Infrastructure Codes and Standards Hierarchy in Short

**IFC / NFPA 1**
- Chapter 23 Stations
- Chapter 50 Haz Matls
- Chapter 53 Compressed Gases
- Chapter 55 Cryogenics
- Chapter 58 Flammable Gases and Cryogenics

**NFPA**
- NFPA 55
- NFPA 2
- NFPA 70
- NFPA 30A

**ASME**
- ASME BPV Section XIII
- ASME B31.12
- ASME A13.1

**CGA**
- CGA S-1.1-3
- CGA-5.5
- CGA H-5

**UL**
- UL2075
Code Review in Short

- How do I apply these requirements to a hydrogen fueling station?

- The hydrogen fueling station can be broken down into the following components/areas for the purposes of code compliance:
  - Storage system
  - Compression system
  - Pressure relief
  - Fire safety/detection System
  - Dispensing system
  - Electrical
  - Maintenance
Storage System

Key Code Citations

- IFC 2015 – section 5303.2 – GH2 containers, cylinders, and tanks to meet either DOT 49 CFR Parts 100-185 or ASME Boiler and Pressure Vessel Code

- NFPA 2-2016 – section 7.1.15.1 – piping systems designed, fabricated and installed in accordance with ASME B31.3

- NFPA 2-2016 – section 7.3.2.3.1.1 – minimum distance for aboveground locations for bulk gaseous systems

- NFPA 2-2016 – section 8.3.2.3.1.6 – siting locations – provides minimum distances for liquid systems from exposures

- NFPA 2-2016 – allows for setback distance reduction through the use of fire walls for select exposures
# Example Key Bulk Storage Setback Distances in NFPA 2

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Phase</th>
<th>Distance (15,000 psi system)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air intakes</td>
<td>Gas</td>
<td>35 ft</td>
</tr>
<tr>
<td>Ignition sources</td>
<td>Gas</td>
<td>35 ft</td>
</tr>
<tr>
<td>Lot lines</td>
<td>Gas</td>
<td>35 ft</td>
</tr>
<tr>
<td>Wall openings</td>
<td>Liquid</td>
<td>75 ft</td>
</tr>
<tr>
<td>Property lines</td>
<td>Liquid</td>
<td>Up to 75 ft</td>
</tr>
<tr>
<td>Flammable/combustible liquids</td>
<td>Liquid</td>
<td>Up to 100 ft</td>
</tr>
<tr>
<td>Unsprinklered building</td>
<td>Liquid</td>
<td>Up to 100 ft</td>
</tr>
</tbody>
</table>
Compression System
Key Code Citations

- NFPA 2-2016 – section 7.1.20 – compressions and processing equipment – systems shall be designed for max. temperature and pressure

- NFPA 2-2016 – section 7.1.20.1 – PRDs required at each stage of the compression cycle to max. allowable working pressure

- NFPA 2-2016 – section 7.1.20.2 – unattended equipment shall have automatic shutdown at high discharge and low suction pressure (out of operating range conditions)

- NFPA 2-2016 – section 7.1.20.3 – equipment that has been shutdown shall be restarted manually or reset after safe shutdown
Pressure Relief

Key Code Citations

- NFPA 2-2016 – section 7.1.5.5 – Pressure Relief Devices
  - PRDs shall protect containers from rupture in the event of overpressure from thermal exposure
  - PRDs shall be designed in accordance with CGA S-1.1, CGA S-1.2, and CGA S-1.3
  - PRDs shall be sized in accordance with the container they are intended to relieve
  - PRDs shall be designed to discharge unobstructed to the open air so that there is no impingement on the container
  - PRDs shall be designed so that moisture cannot collect, freeze, and impede flow
Fire Safety/Detection System

Key Code Citations

- IFC 2015 – section 2309.5.2 and 5.3 – emergency shutoff valve and emergency shutdown systems
  - Require manual emergency shutoff device from hydrogen supply
  - Require manual shutoff between 25 feet and 75 feet from dispenser
  - Activation of the emergency shutdown device will stop hydrogen flow and deenergize systems

- NFPA 2-2016 – section 10.3.1.18.1 – hydrogen gas dispensing systems shall be provided with detection

- NFPA 2-2016 – section 10.3.1.18.2 – detection systems shall automatically activate shutdown of the dispensing system
Dispensing System

Key Code Citations

- NFPA 2 2016 – section 10.3 – dispensing requirements include:
  - Use of listed or approved equipment
  - Hoses operated under MAWP
  - Breakaway devices
  - System pressure testing
  - Warning signs and vehicle impact protection
  - SAE J2600 compliant nozzle
  - Dispensing integrity checks during dispensing operations
Electrical Requirements

Key Code Citations

- NFPA 2 2016 – section 10.3.1.15 – installation of electrical equipment requirements include:
  - Comply with Table 10.3.1.15.1
  - Comply with NEC
- NFPA 2-2016 – Table 8.3.1.2.6 for liquid systems
- NFPA 2-2016 – Table 7.3.23.1.5 for gaseous systems

Classified Areas

<table>
<thead>
<tr>
<th>Location</th>
<th>Divisio or Zone</th>
<th>Extent of Classified Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor dispenser enclosure – exterior and interior</td>
<td>2</td>
<td>Up to 5 feet from dispenser</td>
</tr>
<tr>
<td>Indoor dispenser enclosure – exterior and interior</td>
<td>2</td>
<td>15 feet from the point of transfer in accordance with 10.3.3.2.2.3</td>
</tr>
<tr>
<td>Outdoor discharge from relief valves or vents</td>
<td>1</td>
<td>5 feet from source</td>
</tr>
<tr>
<td>Outdoor discharge from relief valves or vents</td>
<td>2</td>
<td>15 feet from source</td>
</tr>
<tr>
<td>Discharge from relief valves with 15 degrees of the line of discharger</td>
<td>1</td>
<td>15 feet from source</td>
</tr>
</tbody>
</table>
## Maintenance

### Hydrogen Storage and Dispensing System Maintenance and Inspection Requirements

<table>
<thead>
<tr>
<th>Description</th>
<th>Citation in NFPA 2016 edition</th>
<th>Requirement text</th>
</tr>
</thead>
</table>
| General maintenance and recordkeeping requirements for hydrogen storage system | 7.1.28.2                        | 7.3.1.2.8 Maintenance. Maintenance shall be performed annually by a qualified representative of the equipment owner. The maintenance shall include inspection for:  
- physical damage,  
- leak tightness,  
- ground system integrity,  
- vent system operation,  
- equipment identification,  
- warning signs,  
- operator information and training records,  
- scheduled maintenance and retest records,  
- alarm operation,  
- and other safety-related features.  
Scheduled maintenance and retest activities shall be formally documented and records shall be maintained a minimum of 3 years. [55: 10.5.3] |
| Cathodic protection for containers                                         | 8.1.3.1.8.2                     | 8.1.3.1.8.2 Inspection  
(A) Container systems equipped with cathodic protection shall be inspected for proper operation by a cathodic protection tester.  
(B) The cathodic protection tester shall be certified as being qualified by the National Association of Corrosion Engineers. |
| Inspection and testing for out of service tanks                            | 8.1.10.1.1                      | Containers out of service in excess of year shall be inspected and tested as required in 8.1.10.1.2.                                                                                                               |
### Maintenance (cont.)

<table>
<thead>
<tr>
<th>Maintenance Area</th>
<th>Section</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Hose testing**                  | 10.3.1.11.2 | 10.3.1.11.2.1 Hoses, nozzles, and breakaways shall be examined according to the manufacturers recommendations or at least monthly and shall be maintained in accordance with the manufacturers instructions.  
10.3.1.11.2.2 Hoses shall be tested for leaks per manufacturers requirements and any leakage or surface cracks shall be reason for rejection and replacement.  
10.3.1.11.2.3 Testing shall be carried out using an inert gas as the test medium. |
| **Dispenser incident**            | 10.3.1.13.4 | 10.3.1.13.4 Where an overpressure incident that results in operation of the overpressure protection system occurs, the dispenser pressure control system shall be examined and certified by a qualified technician prior to being returned to service. |
| **Detector maintenance**          | 10.3.1.18.1.2 | 10.3.1.18.1.2 The station owner or operator shall maintain a record of detector maintenance and calibration in good condition and accessible to the inspector. |
| **Leak testing**                  | 10.3.1.10  | 10.3.10.1 Piping, tubing and hose, and hose assemblies shall be leak tested after assembly to prove them free from leaks at a pressure equal to at least the normal service pressure of that portion of the system. |
Repair Garages

Key Documents

- NFPA 2 Hydrogen Technologies Code Chapter 18
- International Fire Code Section 2311
- NFPA 30A Code for Motor Fuel Dispensing Facilities and Repair Garages
- NFPA 51B Standard for Fire Prevention During Welding, Cutting, and other Hot Work

Key Requirements

- Sensors to detect hydrogen
- Ventilation to prevent hydrogen accumulation
- Defueling capability to remove hydrogen from vehicles for fuel system repairs
- Automatic sprinkler systems required
- Delineation between major and minor repair facilities
Questions

Nick Barilo, P.E.
Pacific Northwest National Laboratories
Nick.Barilo@pnnl.gov

Carl Rivkin, P.E.
National Renewable Energy Laboratory
carl.rivkin@nrel.gov

Dr. Christine LaFleur, P.E.
Sandia National Laboratories
aclafle@sandia.gov