

Gap Analysis of Codes and Standards for Hydrogen Refueling Stations

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1 Executive Summary

Table 1 illustrates the gaps identified in various codes and standards, provides recommendations to resolve each gap, and assigns a priority level to indicate the order in which the gaps should be addressed.

Table 1: Gaps in codes and standards with recommendations

Country	Standard/Code	Description	Gap	Recommendation
CAN	CSA B339-18	Cylinders, Spheres, and Tubes for the Transportation of Dangerous Goods	Lacks specifications on filling pressure limits for hydrogen containers in this edition: New edition to be released in 2024	49 California Code of Regulations (CFR) Part 173 Subpart G provides the pressure limits for hydrogen cylinders
CAN	CAN/BNQ-1784-000-22	Canadian Hydrogen Installation Code	Does not provide guidelines for classifying hazardous zones and determining risk-informed separation distances for electrical equipment at stations through detailed quantitative analyses	The code must align with the Canadian Electrical Code Part 1, section 18 that covers installation of electrical equipment in hazardous locations. Additional Industrial hydrogen standards such as NFPA 50A, 497 and API 505 provide electrical area classification distances.
ALB, CAN	NFC(AE)	Alberta Fire Code	The code does not explicitly mention requirements for hydrogen-fueling, creating a regulatory roadblock in addressing specific provincial requirements for establishing HRSS	The California Fire Code addresses this gap with section 5473, which sets out minimum separation requirements for regulating hydrogen systems based on the station's capacity

2 Introduction

Applicable codes and standards for Hydrogen Refueling Station (HRS) are broadly divided into following categories shown in Figure 1.

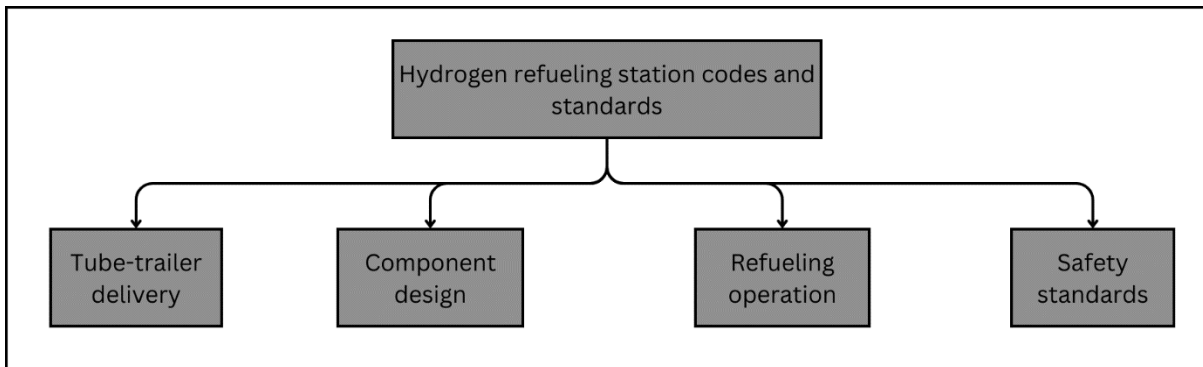


Figure 1: Hydrogen refueling station codes and standards categories

With the emerging hydrogen industry, harmonizing codes and standards applicable for hydrogen end-use applications has gained crucial momentum. This study aims to identify gaps in codes and standards specifically applicable to the design, installation, operation, and maintenance of HRSs.

3 Applicable codes and standards for HRS

Tables 1 to 4 include applicable codes and standards for HRSs. The majority of standards identified in these tables align with the accepted practices in existing HRSs across North America, although a few need to be aligned to hydrogen-specific requirements. Additionally, standards that can be useful for developing potential hydrogen-specific standards and can serve as preliminary guidance are listed in Table 6.

Table 2: Tube-trailer delivery of hydrogen gas - Applicable standards

Country	Standard	Standard description	Gap	Reference
CAN	CSA B339-18	Cylinders, Spheres, and Tubes for the Transportation of Dangerous Goods	Lacks specifications on filling pressure limits for hydrogen containers in this edition: New edition to be released in 2024	[1]
CAN	CSA B340-18	Selection and use of cylinders, spheres, tubes, and other containers for the transportation of dangerous goods, Class 2	Needs to be aligned with the hydrogen specific requirements on update in CSA B339; New edition to be released in 2024	[2]
CAN	CSA B341-18	UN pressure receptacles and multiple-element gas containers for the transport of dangerous goods	No gap exists. This edition provides all requirements for UN pressure receptacles bearing hydrogen gas	[3]
CAN	CSA B342-18	Selection and use of UN pressure receptacles, multiple-element gas containers, and other pressure receptacles for the transport of dangerous goods, Class 2	No gap exists. This edition provides all selection requirements for UN pressure receptacles bearing hydrogen gas	[4]

Table 3: HRS component design - Applicable standards

Country	Standard	Standard description	Gap	Reference
CAN	CAN/BNQ-1784-000-22	Canadian Hydrogen Installation Code	- BNQ standard lacks CSA B51 part 2 tank requirements for ground storage/on-board storage	[5]
CAN	CSA B51-19	Boiler, pressure vessel, and pressure piping code	No gap exists. This edition provides all requirements	[6]

Country	Standard	Standard description	Gap	Reference
			necessary for design and operation	
CAN	CSA/ANSI HGV 4.4-21	Gaseous Hydrogen - Fuelling Stations – Valves	No gap exists. This edition provides all requirements necessary for design and operation	[7]
CAN	CSA/ANSI HGV 4.10-21	Standard for fittings for use in compressed gaseous hydrogen refuelling station	No gap exists. This edition provides all requirements necessary for design and operation	[8]
CAN	CSA/ANSI HGV 4.2-22	Hoses for compressed hydrogen fuel stations, dispensers, and vehicle fuel systems	No gap exists. This edition provides all requirements necessary for design and operation	[9]
US	ASME B31.12-23	Hydrogen Piping and Pipelines	No gap exists. This edition provides all requirements necessary for design and operation	[10]
US	ASME B31.1-22	Power Piping	No gap exists. This edition provides all requirements necessary for design and operation	[11]
US	ASME B31.3-22	Process Piping	No gap exists. This edition provides all requirements necessary for design and operation	[12]
US	CGA S Series -1.1-3-20	Pressure Relief Device Standards	No gap exists. This edition provides all requirements necessary for design and operation	[13]
US	CGA-G-5.5-21	Hydrogen Vent Systems	No gap exists. This edition provides all requirements necessary for design and operation	[14]
US	CGA H-5-14	Standard For Bulk Hydrogen Supply Systems - Second Edition	No gap exists. This edition provides all requirements necessary for design and operation	[15]

Country	Standard	Standard description	Gap	Reference
US	SAE J2600-15	Compressed Hydrogen Surface Vehicle Fueling Connection Devices	No gap exists. This edition provides all requirements necessary for design and operation	[16]
US	UL 2075-23	Standard for Gas and Vapor Detectors and Sensors	No gap exists. This edition provides all requirements necessary for design and operation	[17]

Table 4: Refueling station operations - Applicable standards

Country	Standard	Standard description	Gap	Reference
CAN	CAN/BNQ-1784-000-22	Canadian Hydrogen Installation Code	Does not provide guidelines for classifying hazardous zones and determining risk-informed separation distances for electrical equipment at stations through detailed quantitative analyses	[5]
CAN	CSA/ANSI HGV 4.1-20	Hydrogen-Dispensing Systems	No gap exists. This edition provides all requirements necessary for design and operation	[18]
CAN	CSA/ANSI HGV 4.3-19	Test Methods for Hydrogen Fuelling Parameter Evaluation	No gap exists. This edition provides all requirements necessary for design and operation	[19]
CAN	CSA/ANSI HGV 4.9-20	Hydrogen Fuelling Stations	No gap exists. This edition provides all requirements necessary for design and operation	[20]
INT	ISO 17268-20	Gaseous Hydrogen Land Vehicle Refuelling Connection Devices	No gap exists. This edition provides all requirements necessary for design and operation	[21]

Country	Standard	Standard description	Gap	Reference
US	SAE J2600-15	Compressed Hydrogen Surface Vehicle Fuelling Connection Devices	No gap exists. This edition provides all requirements necessary for design and operation	[16]
US	SAE J2601-20	Fuelling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles	No gap exists. This edition provides all requirements necessary for design and operation	[22]
US	SAE J2601-2-23	Fuelling Protocol for Gaseous Hydrogen Powered Heavy Duty Vehicles	No gap exists. This edition provides all requirements necessary for design and operation	[23]
US	SAE J2601-3-23	Fuelling Protocol for Gaseous Hydrogen Powered Industrial Trucks	No gap exists. This edition provides all requirements necessary for design and operation	[24]
US	SAE J2799-19	Hydrogen Surface Vehicle to Station Communications Hardware and Software	No gap exists. This edition provides all requirements necessary for design and operation	[25]
US	SAE J2719-20	Hydrogen Fuel Quality for Fuel Cell Vehicles	No gap exists. This edition provides all requirements necessary for design and operation	[26]

Table 5: HRS safety standards

Country	Standard	Standard description	Reference
US	NFPA 2	Hydrogen Technologies Code	[27]
US	NFPA 1	Fire Code	[28]
INT	ISO 19880	Gaseous hydrogen - Fuelling stations.	[29]
AB, CAN	Alberta Fire Code	The code does not explicitly mention requirements for hydrogen-fueling station	[30]

4 Potential standards for HRS

A list of standards that can be useful for developing potential hydrogen-specific standards and can serve as preliminary guidance is listed below:

Table 6: List of potential standards for HRS

Country	Applicability	Standard	Standard description	Reference
INT	Hydrogen storage	ISO 11439:2013	Gas Cylinders	[31]
INT	Hydrogen storage	ISO 11114	Gas cylinders	[32]
INT	Hydrogen storage	ISO 9809-1-19	Gas Cylinders - Refillable seamless steel gas - cylinders Design, construction, and testing - Part 1: Quenched and tempered steel cylinders with tensile strength less than 1100 MPa	[33]
INT	Hydrogen storage	ISO 11119-3-20	Gas Cylinders of composite construction	[34]

Country	Applicability	Standard	Standard description	Reference
INT	Hydrogen storage	ISO 11515:2022	Gas Cylinders - Refillable composite reinforced tubes of water capacity between 450 L and 3000 l - Design, construction, and testing	[35]
CHINA	Hydrogen storage/delivery	GB/T 26466	Storage and transportation systems for gaseous hydrogen - Part 1: General requirements	[36]
US	Hydrogen storage/delivery	NFPA 497A	Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas	[37]
US	Hydrogen storage/delivery	OHSA 1910.103	Hydrogen DOT-CFFC-basic requirements for fully wrapped carbon-fiber reinforced aluminum - lined cylinders	[38]
US	Hydrogen storage/delivery	ANSI/AIAA G-095A-2017	Guide To Safety of Hydrogen And Hydrogen Systems	[39]
US	Hydrogen storage/delivery	ANSI/NACE TM0284-2016	Evaluation Of Pipeline and Pressure Vessel Steels for Resistance To Hydrogen-Induced Cracking	[40]
EUROPE	Hydrogen storage/delivery	BS EN 17533	Gaseous hydrogen. Cylinders and tubes for stationary storage	[41]
EUROPE	Hydrogen storage/delivery	BS EN 14025:2018	Tanks for the transport of dangerous goods. Metallic pressure tanks. Design and construction	[42]
EUROPE	Hydrogen storage/delivery	BS EN 12972:2001	Tanks for the transport of dangerous goods. Testing, inspection, and marketing of metallic tanks	[43]
EUROPE	Hydrogen storage/delivery	BS EN 14432:2014	Tanks for the transport of dangerous goods. Tank equipment for the transport of liquid chemicals and liquefied	[44]

Country	Applicability	Standard	Standard description	Reference
			gases. Product discharge and air inlet valves	
EUROPE	Hydrogen storage/delivery	CSN EN 17339	Transportable gas cylinders - Fully wrapped carbon composite cylinders and tubes for hydrogen	[45]

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