I thought of getting bed linen to soften our leap (from 120 feet) but in the same instant, the airship crashed to the ground ... We leaped from the air

*Continued on next page.*

ship ... my wife called to me; ... took me by the hand; (and) led me away." (From the book "The Last Trip of the Hindenburg" by Leonard Adelt.) This account is substantially verified by the news reel film of the fire.

This was an eye-witness report of the burning of an airship that carried a crew of 59. It had capacity for 50 passengers in individual cabins or for 70 passengers on day flights. On the evening it burned, the Hindenburg carried 97 persons.

Passengers had ornate individual cabins with shower baths, a club room for all with an aluminum grand piano, and a carefully insulated smoking room. The kitchen stocked two luxurious tons of the finest foods. Passengers received the best food and drinks, the most modern conveniences, and the envy of other travelers because the Hindenburg sped past ocean liners, outran trains, and remained airborne for days or weeks after other aircraft had to land and refuel. Telephones, electric lighting, and modern appliances served the crew and passengers. Public rooms were large, decorated in the style of ocean liners of the day and they had windows that could be kept open for fresh-air viewing of the grand scenes that unfolded as the giant airship sped along at the cruise speed of 78 mph.

After being launched in 1936, the Hindenburg had completed ten and one-half round trips between Germany and the United States before burning in 1937. Cruising across the Atlantic took 50 to 60 hours under constant power from four 1,200-H.P., V-16 Mercedes-Benz Diesel engines. Wooden propellers 20 feet in diameter were turned by the V-16 engines. The fully loaded range was about 10,000 miles or about 5 to 6 days at cruise speed. It was the largest airship ever built, with an 813-foot long aluminum frame filled with 7,200,000 cubic feet of hydrogen contained in 16 bags made of two layers of woven fabric with a gelatin-latex plastic film cemented between. Two 30 kilowatt diesel-powered generators carried the regular loads and a stand-by unit could deliver additional electric power if needed.

Germany's Nazi Third Reich provided funding to build the Hindenburg. It was run by the Nazi Minister of Propaganda. Huge swastikas were painted on the tail fins and loudspeakers made Nazi propaganda announcements when the giant ship toured cities that it passed. Thousands of small Nazi flags were dropped to float down like tiny parachutes to thrill school children and others that watched the giant Zeppelin pass. Germany had been the first to recognize the military possibilities of dirigibles and had used them in World War I.

The Hindenburg type of airship represented considerable technical advancement and posed a much larger threat because it could fly to virtually any target, drop

bombs, saboteurs, or propaganda, and fly back to Germany without stopping. After the Hindenburg burned, much speculation about sabotage entered the investigation. Was the disaster caused by lightening or sabotage? Nazi investigators were never convinced that the fire was caused by natural sources.

Before World War II, certain natural gas wells in the United States were the only significant source of helium. Helium was extracted from natural gas produced from wells around Hugoton, Kansas. Although the Hindenburg was designed to use inert helium as the lifting gas, U.S. military authorities prevented exportation of helium to Germany. The U.S. Government still holds strategic reserves of helium and closely monitors production and export programs but the reasons for doing so have shifted from dirigibles and centered on the relative scarcity of helium and its myriad of applications ranging from use as an inert cover gas for welding to various heat-transfer applications.

On the fateful evening, camera crews gathered expecting to see a "high docking" in which the Hindenburg would be moored near the top of a 150' mast and secured with ground lines. Their cameras recorded what happened as the Hindenburg dropped lines to waiting crews and the events after the flames appeared.

If the Hindenburg would have been filled with helium, would it have burned and crashed at Lakehurst, New Jersey?

Regardless of much speculation, translation of a letter handwritten in German on June 28, 1937, by Hindenburg crew member and electrical engineer Otto Beyersdorff states "The actual cause of the fire was the extreme easy flammability of the covering material brought about by discharges of an electrostatic nature ..." NASA investigator Addison Bain has verified this finding by scientific experiments that duplicated the vigorous ignition by static discharge to the aluminum powder filled covering material. Spectacular colors of this type of combustion were produced from the burning skin of the giant airship. Mr. Bain concluded that the Hindenburg would have burned and crashed even if helium would have been used as the lifting gas.

Hydrogen is about fifteen-times lighter than air. The hydrogen was rapidly vanishing upwards and the airship was gently falling in the first moments after the fire spread to the hydrogen cells. After ignition by the violently burning surface varnish, flames from hydrogen combustion traveled 500-feet upward, far away from the crew and passengers in the cabins below. What fell to the ground with the passengers were burning shrouds from the exterior fabric, a large inventory of diesel fuel, and combustible materials that were in the cabins.

*Continued on next page.*

Thirty-three persons were killed by jumping or falling out of the descending Hindenburg. Two were killed by burns from the flames that continued to be supported by heavier-than-air materials, fabric and diesel fuel that continued to burn for hours.



**GROUND CREW ESCAPING FROM  
CRASHING HINDENBURG**

Sixty-two persons from the Hindenburg lived through the disaster by being fortunate enough to ride the Hindenburg down and escape the flames and wreckage that fell to the ground. Most of these survivors were relatively unharmed.

"Remember the Hindenburg" should bring thoughts of the 200 persons in the landing-assist team that were below the Hindenburg that were holding or reaching for mooring ropes when the Hindenburg caught fire. If the Hindenburg had carried the same amount of gasoline as the energy released by burning the 7,200,000 cubic feet of hydrogen ... the loss of life would have surely included all of the crew, passengers, and the 200-member landing team.

### CONCLUSIONS

Careful investigation of the Hindenburg disaster verified the opinion of the engineers on the Hindenburg and proved that it was the flammable aluminum powder filled paint varnish that coated the infamous airship, not the hydrogen that started the fateful fire.

The pilot of the Hindenburg repeated the famous experiment of Ben Franklin regarding facilitation of a lightening strike. Ben Franklin flew a kite in a storm to learn about lightening. The captain of the Hindenburg allowed his 813' long, 236 ton, aluminum-powder varnish covered airship be a lightening rod. As the Hindenburg was grounded by dropping landing lines the experi-

ment was complete and electrical discharge from the clouds to the Hindenburg's skin started the fire. The Hindenburg would have burned and crashed even if it had been filled with helium lifting gas or if it would have been held in the air by ropes from another lifting body.

It was unfortunate that the Hindenburg was attempting to dock at 120' above the Earth because all but two of the deaths were from injuries from falling objects or due to falling or jumping from the Hindenburg. The Hindenburg had enough diesel fuel remaining at the time of the disaster to travel all the way to California, if necessary, to find a safe landing site.

No deaths were due to the hydrogen fire that was ultimately ignited by the burning skin of the Hindenburg and which burned quickly and far above the passengers. As the famous news reel shows, the hydrogen fire started considerably after the surface skin started to burn and was over in less than one minute. The diesel fuel and other heavier-than-air components of the Hindenburg continued to burn for at least 10 hours on the ground. §

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# Hindenburg Postscript

*Roy McAlister, P.E.*

*In response to so many requests for additional comment, please note the following:*

Hydrogen is a dangerous substance. In many ways, however, it is much less dangerous than gasoline, ammonia, naphtha, propane or diesel fuel. This is true because of a variety of reasons including:

a. The self-ignition temperature of hydrogen is over 550C (it is sometimes listed as high as 585C) compared to 228C to 501C for different grades of gasoline.

b. If leaked, hydrogen escapes much more rapidly than heavier-than-air fuels such as the diesel fuel that burned for 10 hours after the Hindenburg reached the ground.

The hydrogen fire was ignited by already burning aluminum powder filled flammable varnish that was used to coat the outer surface of the Hindenburg. The 7.2 million cubic ft of hydrogen escaped and burned upward and far above the passengers on the Hindenburg. In less than one minute after the hydrogen bags were interrupted and the hydrogen started to escape, the hydrogen was gone. You can count the seconds in the news reel film of the disaster.

c. What German engineers of the Hindenburg crew determined shortly after the fire and what the German Aerospace Technical Establishment determined by testing the skin varnish and what NASA has determined after extensive testing as reported by Addison Bain is that the Hindenburg would have burned and crashed even if it had been held at altitude by ropes from another lifting body. The Hindenburg would have burned and crashed even if it had utilized helium as the lifting gas. Ben Franklin determined that he could lure lightning to a wire in the cloudy sky. The Hindenburg was repeating the experiment regarding a kite in a lightning storm that Ben Franklin reported. Except, the Hindenburg was a 236 ton, 813' long, aluminum powder coated kite and had 97 passengers on board when it dropped grounding lines from 120' altitude in a sky full of thunder (and lightning) clouds. Fortunately for American history as we prefer it, Ben Franklin conducted his experiment as he stood on the ground instead of finding a way to perch 120' above the ground to be shocked or knocked for a loop.

d. I think it was a bad idea to use hydrogen from 1900 to 1937 "to lift" German airships but after my 30 some years of accident investigations I also notice considerable pilot error. In fact pilot error is the root cause of the Hindenburg disaster. Everyone onboard the Hindenburg knew of the fire hazard due to the light-weight but extremely flammable materials that were selected to construct the giant airship. And, after some 37 years of using hydrogen as the lifting gas for German airships they knew of the flammability of hydrogen. The Hindenburg had enough diesel fuel remaining to fly to California, if needed, to find a safe place to land. Even if it would have landed on the ground instead of trying to unload passengers to a 150' ladder mast it would have been safer because of the 35 deaths only 2 deaths were due to burns, 33 people jumped or fell to their death or were killed by falling objects. The sixty-two surviving persons that rode the gently falling Hindenburg to the ground had only slight injuries.

e. Hydrogen is not poisonous before it is burned and it forms water when it is burned. Compare this to gasoline that is poisonous before it burns and can form carbon monoxide, a very dangerous killer.

During the thirty five years that I have produced, stored and used hydrogen in internal combustion engines, fuel cells, and in various electrochemical and chemical applications it has become increasingly apparent that what I was taught in petroleum and chemical engineering classes and what I repeated when I became a professor was regrettably, in many cases, not true. Illustratively, I was taught that hydrogen could not be contained in steel apparatus because of embrittlement and leaks. I then discovered a 1909 test date stamped into the neck of an old hydrogen cylinder in my fuel cell laboratory. I tested this old but leak-free steel cylinder for ductility and strength. And, I have tested others of similar first-test dates and have made an extensive study of containment materials since then. You are welcome to come and see my steel cylinders from 1916 and 1917. For 20 years before the Hindenburg fire and every five years since, these cylinders have passed every test for safe conveyance under DOT regulations. We can discuss many other myths about which I have investigative evidence.

Please come and take a safe ride in a vehicle that for some 19 years and more than 125,000 miles has cleaned the air that passed through the engine. The hydrogen storage tank on this vehicle is built to specifications for withstanding the point-blank blast of a full stick of dynamite, 6 rounds on target from a .357 Magnum pistol with standard police loads, and it will not blow up if tested in

*Continued next page*

a fire that produces a measured 1,500F surface temperature. (Which of these tests would a tank of gasoline withstand?)

I will also be glad to show you how to make renewable hydrogen at an overall efficiency that is more than a hundred times greater than the true efficiency of gasoline production.

### MANAGING A SAFE LANDING

On a philosophical note, it should be apparent that the pilot of the Hindenburg gave away the best advantage offered by the flammable Hindenburg. This advantage was the tremendous travel range that was still available on the day the Hindenburg burned. The Hindenburg was an amazing luxury airship that outran trains, sped past ocean liners, and could fly round-trip from Berlin to U.S. cities without stopping. It had electric lights, telephone communications, and modern appliances. Passengers could find entertainment in the piano-bar lounge, see movies, enjoy fine dining, and they had opportunities to view passing scenery through open windows, if desired, in public observation lounges. It stocked tons of the finest foods and drinks.

Mismanagement of the situation is the true cause of the Hindenburg disaster. The pilot could have provided his passengers with continued luxurious travel to a safe landing in sunny Florida, wine tasting in California, gambling in Nevada, a day at a dude ranch in Texas, or to see a basket ball game in Kansas, Kentucky, or Indiana. He could have decided to fly back to Europe without stopping to find a safe place to land. But he chose to dock at 120' altitude and have his passengers go down a ladder from a sky turmoiled with thunder storms.

The plight of the Hindenburg could be similar to the situation Civilization is facing in slower motion but with equally dangerous implications.

Civilization has never had it so good and the goodness could be extended, even greatly expanded, but this goodness remains traceable to worldwide dependence upon finite reserves of fossil fuels. We need to utilize diminishing supplies of fossil reserves to build a sustainable future with ample Renewable Energy Parks to make the supplies of energy that we and future generations will need by harnessing solar, wind, wave, falling water, and biomass waste resources. We can approach the future with a Grand Plan to achieve sustainable prosperity without pollution or we can continue to invite depletion, hardship, and misfortune by failing to manage remaining fossil reserves and renewable resources for the best outcome. §

*Continued from page 5.* the following suggestions are needed:  
Deter Urban Sprawl – preserve farming and recreation;  
Renewable chemistry for fertilizers and pesticides;  
Top soil development – Using byproducts of Hydrogen generation. Composting for gardening;  
Conversion of farm vehicles to Hydrogen;  
Bio-mass conversion to Hydrogen;  
Community Colleges, 4H and FFA education;  
Scheduling classes or seminars on how to operate on renewable energy and produce sustainable goods in farm communities;  
Extension services (HDU) Home Demonstration Units;  
Show Total Energy efficiency for off-grid living;  
Co-Ops and independent power producers – family farming;  
US Agricultural Department re-education programs;  
Investigate and urge support for Alternative Fuel usage.

Subsequent years may reflect other topic areas important to your membership and community

2001 - Transportation Sector

2003 - Power Generation

2004 - Commercial Sector

2005 - Medical Sector

2006 - Residential Sector

2007 - Military Sector

Whatever is the result of your strategic planning sessions, it is of paramount importance to tie activities into the community so that AHA Chapters are associated with positive contributions concerning advancement of renewable resources. §

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## AHA Seeks Entries To Hydrogen Cartoon Contest

A request for entrants is hereby announced for the best Solar Hydrogen (how to sell Hydrogen to the general public) cartoons. Elementary and High School students along with thoughtful persons of every age are encouraged to think about the significance of Solar Hydrogen and our environment and to develop a cartoon. Best entrants will be published in the AHA newsletter with prizes given to the top three winners. Prizes include cash and subscription to the AHA newsletter. So get out your thinking caps, sharpen those pencils, or boot up the computer, and start drawing! Winners will be announced in the next issue of the American Hydrogen Association newsletter.

Send to: American Hydrogen Association  
1739 W. 7th Ave  
Mesa, AZ 85202-1906

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### GE ENERGY RENTALS WILL RENT FUEL CELLS:

GE Power Systems will offer rentals of power generation equipment including fuel cells for residential and small commercial applications in central and southern Georgia. Flint Energies will be GE Fuel Cell Systems exclusive distributor for Georgia.

**H-Power Corporation** is partnering with ECO (Energy Co-Opportunity) to introduce residential and small commercial fuel cell systems to rural electric cooperatives and their customers. A servicing school for technicians is part of the program.

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### People Make It Happen:

Many great people have spent countless hours advancing AHA and we want to thankfully mention a few: Nadine and Ray Smucker, Bob Linde, Paul Anderson, Angelica Carrier, Warren Marsh, Misty and Randy Olive, Doreen and David Wastchak, Lee Jones, Lou Linxwiler, D.K. Harrison, John Mills, Chuck Terrey, Bill Chase, Craig Wilson, Bob Wagner, Richard Potts, Robert Schafer, Frances Tyson, Whitey Brayer, Dave Stempien, Roger Kriebel, Chuck Smith, Steve Harris, Walter Paetzold, Ray Coleman, Clem Mesa, Bryon Anderson, Dan Morton, Howard Smith, Tom Dickerman, Don Miller, Charles Bensinger, Monte Ogdahl, Gentle Strength Cop, Mel Larsen, Pak Shem, Laurina and Stig Berqvist, Ben Ferguson, Marie Davis, Judy and Larry Trimmell, Beverly and Lawrence Perovetz, Marsha and Clive Lewis, Marcia Green-shields, Sara and Charlie Enochs.

## The Pollution Free Planet Report

The title of this column is the same as the name suggested by Ray Smucker for an organization initiated by the Phoenix Rotary Club to provide solar hydrogen solutions to worldwide problems of economic demise and environmental degradation. The *Pollution Free Planet* movement has gained the support of all three Arizona Rotary Governors along with endorsements by the past, present, and future presidents of Rotary International.

Pollution Free Planet speakers are in high demand by Rotary Clubs along with those of many other service organizations including Lions, Exchange and Kawanis. Many of the speaking engagements have produced sponsors for publishing AHA literature for local distribution to schools.

In June of 1999, at the Rotary International Convention, in Singapore, where approximately 19,000 delegates representing some 1.2 million Rotary members from around the globe, David Wastchak (member of Rotary International's strategic planning or "dream" team) and Richard Potts, (present president of the Phoenix Rotary Club) provided initiated *The Rotary Hydrogen Fellowship*. Rotary members see these efforts to bring practical and sustainable solar hydrogen solutions as the next major program for Rotary International. Rotary International has quietly provided more than \$250,000,000 in current value to wage a worldwide crusade against polio. This dreaded disease that once threaded to cripple at least one member of every family has virtually been eliminated, and now Rotary is ready to bring solar hydrogen to the world.

The Pollution Free Planet campaign will be brought to places where chronic hunger and sewage contaminated water define living standards and to the most affluent cities where poor air quality and economic uncertainty due to dependence upon finite fossil reserves defeat the search for the good life. Rotary's 1.2 million members are learning about options for using solar hydrogen for home making, transportation, farming and industry. You can expect worldwide betterment because of efforts of this organization that has the credo "service above self."

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### HIPPO an eco-acronym for:

**Habitat destruction, Introduced species, Pollution,  
Population Growth and Over exploitation.**

**REGISTRATION FORMS**

***“The problem is clear, the air isn’t,”***

*a quote from the Pollution-Free Planet Committee*

- Yes, I want to join AHA, or give a gift to help make a transition to clean Hydrogen energy.
- Yes, Enroll me in the automotive conversion class on March 11th & 12th, 2000.
- Yes, Enroll me in the fuel cell short course on March 18th and 19st, 2000.
- Yes, Enroll me in the Ambassador trip to China Nov. 6 thru the 20th.

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- Regular membership (\$39/year)  Family membership (\$49/year)  Senior/student membership (\$25/year)
- Sustaining membership (\$100/year)  Corporation/Institutional (\$2,500/year)  Auto conversion & Fuel Cell Class deposit (\$50.)  Ambassador Trip to China (\$4,550) Call 800-669-7882, Ext. 545 – Jennifer Priest
- Other donation. For foreign mailing, please add US\$8.00

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