



PRELIMINARY REPORT

HAZARDOUS MATERIALS

High-Pressure Hydrogen Gas Cylinder Fire During Transportation

**Diamond Bar, California
February 11, 2018
HMD18FR001**

The information in this report is preliminary and will be either supplemented or corrected during the course of the investigation.

On February 11, 2018, about 1:15 p.m. Pacific standard time, an Air Products and Chemicals, Inc. (Air Products) module of 25 horizontally mounted high-pressure gas cylinders loaded with 240 kilograms (kg) of compressed hydrogen, UN1049, caught fire while being transported by a 2014 Mack truck tractor in combination with a 2015 Cheetah intermodal chassis. The incident occurred on Golden Springs Drive, near South Brea Canyon Road, in Diamond Bar, California (see Figure 1.) About 120 kg of the hydrogen released from 12 of the cylinders that were exposed to the fire. The fire was extinguished, and the trailer was secured around 3:00 a.m. on February 12. No injuries were reported; however, about 500 persons within a 10-block business district were evacuated. Weather at the time of the incident was 69°F, maximum wind gusts were about 14 mph, there was no precipitation, and visibility was 10 miles.



Figure 1. Accident scene. (Photo from YouTube.)

The load of compressed hydrogen originated from Air Products' hydrogen transfill terminal, located in Wilmington, California, and was destined for the California South Coast Air Quality Management District in Diamond Bar. The trailer was intended to resupply a hydrogen fuel cell vehicle refueling station.

Compressed hydrogen is an extremely flammable, colorless, and odorless gas. Hydrogen may form explosive mixtures in air and it is easily ignitable, by static electricity or self-ignition, if a cylinder valve is opened to the air. It burns with an invisible flame. Upon exposure to intense heat and flame, cylinders may vent rapidly or rupture violently.

Structural Composite Industries (SCI), a subsidiary of Worthington Industries, in Pomona, California, manufactured the gas cylinders under US Department of Transportation (DOT) Special Permit 14576. The cylinders were constructed of a carbon fiber composite wrap over an aluminum inner liner. About 6 weeks prior to the incident, FIBA Technologies Inc. (FIBA), a DOT-approved cylinder requalification facility, conducted a 5-year requalification inspection of the cylinder module at a FIBA Technologies testing facility located in Adelanto, California. No exceptions with the cylinders or associated equipment were noted during the requalification inspection.

National Transportation Safety Board (NTSB) investigators completed on-scene work at the Air Products' facility in Santa Fe Springs, California, and the cylinder requalification facility in Adelanto, California. NTSB investigators will travel to the cylinder pressure relief device manufacturing facility in Valley View, Ohio, to complete further investigative work.

Preliminary findings from the investigation include the following:

- The 25 aluminum-lined carbon composite gas cylinders were each 120 inches in length, 17.8 inches in diameter, and had a nominal water capacity of 18,716 cubic inches (312.9 liters).
- The cylinder module was shipped with all but one cylinder full. Each cylinder contained about 10.0 kg of hydrogen at a pressure of approximately 7,500 PSI gauge (psig).
- Cylinder damage was limited to fire exposure. Twenty of the cylinders exhibited varying degrees of fire exposure, but none of them were breached (see Figure 2).
- Pressure relief devices activated on 12 of the cylinders.
- The cylinder manufacturer specifications call for type CG-5 pressure relief devices set at 10,000 psig.¹ However, NTSB investigators and investigation party members found pressure relief devices set at an incorrect pressure rating of 5,833 psig installed in three of the cylinders. Two of these under-rated pressure relief devices had activated. The source of the incorrect pressure relief devices is under investigation.
- The trailer included tubing attached to each pressure relief device outlet to safely vent relieved gases upward to the outside top of the cylinder module. Seven of the vent tubes became detached from the pressure relief device assemblies and vented gas to the interior of the trailer, which fueled the fire. The separated tubing had not been tightly secured by the compression fittings.
- The incorrectly rated pressure relief devices and unsecured vent tubing were not identified during the cylinder requalification inspections at FIBA Technologies Inc.

¹ A CG-5 pressure relief device consists of a rupture disk backed by a fusible plug on the atmospheric side of the disk. The combination pressure-relief device provides protection against cylinder rupture caused by fire or high temperature. If a fire occurs, the fusible metal yields or melts, and cylinder overpressure is relieved by a bursting rupture disk.

- Responding to initial findings, Air Products inspected its remaining fleet of 13 hydrogen cylinder modules. One trailer undergoing qualification inspection was found to have a cylinder with an underrated pressure relief device. Improperly secured vent tubing was found in about half of all the lines inspected.
- Air Products and FIBA have revised the requalification inspection procedures to address fittings securement and pressure relief device compatibility.



Figure 2. Postaccident view of the hydrogen cylinder module.

Parties to the investigation include the Pipeline and Hazardous Materials Safety Administration, Air Products and Chemicals, Inc., and Sherwood Valve LLC.