



Hydrogen Workshop for Fleet Operators



Module 3, “Vehicle Operations and Maintenance Facilities”



Vehicle Operations and Maintenance Facilities Outline

1. Hydrogen Facility Site Selection
2. Hydrogen Facility Requirements
 - Garage space
 - Safety systems
 - Specialty equipment/service bays
 - Spatial implications
 - Maintenance implications
 - Facility cost implications
3. Hydrogen Facility Codes and Standards
 - NFPA
 - USDOT/FTA



The California Fuel Cell Partnership's Headquarters is a 55,000 square-foot, state-of-the-art facility that formally opened on November 1, 2000



Hydrogen Facility Site Selection

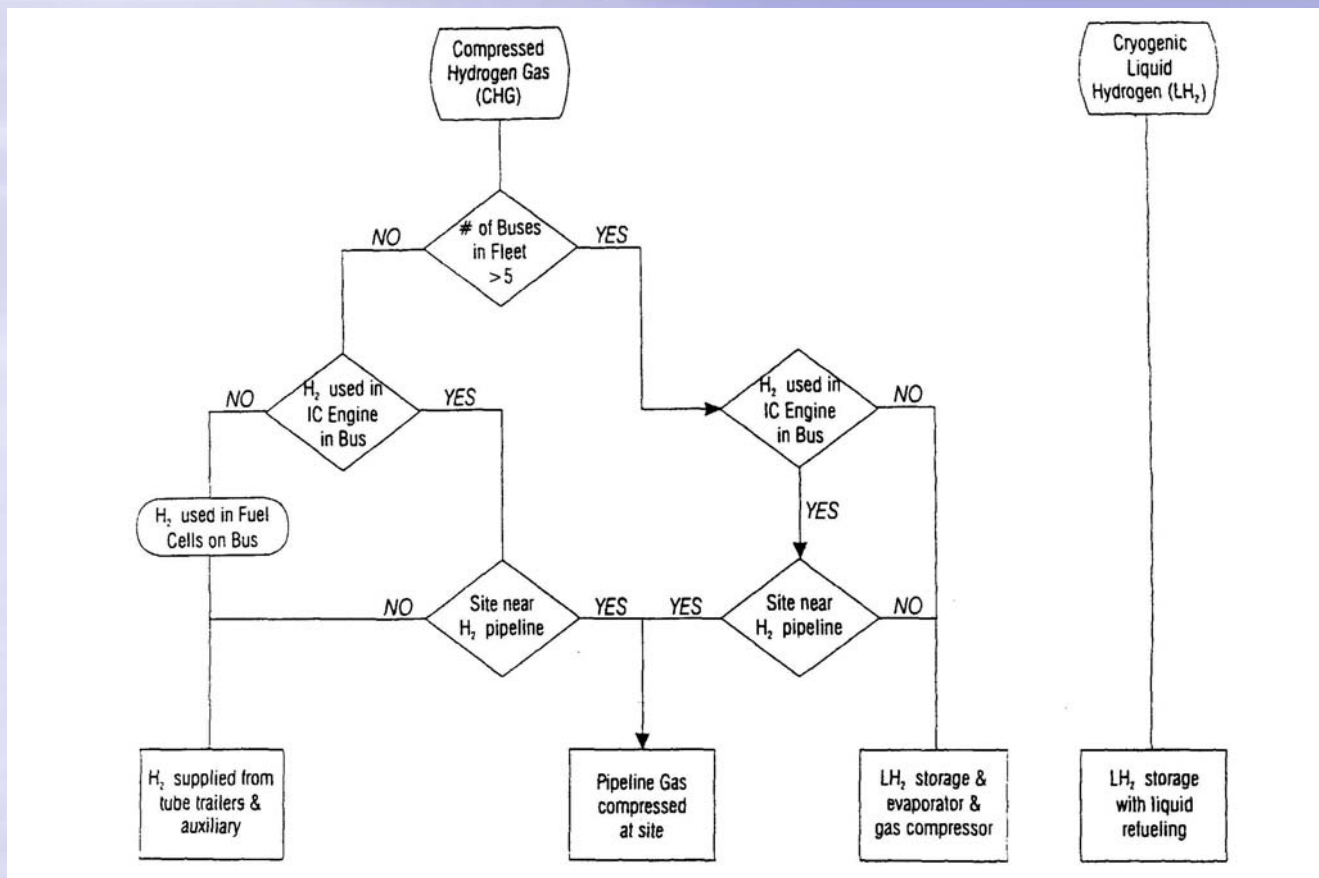
- ▶ Include a review of:
 - Zoning requirements
 - Method of transport of hydrogen to the site
 - Method of transferring hydrogen to storage vessels
- ▶ Hazardous storage and transport requirements apply
- ▶ Sufficient room for the truck to unload (does not apply to on-site production)
- ▶ Buildings must be positioned to meet required separation distances



DOE-funded facility for hydrogen-fueled vehicles and fuel cell buses located at Xerox Corporation in El Segundo, CA



Hydrogen Facility Flow Chart



US Department of Transportation, "Clean Air Program" Design Guidelines for Bus Transit Systems Using Hydrogen as an Alternative Fuel, April 1999



Hydrogen Facility Requirements

▶ Garage space

- 6 air changes per hour
- Hydrogen leak detection system
- Fire detection and suppression system
- Designated parking and storage areas
- Ignition free space heating equipment
- Electrical classification for hazardous locations
- Removal of all electrical panels where hydrogen will be present
- Physical separation between specialty bays (welding, grinding, body, tire, brakes) from PM inspection and bays
- Emergency disconnect to shutdown all unessential electrical equipment in case of unsafe levels of hydrogen are detected

One of Iceland's buses receives its weekly maintenance check-up



Natural Resources Canada, "Transforming the Future: Moving Toward Fuel Cell-Powered Fleets in Canadian Urban Transit Systems", February 2005



Hydrogen Facility Requirements

► Safety systems

- Ceilings should be sloped or contain cavities that direct hydrogen to logical venting points or have adequate ventilation
- Hydrogen discharge fan at each discharge point
- Lights should be suspended far enough not to be immersed in hydrogen in the event of a leak
- Fire suppression sprinklers using water are appropriate for gaseous and liquid hydrogen



SunLine service building. The structural frame is covered with cloth. A vent runs along the length of the roof making it impossible for any escaping hydrogen to be trapped. Local codes recognizes this building as essentially an “outside area”

Natural Resources Canada, “Transforming the Future: Moving Toward Fuel Cell-Powered Fleets in Canadian Urban Transit Systems”, February 2005



Hydrogen Facility Requirements

- ▶ Specialty equipment
 - Service pits can be used since hydrogen is lighter than air
- ▶ Specialty service bay
 - Clean room is necessary for fuel cell-equipped vehicles to ensure that the fuel cells are not contaminated
 - Clean work bench is necessary for fuel cell-equipped vehicles for repairs



Natural Resources Canada, "Transforming the Future: Moving Toward Fuel Cell-Powered Fleets in Canadian Urban Transit Systems", February 2005



Hydrogen Facility Requirements

- ▶ Spatial implications
 - Some hydrogen tanks are located above ground
 - New International Fire Code allows for liquid hydrogen in an insulated, underground tank or for hydrogen generation, compression and storage equipment on top of refueling station overhead canopies
- ▶ Maintenance implications
 - Skills upgrading to test and repair hydrogen sensors and fire suppression systems (training cost of one day per person)
 - Replacement cost of hydrogen sensors of \$7,500 to \$11,500 per building per year
 - Maintenance of fueling structure should be contracted to a gas company. If not possible, maintenance personnel will have to be high-pressure gas certified (training cost of 10 days per person)

Natural Resources Canada, "Transforming the Future: Moving Toward Fuel Cell-Powered Fleets in Canadian Urban Transit Systems", February 2005



Hydrogen Facility Requirements

▶ Facility cost implications

- Older buildings will have to be upgraded
- Current CNG buildings will need minimal modifications
 - ▶ Replace methane detection systems with hydrogen detection
 - ▶ Upgrade air handling equipment where necessary

*CNG transit bus
fueling facility for the
NYCTA's West Farms
Bus Depot*



- Build a new hydrogen facility on-site
 - ▶ \$90-\$100/ft² for maintenance areas
 - ▶ \$200/ft² for maintenance areas for finished areas
- Maintenance cost estimated to increase \$0.20/ft²/year for hydrogen safety equipment

Natural Resources Canada, "Transforming the Future: Moving Toward Fuel Cell-Powered Fleets in Canadian Urban Transit Systems", February 2005



Hydrogen Facility Codes and Standards

- ▶ NFPA 30A – Code for Motor Fuel Dispensing Facilities and Repair Garages
- ▶ NFPA 50A – Standard for Gaseous Hydrogen Systems at Consumer Sites
- ▶ NFPA 50B – Standard for Liquefied Hydrogen Systems at Consumer Sites
- ▶ NFPA 52 – Compressed Natural Gas Vehicular Fuel System Code
- ▶ NFPA 54 – National Fuel Gas Code
- ▶ NFPA 57 – Liquefied Natural Gas Vehicular Fuel System Code
- ▶ NFPA 70 – National Electrical Code
- ▶ NFPA 88A – Standard for Parking Structures
- ▶ NFPA 88B – Standard for Repair Garages
- ▶ NFPA 497A – Recommended Practice for Classification of Class 1 Hazardous Location for Electrical Installations in Chemical Process Areas
- ▶ ICC International Fire Code
- ▶ ICC International Fuel Gas Code



Hydrogen Facility Codes and Standards

- ▶ USDOT/FTA Compressed Natural Gas Safety in Transit Operations
- ▶ USDOT/FTA Liquefied Natural Gas Safety in Transit Operations
- ▶ USDOT/FTA Dispersion of CNG Following a High-Pressure Release
- ▶ USDOT/FTA Design Guidelines for Bus Transit Systems Using Compressed Natural Gas as an Alternative Fuel
- ▶ USDOT/FTA Design Guidelines for Bus Transit Systems Using Liquefied Natural Gas as an Alternative Fuel
- ▶ USDOT/FTA Use of Hydrogen to Power the Advanced Technology Transit Bus (ATTB): An Assessment
- ▶ USDOT/FTA Cylinder Issues Associated with Alternative Fuels
- ▶ United States Department of Labor Occupational Safety and Health Administration (OSHA) Standards



Hydrogen Facility Codes and Standards

- For more information, visit: www.FuelCellStandards.com



FUEL CELL/HYDROGEN INFRASTRUCTURE CODES & STANDARDS

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4.4 Hydrogen Dispensing & Service Stations

	SAE J2600 Compressed Hydrogen Vehicle Fueling Connection Devices	SAE Standard Draft in Progress
	SAE J2601 Compressed Hydrogen Vehicle Fueling Communication Devices	SAE Standard Draft in Progress
	CSA America HGV 4 Fuel Dispensing for Hydrogen Gas Powered Vehicles	US National Standard published-under revision to include hydrogen
	National Institute of Standards and Technology (NIST) Weights and Measures Division Hydrogen Gas Meter Code	US Federal Standard draft in progress
	NFPA 52 Vehicle Fuel Systems Code	NFPA 2005 Standard revised for hydrogen
	ISO TC 197 Working Group #5 Gaseous Hydrogen Blends & Hydrogen Fuels Service Stations and Filling Connections	International Standard Draft in Progress
	ISO TC 197 Working Group #11 Gaseous Hydrogen-Service Stations	International Standard
	EIHP Work Package 2 Refueling station	
	EIHP Work Package 3 Refueling Interface	

4.5 Hydrogen in Vehicles

	EIHP Work Package 4 Vehicles	
	UN Working Party 29 GTR Hydrogen Vehicles	



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