Party Submission of

Bobcat Contracting, LLC

To the

National Transportation Safety Board

Atmos Energy Corporation

Natural Gas-Fueled Explosion During Routine Maintenance

Farmersville, Texas

June 28, 2021

Investigation No. PLD21FR002

Submitted March 18, 2022

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I. ACCIDENT SUMMARY

On June 28, 2021, at approximately 3:30 p.m. Central Daylight Time, employees of Bobcat Contracting, LLC (Bobcat) and FESCO, Ltd. (FESCO) inserted an in-line inspection tool (pig) into the D17-9 launcher at the Atmos Energy Corporation (Atmos) facilities near Farmersville, Texas. At approximately 3:35 p.m., Bobcat employees were removing the "push pole" used to insert the pig from the launcher when natural gas ignited, causing the pig to be ejected out through the open launcher door toward employees of Bobcat and FESCO, who were standing outside of the door. Two Bobcat employees were injured, one fatally. Two FESCO employees were also injured, one fatally. Two Atmos employees and another Bobcat employee were working nearby on the same project, but were not injured. An Atmos employee immediately called 911 and aid was rendered to the injured until medical personnel arrived on the scene.

II. FACTUAL INFORMATION

A. Background on Parties and D17 Launcher Operations

Bobcat Contracting, LLC is based in Hillsboro, Texas and has performed a variety of work for the oil and gas industry for over 25 years, including pipeline construction and maintenance, and many other ancillary services.

As of the date of the accident, Atmos Energy Corporation owned and operated approximately 6,733 miles of gas transmission pipelines, primarily in Texas.[1] The work being performed at the time and place of the accident was part of what was designated as "project 423" and included pigging about 21 miles of 24-inch outer diameter pipe on line D17 from the D17-9 junction in Farmersville, Texas to Rockwall, Texas between June 21, 2021 and July 2, 2021.[2]

Bobcat was hired by Atmos to load, track and receive pigs that were run between the D17 launcher site near Farmersville, Texas and the Rockwall, Texas receiver site. Their specific duties included:[3]

- Collecting information on each pig run in the Pigging Form Pig Run Log
- Collecting site photos of the work being performed
- Ensuring access to the launcher to load pigs and providing the push bar
- Installing new batteries in the transmitter and installing the transmitter in the pig
- Opening the launcher door
- Loading the pig using the excavator
- Pushing the pig into the reduced section of the launcher using the push bar and excavator

Bobcat was not contracted to perform any evaluations to determine whether the configuration as installed would adequately depressurize or remove natural gas from the

[1] Pipeline Operations Factual Report at p. 5.
[2] Pipeline Operations Factual Report at p. 7.
[3] Pipeline Operations Factual Report at p. 8.

launcher prior to opening the launcher door.[4]

FESCO was hired to conduct the flaring operations, including:[5]

- Determining the flaring system/configuration to be used
- Installation of temporary piping to allow the trap to be blown down to the flare stack
- Installing and operating the flaring system

Atmos retained responsibility to oversee the work, including:[6]

- Verifying operator qualifications
- Leading the safety meeting at the launcher
- Verifying the valve configuration
- Overseeing work of contractor employees
- Determining when contractor employees could begin opening the launcher door
- Confirming when the pig is in the correct position
- Purging the launcher with natural gas in preparation for the pig launch scheduled on the following day

At the time of the accident, seven workers were on-site, including:

- Atmos Senior Field Construction Coordinator A (Atmos Sr. FCC A)
- Atmos Senior Field Construction Coordinator B (Atmos Sr. FCC B)
- Bobcat Foreman
- Bobcat Skilled Laborer
- Bobcat General Laborer
- FESCO Project Manager
- FESCO Pipeline Technician

B. Events Prior to the Day of the Accident

Work on project 423 at the accident site started on June 21, 2021 when FESCO installed a portable flaring system at the Junction lot in Farmersville, Texas.[7] The system remained onsite through the date of the accident.[8]

Five pigs were launched from the Junction Lot between June 21, 2021 and June 28, 2021.[9] On Monday, June 21, 2021, workers found that the mainline valve at the site was leaking

[4] Pipeline Operations Factual Report at p. 8, fn. 14.
[5] Pipeline Operations Factual Report at pp. 8-9.
[6] Pipeline Operations Factual Report at p. 9.
[7] Pipeline Operations Factual Report at p. 14.
[8] Id.
[9] Id.

and the flare did not extinguish as expected when the valve was closed.[10] Atmos directed the workers to adjust the position of the valve and were able to find a position where the leak stopped, or at least reduced enough that the flare extinguished.[11] The workers marked that valve position and did not have any problems with the flare not extinguishing during subsequent pig runs, including on the day of the accident.[12]

C. Weather on the Day of the Accident

Weather at the approximate time and place of the accident was reported as light southeasterly winds, light to heavy rain showers and mist, with mostly cloudy to overcast cloud cover.[13] The temperature was between 74° and 75° F, with 100% relative humidity.[14] The high temperature of 87° F occurred near noontime.[15] The total precipitation reported that day was 0.51 inches.[16] No cloud-to-ground lightning strikes were recorded within 15 miles of the accident site during the period workers were onsite.[17]

The Bobcat Skilled Laborer onsite stated that when he arrived, it was pouring rain.[18] When they unloaded the pig it was drizzling, so they set-up an umbrella and prepared the pig underneath it.[19] It was raining the whole time slightly on and off.[20] When they were still preparing the pig, the rain was heavy. He did not recall any lightning.[21] The Bobcat Foreman stated that the rain intensity increased when they started opening the launcher door.[22] The Atmos Sr. FCC A stated that he checked the radar and it looked like they would have a window to complete their work before heavier rain started again.[23] He also stated that the rain began to increase while they were waiting for the flare to go down.[24] Neither the FESCO Pipeline Technician nor the Bobcat Skilled Laborer recalled any lightning.[25]

D. Events on the Day of the Accident

On the day of the accident, the Bobcat crew loaded a gauge pig in preparation for the sixth run in the series of pig runs required under project 423.[26] The first five runs had been completed without incident in the week prior to the accident.[27]

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[10] Pipeline Operations Factual Report at p. 15.
[11] Id.
[12] Id.
[13] Meteorology Specialist's Factual Report at p. 6
[14] Id.
[15] Id.
[16] Meteorology Specialist's Factual Report at pp. 5-6.
[17] Meteorology Specialist's Factual Report at p. 12.
[18] Human Performance Factual Report at p. 11.
[19] Id.
[20] Id.
[21] Id.
[22] Id.
[23] Id,
[24] Id.
[25] Id.
[26] Id.
[27] Id.

When workers arrived, the launcher was pressurized from the early morning pig launch and had to be depressurized prior to opening the launcher door.[28] The pressure in the launcher was not measured, but was expected to be about the same as the natural gas transmission system pressure at the time of the pig launch.[29] Line D17 was in full operation at that time, with approximately 628-pounds-per-square-inch-gauge (psig) of pressure.[30]

FESCO personnel used their portable flare system to depressurize the launcher.[31] After Atmos personnel gave approval to begin flaring, the FESCO Project Manager operated the igniter and the FESCO Pipeline Technician operated the valve connected to the flare flow line.[32] It was opened to allow natural gas from the launcher to flow through the flare flow line and up the flare stack.[33] That valve and the equalizer valve were the only valves open. Heavy rain at the time created difficulty in igniting the flare stack, but after several minutes it ignited.[34] As the natural gas pressure in the launcher decreased and less natural gas flowed to the flare tip, the flame died down and appeared to extinguish.[35]

The Bobcat Foreman recalled that, after getting approval from Atmos, he and the Bobcat Skilled Laborer opened the launcher door.[36] When the launcher door was opened, none of the workers interviewed observed any indication of pressure on the launcher door.[37] The Bobcat Skilled Laborer did not recall any audible sound or indication that gas was still present in the launcher when the door was opened.[38] Likewise, the FESCO Pipeline Technician indicated that he was right near the door while it was being opened, and he did not notice any pressure pushing on the door as it was being opened.[39] None of the workers who were interviewed smelled natural gas when the launcher door was opened.[40]

The Bobcat Foreman used an excavator (track hoe) to lift the pig after the launcher door was opened.[41] Once it was loaded into the launcher opening and the straps were removed, the Bobcat Foreman reversed the excavator back out of the way so the pig could be manually pushed into the launcher by hand using a push pole.[42]

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[28] Pipeline Operations Factual Report at p. 17.
[29] Id.
[30] Pipeline Operations Factual Report at p. 10.
[31] Pipeline Operations Factual Report at p. 17.
[32] Id.
[33] Id.
[34] Atmos Sr. FCC A, Interview at p. 11, lines 21-25.
[35] Pipeline Operations Factual Report at p. 17.
[36] Pipeline Operations Factual Report at p. 18.
[37] Id.
[38] Id.
[39] Id.
[40] Bobcat Laborer, Interview at p. 14; Atmos Sr. FCC A, Interview at p. 31; Bobcat Foremen, Interview at p. 45, lines 13-14; Atmos Sr. FCC B, Interview at pp. 18-19.
[41] Pipeline Operations Factual Report at p. 18.
[42] Id.

The Bobcat Skilled Laborer attached one end of the grounding cable to the launcher's exterior and the other end to the push pole.[43] The Bobcat laborers, assisted by FESCO workers, used the push pole to manually insert the pig into the launcher as far as they could do so manually.[44] The workers then held the push pole and guided the excavator in.[45] The excavator then put its bucket on the push pole and began to push.[46] The Atmos Sr. FCCs monitored the pig's position as the excavator was used to further insert the pig.[47] Atmos Sr. FCC A visually observed the open end of the launcher while Atmos Sr. FCC B monitored the pig's position by listening for a sound as the pig contacted the reducer.[48]

After the pig was inserted to the correct location as determined by the Atmos FCCs, the push pole was manually removed from the launcher. [49] As the push pole pulled away from the pig, it fell to the bottom of the launcher barrel (which is normal).[50]

The FESCO Pipeline Technician indicated that he had the lifting strap in his hand, took one step to put the strap on the ground and the explosion occurred.[51] He indicated that he blacked out when he hit the ground and did not see how far the push pole had been pulled out. [52]

The Bobcat Skilled Laborer indicated that he observed that the push pole was on the very edge of the launcher, about to be pulled off.[53] He indicated that he still held onto the bonding cable as he was pushed up into the air before landing face down on the ground.[54]

The Atmos Sr. FCC A recalled that the push pole had been about halfway out when the flash occurred and blew the pig back out.[55]

The explosion resulted in fatal injuries to the FESCO Project Manager and the Bobcat General Laborer.[56] It also resulted in injuries to the Bobcat Skilled Laborer and a FESCO Pipeline Technician.[57]

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[43] Pipeline Operations Factual Report at p. 19.
[44] Id.; Bobcat Laborer, Interview at p. 17, lines 6-11; Bobcat Foreman, Interview at p. 36, lines 23-25 and p. 47, lines 24-25.
[45] Pipeline Operations Factual Report at p. 19.
[46] Id.
[47] Id.
[48] Id.
[49] Id.
[50] Id.
[51] Id.
[52] Id.
[53] Id.
[54] Id.
[55] Id.; Atmos Sr. FCC A, Interview at p. 64, line 13.
[56] Pipeline Operations Factual Report at p. 19.
[57] Id.

E. Post-Accident Investigation

1. Post-Accident Site Examination

Upon inspection of the scene after the incident, an ATMOS technician using a Remote Methane Leak Detector (RMLD), found gas to be flowing from the flare stack, which was attached to an open 2" valve on the D17 launcher with the main line valve in the closed position and the launcher door closed.[58] The 4" kicker valve was in the closed position.[59] The equalizer valve was in the open position.[60] The push pole was found lying on the ground directly between the launcher and the excavator near the launcher door with the end cap missing, the bolt holding the sections together sheared off, and the far end of the pole bent.[61] Upon inspection of the excavator, a mark was found on the body of the excavator between the tracks that matched the bent end of the push pole.[62]

The NTSB investigation team conducted flow testing and a visual inspection of the accident site in its as-found condition. Pressure in the launcher was measured at Valve 4 and recorded as 0.2 psig.[63] Steady state flow through a 1/8" diameter orifice plate was observed to be 9 inches water column, which equates to a gas flow rate of 1590 cubic feet per day.[64] The flare stack ignited without difficulty, fueled by natural gas that was venting from the pig launcher.[65] Flames were visible throughout a 20-minute hold.[66]

2. Mainline Valve Examination

The mainline valve was leak tested and inspected after the accident. Gas seat leak testing revealed that the mainline valve leaked from the pipeline side of the valve at a volumetric gas leak rate of 22 liters per minute (LPM), which converts to 0.77 Cubic Feet per Minute (CFM), or 1,118 Cubic Feet per Day (CFD) at 640 psig.[67] It leaked from the launcher end of the valve at a volumetric gas leak rate of 1.15 CFM or 1,656 CFD at 640 psig.[68]

A visual inspection of the launcher and pipe ends of the valve revealed that the ball contained evidence of circumferential gouge marks that were oriented in the horizontal direction.[69] Disassembly of the valve revealed metallic debris embedded within the O-ring for the outer seat ring.[70] Mechanical damage in the form of scratches was found on the seat face

[58] Pipeline Operations Factual Report at p. 21.
[59] Pipeline Operations Factual Report at p. 22.
[60] Pipeline Operations Factual Report at p. 20.
[61] Pipeline Operations Factual Report at p. 21 and Figure 6.
[62] Pipeline Operations Factual Report at p. 21.
[63] Pipeline Operations Factual Report at p. 22.
[64] Id.
[65] Id.
[66] Id.
[67] Materials Laboratory Factual Report 21-094 at p. 5.
[68] Id.
[69] Materials Laboratory Factual Report 21-094 at p. 3.
[70] Materials Laboratory Factual Report 21-094 at p. 7.

sealing surfaces on both the launcher end and the pipeline end seat rings.[71] The scratches extended across both the metallic and soft (O-ring) sealing surfaces.[72] The ball contained damage in the form of scratches in areas that corresponded to those found at the seat face sealing surfaces.[73]

3. Flammability Conditions

The NTSB Office of Research and Engineering, Materials Laboratory Division, examined the steps of the pig loading procedure and the flammability conditions within the launcher during that procedure.[74] A computational fluid dynamics software package was used to model the movement of natural gas and air through the launcher barrel, valves, and piping.[75] The modeling created representations of the launcher, launcher door, flare stack piping, and equalizer piping.[76]

Scenario 1 was representative of the actual venting configuration on the day of the accident.[77] The flaring system is used to de-pressurize and burn off the escaping natural gas while all other valves are closed.[78] The model showed that regardless of the flaring time allowed, the concentration of natural gas within the launcher barrel would have remained at or near 100% natural gas.[79]

Atmos Sr. FCC A estimated that the time between the launcher door being opened and the accident was approximately 10 minutes.[80] At 10 minutes into the Scenario 1 simulation, the vertical section of the flare stack piping is filled primarily with air, while the horizontal section of the flare stack piping concentrations of natural gas that range from 100% at the launcher end and something approaching the flammability limits where the vertical and horizontal flare stack pipes come together.[81]

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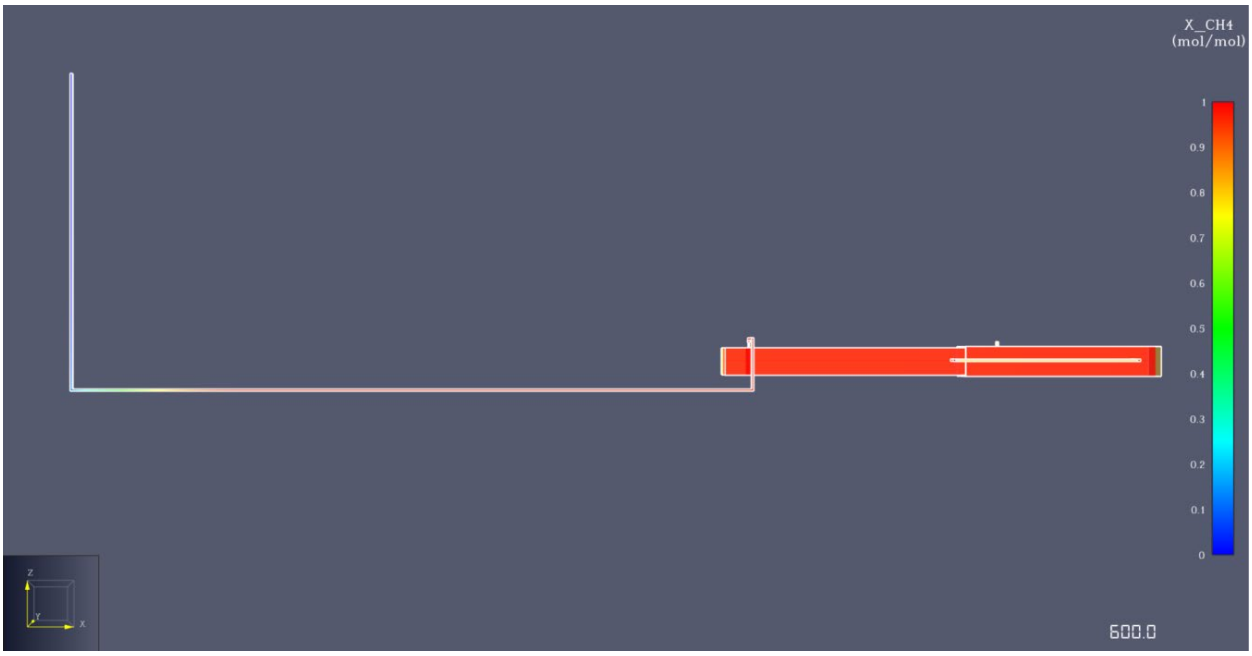
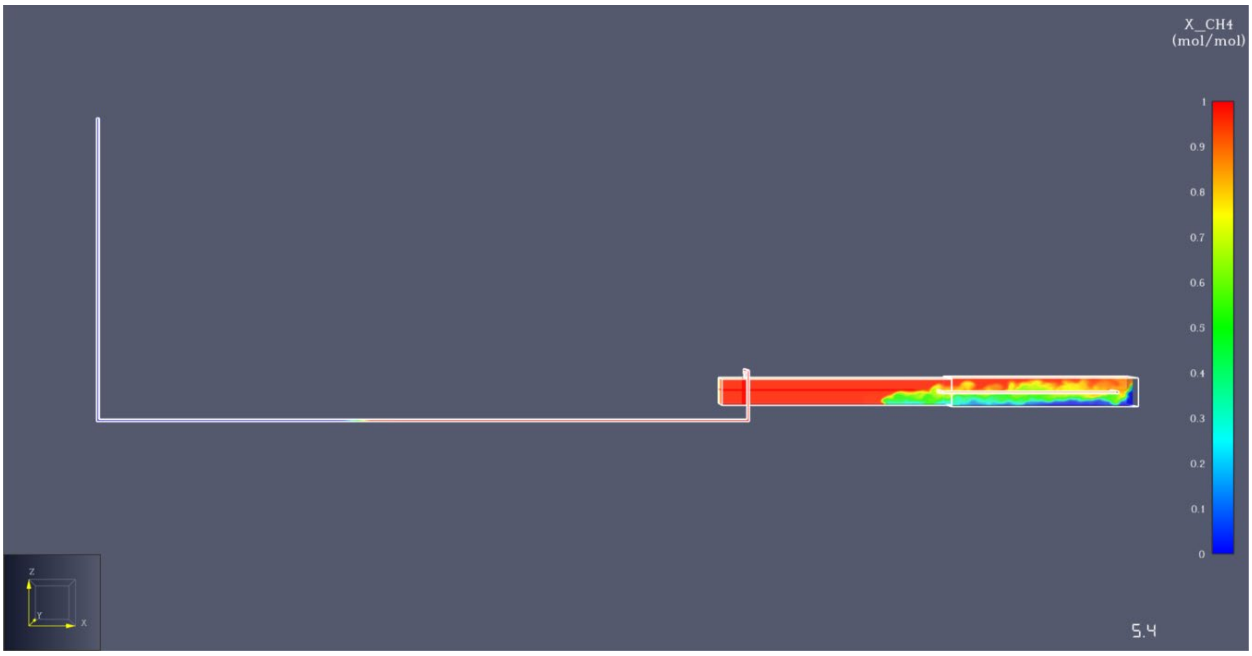
[71] Id.
[72] Id.
[73] Id.
[74] Materials Laboratory Study Report 21-098S at p. 1.
[75] Id.
[76] *See* Materials Laboratory Study Report 21-098S at pp. 4-5.
[77] Materials Laboratory Study Report 21-098S at p. 5.
[78] Id.
[79] Id.
[80] Atmos Sr. FCC A, Interview at p. 46, lines 5-6.
[81] *See* Materials Laboratory Study Report 21-098S at p. 9, Figure 4.



Materials Laboratory Study Report 21-098S, Figure 4: Scenario 1 at 600 seconds. (Side view.)

Scenario 5 of the modeling examined the rate of venting when the launcher door is opened.[82] It assumes a worst-case scenario of the launcher barrel and flare piping being full of natural gas.[83] In this scenario, air rapidly enters the barrel along the bottom of the launcher door's cross section while natural gas escapes along the top of the open door's cross section.[84] Air is also flowing down the flare stack piping and into the launcher barrel.[85]

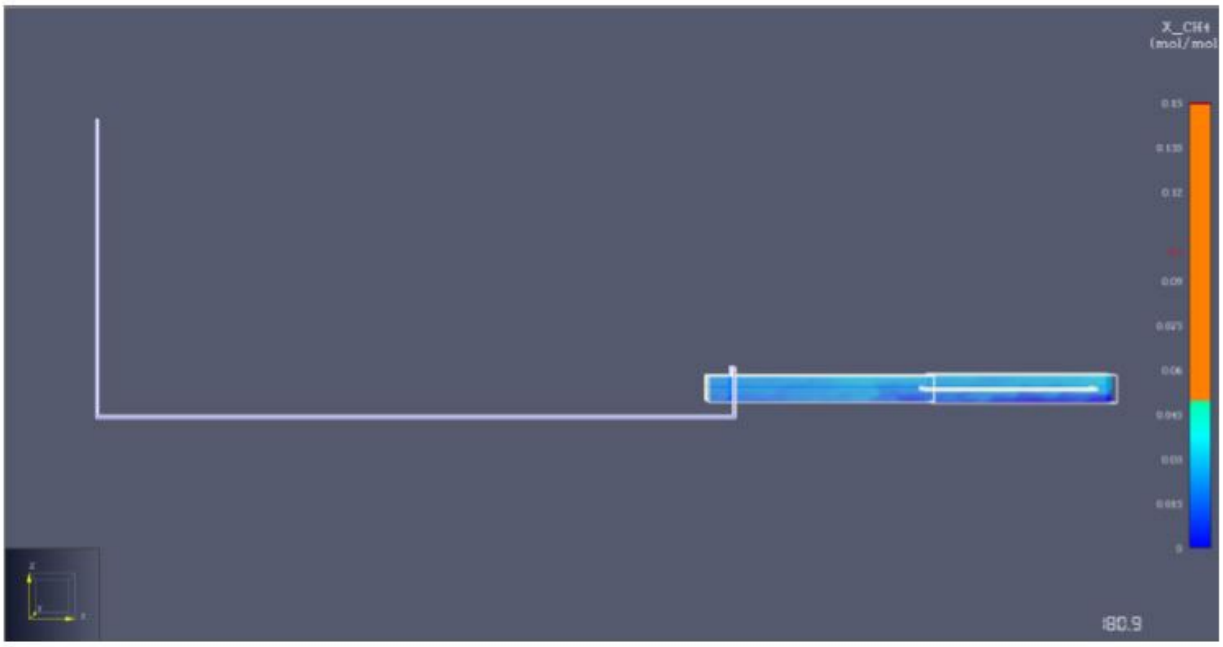
[82] Materials Laboratory Study Report 21-098S at p. 6.
[83] Id.
[84] Id.
[85] Id.



Materials Laboratory Study Report 21-098S, Figure 7: Scenario 5 at 5.4 seconds after the launcher door was opened. (Side view.)

At 60 seconds after door opening, the concentration of the natural gas in the launcher falls into the flammable limits (5-15%).[86] At 120 seconds, the flammable concentrations of natural gas are limited to areas along the top of the launcher barrel.[87] At 180 seconds, there are no longer any areas of flammable gas concentration in the launcher.[88]

[86] Id.
[87] Id.
[88] Id.



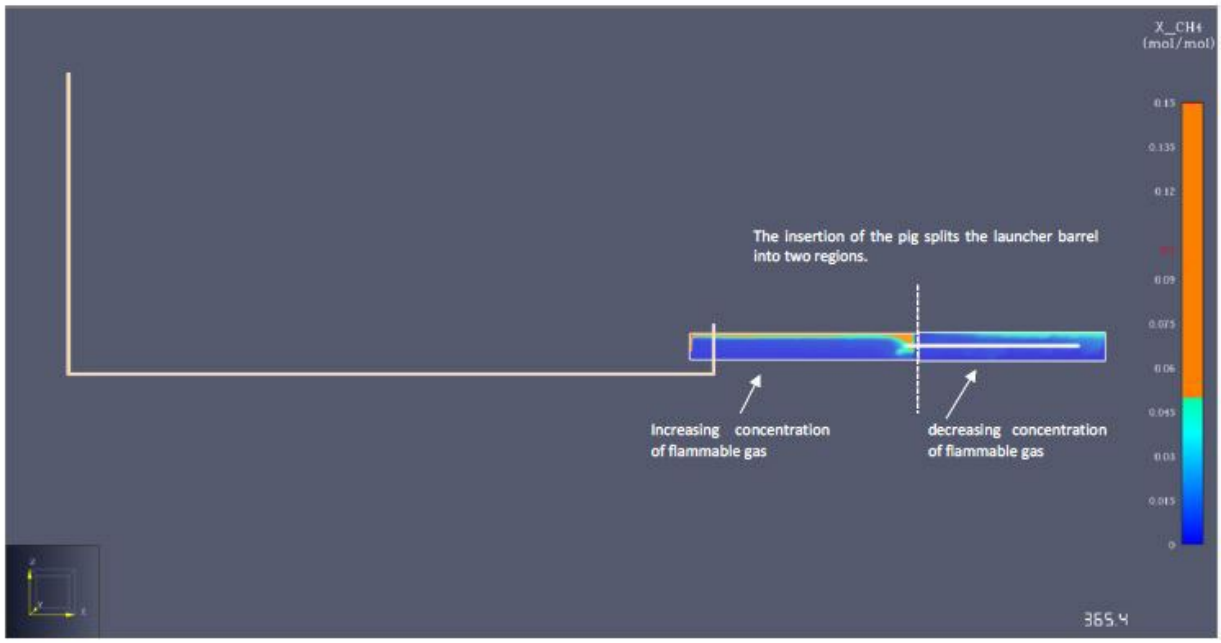
Materials Laboratory Study Report 21-098S, Figure 10: Scenario 5 at 180 seconds. No more flammable regions exist within the launcher barrel. (Side view.)

Scenario 6 of the modeling closely replicates the conditions that existed as the pig was being inserted into the launcher.[89] This scenario includes modeling of the mainline valve leak that was measured on-site to evaluate the rate of formation of a flammable atmosphere inside the launcher barrel.[90] As the pig is being inserted, it effectively splits the launcher barrel into two sections that only communicate via the equalizer piping.[91] This scenario sought to evaluate whether the flammable atmosphere would extend to the section of the launcher barrel with the loading door.[92]

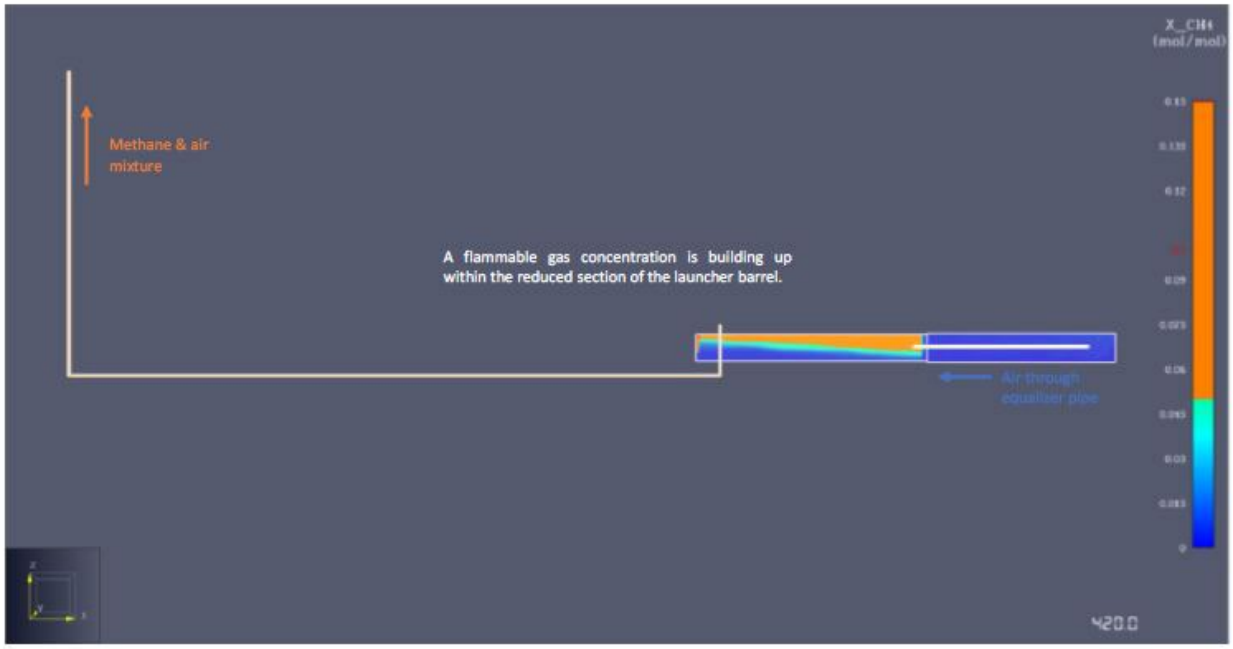
Once the pig was introduced, the concentration of natural gas began to increase substantially within the reduced section of the launcher barrel and decrease (dissipate) substantially in the open section of the launcher barrel.[93] At one minute after the insertion of the pig, a large portion of the reduced section was within the flammable range while the open section of the launcher barrel did not contain flammable regions.[94] At ten minutes, regions along the top of the reduced section and the flare line began to exceed the upper flammable limits.[95] Examination of the direction of flow of gasses through the equalizer piping indicate that air was traveling from the open end of the launcher barrel towards the reduced section of the launcher barrel.[96] Examination of the flow of gas through the flare piping indicated that the gas mixture in the reduced section of the launcher barrel was flowing through the flare piping and out to the

[89] Id.
[90] Id.
[91] Id.
[92] Id.
[93] Materials Laboratory Study Report 21-098S at p. 7.
[94] Id.
[95] Id.
[96] Id.

atmosphere.[97]

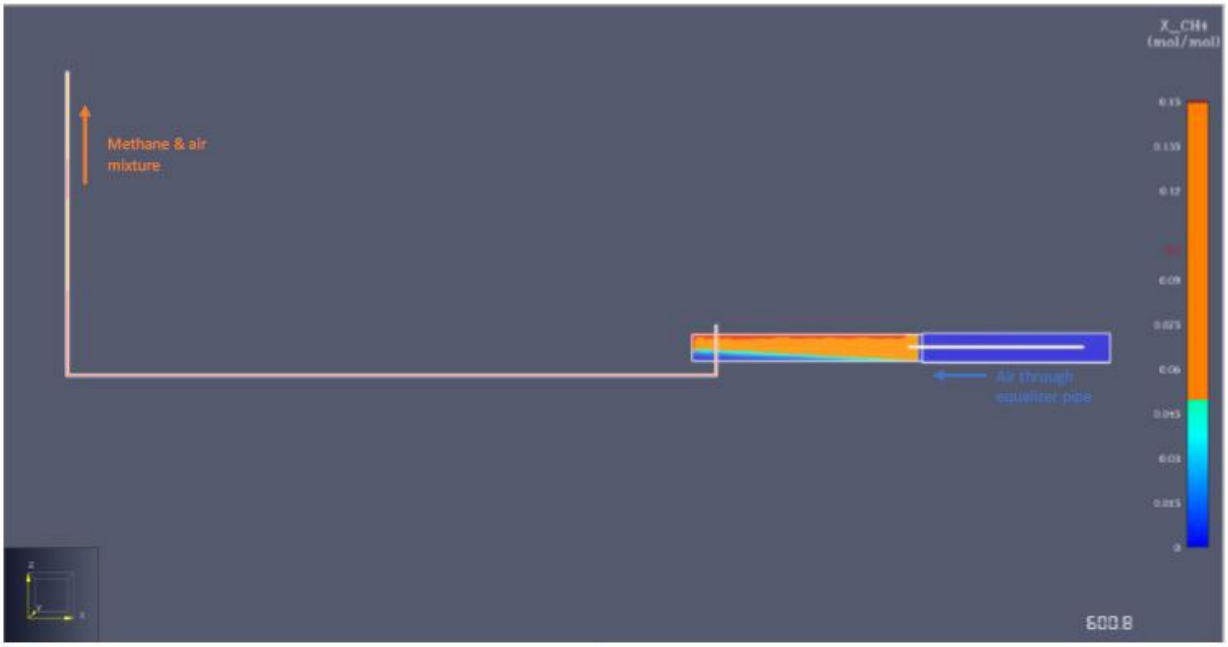


Materials Laboratory Study Report 21-098S, Figure 13: Scenario 6 at 365 seconds. The pig has just been introduced effectively splitting the launcher barrel into two regions joined only by the equalizer piping. (Side view.)



Materials Laboratory Study Report 21-098S, Figure 14: Scenario 6 at 420 seconds. This is 60 seconds after the pig was introduced. (Side view.)

[97] Id.



Materials Laboratory Study Report 21-098S, Figure 15: Scenario 6 at 600 seconds. (Side view.)

III. ANALYSIS

A. A Flammable Atmosphere Was Created Between the Pig and the Mainline Valve, as well as in the flare stack piping, by a Leaking Mainline Valve

Post-accident testing revealed that the mainline valve leaked from the pipeline side of the valve at a volumetric gas leak rate of 22 liters per minute (LPM), which converts to 0.77 Cubic Feet per Minute (CFM), or 1,118 Cubic Feet per Day (CFD) at 640 psig. A visual inspection of the launcher and pipe ends of the valve revealed that the ball had circumferential gouge marks that were oriented in the horizontal direction. Mechanical damage in the form of scratches was found to the seat face sealing surfaces on both the launcher end and the pipeline end seat rings. The scratches extended across both the metallic and soft (O-ring) sealing surfaces. The ball contained damage in the form of scratches in areas that corresponded to those found at the seat face sealing surfaces. These finding are consistent with foreign debris damage.

Modeling performed by the NTSB Office of Research and Engineering, Materials Laboratory Division revealed the flammability conditions within the launcher during the flaring, launcher door opening and pig loading processes. Scenario 1 shows that the flaring system used to de-pressurize and burn off escaping natural gas results in a concentration of natural gas within the launcher barrel at or near 100% natural gas at the end of the process. After 10 minutes, the vertical section of the flare stack piping is filled primarily with air, while the horizontal section of the flare stack piping concentrations of natural gas that range from 100% at the launcher end and something approaching the flammability limits where the vertical and horizontal flare stack pipes come together. (See Figure 4 of the Materials Laboratory Factual Report.)

When the launcher door is opened, Scenario 5 of the modeling shows that air rapidly enters the barrel along the bottom of the launcher door opening while natural gas (which is lighter than air) escapes along the top of the open door opening. After 60 seconds, the concentration of the natural gas in the launcher falls into the flammable limits (5-15%). At 120 seconds, the flammable concentrations of natural gas are limited to areas along the top of the launcher barrel. At 180 seconds, there are no longer any areas of flammable gas concentration in the launcher. (See Figures 7 and 10 of the Materials Laboratory Factual Report.)

Scenario 6 of the modeling closely replicates the conditions that existed as the pig was being inserted into the launcher, including the existence of a leak in the mainline valve. When the pig is inserted into the launcher, it effectively splits the launcher barrel into two sections, the pipeline side and the open side. These two sections are connected only by the equalizer piping.

The direction of flow through the equalizer piping was from the open side of the pig toward the pipeline side of the pig. This flow through the equalizer piping can be explained by the "stack effect" which results from a low-density gas (natural gas) flowing through the flare stack piping and up through the flare stack. This flow draws air and natural gas from the mainline valve side of the launcher as well as from the equalizer piping.

As a result of this, the concentration of natural gas increases substantially on the pipeline side when the pig is inserted into the launcher barrel and quickly reaches a flammable level. The concentration of natural gas on the open side of the pig decreases substantially and never reaches a flammable concentration. Significantly, the concentration of natural gas in the flare line also reaches a flammable concentration. (See Figures 12-15 of the Materials Laboratory Factual Report.)

This modeling makes clear that the only two areas with a flammable concentration of natural gas were the launcher barrel between the pig and the mainline valve and the flare stack piping. The launcher between the pig and the open end remain below the flammable range. Likewise, the flow through the equalizer piping is toward the pipeline side of the pig, so it would have been flowing air that did not contain a flammable concentration of natural gas.

B. The Push Pole and Grounding Cable Were Not Factors in This Accident

The buildup of static electricity has long been understood to pose an ignition hazard under certain conditions in the presence of a flammable concentration of natural gas. One of the precautions that is taken in the pipeline industry is to ensure proper bonding of instruments that are capable of storing or conducting static electricity. In this case, Bobcat took precautions to ensure that the push pole used during this event was bonded to the body of the launcher.

Static electricity from the push pole can be ruled out as a causal factor in this accident for several additional reasons. First, as discussed above, there was not a flammable concentration of natural gas between the open end of the launcher and the pig. Even if there were some natural gas in that section, it would have been located in the top of the launcher barrel and not at the bottom of the launcher where the push pole was being extracted at the time of the explosion.

Second, the weather at the time of the accident was moderate rain showers. The humidity was at or near 100 percent. It has long been understood that as relative humidity rises, electrostatic charges become effectively neutralized. One study showed that static charges are effectively neutralized above a relative humidity of 76 percent.[98] In addition, the workers, their clothing and their tooling/equipment were all soaking wet from the rain, which also made the generation of a static charge highly unlikely.

Third, even if the push pole contained a static charge, when it dropped from the back of the pig to the pipeline, as witnesses stated,[99] it would have immediately bonded to the pipeline and transferred any static charge it contained. The explosion occurred well after that point. These factors strongly suggest that a static electrical discharge was not the ignition source here.

Likewise, the push pole itself can be ruled out as the ignition source for several reasons. As discussed above, there was not a flammable atmosphere in the opening side of the pig, especially along the bottom of the launcher where the push pole was being extracted. While the push pole did fall to the bottom of the launcher when it was being removed, as is normal, there were several seconds between the time the pole hit the launcher and the time of the explosion. Also, the kinetic energy needed to create a spark simply did not exist here. The largest force would have been when the push pole first dropped to the bottom of the launcher tube, yet we know the explosion came after that contact. Even if the push pole were dragged across the bottom of the launcher tube or contacted it during removal, it is highly-unlikely that kinetic energy sufficient to cause a spark would occur.

For all of these reasons, the push pole and grounding cable were not factors in this accident.

C. The Source of Ignition Most Likely Came From the Flare Stack Piping

By process of elimination, the ignition source must have originated in the flare stack piping. As discussed above, the only areas that contained a flammable atmosphere were the launcher between the pig and the mainline valve and the flare stack piping. The launcher between the pig and the opening did not contain a flammable level of natural gas. The equalizer piping would not have contained natural gas because the flow was from the open end of the launcher to the pipeline end of the launcher.

Also, the intake of the equalizer piping was located approximately midway between the top and the bottom of the launcher tube, immediately adjacent to the open door, so it would not have contained any possible remnants of natural gas that may have been flowing out the top of the launcher opening. Even if there was flow through the equalizer piping from the pipeline end of the launcher back to the open end, any natural gas that entered through the equalizer piping would have risen and flowed out the top of the launcher door.

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[98] Effects of humidity, conveying velocity, and particle size on electrostatic charges of glass beads in a gaseous suspension flow, Journal of Electrostatics, S. Nieh and T. Nguyen, Department of Mechanical Engineering, The Catholic University of America.

[99] *See*, for example, Atmos Sr. FCC A, Interview at p. 64, lines 5-6.

There was also no flow path for an ignited gas mixture to have traveled from the open side of the launcher to the pipeline side of the launcher. The pig itself did not contain any pathways between the opening side of the pig and the pipeline side of the pig. While the equalizer piping supported some flow toward the pipeline side of the pig, its intake was midway between the top and bottom of the launcher, right next to the opening, and would not have been in a position to support the flow of an ignited gas mixture originating within the launcher.

The flare stack piping, on the other hand, would have had a flammable concentration of natural gas at various points between the launcher end of the piping and the flare stack. (See Figures 14-15 of the Materials Laboratory Factual Report.)

Significantly, there does not appear to have been a flame arrester installed in the flare stack or associated piping. The lack of a flame arrester provided a potential flow path for an ignited gas mixture to travel from the flare stack piping into the mainline valve side of the launcher.

While it is impossible to precisely determine the source of the ignition, it must have been introduced through the flare stack piping. It may have been hot surface ignition from a glowing ember or debris from the pipeline cleaning, a superheated metallic shaving, or even a malfunctioning flare stack ignitor. It is also possible that the flame on the flare stack appeared to have extinguished, but due to heavy rain obscuring the flare stack or masking the flame, there was still active combustion at the flare stack or inside the flare stack piping.

D. Bobcat's Role was Limited to Loading, Tracking and Receiving the Pigs

The Atmos Field Contractor Coordinators were responsible for overseeing the entire pigging operation, including the pigging operations on the day of the accident. FESCO was hired by Atmos for the flaring operation to flare off the gas in the launcher to zero pressure. Bobcat was hired by Atmos to load, track and receive the pigs. During the pigging operations, all parties involved were required follow Atmos' Appendix R-Loading and Launching a Pig procedure, which is part of the Atmos Pipeline Integrity Management Plan.

The scope of duties was understood by the Bobcat employees involved, and is reflected in the witness interviews conducted by the NTSB. Bobcat was not contracted to perform any evaluations to determine whether the configuration as installed would adequately depressurize or remove natural gas from the launcher prior to opening the launcher door or as the pig was being loaded.

IV. FINDINGS AND CONCLUSIONS

1. Bobcat was responsible only for loading, tracking and receiving pigs that were run between the D17-9 launcher site near Farmersville, Texas and the Rockwall, Texas receiver site.

2. Bobcat was not contracted to perform any evaluations to determine whether the configuration as installed would adequately depressurize or remove natural gas from

the launcher prior to opening the launcher door or as the pig was being loaded.

3. FESCO was hired to perform the flaring operations, including determining the flaring configuration to be used, installation of flare stack piping and operating the flaring system.

4. Atmos retained responsibility to oversee the work, including verifying operator qualifications, leading safety meetings, verifying the valve configuration, overseeing work of contractor employees, determining when contractor employees could begin opening the launcher door, confirming when the pig is in the correct position and purging the launcher with natural gas in preparation for pig launches.

5. FESCO installed a portable flaring system at the D17-9 Junction in Farmersville, Texas.

6. FESCO personnel used their portable flare system to depressurize the launcher just prior to the accident.

7. The FESCO flare stack and associated piping did not contain a flame arrester to prevent propagation of flames originating in the flare stack or piping.

8. Atmos personnel gave direction to Bobcat personnel to open the launcher door.

9. There were no indications of pressure inside the launcher or a natural gas leak when the launcher door was opened.

10. The loading of the pig was routine and consistent with prior pig launches and Atmos' Appendix R- Loading and Launching a Pig procedure.

11. The mainline valve was closed at the time of the accident, but was leaking natural gas into the launcher and flare stack piping.

12. There was a flammable concentration of natural gas in the launcher between the pig and the mainline valve at the time of the accident.

13. There was a flammable concentration of natural gas in the flare stack piping at the time of the accident.

14. There *was not* a flammable concentration of natural gas in the launcher between the pig and the launcher opening at the time of the accident.

15. There *was not* a flammable concentration of natural gas in the equalizer piping at the time of the accident.

16. Flow through the equalizer piping was from the open end of the launcher toward the mainline valve.

17. Removal of the push pole was consistent with prior pig launches.

18. Contact of the push pole with the inside of the launcher could not have served as the ignition source.

19. Weather at the approximate time and place of the accident was light southeasterly winds, light to heavy rain showers and mist, with mostly cloudy to overcast cloud cover.

20. The temperature and humidity at the approximate time and place of the accident was between 74° and 75° F, with 100% relative humidity.

21. Buildup of a static charge under these weather conditions was highly unlikely.

22. The workers, their clothing and their tooling/equipment were all soaking wet from the rain, which also made the generation of a static charge highly unlikely.

23. An ignition source was most likely introduced through the flare stack piping.

V. PROBABLE CAUSE

The probable cause of this accident was the introduction of a flammable concentration of natural gas between an inline gauge tool and a natural gas pipeline created by a leaking mainline valve. A contributing cause of this accident was an ignition source of unknown origin, most likely introduced through the flare stack piping system.