



# National Transportation Safety Board

## Pipeline Accident Brief

### Natural Gas Explosion at Family Residence

#### Firestone, Colorado

#### April 17, 2017

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## Accident Narrative

On April 17, 2017, about 4:45 p.m. local time, a single-family home in Firestone, Colorado, was destroyed by an explosion. (See figure 1.) A resident and a plumber who was working at the house died in the explosion, and two other residents were injured. At the time of the explosion, the fatally injured resident and plumber were replacing a water heater in the basement.



**Figure 1.** Photograph of the residence before and after the accident. Photograph on the left was provided by Weld County, photograph on the right was provided by the Pipeline and Hazardous Materials Safety Administration.

The explosion also damaged the adjacent house, which later was demolished. The Frederick-Firestone Fire Protection District responded to the accident, with mutual aid from three other fire departments and the Firestone Police Department.

## On-scene Investigation

Representatives from the Colorado Oil and Gas Conservation Commission (COGCC), the Frederick-Firestone Fire Protection District, Black Hills Energy (Black Hills), Anadarko

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Petroleum Corporation (Anadarko), and the Pipeline and Hazardous Materials Safety Administration (PHMSA) responded to the accident site to conduct an investigation.<sup>1</sup> A National Transportation Safety Board (NTSB) investigator later went to the accident site to review the initial investigative findings and support subsequent on-scene work.

Since the residence at 6312 Twilight Avenue had domestic natural gas utility service, technicians from Black Hills located and marked the service line in the front of the house, which connected to the distribution main along Twilight Avenue. Black Hills excavated and exposed the interconnect between the service line and the distribution main on the north side of the residence. They found the excess flow valve was closed and no gas was detected in the excavation trench.<sup>2</sup> After excavating and exposing the interconnect between the service line and the side of the residence, Black Hills pressure tested the service line for 10 minutes at 30 pounds per square inch, gauge (psig). The service line held pressure, indicating there were no leaks present. Because the service line held pressure, the excess flow valve likely activated after the house piping was severed in the explosion.

Three severed pipelines were found beneath a concrete pad about 6 feet from the foundation of the house. The three lines were originally connected to natural gas wells as part of a production field. The lines included one 1-inch diameter polyethylene (PE) line and two 2-inch diameter steel lines. The PE line had a tee connection south of the residence, with one branch of the line connected to the Coors V6-14Ji well southeast of the residence, and the other branch running to the Coors V6-13 well to the south and farther west of the residence. (See figure 2.) One of the steel lines had been previously connected to the Coors V6-14Ji well and was later disconnected and abandoned. The other severed steel line was a discontinuous abandoned line which went in the direction of the nearby Coors V6-13 well.

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<sup>1</sup> Black Hills is the local gas distribution company.

<sup>2</sup> *Excess flow valves* are safety devices installed on natural gas distribution pipelines to reduce the risk of accidents. When flow rates through them exceed design limits, the valve automatically closes. Most types of excess flow valves require a technician to reset the valve after a high-flow incident or for it to be replaced altogether.

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**Figure 2.** Aerial view of Anadarko production field from late 2015 with illustration of the pipelines and the Coors V6-14Ji well location.

No records are available that show when the three lines under the concrete pad were cut. Residential building approvals indicate the only known construction at the residence occurred when it was built in 2015. However, the materials associated with these approvals did not contain information about the production field.

After being isolated from the pipeline which went to Coors V6-13, the PE line was field tested between its severed end and the Coors V6-14Ji wellhead and had continuity. The same segment of PE line between the wellhead and its end at the house was pressure tested with nitrogen at 5 psig and also held pressure, indicating that it was sound. During the excavation, natural gas was found at the rear of the residence.<sup>3</sup> Specifically, the soil under the concrete slab had a reading of 10 percent of the lower explosive limit for natural gas, indicating that excessive amounts of natural gas were present in the soil immediately outside the rear of the residence. Natural gas likely leaked from the well and traveled through the PE line toward the residence, where it exited the severed end and migrated through the soil into the basement, where it fueled the explosion. The

<sup>3</sup> *Natural gas* is a naturally occurring hydrocarbon gas mixture consisting primarily of methane which often includes higher alkanes and a small percentage of other components. It is a common well-production by-product and is also used as a fuel gas for residential and commercial use, such as on a gas stovetop. The National Fire Protection Association refers to natural gas not used for residential or commercial purposes as “fugitive gas”. In this report, unless otherwise noted, the terms “natural gas” and “fugitive gas” are synonymous.

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segment of the PE line beyond the tee connection and running toward the Coors C6-13 well and the multiwell separator did not pass a pressure test. Because this segment was not sound, it was not believed to be a pathway for the gas to travel from the Coors V6-13 well or the separator toward the residence.

A 2-inch steel flowline ran from the V6-14Ji well to a separator and tank storage facility to the west, running south of the residence and parallel to Twilight Avenue. This line was pressurized to 500 psig for 1 hour and held pressure, indicating that the flowline had no leaks.

Information gathered during the investigation found that the most likely source of the natural gas that fueled the explosion was the Coors V6-14Ji well, and the pathway for the natural gas to reach the residence was the 1-inch PE line.

## History of the Well

On August 31, 1993, Gerrity Oil and Gas received approval from the COGCC to drill the subject well, Coors V6-14Ji. Drilling began November 30 and the casing was set and cemented 5 days later. It was a vertical well that produced natural gas, as well as natural gas liquids (low molecular-weight hydrocarbons), brine, and crude oil. The well was located about 170 feet south of what would eventually become the residence.<sup>4</sup> Coors V6-14Ji was one of hundreds of wells that were drilled in an area of the Denver Basin known as the Wattenberg Gas Field. Patina Oil and Gas Corporation (Patina) acquired the subject well in 1997.

In 1999, in preparation for a planned housing development, Patina planned to shut down and remove a production facility to the north of the subject well, abandon the existing underground lines from the subject well to that production facility, and install new flowlines to a newly constructed multiwell separator and tank storage facility about a quarter-mile west of the subject well.<sup>5</sup> However, the original production facility to the north remained in use until 2018 and not all flowlines were properly abandoned, including several of the lines involved in this accident. Although a Patina 1999 record stated the abandonment was completed, COGCC records showed this to be incorrect. The well was acquired one more time before the ownership was transferred to Anadarko in October 2013.

On December 14, 2015, Anadarko temporarily “shut in” multiple wells, including Coors V6-14Ji, for emissions upgrades; however, the well was not plugged and no pipelines were abandoned.<sup>6</sup> Anadarko owned and operated this well at the time of the accident and had resumed production from this well less than 3 months prior to the accident.

## Pipeline Abandonment Prior to Incident

When Patina planned to abandon the flowlines from the Coors V6-14Ji well in 1999, COGCC regulations required only that the line be “disconnected from all sources and supplies of

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<sup>4</sup> The local police department indicated the well was 150 feet south of what would become the property.

<sup>5</sup> A *separator* is a pressure vessel used to separate production fluids into crude oil, natural gas, and water/sediment. A multiwell separator performs the same function for the gathered products from multiple wells.

<sup>6</sup> *Plugging* a well is a process of inserting plugs into a well to prevent flow between different geological formation zones. Plugs can be cement or mechanical, and the plugging may involve inserting multiple plugs at different depths.

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natural gas and petroleum, purged of liquid hydrocarbons, depleted to atmospheric pressure, and sealed at the ends.” None of the three lines found at the residence were properly abandoned in accordance with these requirements.

## Postaccident Actions

Anadarko conducted a magnetic survey in the vicinity of the accident site to locate any abandoned pipelines that would not be included in its existing surveys of wells and active pipelines. The survey noted the length and location of flow and return lines, as well as the locations of several wells adjacent to the residential neighborhood. (See figure 2.) Although most pipeline damage and accidents occur with transmission and distribution pipelines, the safety risks associated with strikes to gathering pipelines that carry flammable liquids and gases are similarly hazardous to workers and the public. It is important that pipeline owners and operators maintain and distribute accurate information on the location of pipelines since inadvertent strikes during construction and excavation work is a leading cause of pipeline damage and accidents.<sup>7</sup>

Flowlines and other associated production well pipelines, including the lines involved in this accident, fall under the jurisdiction of state, rather than federal authorities. Following the accident, the Colorado state government and the COGCC made several regulatory changes related to flow and return lines.

On May 2, 2017, the COGCC issued a statewide notice to operators (NTO) mandating new requirements for oil and gas operators with facilities containing flowlines, which were defined to include “well site flowline, return line, sales line, dump line, process piping, fuel gas supply line, and non-well site flowline.”<sup>8</sup> The NTO required all oil and gas operators to “re-inspect any existing flowlines and pipelines located within 1,000 feet of a building unit” and provide data on those lines to the COGCC. Also, oil and gas operators were required to “inspect all existing flowlines and pipelines, regardless of distance to a building unit, to verify that any existing flowline or pipeline not in use, regardless of when it was installed or taken out of service, is abandoned.”<sup>9</sup> The deadline for compliance with this part of the NTO was May 30, 2017.

The NTO also required oil and gas operators to “ensure and document that all flowlines within 1,000 feet of a building unit have integrity” and noted that exemptions for pressure testing did not apply to low-pressure flowlines. Additionally, the NTO required oil and gas operators to “complete abandonment of any flowline or pipeline not actively operated”. This NTO requirement was included because flowlines abandoned prior to July 30, 2001, were not required to be cut below grade. The deadline for compliance with this part of the NTO was June 30, 2017.

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<sup>7</sup> Pipeline and Hazardous Materials Safety Administration, *Pipeline Incident 20 Year Trends*, (Washington, DC: US Department of Transportation, Pipeline and Hazardous Materials Safety Administration, 2019). <https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-20-year-trends>. Accessed October 4, 2019.

<sup>8</sup> Colorado Oil and Gas Conservation Commission, *Notice to Operators Statewide, “Flowlines or Pipelines – 1100 Series Rules”*, (Denver, Colorado: Colorado Department of Natural Resources, Colorado Oil and Gas Conservation Commission, 2017).

<sup>9</sup> The line is to be cut off below grade at the lesser of 3 feet below the ground surface or at the depth of the flowline and sealed as described in the NTO.

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On September 8, 2017, the COGCC initiated rulemaking to strengthen flowline regulations and to enhance 8-1-1 programs for natural gas operations, which was finalized on March 8, 2018.<sup>10</sup> The new regulations applied to all pipelines used for “transferring oil, gas, or condensate between a wellhead and processing equipment to the load point or point of delivery...” such as the return and flowlines involved in this accident.

The new regulations for natural gas operations established requirements for better pipeline integrity management practices because operators are required to “integrity test all new or repaired flowline and crude oil transfer line segments prior to putting them into service and periodically thereafter until the lines are abandoned.”<sup>11</sup> The regulations also established requirements for better pipeline abandonment practices by specifying that all flowlines and crude oil transfer lines are considered active until the line has been abandoned properly; operators are required to conduct periodic integrity tests on all active lines.

On April 16, 2019, the governor of Colorado signed Senate Bill 19-181 into law, requiring the COGCC to undertake additional rulemakings to improve flowline and leak detection requirements, as well as to improve site analysis requirements. This law also amended Colorado’s Oil and Gas Conservation Act.<sup>12</sup>

## Probable Cause

The National Transportation Safety Board determines that the probable cause of the explosion and fire at the Firestone, Colorado, residence was the ignition of fugitive natural gas that had migrated from the Coors V6-14Ji well through a pipeline that was not abandoned by Patina Oil and Gas Corporation and that was most likely severed in 2015 during the construction of the house. Contributing to the accident was the approval by local authorities to allow occupied structures to be built on land adjacent to or previously part of oil and gas production fields without complete documentation from the operator, Anadarko Petroleum Corporation, on the location and status of its gathering system pipelines.

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<sup>10</sup> Colorado Oil and Gas Conservation Commission, *Flowline Rulemaking*, (Denver, Colorado: Colorado Department of Natural Resources, Colorado Oil and Gas Conservation Commission, 2018). <http://cogcc.state.co.us/reg.html#/rules/flowlinerulemaking>. Accessed October 7, 2019.

<sup>11</sup> Colorado Oil and Gas Conservation Commission, *Statement of Basis, Specific Statutory Authority, and Purpose*; “New Rules and Amendments to Current Rules of the Colorado Oil and Gas Conservation Commission,” 2 CCR 404-1; Cause No. 1R Docket No. 171200767, (Denver, Colorado: Colorado Department of Natural Resources, Colorado Oil and Gas Conservation Commission, 2018). <https://assets.bouldercounty.org/wp-content/uploads/2017/04/crestone-exhibit-1-pages-from-cogcc-final-spb-121708.pdf>. Accessed October 7, 2019.

<sup>12</sup> Colorado Oil and Gas Conservation Commission, *Senate Bill 19-181*, (Denver, Colorado: Colorado Department of Natural Resources, Colorado Oil and Gas Conservation Commission, 2019). <https://cogcc.state.co.us/sb19181.html#/overview>. Accessed October 7, 2019.

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For more details about this accident, visit [www.nts.gov/investigations/dms.html](http://www.nts.gov/investigations/dms.html) and search for NTSB accident ID DCA17FP005.

**Report Date: October 18, 2019**

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The NTSB has authority to investigate and establish the facts, circumstances, and cause or probable cause of a pipeline accident in which there is a fatality or substantial property damage, or significant injury to the environment. (49 U.S. Code, Section 1131 - *General authority*)

The NTSB does not assign fault or blame for an accident or incident: rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties...and are not conducted for the purpose of determining the rights or liabilities of any person.” Title 49 *Code of Federal Regulations*, Section 831.4. Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report. 49 U.S. Code, Section 1154(b).

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