Issued: October 19, 2022 Pipeline Investigation Report: PIR-22/03

Atmos Energy Corporation Natural Gas–Fueled Explosion During Routine Maintenance

Farmersville, Texas
June 28, 2021

1. Factual Information

1.1 Accident Summary

On June 28, 2021, about 3:35 p.m. local time, a natural gas explosion occurred during routine maintenance activities at an Atmos Energy Corporation (Atmos) facility near Farmersville, Texas.[1] The natural gas ignited and exploded after workers inserted an in-line tool (or *pig*) into a launcher.[2] (See figure 1.) Seven workers from Atmos, FESCO, Ltd. (FESCO), and Bobcat Contracting, L.L.C. (Bobcat) were on-site at the time of the accident and performing work for

Figure 1. Pig before the explosion. (Courtesy of Bobcat Contracting.)

[1] (a) For more detailed information about this investigation, see the public docket at https://data.ntsb.gov/Docket/Forms/searchdocket and search for number PLD21FR002. Use the CAROL Query to search safety recommendations and investigations. (b) All times in this report are local time unless otherwise noted.

[2] A *launcher* is the portion of the pipeline facility used to insert *in-line tools*, commonly referred to as *pigs*, into a pipeline. *Pig* is a generic name for a device that is inserted into a pipeline and travels through the pipeline. There are numerous types of pigs used for inspection, cleaning, and separating products in pipelines. In this accident, the pig was a gauging pig for detecting dents or internal obstructions that could cause a pig to become stuck in a pipeline.

Atmos.[3] The explosion occurred while the workers were removing the pig insertion tool during the sixth of a series of in-line inspections.[4] The explosion was directed through the open launcher door, ejecting the pig from the launcher, injuring two of the workers and killing two more. At the time of the accident, the weather was 75°F with light to heavy rain showers. No cloud-to-ground lightning strikes were reported within 15 miles of the accident site. Atmos estimated property damage at the site to be about $580,000.

The five surviving workers described the events leading up to the explosion in interviews with National Transportation Safety Board (NTSB) investigators. Shortly before the explosion, workers used a portable flaring system to vent natural gas from the launcher.[5] A worker opened the 1-inch valve that connected the flare flow line to the launcher and allowed natural gas to vent from the launcher to the flare tip, where it was successfully ignited. (See figure 2.) As natural gas pressure in the launcher decreased and less natural gas flowed to the flare tip, the work crew observed the flame die down and extinguish. The Atmos workers, who were overseeing the contractor personnel, did not expect gas to be leaking from the mainline valve, but they did note in interviews that they thought the flare system would provide a safe path for gas leaking past the mainline valve to vent to atmosphere if any leakage happened to occur.[6] The workers were not using any form of gas monitoring other than observing the flare tip.[7]

[3] Bobcat workers were providing pig loading services and FESCO workers were providing flaring services; Atmos personnel were overseeing the overall in-line inspections and approving each step in the process.

[4] (a) An *insertion tool* is a device used to push a pig into a launcher. In this case, the insertion tool was a 16-foot-long metal pole with a cup welded to the end. (b) Pigs were successfully loaded on June 21, 22, 23, 24, and 27, 2021.

[5] A *portable flaring system* is used to direct natural gas from the launcher through a detachable flare flow line, up a portable stack, and to a flare tip, where it is ignited and burned.

[6] The *mainline valve* is one of two valves between the launcher and the transmission pipeline; the pig passes through the mainline valve to enter the transmission pipeline.

[7] The behavior of the flare tip would not indicate the presence or absence of natural gas, but it would provide information about the pressure of gas in the launcher. As such, it provided useful information but was not a reliable indicator of a safe or hazardous atmosphere at the site.

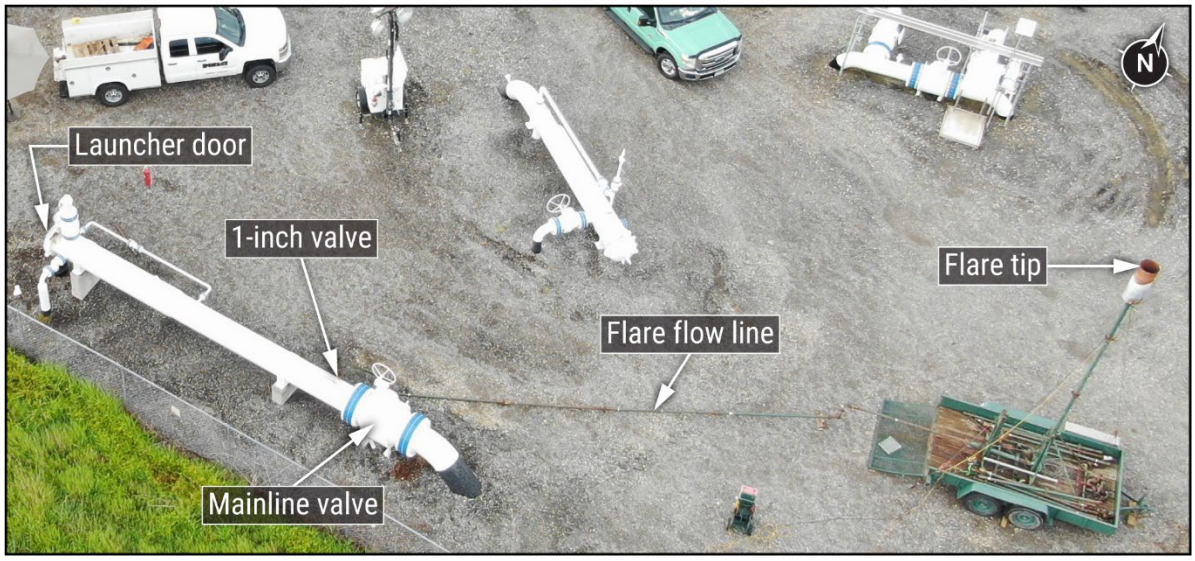

Figure 2. Accident site. (Courtesy of Wylie Fire Department.)

Workers began performing the remaining steps needed to load the pig about 3:28 p.m.: photographing the pig, opening the launcher door, lifting the pig into position with an excavator, attaching a grounding cable to the launcher and insertion tool, manually inserting the pig into the launcher, sliding the pig further into the launcher with the excavator, and removing the insertion tool.[8] Before the insertion tool was completely removed, workers at the site heard a loud sound, and one worker observed a flash near the open launcher door.

An Atmos worker called 9-1-1 at 3:35 p.m. The Collin County Assistant Fire Marshal was the first emergency responder on the scene; he arrived at 3:41 p.m., determined that two of the four injured workers were deceased, and began to assist the two injured survivors. He observed no fire. Other responding agencies included the Farmersville Fire Department, the Texas Department of Public Safety, and the Collin County Sheriff's Office. The Collin County Sheriff's Office took control of the site and documented the accident scene. The Collin County Sheriff's Office also called the Federal Bureau of Investigation to investigate for criminal activity. No criminal activity was found.

1.2 Before the Explosion

Atmos communicated the work requirements for the in-line inspections to representatives from FESCO and Bobcat during a stakeholder meeting on June 15, 2021, and Atmos workers communicated requirements verbally on-site to Bobcat and

[8] A *grounding cable* prevents the buildup of static charge, which can result in sparks.

FESCO workers assigned to this task. Workers were to use Atmos' procedure for loading pigs, and the Bobcat foreman was aware of this procedure. Although each Atmos worker had performed pigging work for no fewer than 8 years, they were not aware of Atmos' pigging-specific procedures, which were formally documented in Appendix R of its *Pipeline Integrity Management Plan* in 2019. (See section 1.6.3 for details on Atmos' pigging procedures.)

On June 21, 2021, Atmos, Bobcat, and FESCO workers began a series of in-line inspections, and FESCO installed a portable flaring system.[9] During the first pig loading in the series, workers suspected that the mainline valve was leaking when the flare did not extinguish as expected.[10] The workers adjusted the position of the mainline valve and found a position where the leak stopped or reduced to the point that the flare extinguished. They marked that position on the valve's exterior and did not have issues with the flare extinguishing during subsequent runs.

1.3 Worker Information

The seven workers from Atmos, FESCO, and Bobcat on-site at the time of the accident had more than 50 years of cumulative pipeline experience. The NTSB's review of company personnel records showed that none of the workers had a history of disciplinary actions related to pipeline safety.

All seven workers had stop work authority, which allowed them to stop work if they had a safety concern. None of the workers expressed a safety concern before the explosion.

1.4 Toxicological Testing

Required post-accident drug and alcohol testing of the three uninjured workers did not detect any alcohol or other tested-for substances.[11] Toxicological testing performed by the Federal Aviation Administration Forensic Sciences Laboratory on

[9] Atmos began using flaring systems to support pig loading and launching activities in February 2021, about 4 months before the explosion, to reduce methane emissions.

[10] Atmos stated that it expected its employees to rely on their experience, training, qualifications, and judgment to determine when reporting potential issues with valves was necessary. Atmos was not aware of any reports of potential issues with the mainline valve in the 10 years before the explosion.

[11] In accordance with Title 49 *Code of Federal Regulations* (*CFR*) 40.85, and as detailed in *49 CFR* 40.87, each of these three workers underwent a post-accident alcohol breath test and a urine drug test for marijuana metabolites, cocaine metabolites, amphetamines, opioids, and phencyclidine (PCP).

specimens from the two injured and two deceased workers did not detect any tested-for substances.[12]

1.5 Postaccident Testing, Examinations, and Modeling

1.5.1 Valve Testing and Examinations

Investigators tested and examined the mainline valve, which was a 24-inch-diameter side-entry ball valve. Pressure testing revealed that the mainline valve was leaking, and examinations found that its sealing surfaces were scratched and gouged. (See figure 3.) This damage created leak paths along the sealing surfaces. The damage was consistent with foreign debris (such as metallic particles) entering the valve from an external source, and the scratches' and gouges' orientations were consistent with wear incurred during normal valve operation. The mainline valve seals were adequately lubricated at the time of the explosion and no abnormal wear was reported. No issues were found with the materials or the process for manufacturing the valve.

[12] The Federal Aviation Administration Forensic Sciences Laboratory tests specimens for a wide variety of substances including toxins, prescription and over-the-counter medications, and illicit drugs; information about these substances can be found at the Civil Aerospace Medical Institute WebDrugs website (https://jag.cami.jccbi.gov/toxicology).

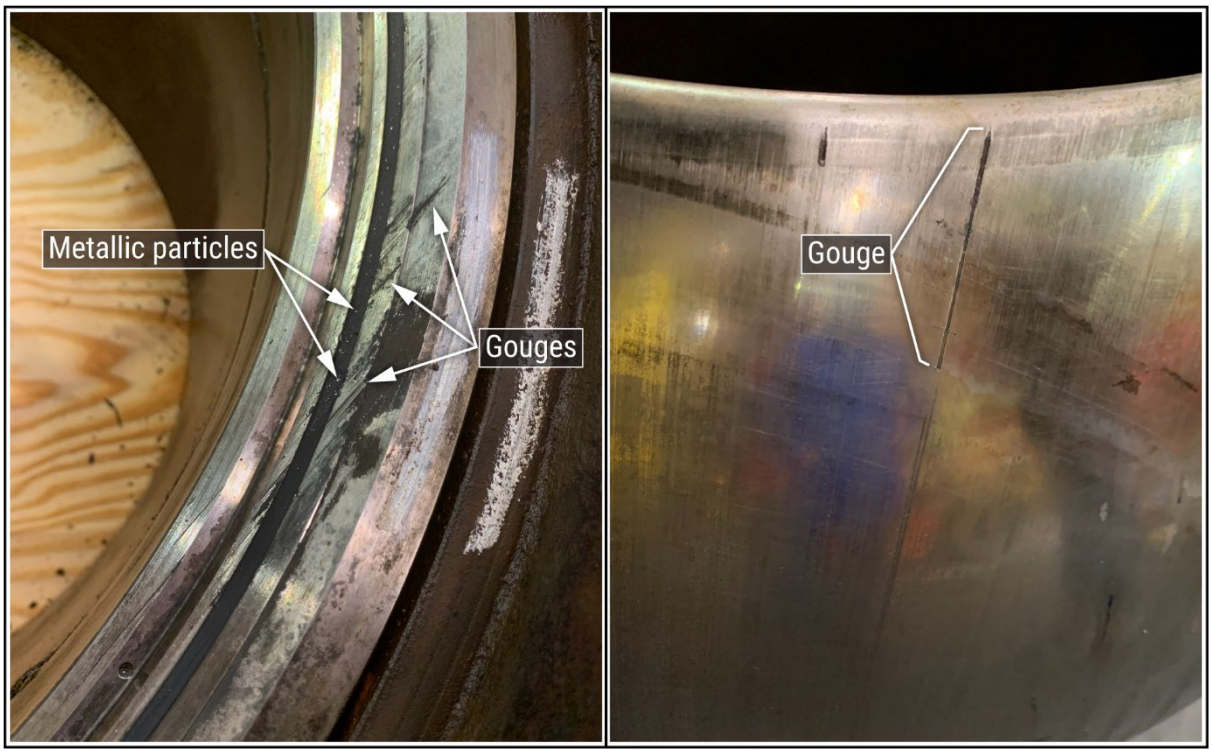

Figure 3. Damaged mainline valve sealing surfaces visible after disassembly into ring (left) and ball (right) components.

Investigators also tested the kicker valve (the only other valve that connected the launcher to Atmos' gas transmission system) and determined that it was not leaking.[13]

1.5.2 Flammability Conditions

The NTSB studied flammability conditions within the launcher by modeling the migration of natural gas through the launcher body, piping, and valves.[14] The results indicated that the concentration of natural gas within the launcher barrel would have remained at or near 100 percent after the flare was extinguished and before opening the launcher door. Once the launcher door was opened, natural gas would have flowed out near the top of the open door and air would have entered near the bottom. As the natural gas was displaced by air, an explosive gas–air mixture would have developed

[13] The *kicker valve* is used to pressurize the launcher after the door is closed, launching the pig into the transmission pipeline.

[14] (a) This modeling was completed using a computational fluid dynamics software package developed by the National Institute for Standards and Technology called Fire Dynamics Simulator. (b) Natural gas is less dense than air when at the same temperature and pressure, so it tends to migrate upward when mixed with a normal atmosphere.

within the launcher, but as long as further natural gas was not introduced, continued venting through the open launcher door would have caused the natural gas concentration to fall below the lower explosive limit within a few minutes.[15]

Insertion of the pig was modeled as a complete blockage within the launcher barrel.[16] When the pig fully obstructs the launcher barrel, the *equalizer piping* (a valved pipe that allows equalization of pressure within the launcher on both sides of the pig) is the only way for gas to move between the launcher barrel sections on either side of the pig. (See figure 4.) Modeling that included the leak from the mainline valve showed that once the blockage was introduced, the concentration of natural gas in the launcher between the pig and open launcher door would have decreased while the concentration between the pig and mainline valve would have increased.

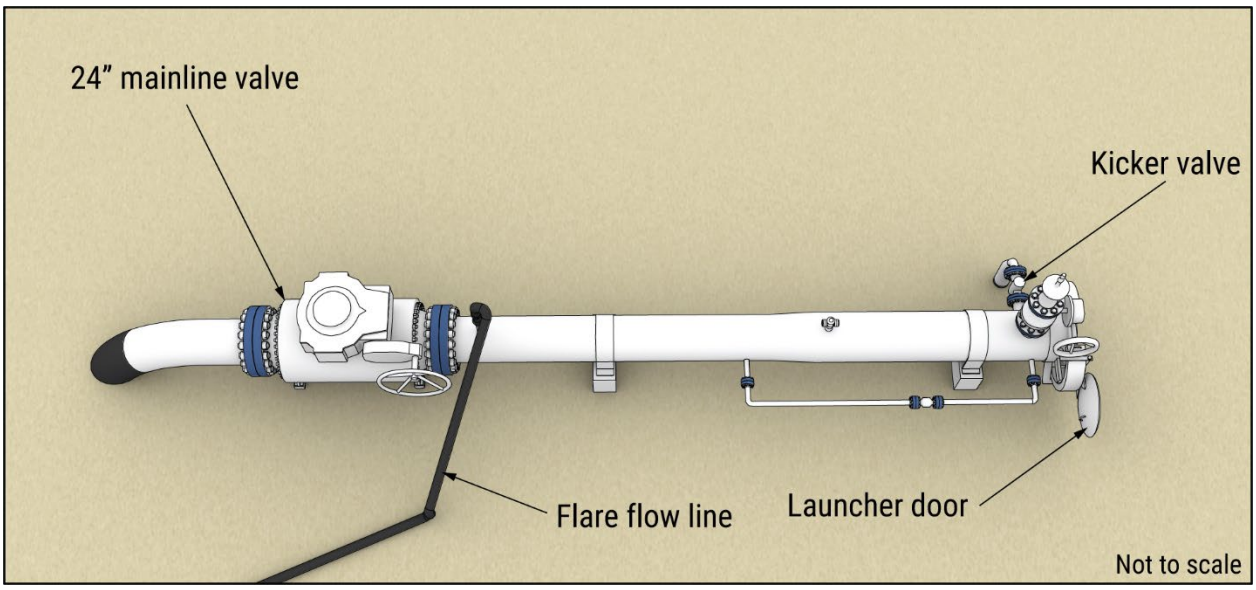

Figure 4. Diagram of pig launcher.

1.5.3 Ignition Source

NTSB investigators considered the as-found launcher and connected equipment, tools used, the mainline valve leak, flammability conditions, and the sequence of events

[15] (a) Natural gas forms an explosive mixture in air at concentrations between the lower explosive limit (5 percent) and upper explosive limit (15 percent). (b) When the model was adjusted to include the leak from the mainline, a thin layer of flammable gas–air mixture persisted in the top of launcher.

[16] In reality, a pig may allow a small amount of gas to seep past if it does not create a gas-tight seal.

before the explosion to evaluate possible ignition scenarios. The NTSB did not determine the ignition source.

1.6 Regulations, Rules, and Procedures

1.6.1 Federal Regulations on Covered Tasks and Worker Qualifications

The Pipeline and Hazardous Materials Safety Administration considers pig loading and launching to be a covered task under Title 49 *Code of Federal Regulations* (*CFR*) Part 192.801, a position documented in Interpretation Response #PI-22-0008. A *covered task* is an activity identified by an operator that is performed on a pipeline facility, is an operations or maintenance task, is performed as a requirement of 49 *CFR* Part 192, and affects the operation or integrity of the pipeline. Employees must be *qualified* for covered tasks and are considered qualified if they have been evaluated, can perform assigned covered tasks, and can recognize and react to abnormal operating conditions (see 49 *CFR* 192.803).[17]

1.6.2 Atmos Worker Qualifications

Atmos did not designate launching pigs as a covered task as defined by federal regulations. Because Atmos did not designate launching pigs as a covered task, it did not require its employees or contractors to be qualified under the regulatory definition to launch pigs. Instead, Atmos relied on on-the-job training for tasks specifically related to pigging.

1.6.3 Atmos Pigging Procedures

Atmos formally documented its pigging procedure in Appendix R of its *Pipeline Integrity Management Plan* in 2019. The procedure was still in place at the time of the accident. The procedure warned that pigging can be dangerous and instructed personnel to monitor for hydrocarbons (such as natural gas), to verify a pressure gauge had been installed to monitor and relieve pressure inside the barrel, and never to stand directly in front of the launcher door. The procedure was intended to serve as a guide for loading a pig under ideal situations and configurations. However, the configuration

[17] An *abnormal operating condition* is a condition identified by the operator that may indicate a malfunction of a component or deviation from normal operations that may (a) indicate a condition exceeding design limits or (b) result in a hazard(s) to persons, property, or the environment (49 *CFR* 192.803).

shown in the procedure did not match the launcher involved in this accident, and the procedure did not mention the use of a flaring system.

The procedure also required workers to make adjustments as needed to ensure that pig loading was performed in a safe and controlled manner, but abnormal operating conditions specific to pig loading were not indicated in this or any other Atmos procedure.

1.7 Postaccident Actions

Atmos suspended all pigging operations on in-service pipelines immediately following the accident and initiated a review of its related processes and procedures. Atmos revised their pigging procedure, established a new covered task for pigging operations, and developed associated training. The revised procedure standardizes launcher designs, requiring additional ports for venting, pressure gauge measurements, and gas monitoring; a grounding lug; and double block and bleed valving for valves that connect launchers to their natural gas transmission system.[18] The revised procedure also requires a site-specific valve sequencing plan, job safety analyses, oversight by a third-party inspector, purging natural gas from the launcher with nitrogen, mandatory stabilization periods, criteria for stopping work if pressure and gas concentration levels rise beyond a defined threshold, and delineation of hazard zones in proximity to launchers and receivers. Additional specifications for on-site tools and grounding requirements were also included to further reduce the risk of inadvertent ignition.

2. Analysis

Workers from Atmos, FESCO and Bobcat were performing routine pig loading on a natural gas pipeline when an explosion occurred in the launcher. The explosion was directed through the open launcher door toward four workers, injuring two and killing two.

The week before the explosion, workers suspected the mainline valve was leaking and adjusted the valve's position until they found a position where the leak stopped or reduced to the point that the flare extinguished. They marked this position on the exterior of the mainline valve and did not have issues with the flare extinguishing on subsequent runs. The Atmos workers overseeing the operation did not expect the valve to leak but believed that if any natural gas did leak into the launcher from the mainline valve, it would vent safely through the flare system to the atmosphere.

[18] (a) A *grounding lug* helps to prevent the buildup of static charge. (b) *Double block and bleed valving* uses two in-line valves that can be closed to vent the line between them.

On the day of the explosion, workers began the routine task of loading a pig for the sixth time in about a week. Workers were equipped with a straight metal rod as their pig insertion tool, necessitating they stand in front of the open launcher.

The flare tip extinguished as expected, and based on modeling, the natural gas concentration remained at or near 100 percent even after workers depressurized the launcher. If the mainline valve had sealed properly, after the launcher door was opened, this remaining natural gas would have vented from the launcher to the atmosphere while air entered, creating a gas–air mixture whose concentration would have fallen below the lower explosive limit within a few minutes.

Opening the launcher door did allow natural gas to vent to atmosphere, decreasing the concentration within the launcher. However, the mainline valve was leaking, which allowed additional natural gas to enter the launcher while workers were loading the pig. After the pig was loaded into the launcher, the pig obstructed the pipe between the mainline valve and launcher door. This obstruction and the leaking mainline valve caused natural gas concentrations between the pig and mainline valve to rise to an explosive concentration. The workers were not using any means of detecting or measuring gas that could have alerted them to the hazardous condition. The gas ignited, causing an explosion.

Although the NTSB did not determine the ignition source, two possible ignition scenarios were identified: (1) an ignition source was present between the pig and mainline valve, or (2) a flammable gas–air mixture and an ignition source were present between the pig and open launcher door which flashed back to the other side of the pig. As a result of the explosion, Atmos revised their pigging procedure to include gas monitoring for hazardous atmosphere and purging the launcher with nitrogen to expel natural gas before opening the launcher door during pigging operations.

Minimum federal safety standards in 49 *CFR* Part 192 require that operators ensure through evaluation that individuals be "qualified" to perform covered tasks, such as pig loading. Qualification includes the ability to safely handle abnormal operating conditions. Atmos was therefore required to ensure its workers and contractors could recognize and react to abnormal operating conditions that could be encountered during pig loading, such as a leaking mainline valve.

At the time of the accident, Atmos did not require its employees or contractors to be qualified to load pigs; instead, Atmos expected its employees to rely on their experience and on-the-job training. Despite their many years of collective experience, the workers were not qualified as required by federal regulations and were not using gas monitors to monitor for hazardous atmosphere. Since the explosion, Atmos has established a new covered task for pigging procedures; workers performing pigging operations must now be qualified as required by 49 *CFR* Part 192, which includes the

ability to safely handle abnormal operating conditions. The new procedure also includes guidance on hazard zones near launchers and receivers and criteria for stopping work.

3. Probable Cause

The National Transportation Safety Board determines that the probable cause of the June 28, 2021, explosion was a leaking mainline valve that allowed natural gas to enter the launcher where it mixed with air, creating a flammable gas–air mixture that was ignited by an undetermined source. Contributing to the explosion and its severity were Atmos Energy Corporation's procedures and training practices that did not prepare workers to recognize and safely respond to abnormal operating conditions.

The National Transportation Safety Board (NTSB) is an independent federal agency dedicated to promoting aviation, railroad, highway, marine, and pipeline safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974, to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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For more detailed background information on this report, visit the NTSB investigations website and search for NTSB accident ID PLD21FR002. Recent publications are available in their entirety on the NTSB website. Other information about available publications also may be obtained from the website or by contacting–

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