NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Regulations, Codes, and Standards (RCS) for Multi-Fuel Motor Vehicle Stations

Carl Rivkin, CSP, P.E.
International Conference on Hydrogen Safety
Hamburg, Germany
11 September 2017

Outline

- Topic 1.Introduction
- Topic 2. RCS for six key fuels
- Topic 3. Representative Multi-Fuel station Configuration
- Topic 4. Safety Issues and RCS Gaps
- Topic 5. Conclusion and questions

TOPIC 1.INTRODUCTION

- Requirements for motor vehicle fuelling stations for gaseous fuels, including hydrogen, are relatively new.
- The liquid motor fuels have been addressed in a single primary (NFPA 30A) document and the gaseous fuels have been addressed in documents specific to the individual gas.
- Multi-fuel stations are subject to requirements in several fuelling regulations, codes, and standards (RCS).
- This paper describes a configuration of a multi-fuel motor vehicle fuelling station and provides a detailed breakdown of the codes and standards requirements.
- The multi-fuel station would dispense what the U.S. Department of Energy defines as the six key alternative fuels: biodiesel, electricity, ethanol, hydrogen, natural gas, and propane.
- The paper identifies apparent gaps in RCS and potential research projects that could help fill these gaps.

Many hydrogen stations will be additions to existing stations

TOPIC 2. RCS FOR SIX KEY FUELS

- The U.S. Department of Energy has defined six key alternative vehicle fuels from the 1992 Energy Policy Act
- The six key alternative fuels are:
- Biodiesel
- Electricity
- Ethanol
- Hydrogen
- Natural gas
- Propane

These six fuels have different levels of market maturity

TOPIC 2. RCS FOR SIX KEY FUELS

Note hydrogen too small to show on bar chart

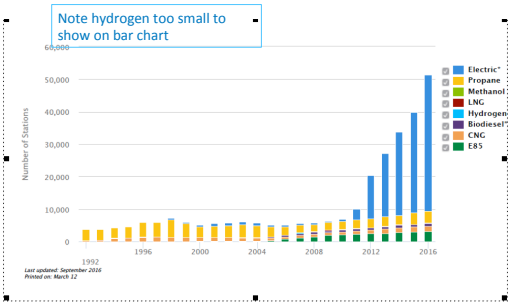


Figure 1. Alternative fuel fuelling stations by fuel type in the United States

TOPIC 2. RCS ANALYSIS DONE FOR SIX KEY FUELS

Example of one of the six tables of key requirements

Table 4. Hydrogen requirements

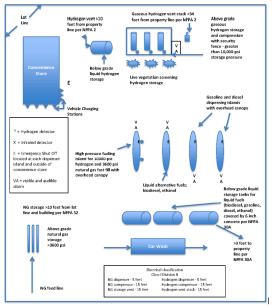
Document	Subject matter
NFPA 2 Hydrogen Technologies Code	Comprehensive hydrogen technologies safety code
NFPA 30A	Installation of all station components and systems, siting requirements, operations, and maintenance
CGA G-5.5 Vent Systems	Vent stack and discharge geometry design standard
S-1.1 Pressure Relief Device Standards - Part 1- Cylinders for Compressed Gases S-1.3 Pressure Relief Device Standards - Part 3 - Stationary Storage Containers for Compressed Gases	Pressure relief device design
ASME B31.3/12	Pressure piping design codes
CGA H-5 Standard for Bulk Hydrogen Supply Systems	General hydrogen safety standard
ASME Boiler and Pressure Vessel Code	Design document for pressure vessels
CSA FC/1	Standard for performance of stationary fuel cells

TOPIC 3.REPRESENTATIVE MULTI-FUEL STATION CONFIGURATION

- Charging stations located at parking spaces
- Fuelling for five of the six key fuels; propane is not included because it is not typically dispensed at retail facilities
- Integrated control systems
- Separation between fuel storage for different fuel types including below grade storage for liquid fuels and liquefied hydrogen
- Defined electrically classified areas at dispensing and storage areas
- Visual and audible alarms
- Charging stations for electric vehicles at convenience store parking spaces
- Storage venting and pressure relief systems
- Vehicle loading egress

TOPIC 3. REPRESENTATIVE MULTI-FUEL STATION CONFIGURATION

Note that in US propane used for mainly rural vehicles



Note that currently vehicle charging is not typically done at conventional fueling stations

Figure 4. Schematic of multi-fuel station

TOPIC 4. SAFETY ISSUES AND RCS GAPS

- Within the United States codes and standards there is a complete set of requirements that would allow the installation and operation of a multi-fuel retail station.
- The number of documents, the multiple cross references within documents to other documents, as well as the cost of obtaining these documents represents a barrier to both project developer compliance and code enforcement.
- The codes and standards requirements for the different fuels reside in several documents and the requirements of these documents are not fully integrated.
- E-stops (emergency station shut-down stops) and other control requirements are not integrated within the RCS (for example initiating an E-stop for hydrogen fuelling would not necessarily shut down all fuelling operations conducted at a multi-fuel station).
- Fuel storage and dispensing setback distances for one fuel can impinge on those for another fuel, such as setback distances for hydrogen storage impinging on setbacks for CNG storage.

TOPIC 4. SAFETY ISSUES AND RCS GAPS

- Fire panels are not designed for the multiple signals that would be produced by the multiple sensing devices required at facilities storing and dispensing multiple fuels.
- Blending fuels can create flammable atmospheres in tank head space where they did not previously exist by changing the flammability range of the vapour accruing in the tank head space.
- Retrofitting of existing facilities to add new fuelling capability creates many issues with bringing an out of compliance facility into review with current requirements.
- When managing changes, the impacts of modifications to one system need to be evaluated regarding their site wide impacts.

TOPIC 4. SAFETY ISSUES AND RCS GAPS

- The gaps in RCS point to several potential research areas. These research areas include the following:
  - Sensors that can perform in a multi-fuel environment
  - Station layout analysis factoring in all of the various setback distances to produce an optimal use of space at a specific location
  - Hazard analyses by component level nodes for multi-fuel operation and impacts of intentional and unintentional releases scenarios, including the safety impacts of routine venting operations
  - Impacts of operations of different fuels on safety aspects of other fuels, such as routine maintenance activities for one fuel impacting safety for another fuel
  - The safety impact of heavier-than-air fuels potentially migrating into below grade storage areas
  - Multi-fuel impacts on materials—for example, the combination of fuels degrading materials that are designed for use with a specified fuel or impacting materials at the station not designed to withstand the impact of that fuel.

TOPIC 5. CONCLUSION

- Basic RCS exist for multi-fuel stations
- There are gaps in integration of these requirements
- Performing a comprehensive risk analysis involving experts from different areas of the fuelling industry. NREL has begun work in assembling these expert groups and plans to proceed with the comprehensive risk analysis.
- Developing an integrated RCS compliance tool for multi-fuel stations as the level of deployment of these fuels increase.

Thank You and Questions

- **Carl Rivkin, CSP, P.E.** - *Safety Research Team Lead*
  carl.rivkin@nrel.gov

This work is supported by the DOE EERE Fuel Cell Technology Office!

U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

NREL
NATIONAL RENEWABLE ENERGY LABORATORY