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한국형 수소충전소의 UAE 구축을 위한 인허가 절차 검토 및 적용 방안 모색

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Review and Analyses of International Standards and Implications for Implementing Korean Hydrogen Charging Station in UAE

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Abstract >> Recently, a hydrogen charging station-related memorandum of understanding (MOU) was signed between Korea Transport Institute and United Arab Emirates (UAE) Ministry of Transport in Abu Dhabi, creating a foundation for exporting green hydrogen charging stations and hydrogen powered public transit buses developed with Korean technology to Abu Dhabi. Reliable construction and operation of the charging stations require a thorough review on associated standards and legal requirements. In particular, it is essential to analyze currently effective standards related to hydrogen production, hydrogen vehicle charging, and hydrogen charging stations. This paper specifically focuses on comparative analysis of hydrogen-related standards in the UAE and the Republic of Korea. Similar to UAE, Korean hydrogen charging station-related standards follow International Organization for Standardization (ISO) standards. From real-life experiences in developing and operating charging stations, even more essence of ISO standards have been adopted in Korean standards than UAE. In particular, ISO standards related to fire prevention are additionally included in Korea. This paper also suggests procedural and administrative strategies for enabling application of Korean hydrogen charging station-related standards in UAE.

Key words : Hydrogen charging station(수소충전소), Standard(규격), UAE(아랍에미리트), Abu Dhabi(아부다비), ISO(국제규격기구), Hydrogen generation (수소 생산)

1. Introduction

In recent years, hydrogen mobility has become more prevalent as countries have been increasingly interested in lowering their carbon footprints and shifting toward the use of renewable energy sources. Since the early 2000s, when the United Arab Emirates (UAE) government first began studying alternative fuels and began placing an emphasis on hydrogen transportation, the UAE has been particularly active in this industry.

The Abu Dhabi Future Energy Company, known as Masdar[1)] which is a UAE state-owned renewable energy company, made a substantial contribution to the growth of the hydrogen transportation industry in the UAE. The Masdar established the Masdar Institute of Science and Technology in 2007 (later merged into Khalifa University in Abu Dhabi in 2017) with the goal of conducting research on the production and storage of hydrogen as part of Masdar's ongoing commitment to the use of renewable energy and the promotion of sustainable development ever since the company's inception in 2005. In 2008, when the hydrogen fuel cell project was first conceived, Masdar also initiated research and development on a hydrogen fuel cell automobile.

In 2023, Emirates National Oil Company, based in Dubai, and Dubai Electricity and Water Authority (DEWA), also based in Dubai, have joined forces to create and operate a joint integrated pilot project for the utilization of hydrogen in the transportation sector[2)]. The planned project would capitalize on both DEWA's existing green hydrogen production facilities in the Mohammed bin Rashid Al Maktoum Solar Park as well as Enoc's understanding of the fuel industry and customer base in order to be successful.

The UAE made public their aim to invest in hydrogen technology in 2017, concurrently with the launch of the Dubai clean energy strategy 2050[3)]. According to the plan, by the year 2050, 75% of Dubai's energy would come from renewable sources. Furthermore, hydrogen will play a significant part in the city's transportation sector. The DEWA has began testing a system that electrolyzes water using solar energy in order to manufacture hydrogen for the city's rising energy requirements. The goal of the project is to meet the needs of the DEWA. The generation of carbon-free, environmentally friendly hydrogen from renewable energy sources is the end goal of this endeavor.

The year 2017 was a watershed year in the evolution of hydrogen mobility in the UAE, as it was the year that saw the opening of Dubai's first hydrogen fuelling station[4)]. The station was built to support fuel cell electric vehicles, which produce only water vapor as emissions and can go up to 700 km without needing a recharge.

The UAE government, commercial sector, and academic community have all contributed to the progress that has been made in the area of hydrogen transportation. Hydrogen is currently being prioritized as a transportation fuel as part of the national commitment to sustainable development and the reduction of the nation's carbon footprint. The actions taken by the UAE in this sector are projected to have a significant impact, both locally and internationally, on the advancement of hydrogen-powered transportation.

The UAE energy strategy 2050[5)] is a comprehensive road map that was introduced in 2017. It describes the country's intention to secure a sustainable and diverse energy mix for the future. The strategy was launched in 2017. The goal of the plan is to accomplish a number of important goals, including highlights of increasing the share of clean energy in the total energy mix to 50% by the year 2050; a 70th reduction in the carbon footprint caused by the gen-

eration of electricity; a 40% increase in the energy efficiency; and the application of forward-thinking and cutting-edge technology to the field of energy production.

The history of collaboration between Korea and the UAE in the field of hydrogen is relatively brief, but significant progress has been made in recent years. Several partnerships and initiatives have been established between the two nations to promote the use of hydrogen as a pure and sustainable energy source.

In 2019, Korea and the UAE signed a memorandum of understanding (MOU) to cooperate on the development of industries pertaining to hydrogen. In 2020, Abu Dhabi National Oil Company and Korea Gas Corporation inked a MOU to explore opportunities for cooperation in the hydrogen value chain. The partnership seeks to develop hydrogen-related technologies and create an ecosystem for hydrogen in the UAE and Korea.

In 2021, Korea and the UAE signed an agreement to collaborate on the development of renewable hydrogen, further strengthening their collaboration in the hydrogen sector.

In January 2023, the Korea Transport Institute (KOTI) of Republic of Korea and the Integrated Transport Centre of the Ministry of Municipality and Transport of Abu Dhabi recently signed a MOU, which has accelerated their partnership for the adoption of hydrogen charging stations and fuel-cell transit buses from Korea.

As a pioneering research, Kwon et al[6]. in 2021 have suggested strategies of Korea-UAE cooperation for hydrogen station and hydrogen bus, which had positive influences leading to the MOU between KOTI and Abu Dhabi. Then, Kim et al[7]. in 2022 have reviewed the status of hydrogen charging stations in California in terms of operations and policies as a foundational research for the Abu Dhabi hydrogen charging station project.

In order to export and implement Korean hydrogen charging stations for transit buses in Abu Dhabi, it is mandatory to review currently adopted charging station-related standards in UAE in comparison to the Korean standards. This paper reviews international, UAE, and Korean standards related to hydrogen charging stations and identifies similarities and differences. In addition, procedural and administrative strategies for construction of stations in Abu Dhabi are presented.

2. Summary of International Organization for Standardization (ISO) standards

The following Table 1 shows the developments of significant ISO standards related to hydrogen energy and hydrogen charging stations. Spanning from 1999 to 2022, the summary shows that ISO continues to actively develop hydrogen related standards.

Table 2 shows hydrogen related standards in Asia including UAE and Korea and well as Gulf Cooperation Council (GCC) standards from which UAE has been adopting standards often in the past. It is noted that the hydrogen generation is not yet included in the Korean standards. However, since Korea is planning to provide 27.9 million mt/year of clean hydrogen by 2050, it is expected that the official standard regarding the production of hydrogen will follow ISO standards.

3. Summary of all international standards

Fig. 1 shows the summary of all international standards reviewed in this paper.

4. Regulatory sandbox in UAE

UAE Regulations Lab is a regulatory laboratory

Table 1. Chronological summary of ISO standards

	ISO standard	
	Code	Desc.
1999	ISO 13984:1999	Liquid hydrogen land vehicle fuelling protocol
2006	FD ISO/TR 15916:2006	Basic consideration for the safety of hydrogen systems
2007	ISO 16110-1:2007	Hydrogen generators using fuel processing technologies
2008	ISO/TS 20100:2008	Gaseous hydrogen - fuelling stations
2010	ISO 16110-2:2010	Hydrogen generators using fuel processing technologies: testing
2012	ISO 17268:2012	Gaseous hydrogen land vehicle refuelling connection devices
2014	ISO 12619-1:2014	Compressed gaseous hydrogen and hydrogen/natural gas blends fuel system components
2015	ISO/TR 15916:2015	Basic considerations for the safety of hydrogen systems
	ISO 5660-1:2015	Heat release, smoke production and mass loss rate
2016	ISO 24490:2016	Cryogenic vessels - pumps for cryogenic service
2018	ISO 16111:2018	Transportable gas storage devices
	ISO 19882:2018	pressure relief devices
2019	ISO 22734:2019	Hydrogen generators using water electrolysis
	ISO 14687:2019	Hydrogen fuel quality
	ISO 19880-8:2019	Hydrogen Fuelling stations - fuel quality control
2020	ISO 19880-1:2020	Gaseous hydrogen - fuelling stations
	ISO 17268:2020	refuelling connection devices
	ISO 1182:2020	Non-combustibility test
2022	ISO 21009-1:2022	Cryogenic vessels - liquid hydrogen storage

Table 2. Chronological summary of asian standards

	GCC		UAE		Korea	
	Code	Desc.	Code	Desc.	Code	Desc.
2015	GSO ISO/TS 20100:2015	Gaseous Hydrogen -- Fueling Stations				
2020			UAE.S ISO 19880:2020	Gaseous hydrogen	Charging. Station: Construction	KOGAS
			UAE.S ISO 14687:2020	Fuel quality	Charging Station: Maintenance	KOGAS
			UAE.S ISO 22734:2020	Generation with water electrolysis		
			UAE.S ISO 16110:2020	Hydrogen generators		
			UAE.S ISO 19882:2020	Pressure relief devices		
2021	GSO ISO 12619-9:2021	Road vehicle-compressed gas			11-1480000-001755-01	Korea Ministry of Environment: H_2 charging station
2022					FP216 2022, FP21 7 2022	Facility/technical/ inspection code for fuel vehicles refueling

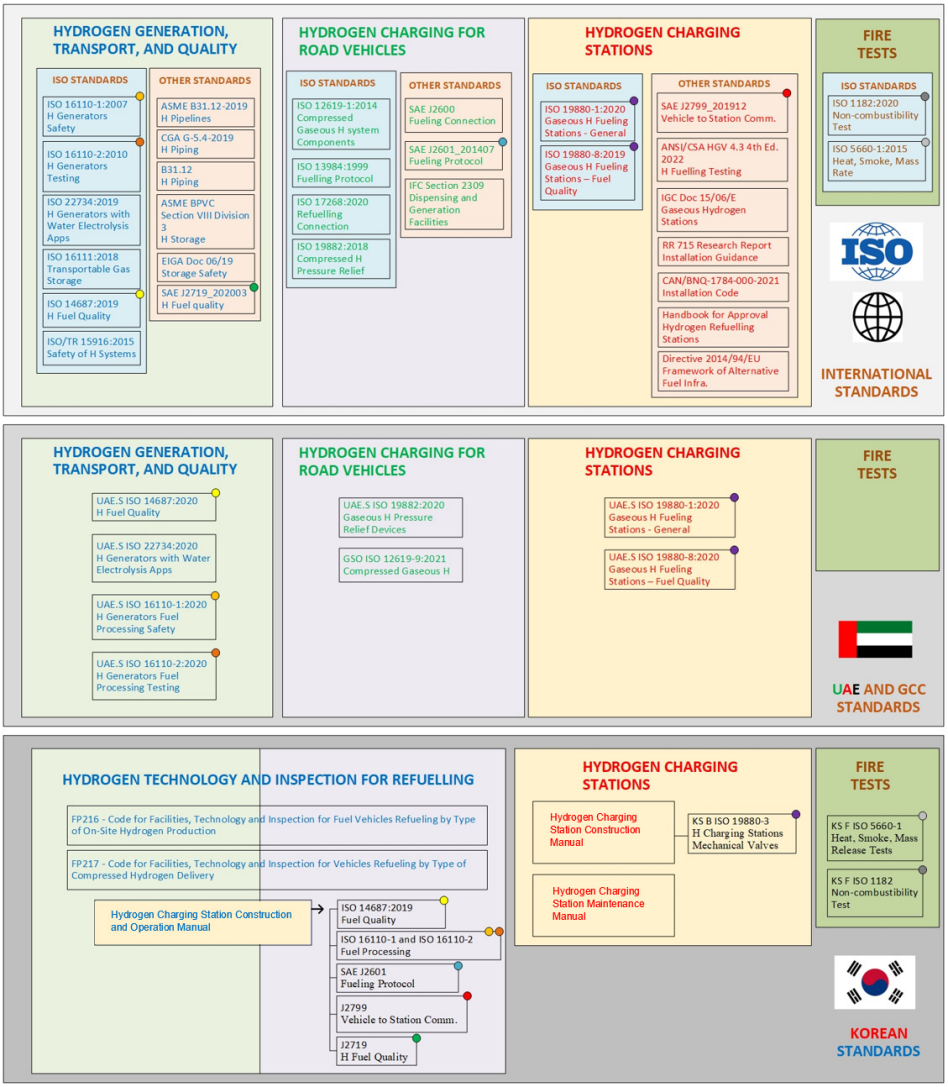

Fig. 1. Summary of all international standards in this paper

launched in the UAE by the Ministry of Industry and Advanced Technology, which was formerly known as the Emirates Authority for Standardization and Metrology (ESMA). The lab was established in 2019 to promote innovation in the UAE's regulatory framework and provide a testing ground for innovative products and services by businesses and entrepreneurs.

The UAE Regulations Lab provides businesses with a controlled environment in which to test their products and services without the risk of violating existing regulations. This enables quicker and more efficient testing and development of innovative solutions, which ultimately results in more effective regulations. The facility is intended to serve numerous industries, such as healthcare, energy, construction, and transportation, among others. Businesses can apply to participate in the lab and evaluate their products and services in a controlled environment alongside regulators.

The UAE Regulations Lab is part of broader ini-

tiatives by the UAE to foster innovation and entrepreneurship. By providing a platform for testing and developing new ideas, the lab is contributing to the establishment of a more innovative and dynamic business environment in the UAE

5. Comparison of standards in UAE and Korea

The Table 3 shows various hydrogen charging station related ISO standards alongside with UAE and Korean adopted standards. The ISO standards related to fuel quality, hydrogen gas safety, hydrogen generators, and gaseous fuelling stations are identical between UAE and Korea. It is noted that Korean standards also additionally include ISO standards for fire tests. The Korean standards also adopts various Society of Automotive Engineers (SAE) standards from the US as well. It is found that Korean adopted standards are compatible with UAE's adopted ISO standards and strengthens further by adopting more ISO standards as well as multiple SAE standards. It is noted that the Korean adopted standards include "reaction to fire tests" for non-combustibility and heat release rate, which UAE have not adopted yet. The standards are expected to cope better with UAE's hot temperature and harsh weather conditions. In essence, Korean standards for hydrogen charging stations are generally compatible with UAE's currently adopted set of standards and additionally includes fire test related ones. It is expected that via the UAE Regulations Lab in collaboration with con-

Table 3. Comparison of ISO, UAE and Korean standards

		International	UAE	Korea
ISO	ISO 14687:2019	Fuel quality	V	V
	ISO/TR 15916:2015	Hydrogen gas safety		
	ISO 16110-1:2007	Hydrogen generators	V	V
	ISO 16110-2:2010	Hydrogen generators	V	V
	ISO 16111:2018	Gas storage		
	ISO 17268:2020	Vehicle refuelling connection		
	ISO 19880-1:2020	Gaseous hydrogen – fuelling stations	V	V
	ISO/DIS 19880-2	Gaseous hydrogen – fuelling stations		
	ISO 19880-3:2018	Gaseous hydrogen – fuelling stations		V
	ISO 19880-4	Gaseous hydrogen – fuelling stations		
	ISO 19880-5:2019	Gaseous hydrogen – fuelling stations		
	ISO/CD 19880-6	Gaseous hydrogen – fuelling stations		
	ISO/CD 19880-7	Gaseous hydrogen – fuelling stations		
	ISO 19880-8:2019	Gaseous hydrogen – fuelling stations		
	ISO/CD 19880-9	Gaseous hydrogen – fuelling stations		
	ISO 1182:2020	Reaction to fire tests – non-combustibility test		V
	ISO 5660-1:2015	Reaction to fire tests – heat release rate		V
USA	SAE J2719_202003	Hydrogen fuel quality for fuel cell vehicles		V
	SAE J2600	Compressed hydrogen surface vehicle fueling connection		
	SAE J2601_201407	Fueling protocols for gaseous hydrogen surface vehicles		V
	SAE J2799_201912	Hydrogen surface vehicles to station communications		V

cerned entities of Abu Dhabi governments, the Korean charging stations can be verified and adopted by Abu Dhabi.

Fig. 2 shows a flow chart of approval interactions among concerned entities in the Abu Dhabi governments, for constructing a hydrogen charging station in Abu Dhabi.

6. Conclusion

This paper reviews and conducts comparative analysis on various international standards related to hydrogen charging stations including those of UAE and Korea focusing on the adaptability of Korean hydrogen technologies for implementing in Abu Dhabi, UAE.

After analyzing the existing standards in UAE, it is found that UAE traditionally adopts GCC standards. However, for emerging technologies such as hydrogen fuel and facilities, UAE have chosen to directly adopt newest ISO standards ahead of GCC updating its own older hydrogen energy related GSO standards. As of now, all hydrogen energy and charging station related standards in UAE are ISO standards adopted by the Ministry of Industry and Advanced Technology, which was formerly known as the ESMA.

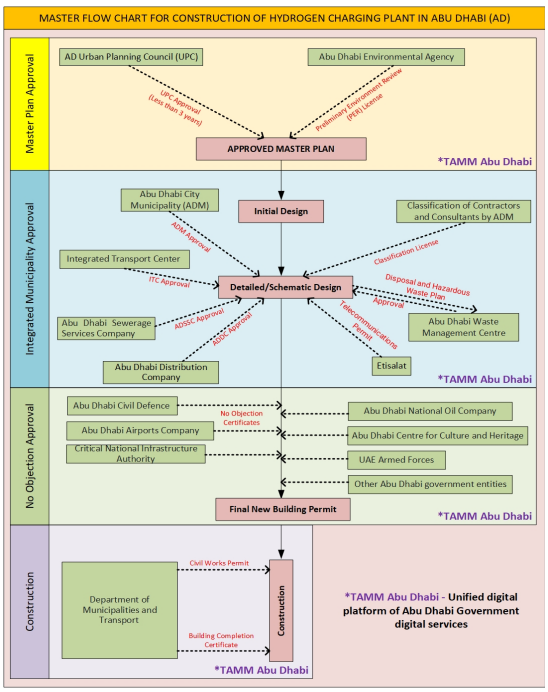

Fig. 2. Approval processes in UAE for construction of a hydrogen charging station

It is also found that Korean standards also generally inherits ISO standards as their backbone and even strengthens and enhances in terms of safety and reliability by adopting additional ISO standards as well as SAE standards.

It is concluded that Korean standards are compatible with UAE standards and feasible to be implemented in UAE without modifications as they are both ISO inherited standards as their common base while Korean standards enhances safety and reliability in various aspects. This suggests that currently available Korean hydrogen technologies that are compatible with the Korean standards can be implemented in Abu Dhabi in their current forms, pending the approval of the Ministry of Industry and Advanced Technology of Abu Dhabi, UAE.

In addition, it is also possible that the Korean technologies be assessed by the UAE Regulation Laboratory and granted with "regulatory sandbox" approval to be implemented in Abu Dhabi, UAE after rigorous testing and experiments against Abu Dhabi's harsh weather conditions.

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