PRELIMINARY REPORT

Pipeline
Over-pressure of a Columbia Gas of Massachusetts Low-pressure Natural Gas Distribution System

Merrimack Valley, Massachusetts
September 13, 2018
PLD18MR003

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

On September 13, 2018, about 4:00 p.m. eastern daylight time, a series of explosions and fires occurred after high-pressure natural gas was released into a low-pressure gas distribution system in the northeast region of the Merrimack Valley in the state of Massachusetts.[1] (See figure 1.) The distribution system was owned and operated by Columbia Gas of Massachusetts (Columbia Gas), a subsidiary of NiSource. The system over-pressure damaged 131 structures, including at least 5 homes that were destroyed in the city of Lawrence and the towns of Andover and North Andover. Most of the damage was a result of structure fires ignited by gas-fueled appliances. Several structures were destroyed by natural gas explosions. One person was killed and at least 21 individuals, including 2 firefighters, were transported to the hospital. Seven other firefighters received minor injuries.

[1] Title 49 *Code of Federal Regulations* (*CFR*) 192.3 defines a low-pressure distribution system as "a distribution system in which the gas pressure in the main is substantially the same as the pressure provided to the customer." The Massachusetts Natural Gas Pipeline Safety Code, Title 220 *Code of Massachusetts Regulations* (*CMR*) 101.06, further defines a low-pressure distribution system "as any system in which the gas pressure in the main is equal to or less than two psig (pounds per square inch gauge)."

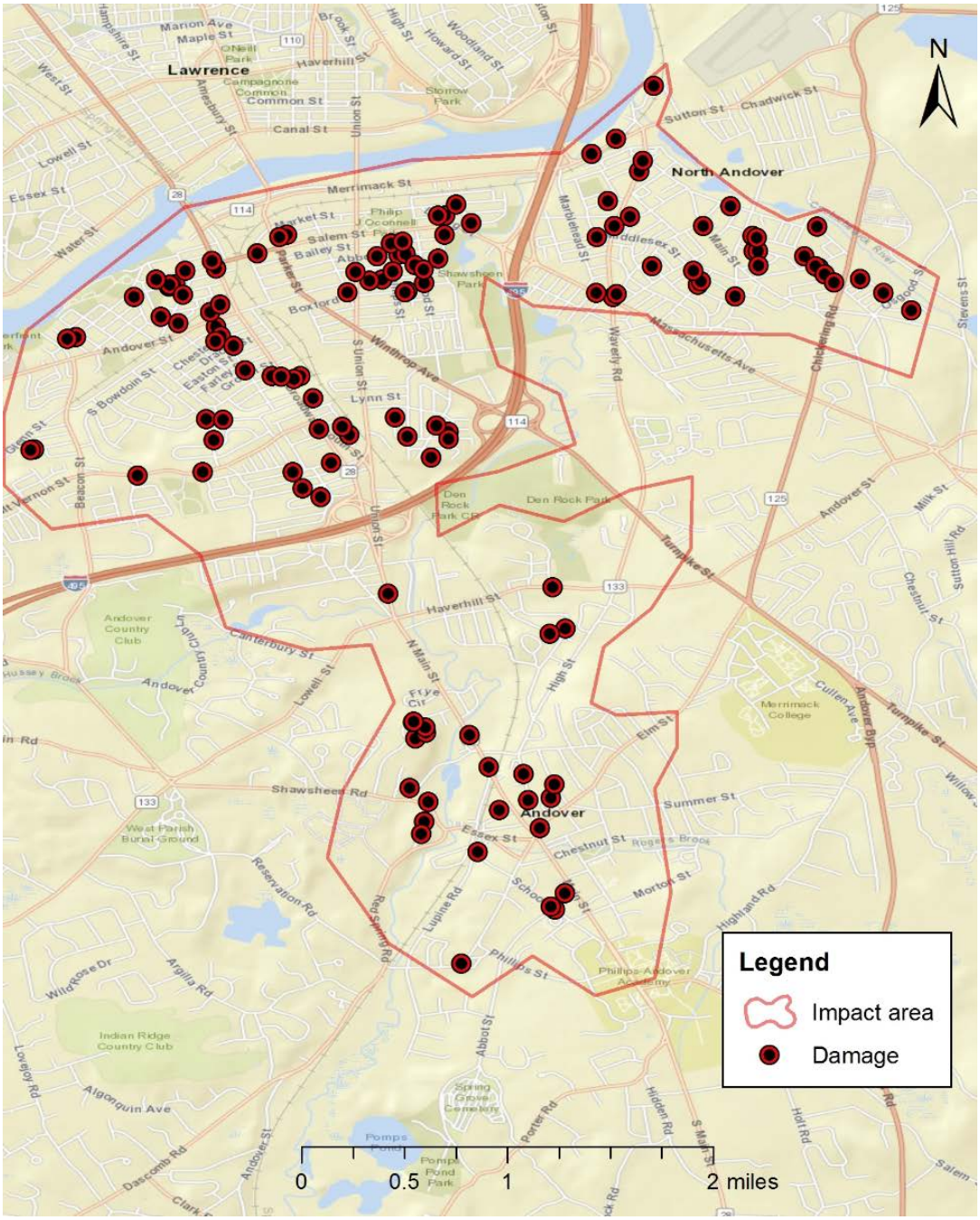

Figure 1. Area impacted by accident depicting structures that were damaged.

Fire departments from the three municipalities were dispatched to address the multiple fires and explosions. (See figures 2 and 3.) First responders initiated the state's fire mobilization plan, that included mutual aid from other districts in Massachusetts, New Hampshire, and Maine.

Figure 2. Aerial view of damaged home where a fatality occurred after the chimney collapsed on vehicle in the driveway.

Figure 3. Aerial view of burned-out home impacted by the event.

Emergency responders asked residents to evacuate from the impacted area to four evacuation centers. At the request of emergency management officials, National Grid shut down electrical power in the affected area to remove a source of ignition. Nearby roads were closed, and freight and

passenger railroad operations were suspended. Columbia Gas also shut down the low-pressure, natural gas distribution system.[2]

The cast-iron, low-pressure distribution system was installed in the early 1900s and had been partially improved with both steel and plastic pipe upgrades since the 1950s. The low-pressure distribution system in the affected area relied on 14 regulator stations to control gas at the required pressure into structures serviced by the system, unlike high-pressure gas distribution systems that place an individual regulator to reduce pressure at each customer service.[3] Each of the regulator stations reduced the pressure from about 75-pounds per square inch gauge (psig) natural gas main pipeline to 12 inches of water column (about 0.5 psig) for delivery to customers.

Prior to the over-pressure event, a Columbia Gas-contracted work crew, which included a Columbia Gas inspector, was performing a Columbia Gas-designed and approved pipe-replacement project at a nearby intersection (South Union Street and Salem Street) in South Lawrence. The contracted crew was working on a tie-in project of a new plastic distribution main and the abandonment of a cast-iron distribution main. The distribution main that was abandoned still had the regulator sensing lines that were used to detect pressure in the distribution system and provide input to the regulators to control the system pressure. Once the contractor crews disconnected the distribution main that was going to be abandoned, the section containing the sensing lines began losing pressure.

As the pressure in the abandoned distribution main dropped about 0.25 inches of water column (about 0.01 psig), the regulators responded by opening further, increasing pressure in the distribution system. Since the regulators no longer sensed system pressure they fully opened allowing the full flow of high-pressure gas to be released into the distribution system supplying the neighborhood, exceeding the maximum allowable pressure.

Columbia Gas developed and approved the work package executed on the day of the accident. The work package did not account for the location of the sensing lines or require their relocation to ensure the regulators were sensing actual system pressure. The work was performed in accordance with steps laid out in the work package. In light of this accident, Columbia Gas implemented a safety stand-down for all employees who perform work related to low-pressure natural gas systems for NiSource subsidiaries.[4]

Minutes before the fires and explosions occurred, the Columbia Gas monitoring center in Columbus, Ohio, received two high-pressure alarms for the South Lawrence gas pressure system: one at 4:04 p.m. and the other at 4:05 p.m. The monitoring center had no control capability to close or open valves; its only capability was to monitor pressures on the distribution system and advise field technicians accordingly. Following company protocol, at 4:06 p.m., the Columbia Gas

[2] Columbia Gas delivers natural gas to about 320,000 natural gas customers in southeastern Massachusetts, including the Merrimack Valley.

[3] Title 49 *CFR* 192.3 defines a high-pressure distribution system as "a distribution system in which the gas pressure in the main is higher than the pressure provided to the customer." The Massachusetts Natural Gas Pipeline Safety Code, 220 *CMR* 101.06, further defines a high-pressure distribution system "as a system in which the pressure in the main is greater than 60 psig, but equal to or less than 200 psig."

[4] *A safety stand-down* is an organized break from work by which employers hold discussions with their employees. They are often taken as occasions to discuss safety topics while also reinforcing the organization's policies regarding safety in general.

controller reported the high-pressure event to the Meters and Regulations group in Lawrence. A local resident made the first 9-1-1 call to Lawrence emergency services at 4:11 p.m.

Columbia Gas shut down the regulator at issue by about 4:30 p.m. The critical valves of the involved natural gas distribution system were closed by 7:24 p.m. Beginning about midnight, crews consisting of two Columbia Gas technicians escorted by two emergency response personnel began shutting off the meters at each house to isolate the homes from the natural gas distribution system. All meters were shut off by the following morning.

National Transportation Safety Board (NTSB) Chairman Robert Sumwalt and Member Jennifer Homendy led a 19-member NTSB team on scene. Parties to the investigation include NiSource, Columbia Gas, Pipeline and Hazardous Materials Safety Administration, Massachusetts State Police, and Massachusetts Department of Public Utilities. In addition to the on-scene work, investigators interviewed multiple people including two Columbia Gas Supervisory Control and Data Acquisition controllers from Columbus, Ohio.

According to Columbia Gas, all cast iron and bare steel piping in the affected neighborhoods will be replaced due to system integrity concerns. The new system will consist of high-pressure plastic mains with regulators at each service meter to reduce the line pressure from the main to the required pressure. The Massachusetts Department of Public Utilities is providing oversight of the new system installation to ensure that all work complies with state and federal safety regulations.

The NTSB's investigation into this accident is ongoing. Future investigative issues include the coordination between the emergency responders and Columbia Gas; an analysis of the engineering work package preparation and execution, including the design documentation; and a review of construction packages for constructability and safety.