

Legal, Health, and Environmental Aspects of IPRO 304

Rita Buresh

September 23, 2004

The safety of the fuel cell powered people transporter, or motor scooter, is of significant concern to the safety and legality of this IPRO. The initial plan was to drive the motor scooter 100 miles on roadways between Chicago and Milwaukee. However the laws that pertain to this motor scooter and hydrogen transport limit the ability for the motor scooter to travel on public roadways. A brief summary of the health and environmental concerns of fuel cell powered vehicles is also contained in this report.

Legal Aspects

Several laws are of concern when considering hydrogen transport and the operation of motor scooters like the one utilized in this IPRO. Since the planned route involved traveling a long distance through Northern Illinois, motor scooter operation on public roadways was considered. Under Illinois statute 625 ILCS 5/11-1403.5 of the Motor Vehicle Code, it is not legal to operate motor scooters on roadways or sidewalks without proper approval by local jurisdictions. Because original route plans involved riding through multiple municipalities in Illinois the approval process is potentially costly, time consuming, and beyond the focus of this project. As a result, it was decided that with approval from the project sponsors, the 100-mile distance would be limited to an on-campus route or one of multiple loops around a parking lot.

Under 49 CFR (100-800), the federal Hazardous Materials Regulation code followed by the DOT and Hazmat, hydrogen is considered a flammable compressed gas (class 2.1). All cylinders must be ANSI approved compressed gas cylinders and must be labeled with the proper chemical name, "Flammable Gas," "Portable Tank," and the international identification number, UN1049. Cylinders must be transported on a suitable-frame vehicle, with a flat floor or platform. The cylinders must be securely attached to the frame to prevent any movement, including any contact with other cylinders. Cylinders cannot be stacked and must be stored vertical, unless designated as a horizontal-mount cylinder. Special codes exist for the transport of cryogenic, liquid hydrogen.

State codes require that all transporters of hydrogen and hazardous materials must obtain a state permit and refer to the 49 CFR codes. Chicago fire codes follow the Nation Fire Protection Agency codes 50A and 50B. However, neither of those codes applies to hydrogen systems involving cylinders with volumes less than 4CM (11CF). While all of these codes apply to the transport of hydrogen on roadways, the motor scooter is not a road-safe vehicle. The interpretation of these codes in reference to the people transporter is undefined. All codes should be followed to the best of their interpretation for the safety of the project.

There are no existing codes of laws for the use of fuel cell powered vehicles or the use of hydrogen as a commodity fuel. A task force largely consisting of ASME and ANSI members is developing an international set of codes for the use of hydrogen as a fuel and for fuel cell powered vehicles.

Safety and Health Risks of Hydrogen Fuel

Despite claims that hydrogen is a hazardous and unsafe for vehicle use, it is no more dangerous than gasoline or methane. The flammability limits of hydrogen, 4.1-74.0%, are much larger than gasoline, 1.4-7.6%, and methane, 5.3-15%, but hydrogen dissipates quickly in open spaces due to its low density, reducing risks for reactions and ignitions. A hydrogen fire emits one-tenth the heat of a gasoline fire, and the explosive power of hydrogen is 22 times weaker than the explosive power of gasoline.

Hydrogen is highly flammable and can react violently with oxidizers, such as oxygen, in constrained volumes. The major health hazard of hydrogen is thermal burns from fires. Hydrogen is non-toxic but may cause asphyxiation in enclosed environments. Hydrogen flames are clear or light blue, which often are not visible to the eye. If a fire does start, the only way to extinguish it is to cut off the supply. The major health hazard of hydrogen is thermal burns from fires.

Environmental Factors

Hydrogen fuel cells are highly appealing to environmentalists because they produce little carbon emissions, no sulfur emissions, and little or no nitrous oxide emissions. Conventional gasoline combustion engines in vehicles produce 130 gm of carbon emissions per mile, while fuel cell powered vehicles produce 49-57 gm of carbon emissions per mile. This is a substantial decrease in the carbon emissions and supports the appeal of fuel cell powered vehicles. Also, 1 kg of hydrogen contains the same amount of energy as 2.1 kg of natural gas and 2.8 kg of gasoline. Hydrogen fuel cells utilize this energy with 60% efficiency, compared to gasoline combustion engines that are 18-20% efficient.

Production of hydrogen has increased by 23 percent between 1994 and 1999. Current hydrogen consumption is almost entirely by industry, i.e. oil refining, petrochemical production, electronics, rocket fuel, and food processing, but NASA currently uses hydrogen as an energy carrier. Current production of hydrogen is through fossil fuels; long-term production will be largely derived from renewable resources, i.e. water and solar energy, to meet a growing demand to reduce or eliminate fossil fuel consumption. Alternative hydrogen production processes rely on natural gas or ethanol, a renewable resource.

Besides having significant environmental benefits, there are economic benefits of fuel cell vehicles. The current cost of hydrogen fuel is 6.1 cents per mile while a gasoline costs 8.3 cents/mile. Optimistic projections with the increase in the hydrogen infrastructure lower the cost to 4 cents per mile. This hydrogen cost is estimated without a highway or environmental tax that currently exists on gasoline. Regardless of cost, the use of hydrogen as a fuel provides several benefits. With the proper regulations and codes, it can be as safe if not safer than gasoline, natural gas, or propane.

References

Fuel Cell Handbook, Department of Energy

National Hydrogen Association, www.hydrogenus.com

Hydrogen and the Law, presentation