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STATION FOOTPRINT
Separation Distances, Storage Options and Pre- cooling

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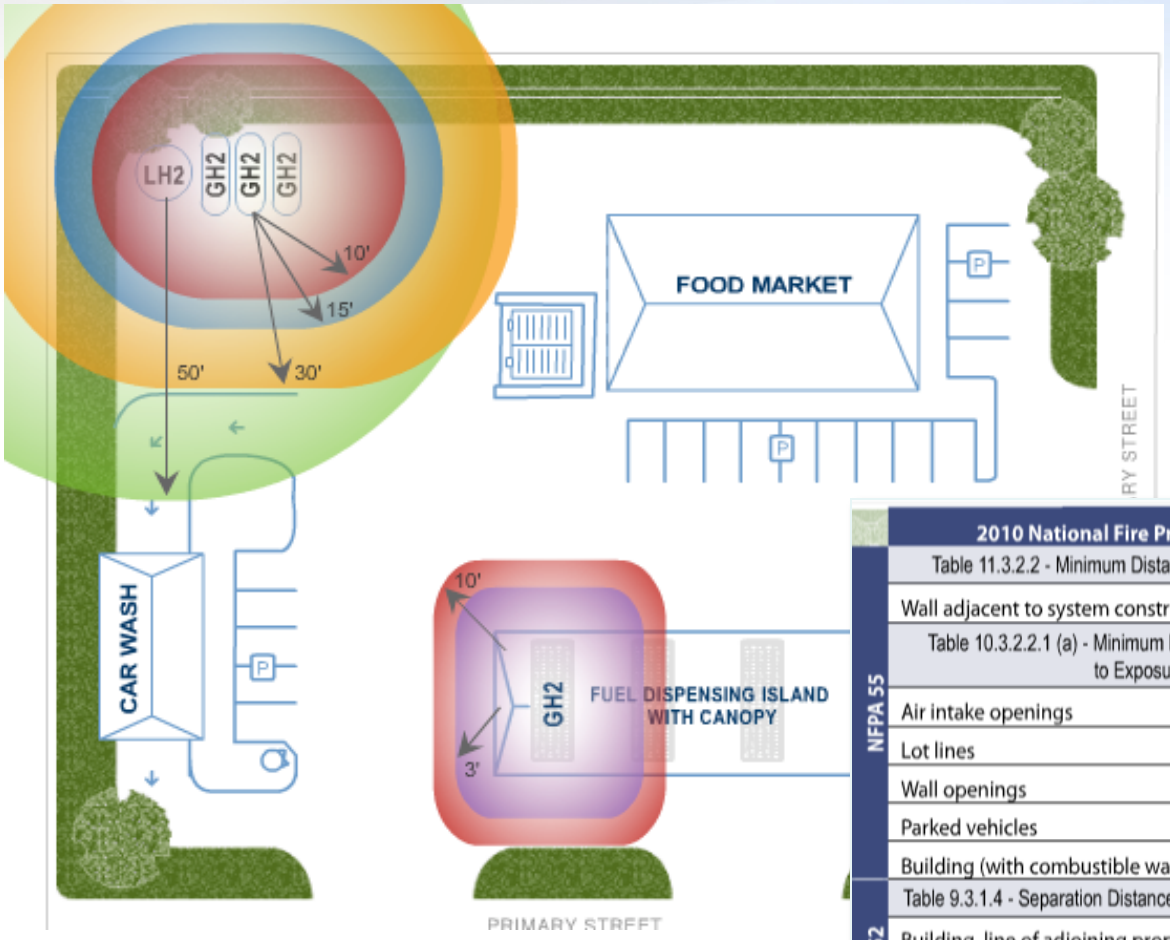
Separation Distances

Why do we have separation distances?

- Hydrogen Release Hazards: Jet Fire or Deflagration/Detonation
  - Jet Fire - Immediate ignition of high pressure release
  - Deflagration/Detonation - Delayed ignition of combustible mixture
- Use distance to mitigate these hazard
  - Control the Sources of Ignition - unclassified electrical, smoking,
  - Prevent combustible mixture – air intakes, building openings, ceiling height/ overhead design
- Distance reduces by ½ with a barrier wall

Separation Distances



- Distances create challenges for existing stations
- Permitting is more than safety – also aesthetics *(think of vertical storage tanks in downtown Santa Barbara or Newport Beach)*

	2010 National Fire Protection Association (NFPA) Setbacks	
NFPA 55	Table 11.3.2.2 - Minimum Distance from Liquefied Hydrogen Systems to Exposures	
	Wall adjacent to system constructed of combustible materials*	50 feet
	Table 10.3.2.2.1 (a) - Minimum Distance from Outdoor Gaseous Hydrogen Systems to Exposures	
	Air intake openings	30 feet
	Lot lines	30 feet
	Wall openings	30 feet
	Parked vehicles	15 feet
	Building (with combustible walls)	10 feet
NFPA 52	Table 9.3.1.4 - Separation Distances for Outdoor Gaseous Hydrogen Dispensing Systems	
	Building, line of adjoining property that can be built on, any source of ignition+	10 feet
	Nearest public street or public sidewalk+	10 feet
	Storage containers+	3 feet

Setbacks are applicable to a 7,000 psi hydrogen system
*1,500 liter liquid hydrogen storage tank
+Only pertains to dispensing equipment

Source: "Introduction to Hydrogen for Code Officials"
http://www.hydrogen.energy.gov/training/code_official_training/

Storage Choices

	Gas (50-500 kg/day)	Gas (>500 kg/day)	Liquid (100-500 kg/day)	Liquid (>500 kg/day)
Aboveground				
Mobile	X			
Modular	X			
Installed	X	X	X	X
Below Ground				
Onsite		X	X	X
Cavern		X		

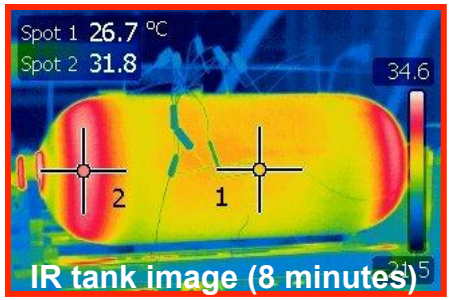
Project Engineer Concerns:

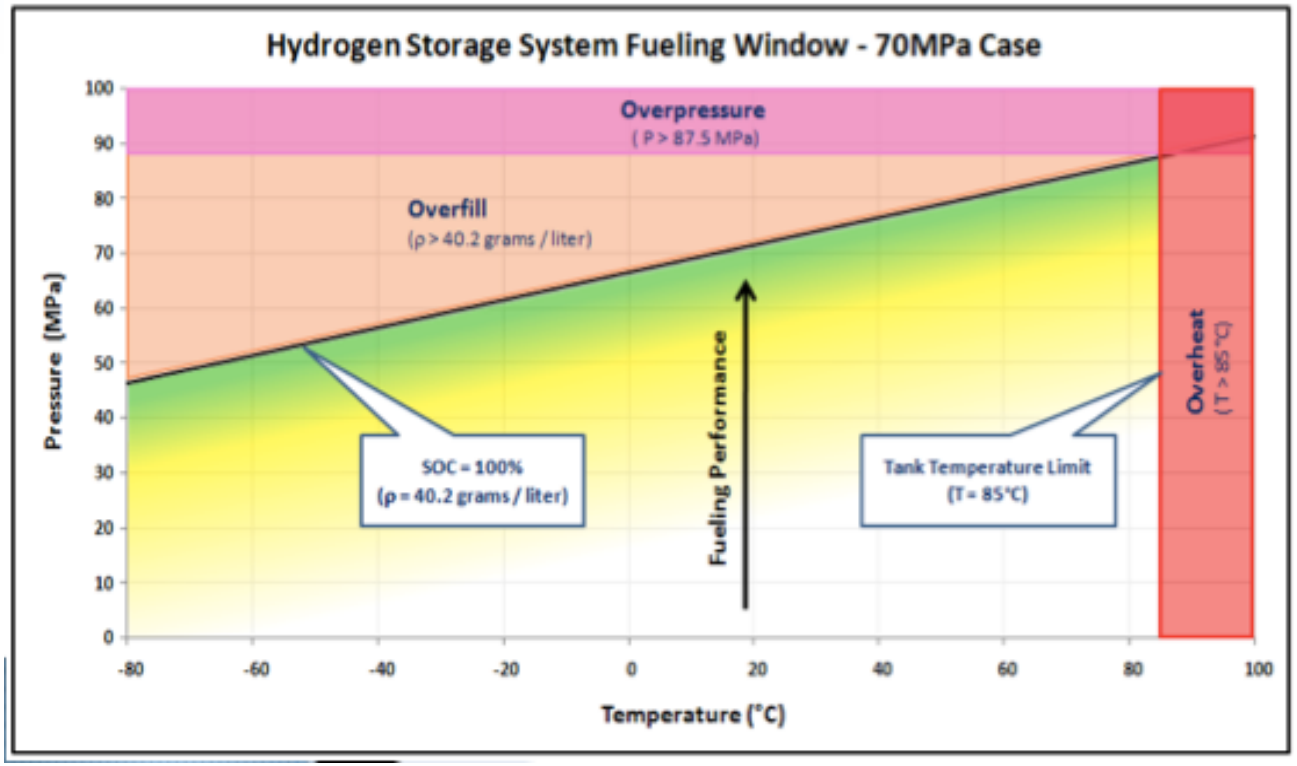
- How much gas will the station actually need to provide?
- How long will this project last?
- >10 Year Life - Can I re-use the storage for something else? Re-certification?

Pre-Cooling

What is pre-cooling?

Suppress the effects of compression heating by cooling the process fluid upstream of the dispenser





Why Pre-cooling?

The fueling target is optimization of density and time with the boundary conditions of overheat, overpressure and overdensity (overfill)

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Pre-Cooling Specifications

	H70 Type B (-20C)	H70 Type A (-40C)
Pre-Cooling Power (30C Ambient)	18kW (24 hp)	45kW (60 hp)
Estimated Costs* (Cooling Equip. and HX)	~$20-40K	~$40-80K

Other Requirements:

- Flow rates up to 1.67kg/min (target 3min fill)
- Pressures up to 87.5MPa
- Must remain below -33C during fueling
- Hydrogen compatible
- Operate in range of ambient conditions

*Limited published information on capital, reliability or operating costs estimated costs based on published commercial HVAC system costs and a theoretical high pressure heat exchangers made from 316L stainless steel.

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Back up Slides

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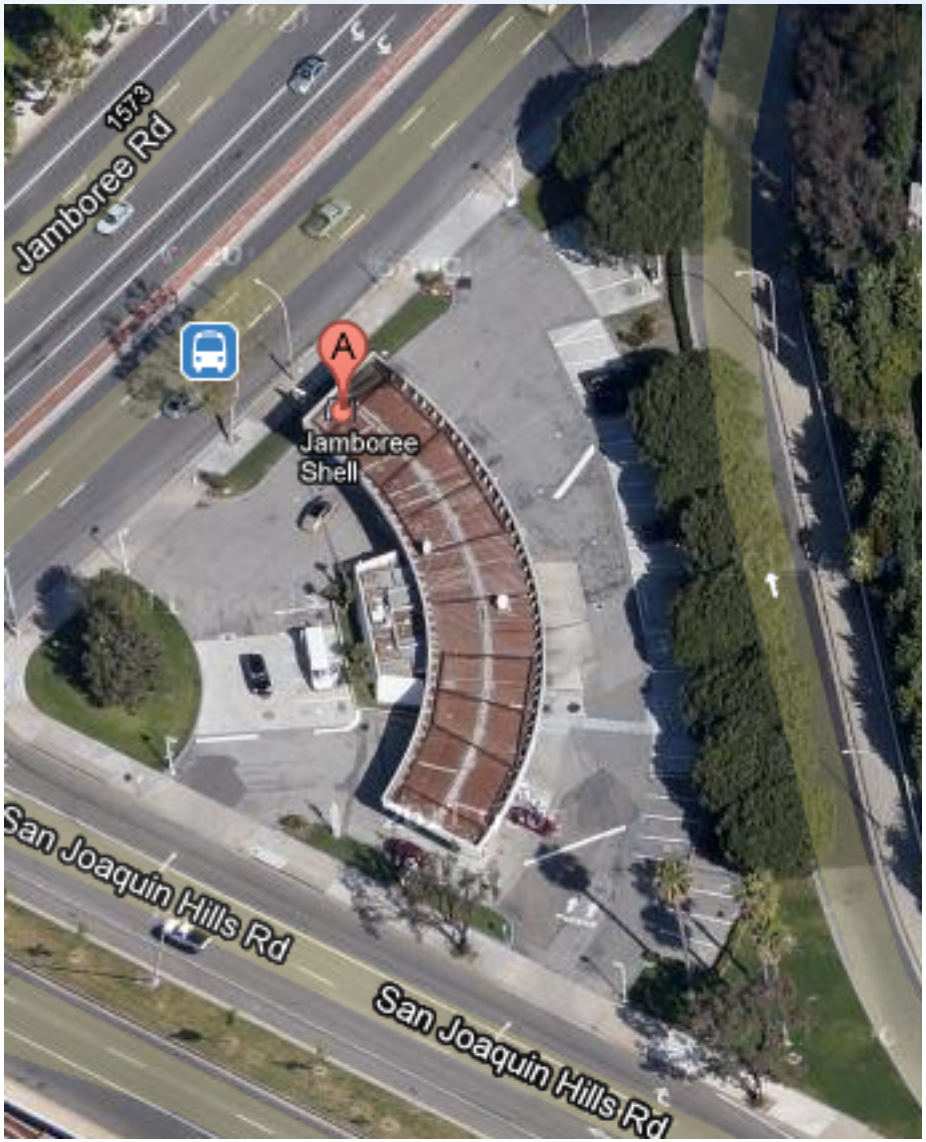
Storage Assessment

Source: http://www.ika.rwth-aachen.de/r2h/index.php/Underground_Hydrogen_Storage_in_Refuelling_Stations

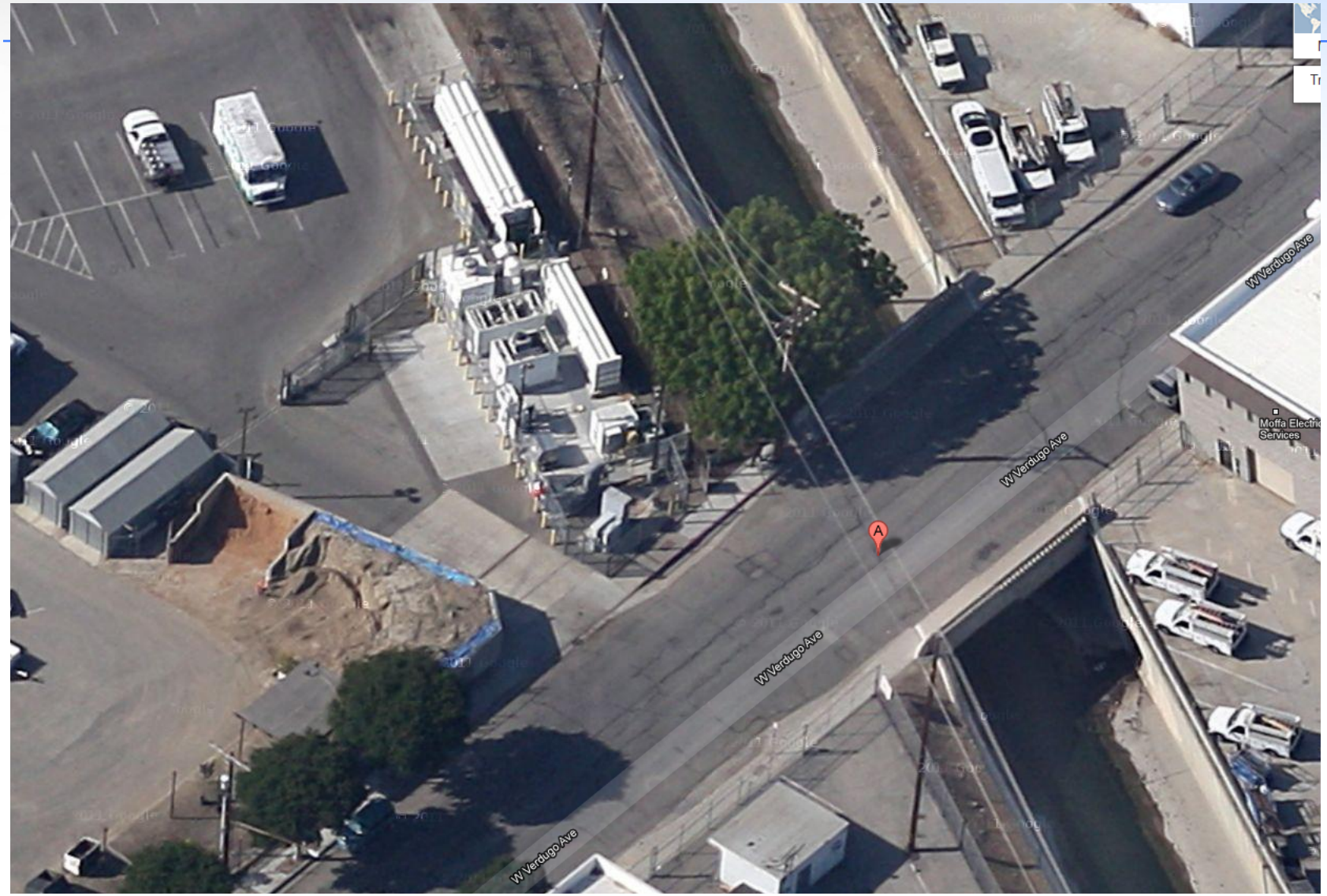
Vessel type	Use	Approximate H'2 'capacity (tonnes)	Approximate water capacity (m^3)	Boil-off rates % per day	State of development of the application
Small transportable	Vehicle fuel tank	0.006-0.008	0.1-0.15	up to 3-5	Prototype
	Transportable refuelling units	0.8	12		Prototype
	Road Trucking	3.5	50	0.3-0.5	Established
Large transportable	Railway transport	7-8.5	100-120	0.2-03	Established
	Barge transport	7-21	100-300	0.2-0.3	Concept
	Ship transport	2800-3500	40000-50000	<0.2	Concept
Small medium stationary	Vehicle refuelling stations	0.7-2.1	10-30	0.5-1[20]	Prototype
	Deposit at customer site	1.1 - 5.3	10-75	0.2-0.3	Established
Large stationary	Deposit at merchant LH_2 plants	35-115	500-1600	0.2-0.3	Established
	Deposit at special users'site	228	3220	<0.2	Established
	Deposit at large-scale LH_2 plants	3500	50000	<02	Concept

Shell, Newport Beach 350 triangle



Fountain Valley 150’ triangle

Burbank 50’ x 150’



Livermore Greenville Rd (I-580)
NOT A HYDROGEN STATION shown for discussion