

FACILITATING THE SAFEST POSSIBLE TRANSITION FROM FOSSIL TO HYDROGEN FUELS: HYDROGEN EXECUTIVE LEADERSHIP PANEL

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ABSTRACT

In recent years, federal and state safety authorities have worked to bring emergency planners and responders together with industry, the scientific community and consumers to ensure high levels of safety with gas and liquid pipelines, and more recently, with liquefied natural gas terminals. The U.S. Department of Transportation (DOT) is the federal authority on the safe transportation of energy, and the National Association of State Fire Marshals (NASFM) represents state-level safety authorities. Together, they have produced firefighter safety training materials, technical guidance and information for use in communities considering new energy infrastructure, and conducted research to support these activities. In 2004, the DOT-NASFM partnership established the Hydrogen Executive Leadership Panel (HELP) to ensure a safe transition from fossil fuels to hydrogen fuel cells. HELP brings together senior policy-level experts from all sectors to understand and recommend mitigation strategies for the risks associated with the transportation and use of hydrogen in motor vehicles. The initial group includes experts from the United States, Canada, and Europe. HELP will be supported by an advisory committee of emergency planners and responders—individuals well-equipped to describe real-world scenarios of greatest concern—and by a second advisory committee of engineers and scientists who will help translate the real-world scenarios into useful technical solutions. By September 2005, HELP expects to define the initial real-world scenarios of greatest concern, and bring together teams of experts to collaborate with automakers, energy producers, government authorities, consumers and public safety officials. Much work lies ahead, including creating guidance for hydrogen powered automobiles, emergency response safety training, establishing test methods to reflect real-world incident scenarios, and modifying state and local building and fire codes. The HELP leadership will present its strategic plan and first report at the International Conference on Hydrogen Safety in September 2005.

INTRODUCTION

The U.S. Environmental Protection Agency predicts that because of technological progress with hydrogen fuel cells, some day consumers will drive autos that no longer pollute the air and harm human health. Major energy companies see that day coming relatively soon. One energy producer says that we have entered a so-called Collaborative Phase where hydrogen fuel cell technologies produced in an Invention Phase will be readied for a Commercial Phase perhaps a decade from now.

Because public impressions of hydrogen will be formed during this Collaborative Phase, it is a time – in the words of an automaker – where, “We cannot risk a single accident.” Industry experts speak of “layer upon layer” of safety precautions now in place in the first hydrogen-powered autos and in hydrogen fueling stations as evidence of industry’s commitment to “zero incidents” during the

Collaborative Phase. The U.S. Department of Energy's Hydrogen Posture Plan [1] talks about overcoming "barriers to commercialization and infrastructure development," and goes on to say that consumer confidence in the safety of hydrogen is paramount. Yet, with not a single incident on record and public safety as a clear priority, "the community is in an uproar" over a hydrogen fueling station located in Southeast Washington, D.C., according to fire code enforcement officials assigned to the project. Whether justified or not, public fears of nuclear energy, pipelines and liquefied natural gas (LNG) terminals have resulted in endless permitting delays that could prove fatal if the public reacts similarly to hydrogen.

Randall Napoli, the Florida State Fire Marshal, is willing to facilitate the transition but bemoans the fact that "there are no standards." His office is doing the best with what it has, as it reviews plans for hydrogen fueling stations proposed for a Florida "Hydrogen Highway." A technology company expert promises that hydrogen fuel cell safety standards are under development. Even so, one fire chief paints a picture of hazards unanticipated by regulators as emergency responders attempt to rescue persons trapped in automobile accidents. Yet another public safety official adds that buildings in his state are already equipped with hydrogen fuel cells. "I am committed to helping this transition however I can," he says. "Even so, I have nothing but questions about what it means to the safety of the people of my state."

Although these statements vary widely, all are honest expressions from individuals responsible for the transition from fossil to hydrogen fuels. Because of the importance of the transition, these and other leaders have joined to form HELP with this mission in mind:

To bring together emergency responders, government regulators, scientists, consumers and experts from the automotive and energy industries to facilitate a safe and orderly transition to hydrogen and other alternative fuel sources.

PROGRAM SCOPE

California Governor Arnold Schwarzenegger envisions a Hydrogen Highway Network by 2010, because "an early network of only 150 to 200 hydrogen fueling stations throughout the State (approximately one station every 20 miles on the State's major highways) would make hydrogen fuel available to the vast majority of Californians [2]." The Governor's vision of Hydrogen Highways is shared by government and industry officials from British Columbia, Illinois and Florida to Germany, where Linde Gas and Engineering has announced plans for 35 hydrogen fueling stations connecting the Federation's major cities. As this document was in review, plans for yet another Hydrogen Highway were announced for roadways running from Washington, D.C. to New York City.

The concept of a Hydrogen Highway is not just an important part of the Collaborative Phase of the transition. Hydrogen Highways *are* the Collaborative Phase, because they will be our best and perhaps only opportunity to understand how to ensure safety and build public confidence as the Commercial Phase draws closer.

Hydrogen Highways are not just networks of hydrogen fueling stations, but the hydrogen-powered autos that will use them, and all that surround and service them. Autos are systems of systems, operating within other systems. Substitute hydrogen for gasoline, and the risks present in each system inevitably change for better or worse. For HELP to understand the impacts of hydrogen – and for the safety of Hydrogen Highways to be ensured – we also must understand these systems as they now exist and how they are expected to change as the transition proceeds.

From decades of experience, we understand some of these interactions well. Others are yet to be defined. Definitions and standards are needed. But we should take care to think before we write. If we adopt standards for the individual systems before we understand the interactions, safety will not be served and further innovation is likely to be discouraged.

These are among the systems that define the scope of HELP's mission:

Human behavior. A comprehensive system of laws and public education focus on the most irresponsible behaviors, *e.g.*, drunk and reckless driving, speeding, smoking while fueling, ignoring stop signs, etc., as well as simple carelessness, *e.g.*, failure to use seatbelts and directional signals, etc. Although traffic safety laws are well enforced, tens of thousands of persons die each year in accidents caused by irresponsibility and carelessness.

Arson is an obvious example of criminal behavior linked to auto safety. But there are others. In the mid 1990s, roughly 80 out of every 1,000 gas station attendants – some 15,500 workers – were victims of violent crimes on the job each year [3]. The overall incidence of violent crime has dropped significantly since the mid 1990s, but the fact remains we have much to consider in assessing human behavior relevant to the building of Hydrogen Highways.

Mass transit. Motorbuses will be among the first vehicles involved in hydrogen fuel cell demonstration projects. In 2002, the most recent year for which data are available, the Federal Transit Administration (FTA) reports there were 45,325 motorbuses on United States roads, and that they collectively generated 18.1 billion passenger miles. That same year, FTA reports there were 19,892 motorbus accidents resulting in more than \$25,662,251 in damage [4]. Some 78 persons died and another 11,995 were injured in those accidents.

Automobiles. Today's automobiles are designed to anticipate reckless and careless use. Front and side airbags, crush zones and steel cages around passengers, protected fuel tanks, improved tires, suspension systems and weight distribution that prevent roll-overs are all features that may be as appropriate for hydrogen fuel-cell powered autos as they are today. But we have yet to understand how the shift from fossil to hydrogen fuels changes the probability and severity of fire and explosions, contributes to flame spread and affects emergency responses and rescues.

In the United States, significantly more people die each year in auto fires [5] – presumably trapped in their vehicles – than die in all upholstered furniture and mattress fires ignited by smoking materials and open flames in the home [6]. In sharp contrast to the autos built when the two federal auto fire safety standards were adopted, today's motor vehicles present much different fire risks, *e.g.*, substantially more combustible materials in passenger compartments, and higher voltage batteries to power more motors and appliances, and perform more functions. The two federal motor vehicle safety standards that address fire risks were adopted in the 1970s [7] and as the auto fire loss data reveal, are of questionable effectiveness. For example, the standard for the fire performance of auto interiors measures horizontal flame spread in spite of the fact that fire spreads much faster vertically. The rate of flame spread takes on greater relevance when one considers the fact that in nearly half of all post-collision auto fires resulting in a death, emergency responders arrive at the scene considerably after the collisions occur, [8] and often beyond the point where most rescues are possible.

Emergency response. Firefighters responded to an estimated 286,000 fires in highway vehicles in 2003, not counting 30,500 fires related to arson [9]. The cost has become so overwhelming that some departments now charge insurance companies for responses. Although emergency responders have decades of experience with gasoline fires, incidents involving autos have produced a series of unwelcome surprises – such as the collision-absorbing bumper pistons that can explode and propel shrapnel during engine fires – placing firefighters and others at risk. Most firefighters have no training to deal with the high voltage electrical systems in hybrid autos. Proper training and equipment will be critical as emergency responders face the challenges of Hydrogen Highways. But, the best means of addressing the cost and safety of emergency responders will be through far fewer incidents.

Hazardous materials transportation. For the foreseeable future, hydrogen and other motor fuels will continue to be delivered to fueling stations by truck. The U.S. Department of Transportation estimates [10] that in 1997 hazardous materials motor carriers transported approximately 1.2 million tons of flammable liquids (about 81 percent of all hazardous materials on roadways) with an average distance traveled of 73 miles per shipment. That same year, carriers of all hazardous materials were involved in 11,932 highway incidents, a number that increased to 13,615 by 2003, [11] producing eight deaths and 103 injuries. During the Collaborative Phase, shipments of hydrogen will increase, as will the probability that tankers with gasoline, diesel and hydrogen will come into close proximity on highways and at filling stations.

Filling stations. Industry sources report that 195,455 U.S. retailers sold gasoline in 2000 [12]. These retailers may also sell diesel, compressed gases, lubricants, automotive paints and other flammable materials. Fueling stations exist on interstate highways, country roads and crime-ridden neighborhoods – situated for convenience to motorists and, therefore, on well-traveled roads. Station employees may be well-trained mechanics or relatively low-wage employees. At fueling stations, autos collide with filling pumps, consumers and gas station employees make dangerous mistakes, and violent crimes are committed. During the Collaborative Phase, hydrogen will be sold in real-world conditions and much will be learned.

Maintenance and repair. During the first years of the Collaborative Phase, we assume that automakers will perform all maintenance on hydrogen fuel cell-powered autos. But, as the Commercialization Phase approaches, maintenance will fall to the professionals, amateurs and the frauds servicing today's autos. The Bureau of Labor Statistics reports that in 2002, about 818,000 persons held jobs as trained automotive service technicians and mechanics [13] and, as the transition evolves, servicing hydrogen-powered autos must become part of their training. Today and in the future, unskilled and fraudulent repairs will remain a significant concern. Towing a hydrogen fuel cell-powered auto may require special precautions.

Automotive parking and enclosed spaces. Hydrogen Highways will connect people with their destinations – homes, workplaces, schools, stores, churches, train stations, airports and recreational facilities. Most reported auto fires are not the result of collisions and may even occur when an auto is not in use [14]. Well into the Commercialization Phase, fire safety officials must consider the fire performance of autos powered by gasoline, diesel and compressed gases including hydrogen, because in any given parking lot or garage, the full range of autos are likely to be parked side by side.

Fixed facilities. The U.S. Department of Energy predicts, “By 2020, fuel cells will be intimately integrated in buildings, part of a flexible portfolio of options for meeting energy needs and/or supporting the grid [15].” The fact is that hydrogen fuel cells are available now for use in public and private space. Fuel cell use in buildings may or may not be regulated by existing fire codes and law -- which were not written with widespread use of hydrogen in mind – and fuel cells have received little attention as a consumer product.

HELP'S GOALS

Moving forward, HELP will seek to achieve two long-term goals supported by numerous objectives. The goals are as follows. HELP is now in the process of defining short-term objectives, which will be revealed publicly at the HY-SAFE conference in September.

Goal I: Hydrogen Highways safely built and operated, with zero hydrogen fuel cell incidents requiring emergency response. HELP should be equipped to assist in the planning and permitting of all proposed Hydrogen Highways.

Goal II. A significant overall improvement in passenger survivability of automobile fires, as defined first by mitigating the greatest risks and then by fatality and injury data, so that the fire risks present in today's autos are not carried forward as we enter the Commercialization Phase. Metrics reflecting incremental progress to be defined by HELP will be released by December 2005.

These goals will be managed by HELP, which consists of experts from the auto, energy and insurance industries, government regulators and emergency responders. Chief Frederick Postel of the West Sacramento, CA, Fire Department and a Director of ICFSHE chairs HELP, which is supported by two advisory committees -- one consisting of engineers and scientists and the other consisting of emergency responders.

HELP and its advisory committees will define and oversee publicly and privately funded projects, including facilitation of Hydrogen Highways, relying on these strategies:

- Developing an objective understanding of the hydrogen, fuel cell, and other technologies receiving the most serious attention, and the infrastructure that may be required to support these technologies.
- Establishing and maintaining the free flow of information among HELP participants and other stakeholders, and facilitating objective discussions of the safety implications of the transition.
- Identifying and working to resolve the most significant public safety concerns for consideration by Governments and those engaged in the development of the new energy technologies, including detailed descriptions of real-world incident response scenarios related to the new energy technologies.
- Developing and maintaining information that will facilitate the development of emergency responder safety guidelines, training materials, guidance to emergency services training facilities, safety performance test methods, and other emergency response resources associated with the transition to new energy technologies.
- Developing and maintaining information that facilitates public education about the safety of hydrogen-based and other alternative fuels.

The first projects should be selected in the fourth quarter of 2005, and quarterly reports will be issued thereafter.

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