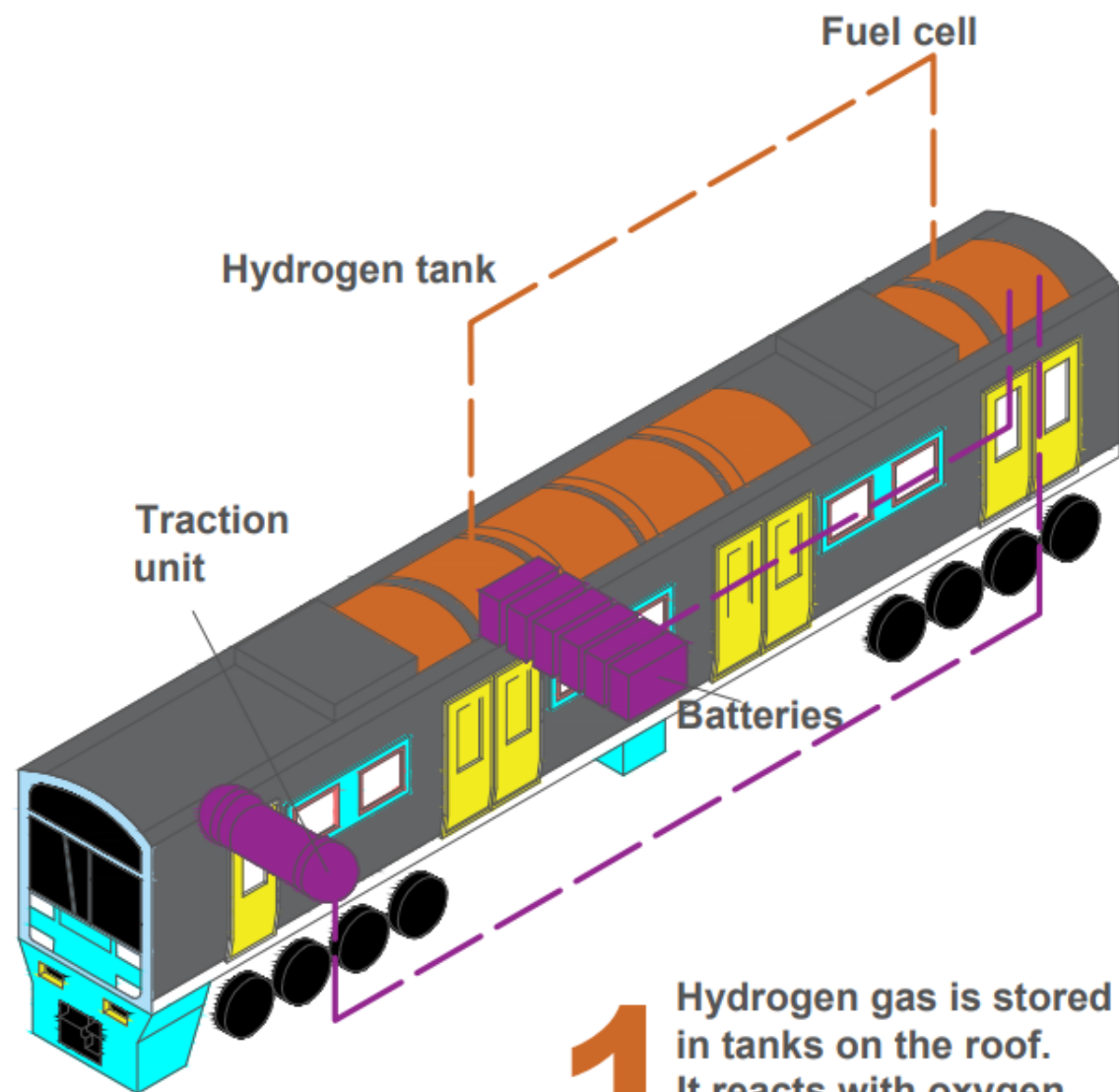




1 Hydrogen gas is stored in tanks on the roof. It reacts with oxygen in fuel cells and generates electrical energy

2 Electricity from the fuel cell powers the wheels via traction unit during acceleration and stored in lithium-ion batteries

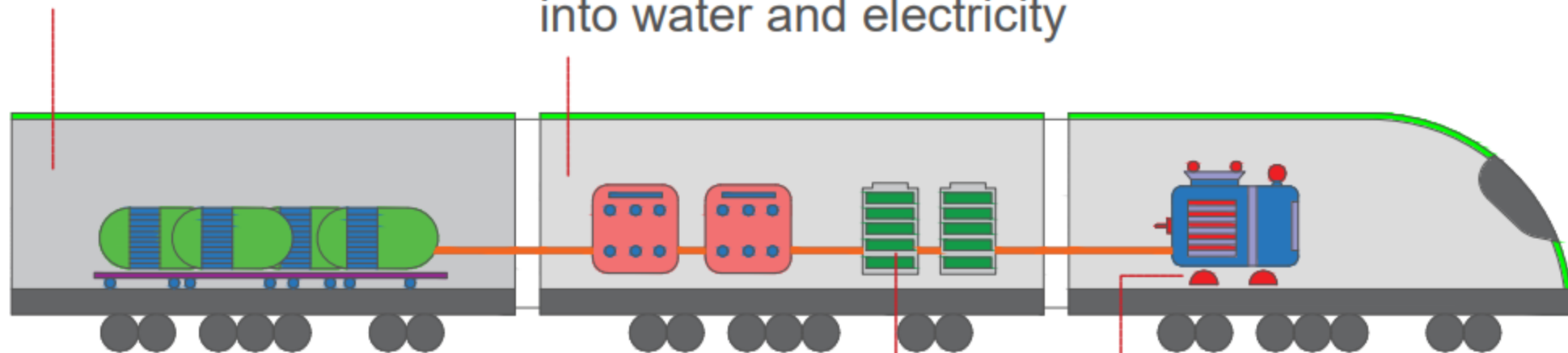
3 It has the same performance as a traditional diesel train but its only exhaust is water and steam

1

Hydrogen is stored
in **four fuel tanks**

2

The **fuel cell** converts
hydrogen and oxygen
into water and electricity

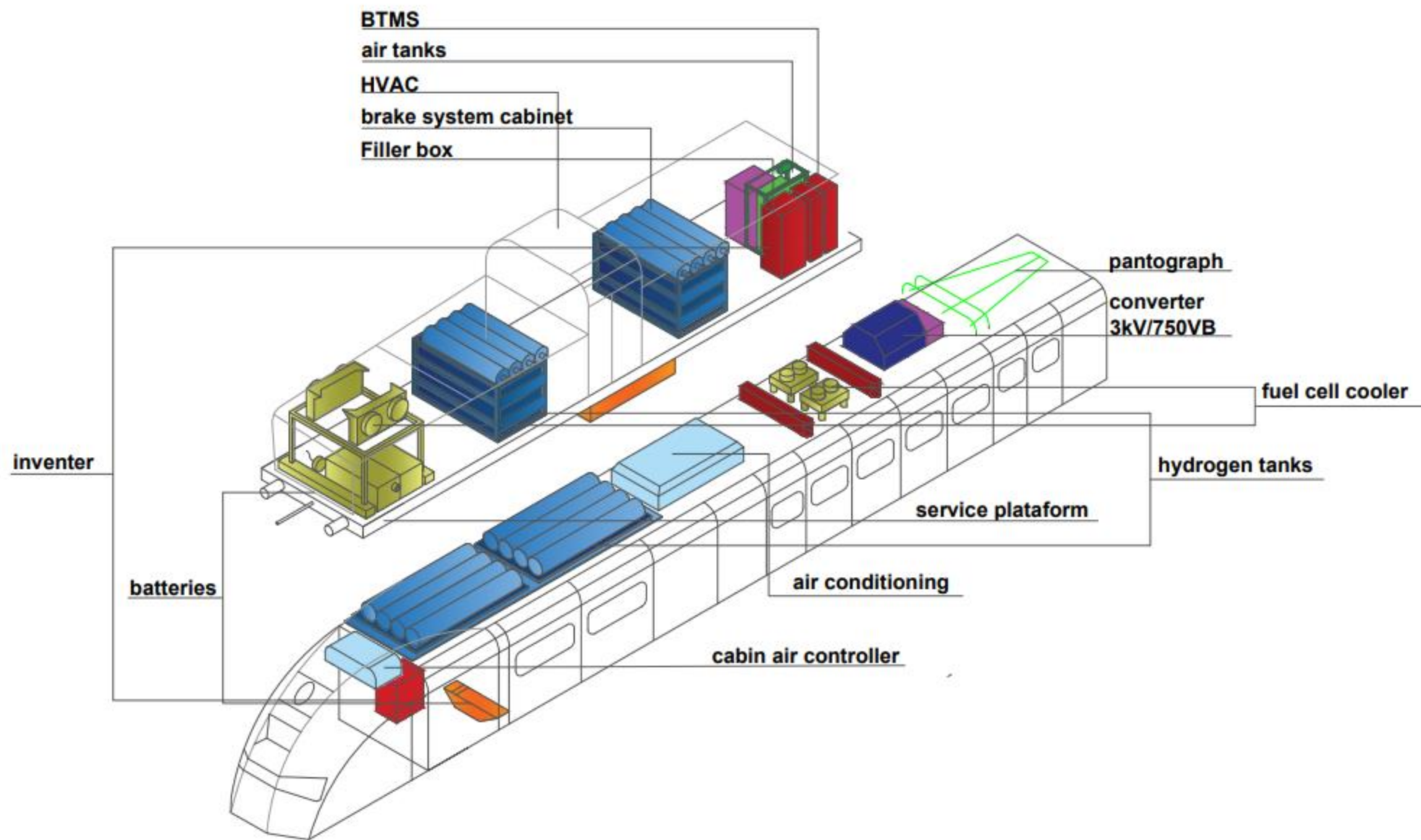


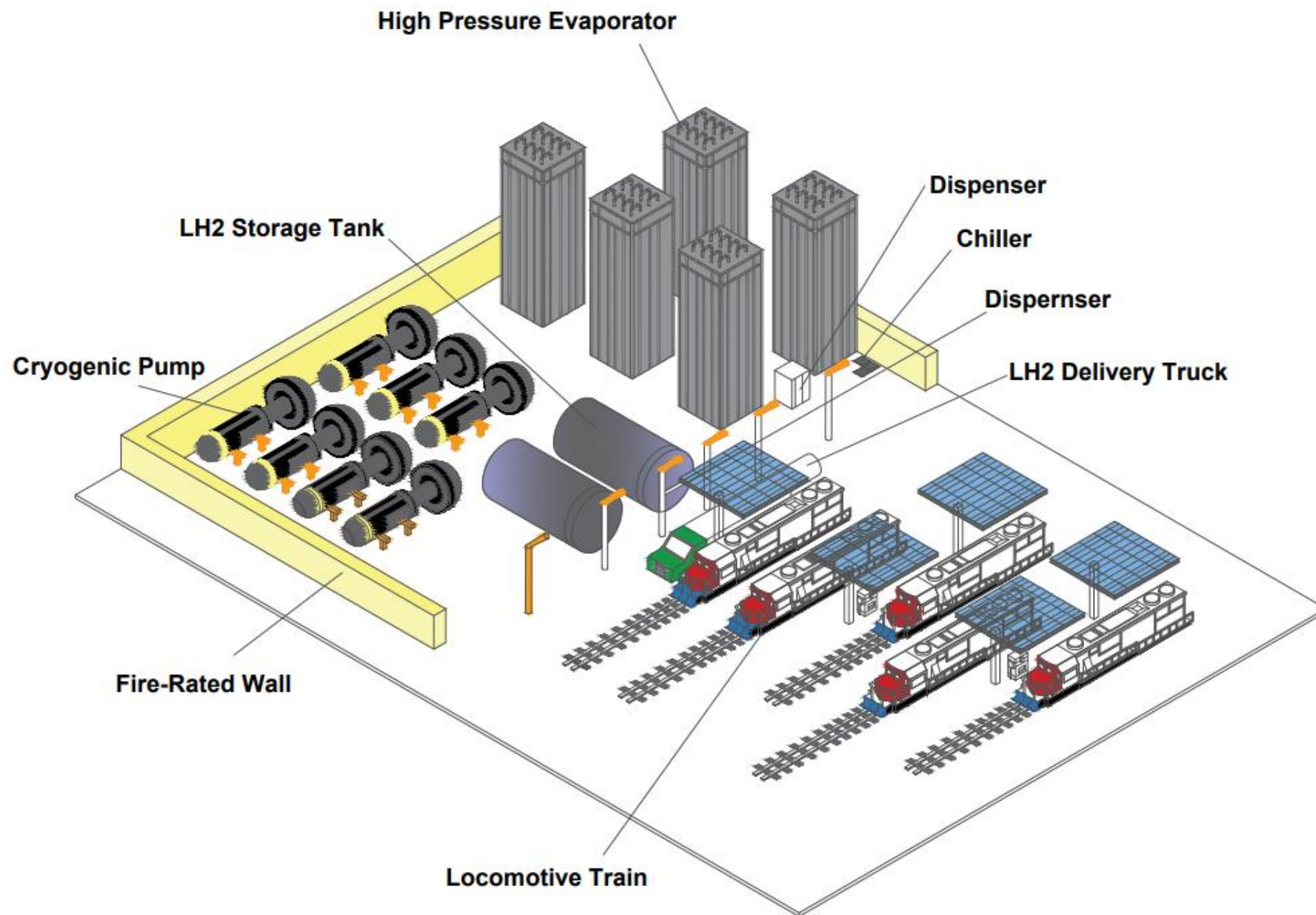
3

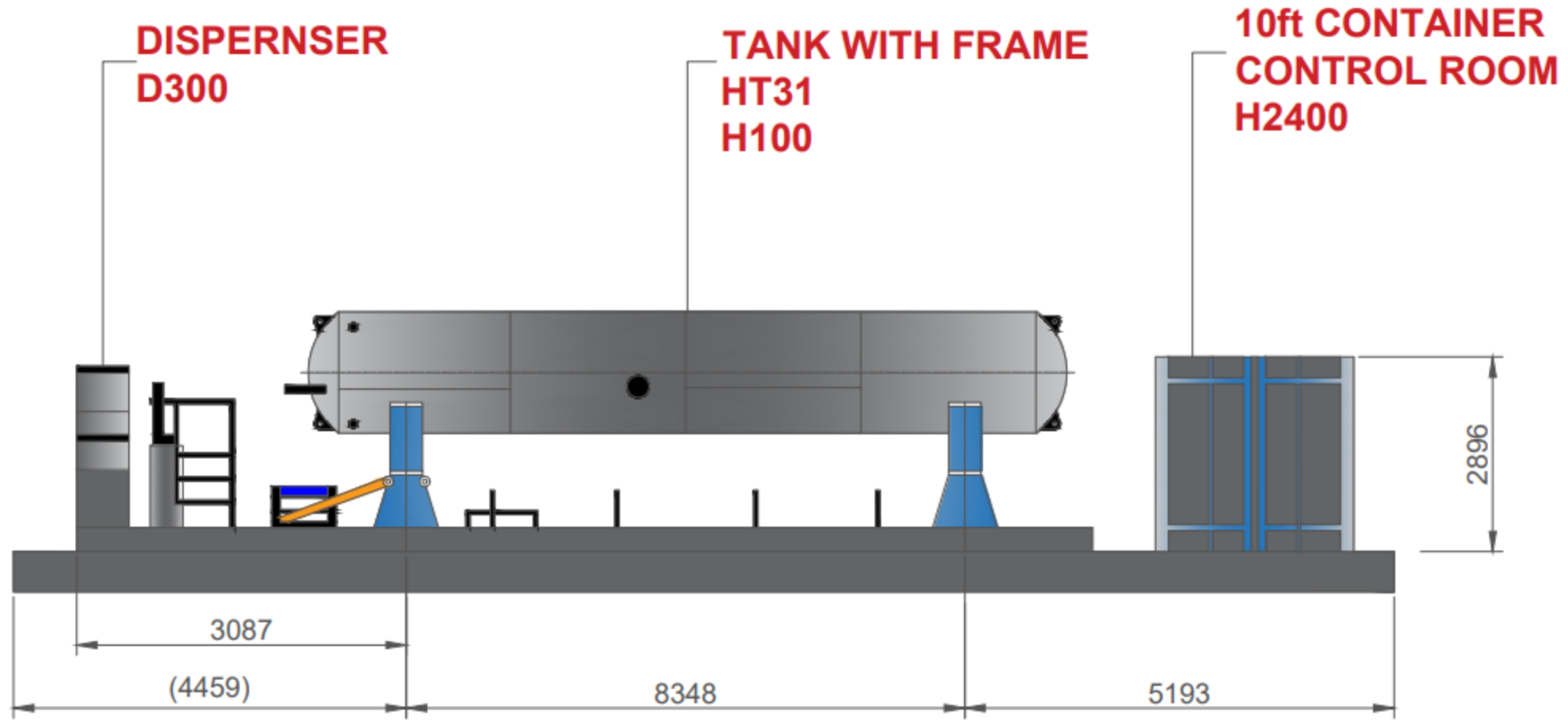
Energy can be stored
in **two lithium batteries**

4

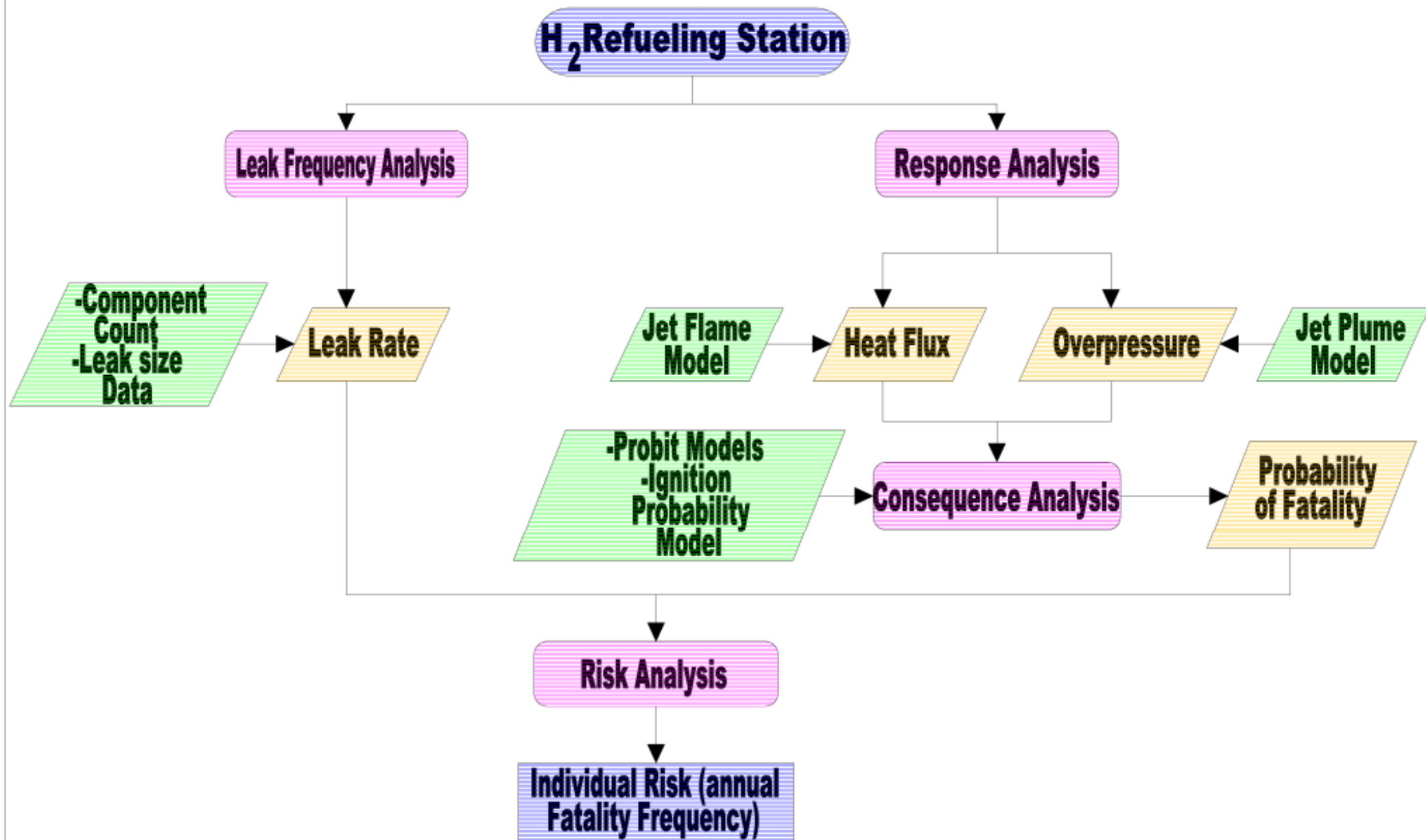
Electric motors
move the train



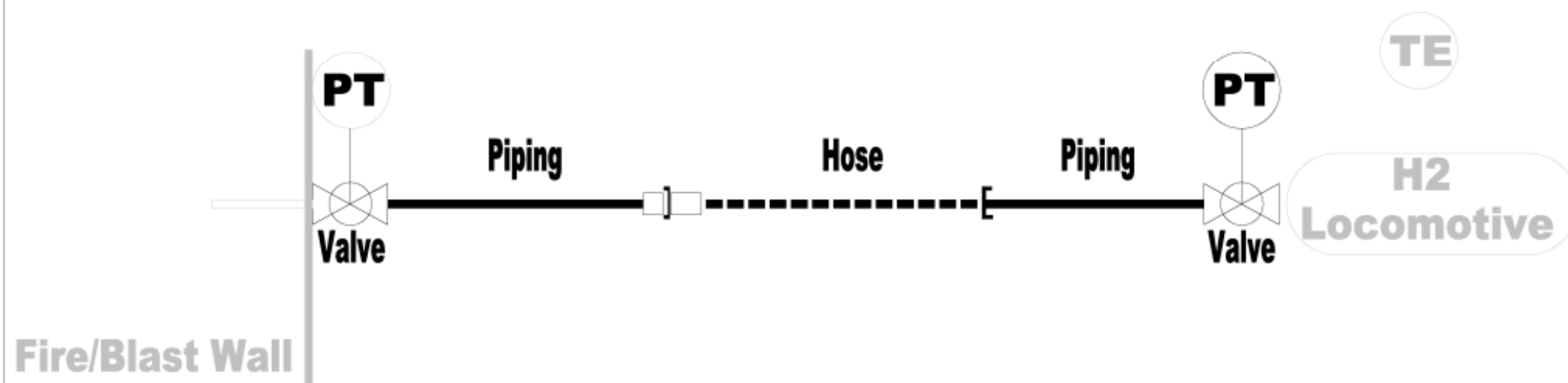




- 8kg/minute flow rate per hose
- Skid mounted station provide up to 1300kg liquid hydrogen storage
- Weights and Measures Dispenser accuracy exceeds 1,5%



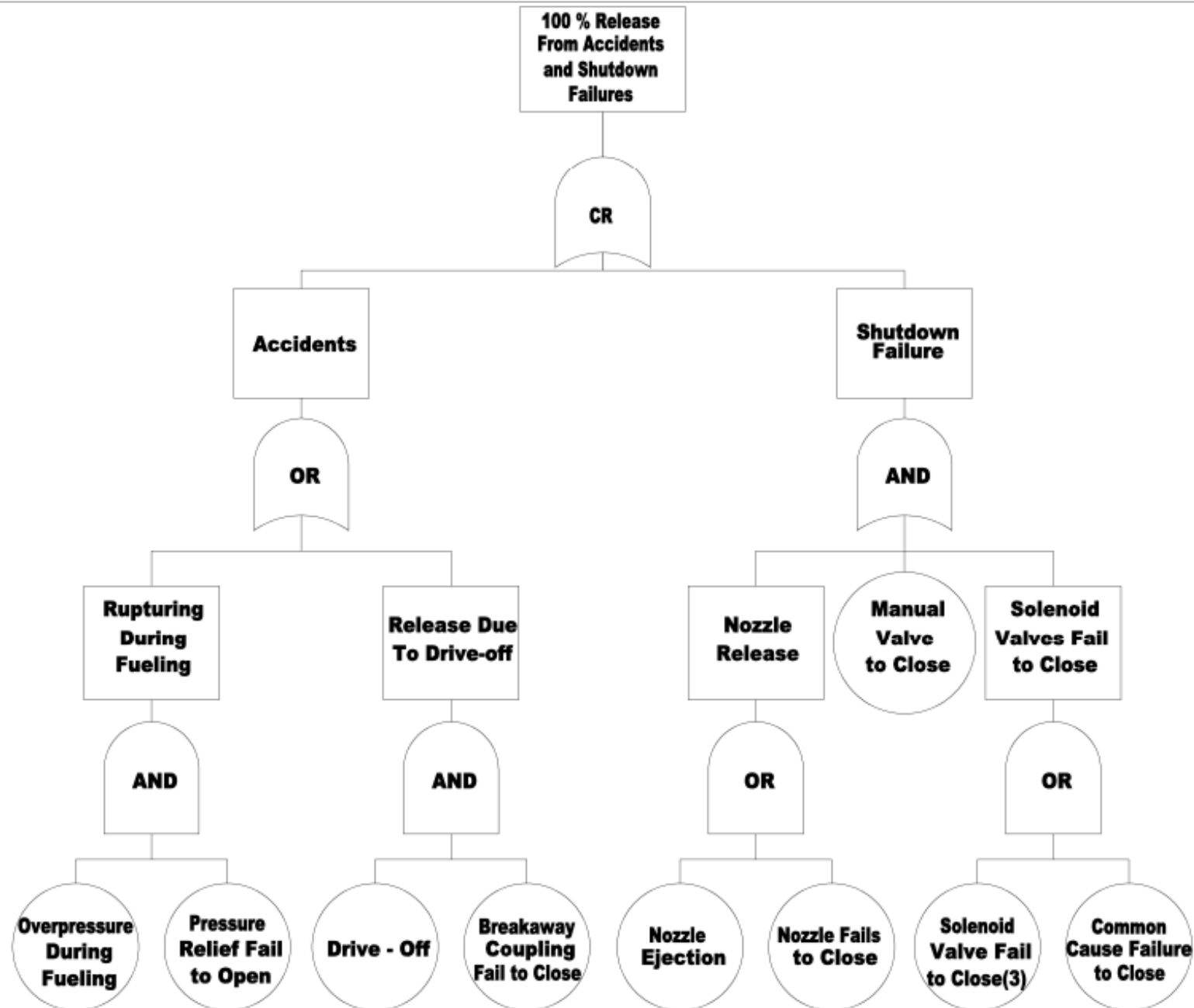
Flow Chart of Risk Calculation



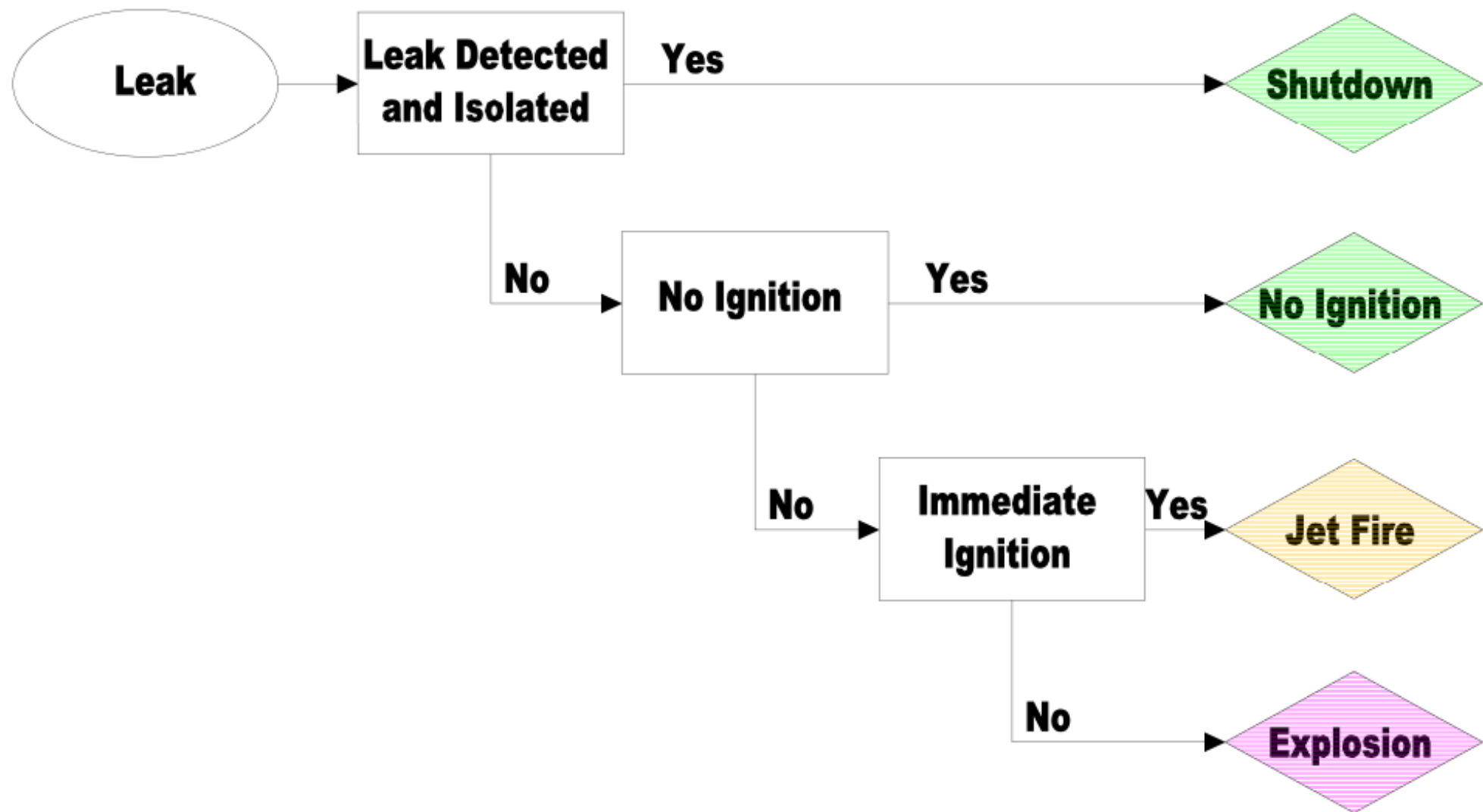
Refueling Station P&ID

Refueling Station Component Count

Component	Count
Valve	2
Piping (m)	10
Hose	1
Instrument	2
Joint	8
Refueling Nozzle	1



Fault Tree for Full-Bore Leaks refueling, Labeled with Probability of Each Potential Failure Event per Refueling



Event Consequence Diagram for a Component Leak

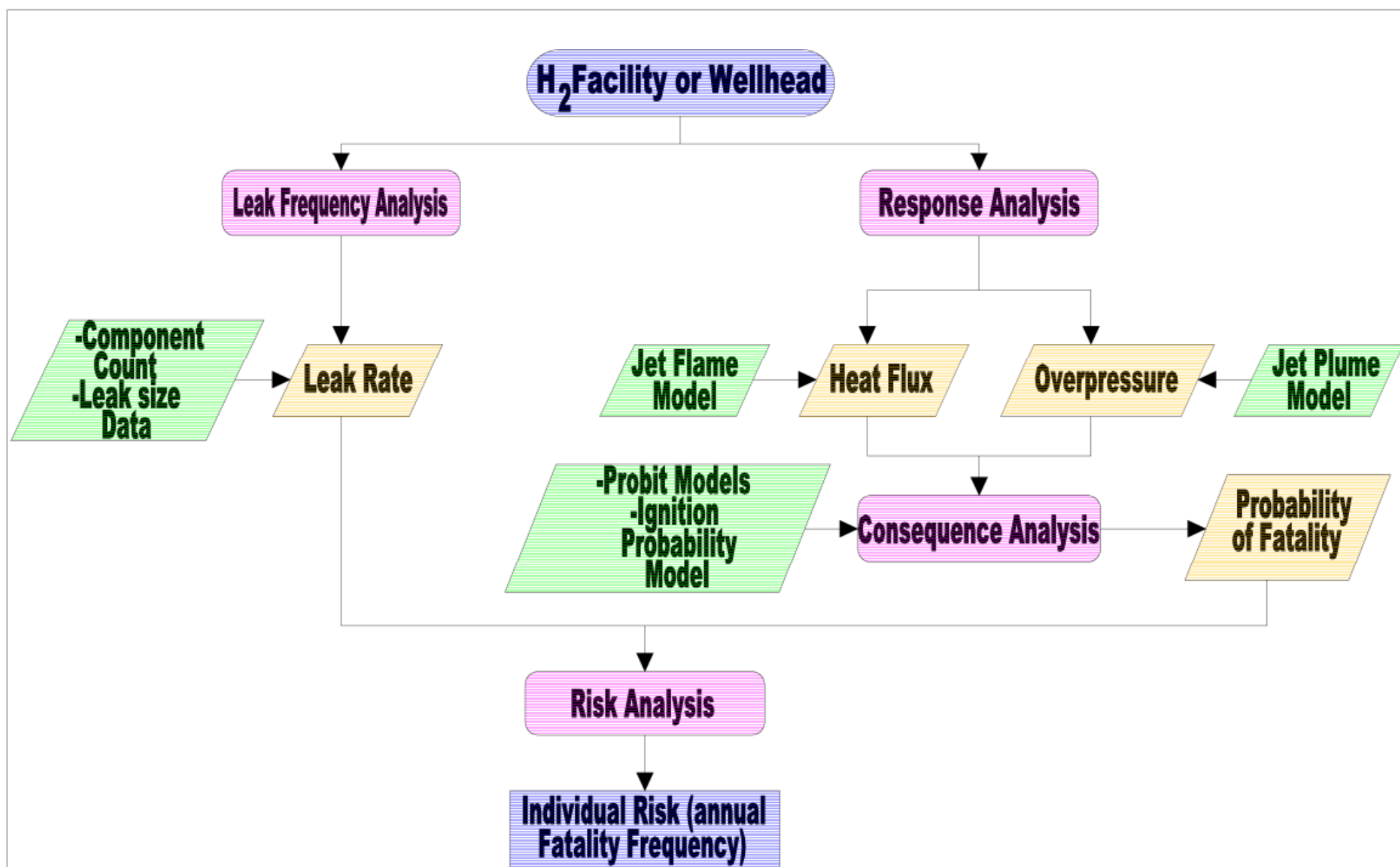
Summary of Codes and Standards with Capacity Thresholds

Document Number	Version	Document Name	Fuel	Phase	Capacity Thresholds
ANSI/IAIAA G-095A - 2017	2017	Guide to Safety Hydrogen and Hydrogen Systems	Hydrogen	Unspecified	Maximum of 150 kg for transportation in cargo aircraft.
29 CFR 1910.103	2007	Hydrogen	Hydrogen	Unspecified	None found.
29 CFR 1910.119	2023	Process safety management; highly hazardous chemicals	Hydrogen	Gaseous	Hazard analysis and mishap investigation and reporting required for aggregate capacities over 10,000 lbs.
40 CFR 68	2024	Chemical Accident Prevention Provisions	Hydrogen	Unspecified	Aggregate capacity maximum of 10,000 lbs.
CGA H-3	2013	Cryogenic Hydrogen Storage	Hydrogen	Liquid	Per-tank maximum of 25,000 gal.
CGA H-5	2014	Bulk Hydrogen Supply Systems	Hydrogen	Gaseous	Minimum of 5000 scf.
NFPA 2	2023	Hydrogen Technologies Code	Hydrogen	Gaseous	MAQ of 1000 scf for unsprinklered indoor control areas with no gas cabinet, gas room, or exhausted enclosure.
					MAQ of 2000 scf for unsprinklered indoor control areas with gas cabinet, gas room, or exhausted enclosure, and for sprinklered areas with no gas cabinet, gas room, or exhausted enclosure.
					MAQ of 4000 scf for unsprinklered indoor control areas with gas, gas room, or exhausted enclosure.
					MAQ of 5 gal for unsprinklered indoor control areas with no gas room, or exhausted enclosure.
NFPA 30	2024	Flammable and Combustible Liquids Code	Ignitable Liquids	Liquid	MAQ of 45 gal for unsprinklered indoor control areas with gas cabinet, gas room, or exhausted enclosure, and for sprinklered areas.
					MAQ of 45 gal for unsprinklered indoor control areas with gas cabinet, gas room, or exhausted enclosure, and for sprinklered areas.
					Maximum of 75,000 gal of aggregate capacity.
					Maximum of 119 gal per individual drum or container, 660 gal per individual portable tank, and 793 gal per intermediate bulk container.
NFPA 30A	2024	Code for Motor Fuel Dispensing Facilities and Repair Garages	Motor fuels	Liquid	Maximum of 30 gal per control area for Class IA liquids.
					Maximum of 120 gal per control area for Class IB and IC liquids, for combined Class IABMC liquids and for Class II liquids.
					Maximum of 330 gal per control area for Class IIIA liquids.
					Maximum of 13,200 gal per control area for Class IIIB liquids.
NFPA 30A	2024	Code for Motor Fuel Dispensing Facilities and Repair Garages	Motor fuels	Liquid	Maximum of 1,100 gal for outdoor storage adjacent to a building.
					Maximum of 100,000 gal for individual Class I, II, or IIIA liquid tanks stored in buildings.
					Maximum of 12,000 gal for individual tanks or 15,000 gal for tanks installed in vaults.
					Maximum of 48,000 gal aggregate capacity.
NFPA 51	2023	Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes	Oxygen	Gaseous	Maximum of 120 gal per indoor tank for each of Class I, II, and IIIA motor fuels, with some exceptions.
					Maximum of 120 gal per indoor tank for each of Class I, II, and IIIA motor fuels, with some exceptions.
					Maximum of 120 gal per indoor tank for each of Class I, II, and IIIA motor fuels, with some exceptions.
					Maximum of 120 gal per indoor tank for each of Class I, II, and IIIA motor fuels, with some exceptions.
NFPA 52	2023	Vehicular Natural Gas Fuel Systems Code	CNG	Gaseous	Maximum of 9 scf per 1000 ft ² for indoor residential fueling.
					Maximum of 750 scf aggregate capacity and 433 scf single storage capacity for residential fueling.
					Maximum of 3000 scf aggregate volume for outdoor vehicle fueling appliances.
					Maximum of 3000 scf aggregate volume for outdoor vehicle fueling appliances.
NFPA 54	2024	National Fuel Gas code	Fuel Gas (Natural Gas, LP-Gas)	Gaseous	None Found.
					None Found.
					None Found.
					None Found.
NFPA 58	2024	Compressed Gases and Cryogenic Fluids Code	Ethylene Oxide	Gaseous	Maximum of 10,000 gal for indoor storage.
					Maximum of 10,000 gal for indoor storage.
					Maximum of 10,000 gal for indoor storage.
					Maximum of 10,000 gal for indoor storage.
NFPA 59A	2023	Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)	LNG	Liquid	Maximum of 30,000 gal for dispensing systems.
					Maximum of 300 gal aggregate capacity for containers supplying fuel to LP-gas-powered vehicle.
					Maximum of 300 gal aggregate capacity for containers supplying fuel to LP-gas-powered vehicle.
					Maximum of 300 gal aggregate capacity for containers supplying fuel to LP-gas-powered vehicle.

QUANTITY LIMITS IN EXISTING CODES AND STANDARDS

Gaseous Fuel Limits

Fuel	Document Number	Aggregate Capacity Limit	Reference Section	Notes	
Hydrogen	NFPA 2	None	Chapter 7 (Gaseous Hydrogen)	This chapter is being removed the next version of the document and hydrogen will be exclusively handled by NFPA 2	
	NFPA 55	None	Chapter 10 (Gas Hydrogen Systems)		
	CGA H5	None	Scope		
Hydrogen	NFPA 51	120 ft ³ for single cylinder of oxygen	Section 1.1.5 (Scope)	Applies to system with over 5000 scf of hydrogen; taken from 2014 version	
		120 ft ³ for single cylinder of oxygen			
CNG	NFPA 52	None	Chapter 9 (Outdoor Storage), Chapter 11 (CNG Fueling)	No for industrial applications; limits are also by appliance rather than aggregate capacity in an entire facility	
		9.0 scf. per residential fueling appliance (indoor)	Chapter 12 (Residential fueling Appliance)		
		750 scf. total in the residential fueling appliance (433 scf per single container)	Section 3.1.14.2 (Vehicle Fueling Appliances Installed Outdoors)		
		300 scf aggregate volume 750 scf single container capacity			
Natural Gas	NFPA 54	None			
Manufactured Gas		None			
Vapor-phase LPG (propane, butane) and LP-Gas-air mixtures		None			
LP - Gas	NFPA 58	30,000 gal (dispensing systems)	Section 5.2.1.9 in chapter 5 (LP-Gas Equipment and Appliances)		
		300 Gal (aggregate water capacity of containers) supplying fuel to LP-gas-powered vehicle)	Section 12.3.2.3 in Chapter 12 (Motor Vehicles Intended for On-Road Use Vehicle Designed to Transport Passengers and Are Fueled by LP-Gas)		
Compressed Gases	NFPA 55	None	Chapter 7 (Compressed Gases)		
		None	Section 13.4 (Insulated Liquid Carbon Dioxide Systems)		
Carbon Dioxide	NFPA 55	10,000 lb (indoors)	Section 14.3 (Storage of Ethylene Oxide)	No capacity limit provided for outdoor storage	
Ethylene Oxide		None	Chapter 15 (Acetylene Cylinder Charging Plants)		
Acetylene		None	Chapter 16 (Liquid Nitrous Oxide Systems)		
Nitrous Oxide		MAQs set by control area	Table 6.3.1.1 (Maximum Allowable Quantity (MAQ) of Hazardous Materials per Control Area)		MAQ by control area does not necessarily mean that is the size limit for the system as a whole
Hydrogen	NFPA 2	75,000 gal	Table 8.3.2.3.1.6 (a) Minimum Distance from Outdoor Bulk Liquefied Hydrogen (LH ₂) Systems to Exposures. Up to 75,000 gal (280,000 L). Typical Inner Diameter (d) 1.5 in. (38.1 mm) in Chapter 8 (Liquid Hydrogen)	Based on size of tanks that can have been built	
	NFPA 55	283,906 L	Table 11.3.2.2 (Minimum Distance from Outdoor Bulk Liquefied Hydrogen Systems to Exposures) in Chapter 11 (Bulk Liquefied Hydrogen Systems)		
		CGA H-3	25,000 GAL PER TANK	Scope	Taken from the 2013 version, no aggregate capacity
	CGA H-5	None	Scope	Applies to supply system with over 39.7 gal of H ₂ taken from the 2014 version	
Ignitable (Flammable or combustible) Liquids in Containers	NFPA 30	119 gal (individual capacity for drums or containers)	Section 9.1 (Storage of Ignitable Liquids in Containers - General Requirements Scope), Section 10.1 (Storage of Ignitable Liquids in Containers-Mercantile Occupancies Scope), Section 11.1 (Storage of Ignitable Liquids in Containers-Industrial Occupancies Scope), Section 12.1 (Storage of Ignitable Liquids in Containers-Storage Occupancies Scope), Section 13.1 (Storage of Ignitable Liquids in Containers-Detached, Unprotected Buildings Scope), section 14.1 (Hazardous Materials Storage Lockers Scope), Section 15.1 (Outdoor Storage Scope)	There are additional requirements provided for tanks that have capacities above the ones listed (Section 21.1, Storage of Ignitable Liquids in Tanks-Requirements for All Storage Tanks Scope) - so these aren't aggregate capacity requirements nor a hard limit on individual tank capacity requirements	
		660 gal (individual capacity for portable tanks)			
		793 gal (intermediate bulk containers)			
		Aggregate quantities of fuels are limited by control area, not by overall facility			
		1100 gal (outdoor storage adjacent to a building)	Section 15.4 (Outdoor Storage Adjacent to a Building)		
		None	Table 22.4.1.1(b) reference Table for Use with Tables 22.4.1.1(a), 22.4.1.3 and 22.4.1.5)		Provides setback distances for tank capacity ranges; the largest range is 3,000,001 gal or more
Class III & Stable Fluids		None	Table 22.4.1.5 (Location of Aboveground Storage Tanks Storings Class IIIb Liquids (F _P ≥200°F(93°C)	Provides setback distances for tank capacity ranges; the largest range is 100,001 gal or more	
Class I, Class II and Class IIIA Liquids		100,000 gal (individual tank limit for tanks limit for tanks stored in storage tank building)	Section 24.4.3		
Cryogenic Fluids	NFPA 55	None	Chapter 8 (Cryogenic Fluids)		
LNG	NFPA 59A	1,056,000 gal water capacity	Section 17.1.1 (Requirements for Stationary Applications for Small Scale LNG	Based on size of tanks that can have been built	



Individual risk assesment methodology flow diagram