March 12, 2026 Pipeline Investigation Report PIR-26-01

Atmos Energy Corporation Natural Gas-Fueled Home Explosions and Fires

Jackson, Mississippi
January 24, 2024, and January 27, 2024

Abstract: This report discusses the January 2024 natural gas-fueled explosions and fires at two separate homes in Jackson, Mississippi, which occurred 3 days apart, collectively resulting in one injury, one fatality, and three destroyed homes. Safety issues identified in this report include compression coupling leaks, insufficient leak management program, inadequate distribution integrity management program, ineffective public awareness program, and absence of natural gas detection alarms in buildings. As part of this investigation, the National Transportation Safety Board issued safety recommendations to the Department of Transportation Office of Inspector General, the Pipeline and Hazardous Materials Safety Administration, and Atmos Energy Corporation and reiterated recommendations to the Pipeline and Hazardous Materials Safety Administration and to 50 states, the Commonwealth of Puerto Rico, and the District of Columbia.

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Acronyms and Abbreviations

Abbreviation	Name
ASCE	American Society of Civil Engineers
CFR	*Code of Federal Regulations*
GPTC	Gas Piping Technology Committee
JFD	Jackson Fire Department
MS PSC	Mississippi Public Service Commission
MSU	Mississippi State University
MAFES	Mississippi Agricultural and Forestry Experiment Station
NTSB	National Transportation Safety Board
O&M	operations and maintenance
PHMSA	Pipeline and Hazardous Materials Safety Administration
psig	pounds per square inch, gauge
PSMS	Pipeline Safety Management Systems
SME	subject matter expert

Executive Summary

What Happened

On January 24, 2024, about 8:14 a.m. local time, natural gas leaked from a compression coupling into a home on Bristol Boulevard in Jackson, Mississippi, causing an explosion and fire that resulted in one fatality, one injury, and a destroyed home. Three days later, on January 27, 2024, about 4:34 a.m., natural gas leaked from a compression coupling into a home on Shalimar Drive, about 0.7 miles from the first explosion, causing an explosion and fire that destroyed two homes. (A compression coupling is a pipeline component that joins and seals two pipes together. It is typically belowground and connects a service-line pipe to a main-line pipe.)

What We Found

We found that near the accident homes, natural gas leaked from service-line pipes that had partially pulled out of compression couplings and migrated through the ground and into the homes where it fueled the explosions. The leaks near the accident homes were the result of expansive clay soil movement that caused the service-line pipes at both locations to, over time, partially pull out of the compression couplings. For both accidents, Atmos Energy Corporation (Atmos) leak surveys detected belowground leaks weeks before the explosion and classified them as nonhazardous. This nonhazardous classification meant that Atmos would not repair the leaks immediately. Atmos did not have companywide leak management procedures requiring employees to frequently monitor open, belowground natural gas leaks located in adverse-soil conditions, which existed in Jackson, Mississippi, at the time of the two accidents. As a result, the accident leaks became hazardous before Atmos repaired them.

Several people in the two accident neighborhoods smelled natural gas odorant and were unaware of pipeline safety guidance to evacuate and then immediately report the smell by calling 9-1-1 and the gas company. In the accidents in Jackson, Mississippi, and in several natural gas accidents that the NTSB has investigated, the operator's public awareness program was ineffective at educating the public on how to safely respond to the smell of natural gas odorant. Atmos's ineffective communications regarding the need to report any smell of natural gas odorant inhibited necessary reporting from residents who continued to smell natural gas odorant in and near their homes. In addition, in the two Jackson accidents and in previous Atmos accidents in Dallas, Texas, and Avondale, Louisiana, Atmos missed an opportunity to effectively educate and prepare emergency response officials in its service areas to address natural gas emergencies.

Atmos's failure to gather relevant information about its service-line records prevented it from effectively assessing the risk to its assets. In addition, Atmos's distribution integrity management program did not effectively identify and then mitigate the risks to its system. Also, had a natural gas alarm been installed inside the Bristol Boulevard accident home, it could have alerted occupants that natural gas was present, prompting them to evacuate and report the leak, making Atmos aware that the leak had likely worsened and required corrective action.

The National Transportation Safety Board determines that the probable cause of the two explosions at two separate homes in Jackson, Mississippi, was Atmos Energy Corporation's inadequate leak management program, which allowed for known natural gas leaks, from service-line pipes that had partially pulled out of compression couplings due to soil movement, to be left unrepaired for at least 8 weeks, resulting in gas leaking from the compression couplings and then migrating to the nearby homes and igniting. Contributing to the explosions was Atmos Energy Corporation's inadequate integrity management program, which did not appropriately assess and address risk in its pipeline system. Also contributing was an ineffective public awareness program, which did not adequately educate the public or emergency response officials on how to respond to a suspected natural gas leak.

What We Recommended

As a result of this investigation, we issued 10 new safety recommendations and reiterated 3 recommendations. We recommended that the Department of Transportation Office of Inspector General audit the Pipeline and Hazardous Materials Safety Administration's ongoing joint assessment of Atmos Energy Corporation. We recommended that the Pipeline and Hazardous Materials Safety Administration issue an advisory bulletin urging operators to adopt probabilistic risk models. We recommended that Atmos:

- Locate and replace all mechanical couplings and mechanical joints in expansive soils that are not resistant to pipe pullout.
- Require weekly monitoring of nonhazardous belowground leaks identified in locations with adverse-soil conditions.
- After updating its leak monitoring procedures to address leaks in adverse-soil conditions, train its technicians.

- Train emergency response officials more frequently and monitor the effectiveness of the training.
- Require technicians to immediately notify people near an unrepaired leak that the hazard potential of a leak can change over time, and that they should evacuate the area and then call 9-1-1 and Atmos every time they smell natural gas odorant.
- Proactively identify and collect missing service-line information for all its operating divisions.
- Transition from a relative-risk model to a probabilistic risk model.
- Make natural gas alarms available to members of the public who live in its distribution areas.

We reiterated two recommendations to the Pipeline and Hazardous Materials Safety Administration. The first was a 2025 recommendation to identify effective means for natural gas distribution pipeline operators to communicate with people within the coverage area of a natural gas distribution pipeline system and help operators improve public awareness of natural gas safety. The second was a 2021 recommendation to evaluate industry implementation of gas distribution pipeline integrity management requirements and develop updated guidance for improving the effectiveness of the requirements. We also reiterated a 2025 recommendation to the 50 States, Puerto Rico, and the District of Columbia to require natural gas alarms in businesses, residences, and other buildings where people congregate.

1 Factual Information

1.1 The Accidents

On January 24, 2024, about 8:14 a.m. local time, a home explosion and fire occurred at 185 Bristol Boulevard (Bristol Boulevard accident home) in Jackson, Mississippi, resulting in one fatality, one injury, and a destroyed home.[1] Three days later, on January 27, 2024, about 4:34 a.m., approximately 0.7 miles southeast of the first explosion, another home explosion and fire occurred at 1146 Shalimar Drive (Shalimar Drive accident home), and the fire spread to a neighboring home, resulting in two destroyed homes.[2] (See figure 1.) At the time of both accidents, weather conditions included light to heavy rain, and the temperature was about 60°F.

[1] All times are local unless otherwise noted.

[2] (a) The Shalimar Drive accident did not result in any injuries. (b) Visit http://www.ntsb.gov to find additional information in the public docket for this National Transportation Safety Board (NTSB) accident investigation (case number PLD24FR003). Use the CAROL Query to search safety recommendations and investigations.

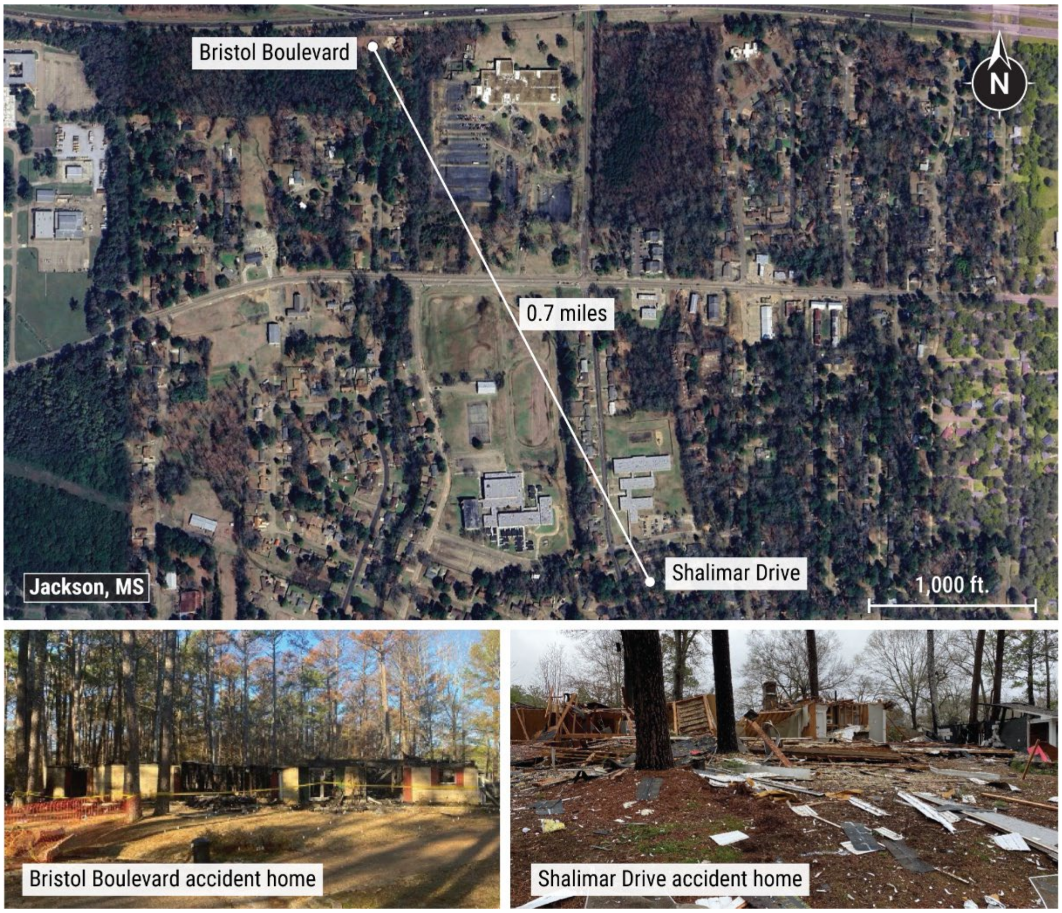

Figure 1. Map and photographs of the accident locations. (Courtesy of Google Earth, the Pipeline and Hazardous Materials Safety Administration, and the Mississippi Public Service Commission [clockwise from the top].)

Atmos Energy Corporation (Atmos) owned and operated natural gas pipeline assets near the Bristol Boulevard accident home and the Shalimar Drive accident home.[3] Atmos distributed natural gas to both homes with 2-inch diameter coated-steel gas mains that ran in front of the homes.[4] Service lines to individual homes were connected with 3⁄4-inch steel service tees that were welded on the main

[3] (a) See section 1.8 for more information on Atmos. (b) This report uses the term *assets* to refer to the specific elements of a pipeline distribution system.

[4] (a) A gas *main* (or *main line*), which is typically belowground, is a natural gas distribution pipeline that serves as a common source of supply for more than one service line. (b) The main near the Bristol Boulevard accident home was installed in 1967; the main near the Shalimar Drive accident home was installed in 1962.

and joined to a 3⁄4-inch steel service line.[5] Dresser Style 90 seal-only compression couplings made the mechanical joints that connected the service lines to the service tees. (This report's references to Dresser Style 90 compression couplings refer to the seal-only design unless otherwise noted. The seal-only design is not configured to resist pipe pullout, meaning it is not designed to hold the pipe in place. Other versions of the Dresser Style 90 compression coupling include a clamping design that resists pipe pullout; however, the seal-only design does not.) (See section 1.5 for more information on Dresser Style 90 compression couplings.) Around the time of the two accidents, the gas mains near both homes were operating below the maximum allowable operating pressure of 40 pounds per square inch, gauge (psig).[6]

1.1.1 Bristol Boulevard

The Bristol Boulevard accident home, built in 1972, was a single-story, single-family, wood-framed structure with masonry construction on a concrete foundation. (See figure 2.) The home was constructed on soil composed of Yazoo clay, an expansive clay prone to movement (shrinking and swelling) during cycles of dry and wet weather.[7] (See section 1.4 for more information on expansive soil.)

[5] (a) A *service line,* which is typically belowground except when it is near a gas meter, is a pipeline that transports natural gas (or another commodity) to a customer. (b) The NTSB could not confirm the service-line installation dates (Atmos reported that it did not have the installation records for the service lines at the two accident homes.); however, the NTSB determined that the accident compression couplings contained components manufactured in or before 1963. (c) *Compression couplings* are a type of mechanical fitting (or mechanical coupling) used to join and pressure seal two pipes together without requiring soldering, welding, or threading. (d) A *service tee,* which is typically belowground, creates a branch connection that enables a service line to connect to a main.

[6] (a) At the time of the Bristol Boulevard accident, the main near the Bristol Boulevard accident home was estimated to be operating about 36.5 psig. At the time of the Shalimar Drive accident, the main near the Shalimar Drive accident home was estimated to be operating about 36.6 psig. The NTSB also reviewed the operating pressure histories for both accident locations, and they were below the maximum allowable operating pressure. (b) Natural gas distribution operators typically conduct pipeline operations slightly below the maximum allowable operating pressure to allow for potential pressure fluctuations.

[7] (a) Soil is composed of sand, silt, and clay. (b) *Expansive soil* is soil that undergoes significant volume changes—shrinking when dry and swelling when wet—because of its high clay content.

Figure 2. The Bristol Boulevard accident home before the explosion. (Courtesy of Google Maps.)

While Atmos provided natural gas service to the Bristol Boulevard accident home, it did not provide gas service to all the homes in the neighborhood, including the home at 175 Bristol Boulevard (Bristol Boulevard affected home), at which, postaccident, Atmos bar-hole testing detected explosive levels of natural gas.[8] Figure 3 shows the accident neighborhood, indicating the homes that had natural gas service and those that did not. It also shows the accident leak location, which will be discussed in section 1.6.1.1.2.

[8] *Bar-hole testing* describes a gas measurement technique in which a technician makes a small diameter hole in the ground with a steel bar, inserts a probe into the hole, and obtains a gas measurement. Technicians review bar-hole readings to determine the extent of natural gas in the ground in the tested area. (See section 1.6 for more information on this and other accident-related examinations and testing.)

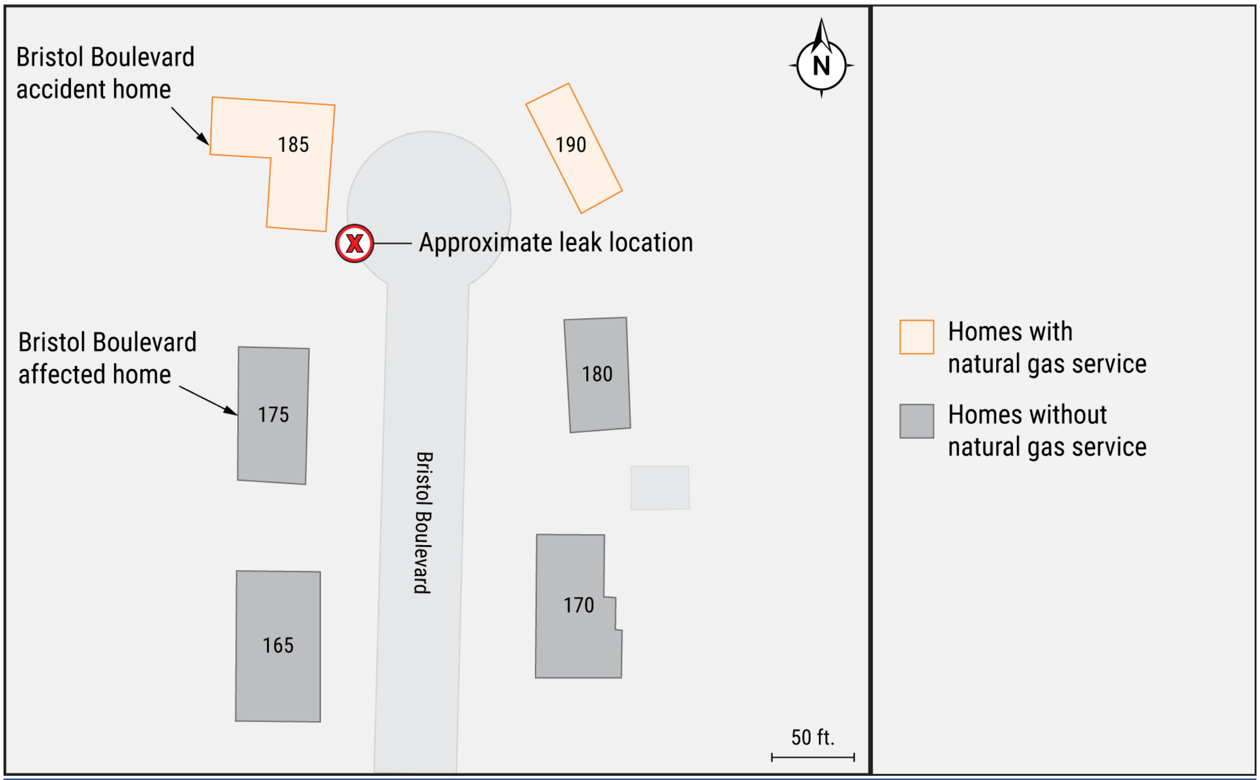

Figure 3. The Bristol Boulevard accident neighborhood.

About 9 weeks before the accident on Bristol Boulevard, on November 17, 2023, after a routine, periodic mobile leak survey detected an indication of natural gas, an Atmos contractor, a survey technician, investigated the indication by conducting a walking leak survey near the Bristol Boulevard accident home.[9] (Atmos conducted walking leak surveys in response to mobile leak surveys that detected indications of natural gas.) The technician located a leak and classified the leak as grade 2, meaning he determined the leak was nonhazardous at that time but noted that it required a scheduled repair because it could become hazardous in

[9] (a) Atmos's procedures required it to conduct mobile leak surveys every 5 years. (b) In a *mobile leak survey,* the pipeline operator deploys a vehicle (such as a truck or an aircraft) with mobile-data collection equipment to detect methane concentrations (the primary component of natural gas is methane). (c) In a *walking leak survey*, a technician walks near or over gas mains and service lines and up to each meter set (the gas meter and associated components) in the survey area while carrying a handheld leak-detection instrument. (d) Federal regulations in Title 49 *Code of Federal Regulations* (*CFR*) Part 192.801 Subpart N provide minimum requirements for operator qualifications for individuals performing covered tasks on a pipeline facility. The Atmos employees and contractors associated with the accidents met Atmos's operator qualifications. (e) An *indication* of natural gas is an observable sign, such as a reading from a detection instrument, that natural gas may be present.

the future.[10] (This report's references to leaks refer to belowground leaks unless otherwise noted. Aboveground leaks can also occur in pipeline systems; however, this report focuses on belowground leaks.)

Many natural gas distribution pipeline operators use Gas Piping Technology Committee criteria to evaluate leaks, which include elements such as leak location, gas concentration (percentage of gas in air), gas migration potential, and soil conditions.[11] Technicians use these criteria to determine whether to classify leaks as grade 1, grade 2, or grade 3. According to Gas Piping Technology Committee standards, grade 1 leaks are hazardous and include gas leaks that have migrated into or under a building. (Gas migration occurs when underground gas escapes and travels through soil, rocks, or wells to the surface or to nearby buildings.) Grade 2 leaks are nonhazardous (and require scheduled repair based on possible future hazard) and include gas leaks that under frozen or adverse-soil conditions would be likely to migrate to the outside wall of a building. Grade 3 leaks are also nonhazardous (but do not require scheduled repair) and include gas leaks that are under a street in areas without wall-to-wall paving where it is unlikely the gas could migrate to the outside wall of a building.[12]

Based on its classification procedures at the time for grade 2 leaks in Mississippi, Atmos scheduled the leak to be reevaluated every 6 months and repaired within 1 year (not to exceed 15 months).[13] (See section 1.9.1 for more information on Atmos's leak management procedures.) At the time of the leak survey, the city of Jackson was in a cycle of dry weather, which causes expansive soil to shrink (the Bristol Boulevard accident home was constructed on expansive soil). (See section 1.3 for more information on the weather.)

On November 20, 2023, 3 days after Atmos first identified the leak, the Bristol Boulevard accident homeowner smelled natural gas odorant near the home

[10] During this survey, the technician recorded 100% gas in a bar hole that was about 48 feet from the building, criteria that, among other factors, resulted in him classifying the leak as grade 2.

[11] Federal regulations require natural gas distribution operators to find, evaluate, and repair leaks but do not prescribe specific leak classification criteria.

[12] See section 1.9.1.1 for more information on leak evaluation and section 1.9.1.2 for more information on leak classification.

[13] (a) Because of state-specific pipeline safety standards, Atmos's procedures could vary by state. (b) In federal pipeline regulations "at least once each calendar year, but at intervals not to exceed 15 months" is common language and gives natural gas operators scheduling flexibility while eliminating the possibility that 2 years can pass before they repair a leak.

and reported the odor to Atmos.[14] (See section 1.9.2.2 for more information on the odor complaints in this investigation.) An Atmos employee, a senior utility technician, responded and conducted a leak investigation.[15] The technician located a leak near the home (the same leak that the Atmos contractor had identified 3 days before) but did not reclassify the leak or develop a sketch to record the natural gas readings that he had taken.[16] He later told the National Transportation Safety Board (NTSB) that he determined that the leak was not a grade 1 based on his leak investigation, and that he knew an Atmos contractor had already identified and documented the leak because he had seen bar holes and spray markings near the leak. He also said that he did not reclassify the leak because his leak investigation did not show natural gas migration (an investigation that showed natural gas migration may have indicated that the leak was hazardous).[17] The technician recalled telling the Bristol Boulevard accident homeowner that he was safe, updating the notes on the job ticket, and closing out the job.

On January 24, 2024, the city of Jackson was in a cycle of heavy rainfall, which causes expansive soil to swell. The Bristol Boulevard accident homeowner was asleep in bed when he was awakened by an explosion inside his home. The neighbors at the Bristol Boulevard affected home called 9-1-1.

The explosion and fire destroyed the Bristol Boulevard accident home. (See figure 4.) Emergency medical services arrived on the scene and treated the Bristol Boulevard accident homeowner for a minor injury. After the Jackson Fire Department extinguished the fire, they found the Bristol Boulevard accident

[14] Because natural gas is odorless, strong smelling chemical additives called odorants are mixed with natural gas before distribution to help reduce the risk that leaks will go unidentified. The most common odorant added to natural gas is mercaptan, which has a characteristic "rotten egg" or sulfurous odor.

[15] A *gas leak investigation* is a process of searching for potential leaks in a pipeline system. Atmos conducted leak investigations in response to odor complaints or reports of natural gas. Atmos conducted leak surveys when it had identified a suspected leak and was aware of its general location. Atmos's procedures required technicians conducting leak surveys and leak investigations to use the same methods to check for indications of natural gas.

[16] (a) Atmos procedures required technicians to classify and record any leaks that they found during leak investigations. (b) During this investigation, the technician recorded 4% gas in a bar hole that was about 48 feet from the building.

[17] The technician did not reclassify the leak therefore it remained a grade 2.

homeowner's wife inside the home, and emergency medical services pronounced her deceased.[18] Table 1 shows a timeline of the Bristol Boulevard accident events.

Figure 4. Aerial photograph of the Bristol Boulevard accident home after the explosion and fire. (Courtesy of Atmos.)

[18] The investigation did not determine whether the wife was also a listed homeowner.

Table 1. Timeline of Bristol Boulevard accident events.

Date	Event
09/2023	Drought conditions reported in Jackson, MS.
11/17/2023	An Atmos contractor, a survey technician, identified a leak during a leak survey, determined it was nonhazardous, and classified it as grade 2.
11/20/2023	Bristol Boulevard accident homeowner smelled natural gas odorant outside the home and called Atmos.
11/20/2023	An Atmos employee, a senior utility technician, identified a leak during a leak investigation (the same leak the Atmos contractor had identified 3 days before) and determined it was nonhazardous (not a grade 1 leak). He did not reclassify the leak therefore it remained a grade 2.
01/24/2024	Heavy rain reported in Jackson, MS.
01/24/2024	Bristol Boulevard accident home exploded and caught fire.

1.1.2 Shalimar Drive

The Shalimar Drive accident home, built in 1963, was a single-story, single-family, wood-framed structure with masonry construction on a concrete foundation. (See figure 5.) Like the Bristol Boulevard accident home, it was constructed on soil composed of Yazoo clay, an expansive clay prone to movement during cycles of dry and wet weather.

Figure 5. The Shalimar Drive accident home before the explosion. (Courtesy of Google Maps.)

While Atmos provided natural gas service to the Shalimar Drive accident home and the home at 1138 Shalimar Drive (Shalimar Drive affected home), which caught fire during the accident, it did not provide gas service to all the homes in the neighborhood. Figure 6 shows the accident neighborhood, indicating the homes that had natural gas service and those that did not. It also shows the accident leak location, which will be discussed in section 1.6.1.2.2.

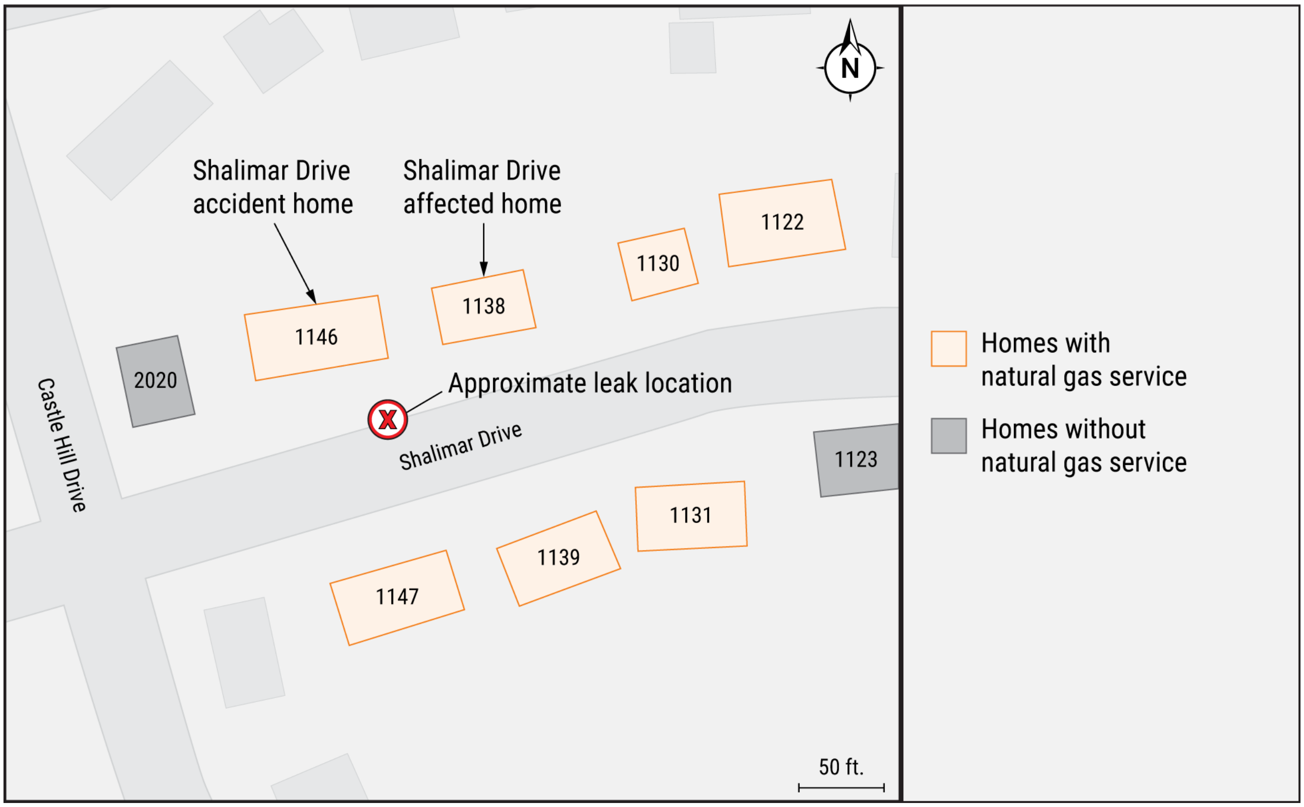

Figure 6. The Shalimar Drive accident neighborhood.

About 8 weeks before the accident on Shalimar Drive, on December 1, 2023, after a routine, periodic mobile leak survey detected an indication of natural gas, an Atmos contractor, a survey technician, investigated the indication by conducting a walking leak survey near the Shalimar Drive accident home.[19] The technician located a leak and classified the leak as grade 3, meaning he determined the leak was nonhazardous.[20] Based on its classification procedures at the time for grade 3 leaks in Mississippi, Atmos scheduled the leak to be reevaluated every 15 months and repaired within 36 months. At the time of the leak survey, the city of Jackson was in a cycle of dry weather, which causes expansive soil to shrink (the Shalimar Drive accident home was constructed on expansive soil).

On January 27, 2024, the city of Jackson was in a cycle of heavy rainfall, which causes expansive soil to swell. The district fire chief was at the fire station when he heard a loud thump, a sound he thought could be a falling tree but would later

[19] This was not the same Atmos contractor that responded to the Bristol Boulevard location.

[20] During this survey, the technician recorded 4% gas in a bar hole that was about 34 feet from the building, criteria that, among other factors, resulted in him classifying the leak as grade 3.

identify as the explosion on Shalimar Drive. He told the NTSB that about 5 minutes after he heard the sound, the fire station was dispatched to the accident.

The explosion and fires destroyed the Shalimar Drive accident home and the Shalimar Drive affected home. (See figure 7.) Table 2 shows a timeline of the Shalimar Drive accident events.

Figure 7. The Shalimar Drive accident home (left) and the Shalimar Drive affected home (right) after the explosion and fires. (Courtesy of the Mississippi Public Service Commission.)

Table 2. Timeline of Shalimar Drive accident events.

Date	Event
09/2023	Drought conditions reported in Jackson, MS.
12/01/2023	An Atmos contractor, a survey technician, identified a leak during a leak survey, determined it was nonhazardous, and classified it as grade 3.
01/27/2024	Light to heavy rain reported in Jackson, MS.
01/27/2024	Shalimar Drive accident home exploded and caught fire; the fire later spread to the Shalimar Drive affected home.

1.2 Emergency Response

1.2.1 Bristol Boulevard

1.2.1.1 Jackson Fire Department

On January 24, 2024, about 8:15 a.m., the Jackson Fire Department (JFD) dispatched to Bristol Boulevard to suppress a house fire and to search for a person trapped inside. Over the course of its response, the JFD deployed 1 district fire chief, 17 fire suppression personnel, 4 engine trucks, 1 ladder truck company, and 1 rescue squad. (See section 1.9.2.1.2 for information on emergency response official training.)[21] About 8:23 a.m., the JFD arrived on the scene to find the Bristol Boulevard accident home engulfed in flames. The captain of the rescue squad told the NTSB that he began to suspect the fire was natural gas fed when the fire persisted, he smelled natural gas odorant, and he saw a torch-like blue flame on the side of the home near the gas meter. The district fire chief arrived and called Atmos and the electric-utility provider to the scene.[22] The JFD reported that about 8:47 a.m. it had the fire controlled.[23] The JFD extinguished the fire and continued its response until it completed a search of the Bristol Boulevard accident home and recovered the deceased victim, reporting that it cleared the scene about 2:47 p.m.

1.2.1.2 Atmos Energy Corporation

Around 9:06 a.m., about 30 minutes after the JFD called requesting support, Atmos arrived at Bristol Boulevard and began its emergency response, which included bar-hole testing, monitoring for gas migration, and locating the isolation valve to shut off the gas to the affected area.[24] About 11:15 a.m., Atmos responders expanded the safety perimeter beyond the accident home, evacuating the

[21] The terms "emergency responders," "first responders," and "emergency response officials," which this report uses, all have the same meaning and refer to people who perform emergency response activities, such as law enforcement officers, fire fighters, and emergency medical services personnel.

[22] The electric-utility provider's personnel addressed requests to disconnect electricity service and did not directly participate in the emergency response.

[23] A *controlled fire* is one that is contained but not fully extinguished.

[24] (a) An *isolation valve* is a device used to stop or regulate fluid or gas flow in a pipeline or other system. (b) A senior service technician was first to arrive on the scene followed by a field construction coordinator, an operations supervisor, and other Atmos emergency responders.

Bristol Boulevard affected home and the home at 190 Bristol Boulevard.[25] Atmos performed a pipeline squeeze off to isolate the main about 12:42 p.m., which shut off gas to the area.[26]

1.2.2 Shalimar Drive

1.2.2.1 Jackson Fire Department

On January 27, 2024, about 4:34 a.m., the JFD dispatched to Shalimar Drive to suppress two house fires. Over the course of its response, the JFD deployed 1 district fire chief, 15 fire suppression personnel, 3 engine trucks, and 2 rescue squads. About 4:39 a.m., the JFD arrived on the scene and, according to the district fire chief, found the Shalimar Drive accident home without fire but the Shalimar Drive affected home still in flames.[27] The district fire chief told the NTSB that he began to suspect the fire was natural gas fed when the fire persisted; he smelled natural gas odorant; he saw blue flames on the side of both homes near the gas meters, which were facing each other; and he heard sounds of gas hissing. Shortly after arriving, the district fire chief called Atmos and the electric-utility provider to the scene. The JFD reported that about 5:30 a.m. it had the fire controlled. The JFD extinguished the fire and continued its response until it completed a search of the Shalimar Drive accident home and the Shalimar Drive affected home and determined that they were empty, reporting that it cleared the scene about 9:01 a.m.[28]

1.2.2.2 Atmos Energy Corporation

Around 5:35 a.m., about 42 minutes after the JFD called requesting support, Atmos arrived at Shalimar Drive and began its emergency response, which included bar-hole testing, monitoring for gas migration, and locating the isolation valve to shut

[25] Atmos evacuated these homes because bar-hole testing had detected indications of natural gas near them.

[26](a) A pipeline *squeeze off* is a method used to stop or control the flow of a fluid, such as gas or water, in a polyethylene or other flexible pipe and involves compressing the pipe between parallel bars to pinch the pipe shut. (b) The JFD was able to control the fire before Atmos shut off the gas because, when it was safe to do so, they had turned off the gas at the gas meter.

[27] This was not the same district fire chief that responded to the Bristol Boulevard accident.

[28] The Shalimar Drive affected home homeowner told JFD firefighters that the home was a vacant rental property, and he had been preparing it for the next tenant.

off the gas to the affected area.[29] About 8:10 a.m., Atmos responders expanded the safety perimeter beyond the Shalimar Drive accident home and the Shalimar Drive affected home, evacuating the homes at 1130 and 1131 Shalimar Drive.[30] Atmos performed a pipeline squeeze off to isolate the main about 8:28 a.m., which shut off gas to the area.

1.3 Weather

Around the time of the two accidents, the city of Jackson had cycles of dry and wet weather. In September 2023, the state of Mississippi experienced exceptional-drought conditions, which were still present when Atmos identified the Bristol Boulevard accident leak in November 2023 and when it identified the Shalimar Drive accident leak in December 2023.[31] Rainfall in Jackson in November 2023 was 2.68 inches below normal for the month; rainfall in Jackson in December 2023 was 1.66 inches below normal for the month. At the end of 2023, rainfall in Jackson was 15.10 inches below normal for the year. The precipitation in January 2024 began the process of ending the drought. In January 2024, the month of the two accidents, precipitation in Jackson totaled 9.48 inches. This was 4.51 inches above normal and the ninth wettest month in the city's history.

1.3.1 Bristol Boulevard

On January 24, 2024, at the time of the Bristol Boulevard accident, the Hawkins Field Airport weather station reported heavy rain and thunderstorms in the vicinity and a temperature of 62°F.[32] This weather station reported a 24-hour rainfall accumulation of 2.76 inches.

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[29] A senior service technician was first to arrive on the scene followed by a crew leader, a senior utility technician, and other Atmos emergency responders.

[30] Atmos evacuated the home at 1130 Shalimar Drive because bar-hole testing had detected an indication of natural gas near the home's foundation. Atmos evacuated the home at 1131 Shalimar Drive, which was directly across the street, as a precaution until the electric-utility provider could shut off power to the home at 1130 Shalimar Drive.

[31] (a) Exceptional-drought conditions are the highest level of drought and include widespread crop and pasture losses; exceptional-fire risk; and shortages of water in reservoirs, streams, and wells that result in water emergencies. (b) Mississippi experienced exceptional-drought conditions until February 2024.

[32] The Hawkins Field Airport weather station is about 5.7 miles from each accident location.

1.3.2 Shalimar Drive

On January 27, 2024, at the time of the Shalimar Drive accident, the Hawkins Field Airport weather station reported light to heavy rain in the vicinity and a temperature between 62°F and 63°F. This weather station reported a 24-hour rainfall accumulation of 1.09 inches.

1.4 Expansive Soil

At the time of the two accidents, four of Atmos's six regional divisions, including the Mississippi Division, had distribution areas that included expansive soil, or what the US Geological Survey referred to as soil with "high-swelling potential." Figure 8 shows a US map of Atmos's headquarters and regional divisions transposed over a map of expansive-soil locations.

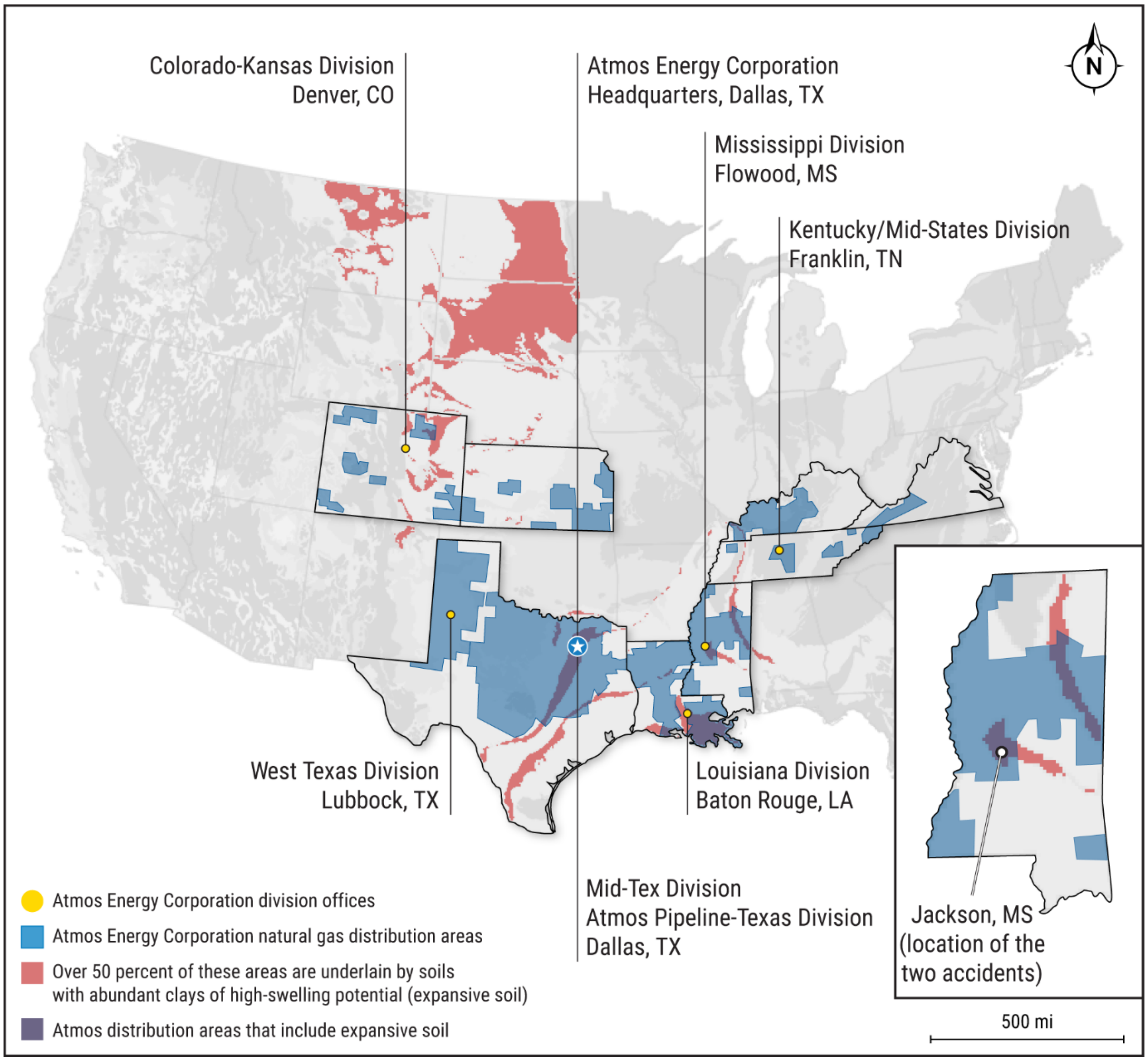

Figure 8. US expansive soil map overlaid with Atmos's headquarters (starred) and regional divisions. (Courtesy of the US Geological Survey and Atmos with NTSB annotations.)

Yazoo clay, an expansive clay, is prevalent in Jackson, where the accidents occurred. A 1988 Mississippi Department of Natural Resources paper noted that Yazoo clay had "long been" associated with the city of Jackson and that the expansive nature of the clay caused soil movement, which was the primary reason for the foundation and structure issues in the city (Stover, Williams, and Peel 1988). The paper noted that expansive clays can absorb large amounts of water (or swell) during periods of prolonged rainfall. A 1993 Mississippi State University (MSU) paper reaffirmed the abundance of expansive clay soil in Mississippi and the threat that it posed to structures, asserting that the soil caused "major problems for foundations, roads, sidewalks, pipelines, excavations, and industrial and agricultural operations" (MSU MAFES 1993).[33]

One such problem that expansive soil causes for natural gas distribution pipeline systems, though not described in either paper, occurs when rain oversaturates the soil and natural gas migrates from an active leak, and the leak becomes hazardous. The NTSB's Dallas investigation described how this can happen as follows: Under dry conditions, natural gas from an active natural gas leak may find a path to vent from the ground and disperse in the atmosphere without becoming hazardous (without reaching explosive levels). However, when the natural gas venting pathway to the surface becomes obstructed (which can occur when heavy rains oversaturate the soil), the gas cannot vent through the soil, so it migrates laterally in search of an area to vent, where it may enter a home or occupied structure and accumulate to explosive levels (NTSB 2021).[34]

At the corporate level and in the field, Atmos's employees were aware of the potential threat that expansive soil posed to pipelines. In 2022, in response to NTSB Safety Recommendation P-21-12, which recommended that Atmos assess and revise its distribution integrity management program, Atmos reported that it had updated its distribution integrity management risk model to consider the swell potential of clay soil.[35] (See section 1.9.3.2 for more information on Atmos's distribution integrity management risk model.) In addition, in interviews with the NTSB, two Atmos employees in Jackson with field experience noted the effect that expansive soil could have on pipeline compression couplings during certain weather conditions. An Atmos operations manager who oversaw Atmos leak management in the city said that, in his experience, the cases of complete compression coupling failure occurred when the weather changed from drought conditions to rain conditions because the soil in the area was "Yazoo clay," which was "expansive."[36] Another Atmos employee,

[33] A Bristol Boulevard resident told the NTSB that there was soil movement near his home before the accident. In addition, a Bristol Boulevard affected home resident told the NTSB that the soil in her backyard had moved, creating a large hole; she did not indicate whether the soil movement had occurred before or after the accident.

[34] See section 1.10.1.3 for more information on the NTSB's Dallas investigation.

[35] Safety Recommendation P-21-12 is classified Closed—Acceptable Action. (See section 1.10.1.3 for more information on this safety recommendation.)

[36] The operations manager had 28 years of Atmos experience.

an operations supervisor of construction, made a similar statement, saying the following:

> Right here in Jackson, I mean -- I've worked in the Delta too -- it's almost the same kind of soil. You know, it's when, you know, seasons change, drought, a lot of rain, the ground moves, and that's when -- if there's a slip or something like that [a compression coupling failure] -- that's when it usually occurs.[37]

1.5 Dresser Style 90 Compression Coupling

As discussed in section 1.1, Atmos's pipeline assets at the Bristol Boulevard accident home and the Shalimar Drive accident home included Dresser Style 90 compression couplings. A Dresser Style 90 compression coupling is composed of a coupling body, gasket, gasket retainer cup, and end nut. The gasket is tapered at one end (the "toe") and flat at the other (the "heel"). The gasket toe contains a tightly wound coil of metal that runs around its circumference called "armor."[38] The retainer cup presses against the heel, and the end nut presses against the cup. A technician inserts the pipe into the end of the coupling and then tightens the nut down, compressing the gasket between the pipe and the coupling, creating a seal.[39] Figure 9 shows a schematic cross section of a Dresser Style 90 compression coupling, highlighting the armor in the gasket toe.

[37] (a) The operations supervisor had 24 years of Atmos experience. (b) The Mississippi Delta is also known as the "Yazoo–Mississippi Delta."

[38] According to Dresser, the manufacturer, the armor helps maintain electrical continuity between the inserted pipe and the coupling for the purposes of cathodic protection systems.

[39] (a) In modern installation instructions, Dresser recommends inserting the pipe a minimum depth of 2 inches to avoid pipe pullout or blowout under pressure. The installation instructions from the 1960s and the 1970s did not provide a recommend minimum pipe-insertion depth, which Dresser refers to as "stab depth." (b) In modern installation instructions, Dresser recommends technicians mark the pipe to show the insertion depth. The installation instructions from the 1960s and the 1970s did not provide these instructions. The NTSB did not observe installation insertion-depth markings on the accident service lines. (c) To create the seal, the retainer cup pushes the gasket, which forces the outer wall of the gasket against the inner wall of the compression coupling body, resulting in a compressive force on the outer wall of the pipe.

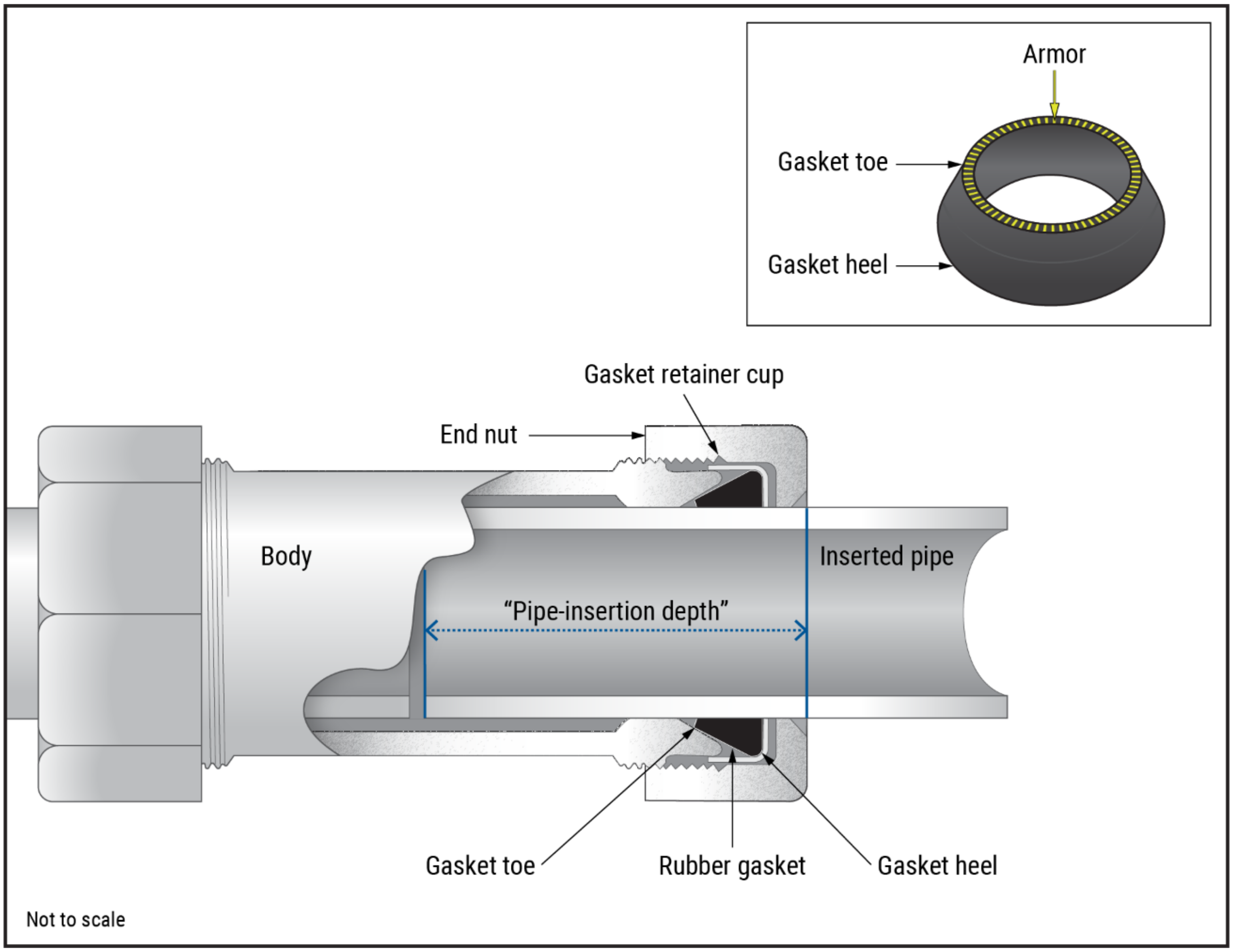

Figure 9. A Dresser Style 90 compression coupling.

1.6 Examinations and Testing

1.6.1 On-Scene Examinations and Testing

The Mississippi Public Service Commission and Atmos began investigating the Bristol Boulevard and Shalimar Drive accidents soon after each accident occurred.[40] The NTSB initiated its investigation of the Bristol Boulevard accident on

[40] (a) The Mississippi Public Service Commission regulates the natural gas distribution pipeline operators in the state of Mississippi, which include Atmos. (See section 1.11 for more information on state oversight.) (b) Atmos began its investigation on January 24, 2024, the day of the Bristol Boulevard accident, about 9:06 a.m. The Mississippi Public Service Commission began its investigation on January 25, 2024, the day after the Bristol Boulevard accident, about 9:30 a.m.

January 26, 2024, and added the Shalimar Drive accident to the investigation on January 28, 2024.

1.6.1.1 Bristol Boulevard

1.6.1.1.1 Bar-Hole Testing and Open-Air Testing

On January 24, 2024, shortly after the explosion, about 12:42 p.m., Atmos conducted bar-hole testing and open-air testing at the Bristol Boulevard accident location. Bar-hole testing measurements indicate whether there is natural gas present in the tested soil, which helps determine whether a pipe near a structure or residence is leaking gas. Open-air testing measurements indicate whether there is natural gas in the atmosphere, which helps determine the presence or magnitude of a gas leak.

Atmos detected subsurface natural gas between the street and the Bristol Boulevard accident home's service riser and near the Bristol Boulevard affected home's driveway.[41] The testing also identified open-air natural gas concentrations inside the Bristol Boulevard affected home. Test readings ranged from 2% to 100% gas in air by volume. Figure 10 shows the results of this testing and indicates whether each result was above, below, or within the explosive range of natural gas, which is between 5% and 15% gas in air by volume.[42]

[41] A *service riser* is a pipe that connects underground piping and assets to aboveground piping and assets, such as the gas meter.

[42] Natural gas will not explode at concentrations below 5% gas in air by volume or at concentrations greater than 15% gas in air by volume. A natural gas concentration between 5% and 15% gas in air by volume is dangerous because it could ignite if it contacts an ignition source (such as an electric spark or a flame).

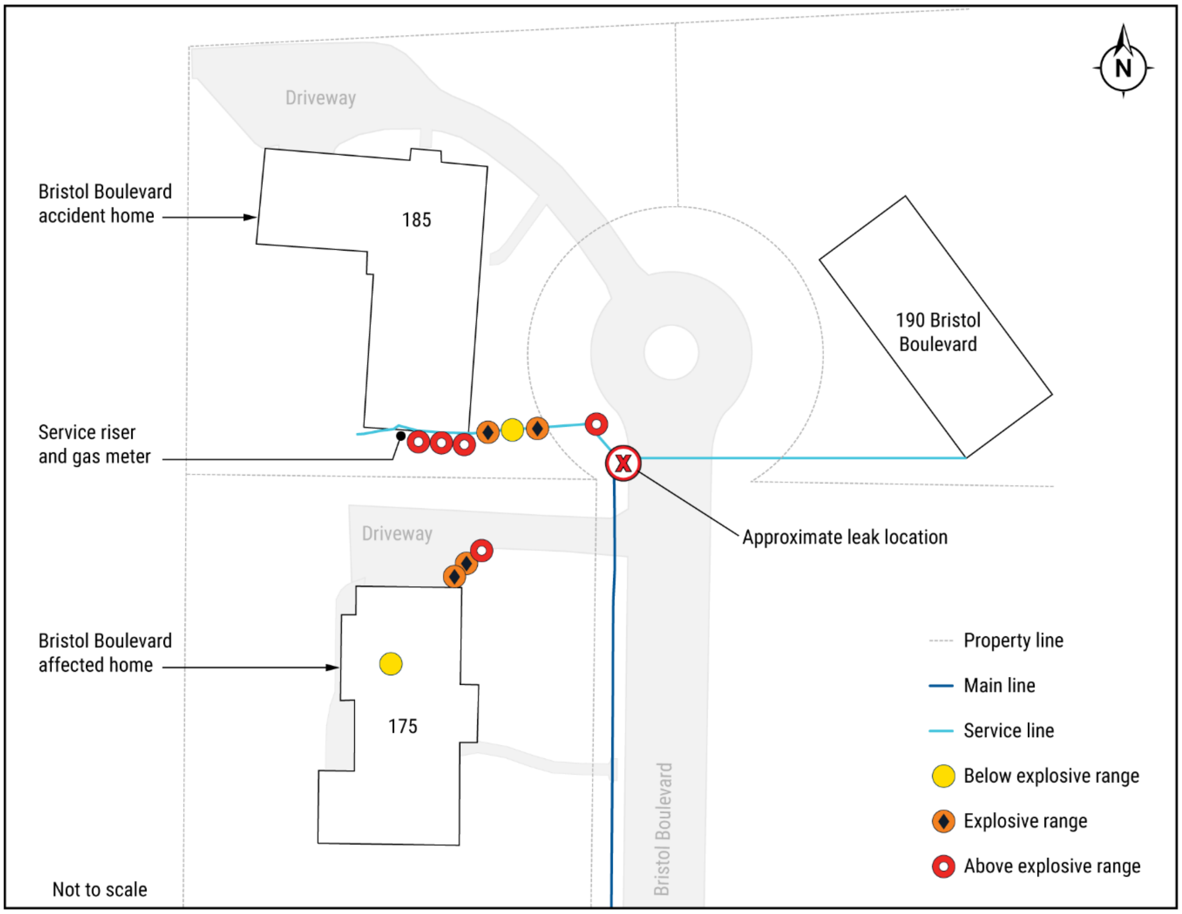

Figure 10. Postaccident bar-hole testing and open-air testing conducted at Bristol Boulevard on January 24, 2024, about 12:42 p.m.

On January 29, 2024, 5 days after the explosion, about 9:15 a.m., Atmos conducted bar-hole testing and open-air testing under NTSB direction at the Bristol Boulevard accident location. This testing detected subsurface natural gas around the Bristol Boulevard accident home and the Bristol Boulevard affected home. This was residual gas that was still present in the soil in the days following the accident. Atmos had not restored natural gas service at the time of these tests. Test readings ranged from 0.0015% to 5.8% gas in air by volume. Figure 11 shows the results of this testing.

Figure 11. Postaccident bar-hole testing and open-air testing conducted at Bristol Boulevard on January 29, 2024, about 9:15 a.m.

1.6.1.1.2 Pressure Testing

On January 25, 2024, January 26, 2024, and January 31, 2024, Atmos conducted pressure testing at the Bristol Boulevard accident location. Pressure testing helps determine whether a leak is present on the tested section of pipe. Pressure testing began with a section of the main and the service lines to the Bristol Boulevard accident home and the home at 190 Bristol Boulevard (the home directly across the street from the Bristol Boulevard accident home). The pressure did not hold, indicating a leak on the tested section of pipe. After identifying the leak on the service line to the home at 190 Bristol Boulevard, Atmos pressure tested smaller sections of the pipe to pinpoint the location of the leak and then excavated. Atmos exposed the leaking section of pipe and found a Dresser Style 90 straight compression coupling attached to the service line. (As discussed in section 1.1, unless otherwise noted, this report's references to Dresser Style 90 compression couplings refer to the seal-only design, which is not designed to resist pipe pullout.)

Further pressure testing pinpointed the leak on the Dresser Style 90 straight compression coupling at the connection between the compression coupling and the service line to the home at 190 Bristol Boulevard. The compression coupling had not completely separated from the service line; the leak occurred in the space between the partially separated components. Figure 3, figure 10, and figure 11 show the approximate leak location.

1.6.1.2 Shalimar Drive

1.6.1.2.1 Bar-hole Testing and Open-Air Testing

On January 27, 2024, shortly after the explosion, about 5:30 a.m., Atmos conducted bar-hole testing and open-air testing at the Shalimar Drive accident location. Atmos detected subsurface natural gas near the main in front of the Shalimar Drive accident home, the Shalimar Drive affected home, and the home at 1130 Shalimar Drive. Atmos also detected subsurface gas between the main and the Shalimar Drive accident home and the Shalimar Drive affected home. Test readings ranged from 0.25% to 50% gas in air by volume. Figure 12 shows the results of this testing and indicates whether each result was above, below, or within the explosive range of natural gas, which is between 5% and 15% gas in air by volume.

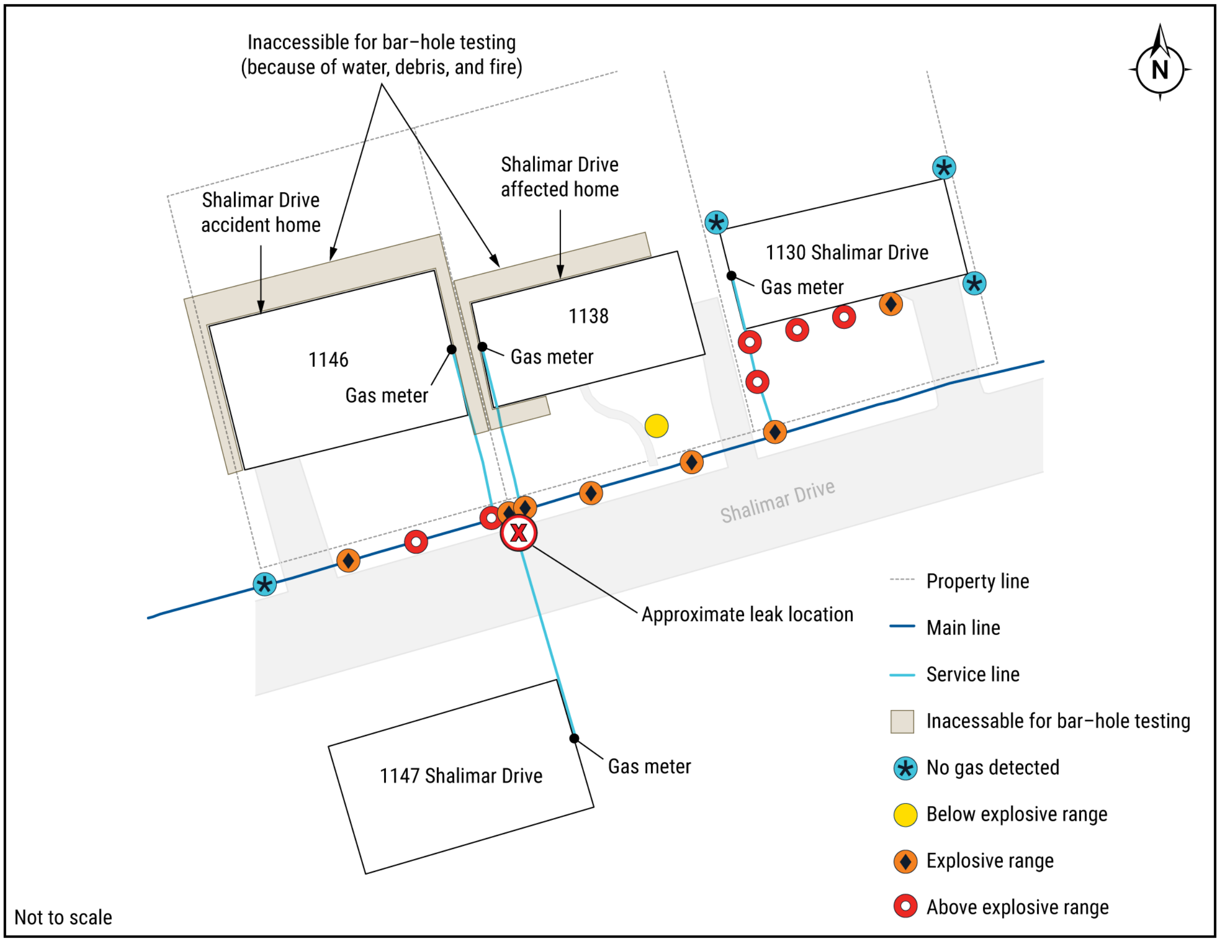

Figure 12. Postaccident bar-hole testing and open-air testing conducted at Shalimar Drive on January 27, 2024, about 5:30 a.m.

On January 29, 2024, 2 days after the explosion, about 9:40 a.m., Atmos conducted bar-hole testing and open-air testing under NTSB direction at the Shalimar Drive accident location. This testing detected subsurface natural gas near the Shalimar Drive accident home, the Shalimar Drive affected home, and the home at 1130 Shalimar Drive. The testing also identified open-air natural gas concentrations inside the home at 1130 Shalimar Drive. This was residual gas that was still present in the soil and air in the days following the accident. Atmos had not restored natural gas service at the time of these tests. Test readings ranged from 0.005% to 50.7% gas in air by volume. Figure 13 shows the results of this testing.

Figure 13. Postaccident bar-hole testing and open-air testing conducted at Shalimar Drive on January 29, 2024, about 9:40 a.m.

1.6.1.2.2 Pressure Testing

From January 28, 2024, through January 30, 2024, Atmos conducted pressure testing at the Shalimar Drive accident location. Pressure testing began with a section of the main and the service lines to the Shalimar Drive accident home, the Shalimar Drive affected home, and the home at 1147 Shalimar Drive (the home directly across the street from the Shalimar Drive accident home). The pressure did not hold, indicating a leak on the tested section of pipe. After identifying the leak on the service line to the home at 1147 Shalimar Drive, Atmos pressure tested smaller sections of the pipe to pinpoint the location of the leak and then excavated. Atmos exposed the leaking section of pipe and found a Dresser Style 90 elbow compression coupling attached to the service line.[43] Further pressure testing pinpointed the leak

[43] Dresser refers to this compression coupling as the "Dresser Style 90° ELL Seal-Only."

on the Dresser Style 90 elbow compression coupling at the connection between the compression coupling and the service line to the home at 1147 Shalimar Drive. The compression coupling had not completely separated from the service line; the leak occurred in the space between the partially separated components. Figure 6, figure 12, and figure 13 show the approximate leak location.

1.6.2 Laboratory Examinations and Testing

1.6.2.1 Bristol Boulevard

1.6.2.1.1 Pipeline Assembly

The NTSB examined the natural gas distribution pipeline assembly that serviced the home at 190 Bristol Boulevard (the home directly across the street from the Bristol Boulevard accident home), which included portions of the main and the service line, the service tee, a Dresser Style 90 elbow compression coupling, a nipple connector, and a Dresser Style 90 straight compression coupling.[44] (See figure 14.)[45] NTSB pressure tests confirmed Atmos's pressure testing on the scene, which found the leak on the Dresser Style 90 straight compression coupling, pinpointing the connection between the compression coupling and the service line to the home at 190 Bristol Boulevard.[46]

[44] (a) The assembly arrived at the NTSB coated in black tape. (b) Atmos reported that during excavation, the service line separated from the Dresser Style 90 straight compression coupling. (c) In operation, compression couplings are part of the service line. (d) In the figure, the "saw-cut" end of the service line is the end that was closest to the home at 190 Bristol Boulevard, the end that technicians cut during excavation.

[45] The figure also indicates the approximate leak location.

[46] The NTSB did not pressure test the connection between the main and the service line because the two components separated during excavation. The NTSB's pressure tests of other assembly components did not identify any leaks.

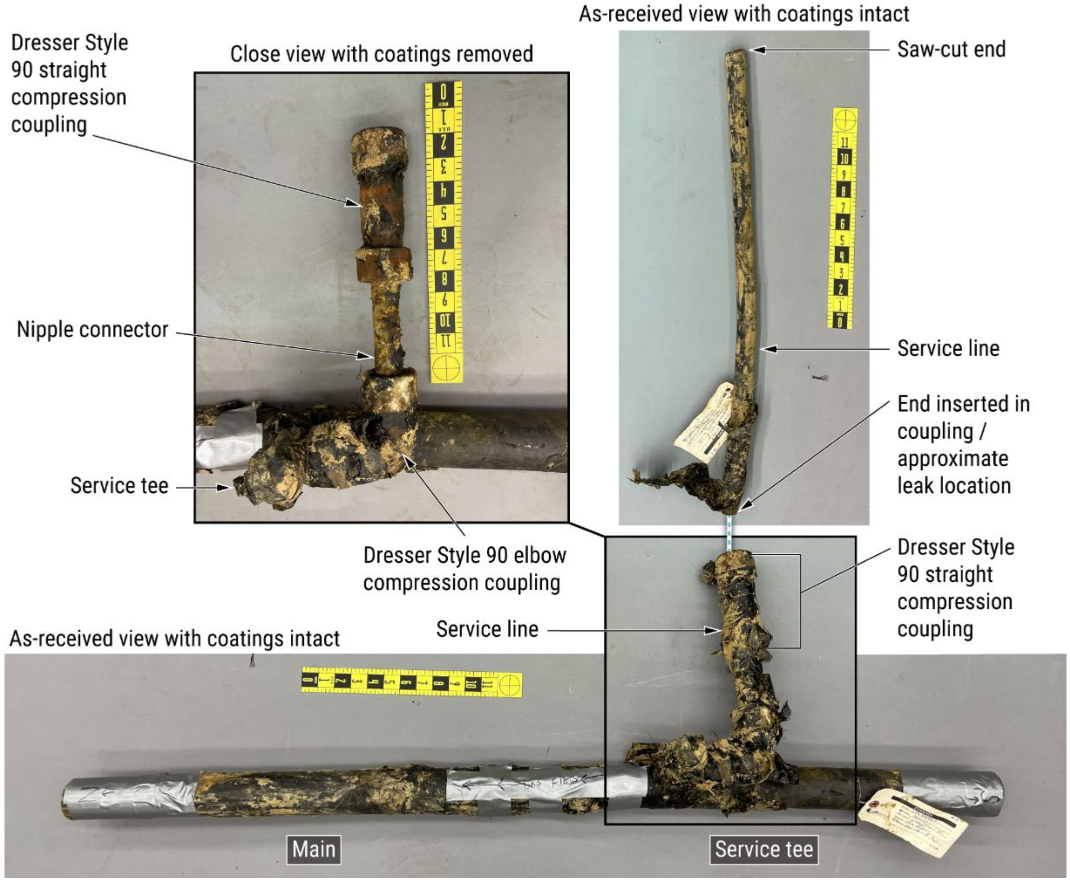

Figure 14. The Bristol Boulevard natural gas pipeline assembly.

1.6.2.1.2 Service Line

The NTSB examined the section removed from the 190 Bristol Boulevard service line, which was approximately 29 inches long with a 1.04-inch outer diameter and bent approximately 13 inches from the upstream end.[47] A visual examination revealed a set of shallow, parallel scratch marks on the outer surface of the service-line pipe between 1.5 and 2 inches from the upstream end, spaced

[47] (a) The steel service-line pipe had a hard black coating. This observation applies to both accident locations. (b) The direction of the flow of gas determines upstream and downstream designations. In this case, the upstream end of the bent segment of service-line pipe was the connection between the pipe and the straight compression coupling, and the downstream end of the service-line pipe was the connection to the home at 190 Bristol Boulevard. (c) The NTSB's review of evidence did not show that the bend in the service line was a factor in the accident.

approximately 0.02 inches apart. The examination found scratches of similar size and shape at the end of the service-line pipe.[48] (See figure 15.)

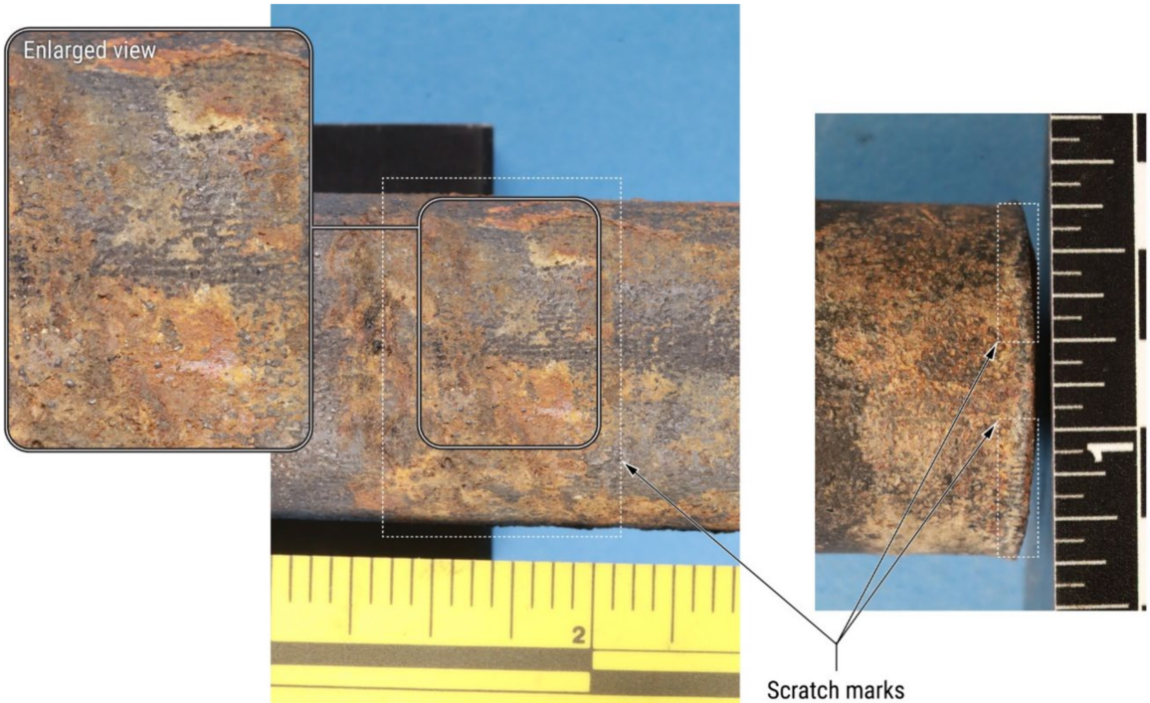

Figure 15. Scratches on the upstream end of the service line at Bristol Boulevard.

1.6.2.1.3 Gasket

The NTSB examined the gasket on the Dresser Style 90 straight compression coupling from the home at 190 Bristol Boulevard.[49] Mechanical testing showed that the rubber in the gasket had not significantly degraded while in use.[50] The gasket toe contained armor, as designed.[51] (See figure 9.) The spacing between the windings of this armor measured approximately 0.02 inches, which roughly matched the spacing

[48] The NTSB found rust in and around the scratches on the service-line pipe. The NTSB did not find significant material loss or penetration into any service-line components. These two observations apply to both accident locations.

[49] Alphanumeric markings on the heel of the gasket correspond to a manufacture date of 1971.

[50] The tests showed that the mechanical properties of the rubber in the examined gasket were similar to the original manufacturer specifications. This observation applies to both accident locations.

[51]The gasket armor was approximately 0.8 inches from the opening of the compression coupling where the pipe would have been inserted. This observation applies to both accident locations.

of the scratch marks found on the service-line pipe. This is evidence that the service-line pipe had, at some point, moved within the compression coupling.

1.6.2.1.4 Copper-Water Pipeline

The NTSB examined a copper-water pipeline assembly that was installed above the service line to the home at 190 Bristol Boulevard and had rested near the connection between the compression coupling and the service-line pipe. The examination did not reveal any significant evidence of contact either on the top of the service line or on the bottom of the copper-water pipeline, such as evidence of rubbing, local deformation, or material transfer. Figure 16 is a postaccident-excavation photograph showing the copper-water pipeline traversing over the service line.

Figure 16. Excavation photograph of the copper-water pipeline and the service line near the Bristol Boulevard accident location. (Courtesy of Atmos.)

1.6.2.1.5 Surface Load

The NTSB conducted a study to calculate the potential stress that a surface load, specifically a vehicle, might have on a buried pipe. Atmos provided photographs showing the yard of the Bristol Boulevard accident home with tire marks in the approximate location of the belowground accident service line (the service line to the home at 190 Bristol Boulevard, which was in the front yard of the Bristol Boulevard accident home). The NTSB calculated the impact of a 20,000-pound surface load (the maximum weight allowed for a single axle on a vehicle in Mississippi) on a natural gas service line and determined the maximum theoretical downward pressure on the service-line pipe was 8.1 pounds per square inch. Carbon steel, a material similar to the accident service-line pipe, has a yield strength (the amount of stress a material can withstand before it starts to deform) of approximately 30,000 pounds per square inch.[52]

The NTSB also calculated how much a belowground pipe might shift based on any soil movement associated with a 20,000-pound surface load (the theoretical surface load of a vehicle). According to a US Army Corp of Engineers manual, the Young's modulus of soft clay is approximately 780–3100 pounds per square inch (expansive clay, the clay located at the Bristol Boulevard accident location, is soft when it is wet) (US Army Corp of Engineers 1990).[53] In the case of the softest clay, the theoretical applied load would cause approximately 1% strain (or 0.01 inch of movement per 1 inch of soil) at the pipe.[54] In addition, the NTSB's examination of the accident service-line pipe and compression coupling did not reveal any damage that could be attributed to shifting related to surface loads.

1.6.2.2 Shalimar Drive

1.6.2.2.1 Pipeline Assembly

The NTSB examined the natural gas distribution pipeline assembly that serviced the home at 1147 Shalimar Drive (the home directly across the street from the Shalimar Drive accident home), which included portions of the main and the service line, the service tee, and a Dresser Style 90 elbow compression coupling.

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[52] (a) This evaluation was based on American Society for Testing and Materials A53, the standard for carbon-steel pipe used for mechanical, pressure, and structural applications. (b) The American Society for Testing and Materials, known as ASTM International, is a standards organization that develops and publishes international standards for materials, products, systems, and services.

[53] (a) *Young's modulus* is a mechanical property of solid materials that measures the compressive stiffness (or strain) when the force is applied lengthwise. (b) The US Army Corp of Engineer manual cites the Young's modulus of soft clay at 50–200 tonnes per square foot, which is converted to pounds per square inch in the body of the report.

[54] This calculation assumed a simplified linear model for estimating soil movement under instantaneous load and did not account for variables such as loading time, soil plasticity, or constraints from the surrounding soil.

(See figure 17.)[55] NTSB pressure tests confirmed Atmos pressure testing on the scene, which found the leak on the Dresser Style 90 elbow compression coupling, pinpointing the connection between the compression coupling and the service line to the home at 1147 Shalimar Drive.

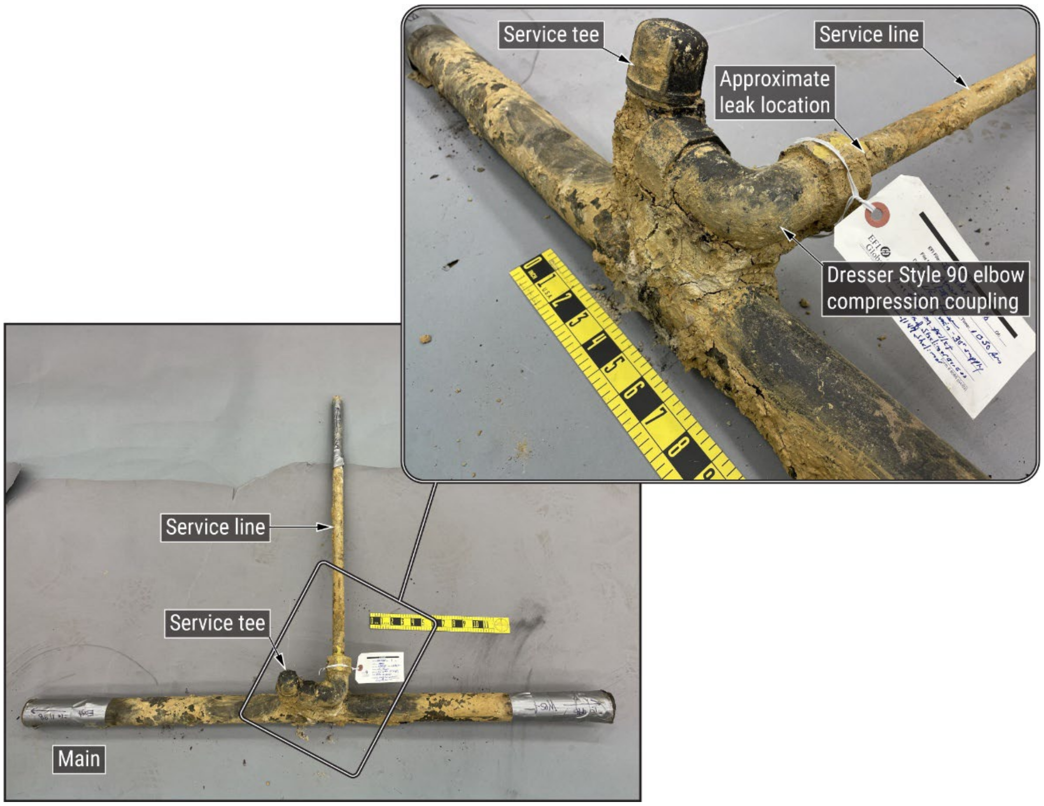

Figure 17. The Shalimar Drive natural gas pipeline assembly.

1.6.2.2.2 Service Line

The NTSB examined the section removed from the 1147 Shalimar Drive service line, which was approximately 30 inches long with a 1.05-inch outer diameter. A visual examination of the Shalimar Drive accident service line revealed a set of shallow, parallel scratch marks on the outer surface of the service-line pipe between 1.75 and 1.25 inches from the upstream end, spaced approximately 0.02 inches apart. The examination found scratches of similar size and shape at the end of the service-line pipe. (See figure 18.) The examination also showed that the end of the service-line pipe did not extend past the toe of the gasket and into the main body of

[55] The figure also indicates the approximate leak location.

the compression coupling, meaning the service-line pipe was not fully inserted into the coupling, it had partially pulled out. (See figure 19.)[56]

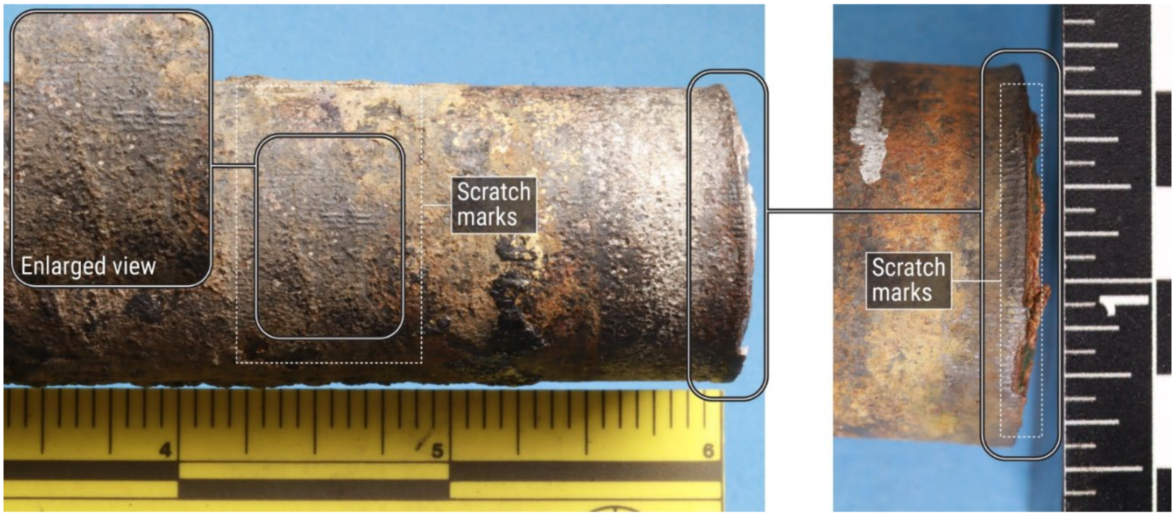

Figure 18. Scratches on the upstream end of the service line at Shalimar Drive.

[56] In the figure, the end nut is removed from the compression coupling.

Figure 19. The Shalimar Drive service-line pipe and gasket.

1.6.2.2.3 Gasket

The NTSB examined the gasket on the Dresser Style 90 elbow compression coupling from the home at 1147 Shalimar Drive.[57] Mechanical testing showed that the rubber in the gasket had not significantly degraded while in use. The gasket contained coil-wound armor, and the spacing between the windings of this armor measured approximately 0.02 inches, which roughly matched the spacing of the scratch marks found on the service-line pipe. This is evidence that the service-line pipe had, at some point, moved within the compression coupling.

[57] Alphanumeric markings on the heel of the gasket correspond to a manufacture date around 1963.

1.7 Regulations and Advisory Bulletins

1.7.1 Regulations

1.7.1.1 Public Awareness

Natural gas distribution pipeline public awareness programs educate the public on pipeline safety, including how to respond to a suspected natural gas leak. Federal regulations in Title 49 *Code of Federal* Regulations (*CFR*) 192.616 provide minimum standards related to pipeline operator public awareness programs, requiring operators to develop and implement a written continuing public education program that follows the American Petroleum Institute's Recommended Practice 1162 baseline and supplemental guidance, which encompass five areas. The first area is *target audiences* and includes the affected public, emergency response officials, excavators, and public officials.[58] The second area is *message content* and includes:

(1) the pipeline purpose and product transported,

(2) safety precautions and emergency response steps,

(3) how to recognize and report pipeline releases (how to respond to suspected natural gas leaks), and

(4) the importance of calling 8-1-1 before digging.

Delivery frequency is the third area, which American Petroleum Institute Recommended Practice 1162 typically requires every 1 to 4 years, depending on the audience. The fourth area is *delivery methods* and includes mailings, brochures, bill inserts, community events, and media campaigns. Lastly, the fifth area is *program evaluation* and requires operators to assess their public awareness program effectiveness through surveys, feedback, or other metrics. (See section 1.9.2 for information on Atmos’s public awareness program.)

1.7.1.2 Distribution Integrity Management

Distribution integrity management is a process that natural gas distribution pipeline operators use to identify, assess, and manage risks to their pipeline

[58] The affected public group includes members of the public who are natural gas customers and those who are not.

systems.[59] Federal regulations in 49 *CFR* Part 192 Subpart P provide minimum standards for pipeline operator distribution integrity management programs and include seven required elements.[60] The first element is system *knowledge* (the term "system data" has the same meaning), which includes (1) identifying the characteristics of the pipeline's design and operations and the environmental factors that are necessary to assess the applicable threats and risks to its gas distribution pipeline;

(2) considering the information gained from past design, operations, and maintenance; and

(3) identifying additional information needed and providing a plan for gaining that information over time through normal activities conducted on the pipeline.[61]

The second element is *identify threats*, which requires operators to consider reasonably available information to identify existing and potential threats. *Evaluate and rank risk* is the third element and requires operators to determine the relative importance of each threat and estimate and rank the risks posed to their pipelines. The fourth element, *identify and implement measures to address risks*, requires operators to determine and implement measures designed to reduce the risks from failure of its gas distribution pipeline. The regulations state that such measures must include an effective leak management program.[62] The fifth element is *measure performance, monitor results, and evaluate effectiveness*. This element requires operators to develop and monitor performance measures from an established baseline to evaluate the effectiveness of their integrity management programs.[63] Lastly, the sixth and seventh program elements are *periodic evaluation and*

[59] The Pipeline and Hazardous Materials Safety Administration introduced distribution integrity management requirements in 2009 to "enhance safety by identifying and reducing pipeline integrity risks."

[60] See 49 *CFR* 192.1007.

[61] System knowledge [also known as system data] includes asset information such as location, material composition, size, joining method, construction method, installation date, soil conditions (where appropriate), operating and design pressure, history, operating experience performance data, the condition of the system, and any other characteristics the operator notes as important to understanding its system (PHMSA 2015).

[62] See 49 *CFR* 192.1007(d).

[63] See 49 *CFR* 192.1007(e)(1).

improvement and *report results*. (See section 1.9.3 for information on Atmos's distribution integrity management program.)

1.7.2 Advisories and Reports

1.7.2.1 Advisory Bulletin on Couplings

The Pipeline and Hazardous Materials Safety Administration (PHMSA), the federal regulator for US pipelines, issues advisory bulletins and publishes reports to inform pipeline operators and personnel of safety risks within the industry and to provide guidance on best practices. In 2008, PHMSA issued an advisory bulletin on mechanical coupling failures. (Mechanical couplings, which include compression couplings, were involved in the two Jackson accidents.) In the bulletin, PHMSA summarized several events involving mechanical coupling failures and noted that failures could occur when:

(1) there was inadequate restraint for the potential stresses on the two pipes,

(2) the couplings were incorrectly installed or supported, or

(3) the coupling components degraded over time.

The advisory bulletin cited pipe pullout as a predominant mechanical coupling failure mode and stated that soil shifting (or soil movement) from earthquakes or heavy rains were factors that could produce pullout forces. PHMSA advised operators to:

(1) ensure leak surveys were properly conducted,

(2) improve recordkeeping on couplings to help identify a trend of problems that may occur with a specific coupling or type of installation, and

(3) consider adopting a full replacement program if there were too many unknowns related to couplings in service (PHMSA 2008).

1.7.2.2 Report on Pipeline Risk Models

In 2020, PHMSA published a report highlighting the strengths and limitations of the different types of pipeline distribution integrity management risk models.[64] In the report, PHMSA reviewed four risk model types and evaluated the effectiveness of

[64] PHMSA published this report in response to Safety Recommendation P-15-12. Safety Recommendation P-15-12 is classified Closed—Acceptable Action.

each type in supporting pipeline operator risk assessments and decision-making. PHMSA assessed the qualitative model, the relative-assessment (index) model (relative-risk model), the quantitative system and probabilistic model, and the probabilistic model. The report notes that quantitative and probabilistic models are more robust than qualitative and relative-risk models. PHMSA made several conclusions in the report, including:

(1) Probabilistic risk models were a best practice for large, complex systems and systems lacking data because they were more versatile and provided greater capabilities for risk insights and decision-making support than the other types of models.

(2) Pipeline operators who continued to use relative-risk models should supplement personnel judgment (subject matter expertise) with as much pipeline physical attribute data (system data) as could reasonably be acquired over time.[65]

(3) Pipeline operators should take ongoing actions to improve and update (system) data quality and completeness over time (PHMSA 2020).

(See section 1.9.3.2 for more information on Atmos's distribution integrity management risk model.)

1.8 Atmos Energy Corporation

1.8.1 Company Overview

At the time of the two accidents, Atmos was an independent, publicly held natural gas distribution company, headquartered in Dallas, Texas, employing about 5,000 people across its six regional divisions, with operations in eight US states.[66] (See figure 8.) Atmos served more than three million customers in over 1,400 communities, which encompassed approximately 75,000 miles of distribution pipeline. Atmos was the largest natural gas distributor in the states of Louisiana, Mississippi, and Texas. The operator established its Mississippi Division in 2002 when

[65] The report noted that relative-risk models were best suited for small, less complex pipeline systems.

[66] At the time of the two accidents, Atmos operated in Colorado, Kansas, Kentucky, Louisiana, Mississippi, Tennessee, Texas, and Virginia,

it acquired pipeline assets from Mississippi Valley Gas to deliver natural gas to over 250,000 customers.

1.8.2 Pipeline Safety Management Systems

Pipeline Safety Management Systems (PSMS) is a framework that assists pipeline operators in improving their safety performance. American Petroleum Institute's Recommended Practice 1173 provides guidance for developing and implementing PSMS.[67] The essential elements of PSMS include:

(1) leadership and management commitment;

(2) stakeholder engagement;

(3) risk management;

(4) operational controls;

(5) incident investigation, evaluation, and lessons learned;

(6) safety assurance;

(7) management review and continuous improvement;

(8) emergency preparedness and response;

(9) competency, awareness, and training; and

(10) documents and record keeping.

The NTSB's Dallas investigation determined that, after the accident, Atmos reported it had accelerated the implementation of PSMS by updating its initial self-assessment and engaging a third-party expert to perform an enterprise-wide PSMS assessment and gap analysis. The NTSB's Farmersville investigation determined that, after the accident, Atmos reported it continued to focus on identifying and mitigating potential risks, and that it had a corporate officer primarily responsible for the design, adoption, and implementation of PSMS.[68] Atmos used the American Petroleum Institute Recommended Practice 1173 implementation tool to

[67] Federal regulations do not require natural gas distribution operators to have a PSMS.

[68] See section 1.10 for more information on the NTSB's Dallas and Farmersville investigations.

evaluate its conformance to PSMS standards. Each level in the PSMS model represents a different stage in the maturity process, from planning to developing to implemented and, finally, to sustaining. Atmos's last PSMS maturity self-assessment before the two accidents in Jackson was in 2023, and it showed a conformance level between the "developing" and "implemented" levels.

1.8.3 Safety Performance

The NTSB's review of PHMSA's public pipeline safety data noted that, around the time of the accidents, Atmos's reported safety incident rates were higher than those for similarly sized natural gas distribution operators.[69] Between 2018 and 2022, Atmos had 7 "Serious Incidents" and 24 "Significant Incidents."[70] Atmos's 5-year rate for serious incidents per 1,000 miles was 0.013 (for all its operating divisions), compared to the 0.009 average of other similarly sized operators.

1.9 Procedures and Policies

1.9.1 Leak Management

Atmos's procedures stated that leak management was accomplished by leak surveying and involved locating, grading (or classifying), repairing, and monitoring leaks. In 2023, the year before the two Jackson accidents, Atmos repaired 182 hazardous (grade 1) leaks in Jackson. (See figure 20.) (As discussed in section 1.1, this report's references to leaks refer to belowground leaks unless otherwise noted.)

[69] (a) Regulations in 49 *CFR* 191 provide specific criteria for a pipeline safety "incident." (b) This report uses the terms "incident" and "accident" interchangeably.

[70] (a) A *serious incident* is one that includes (with some exclusions) a fatality or injury requiring in-patient hospitalization. (b) A *significant incident* is one that includes (with some exclusions) any of the following: a fatality or injury requiring in-patient hospitalization; $50,000 or more in total costs, measured in 1984 dollars; highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more; and liquid releases resulting in an unintentional fire or explosion.

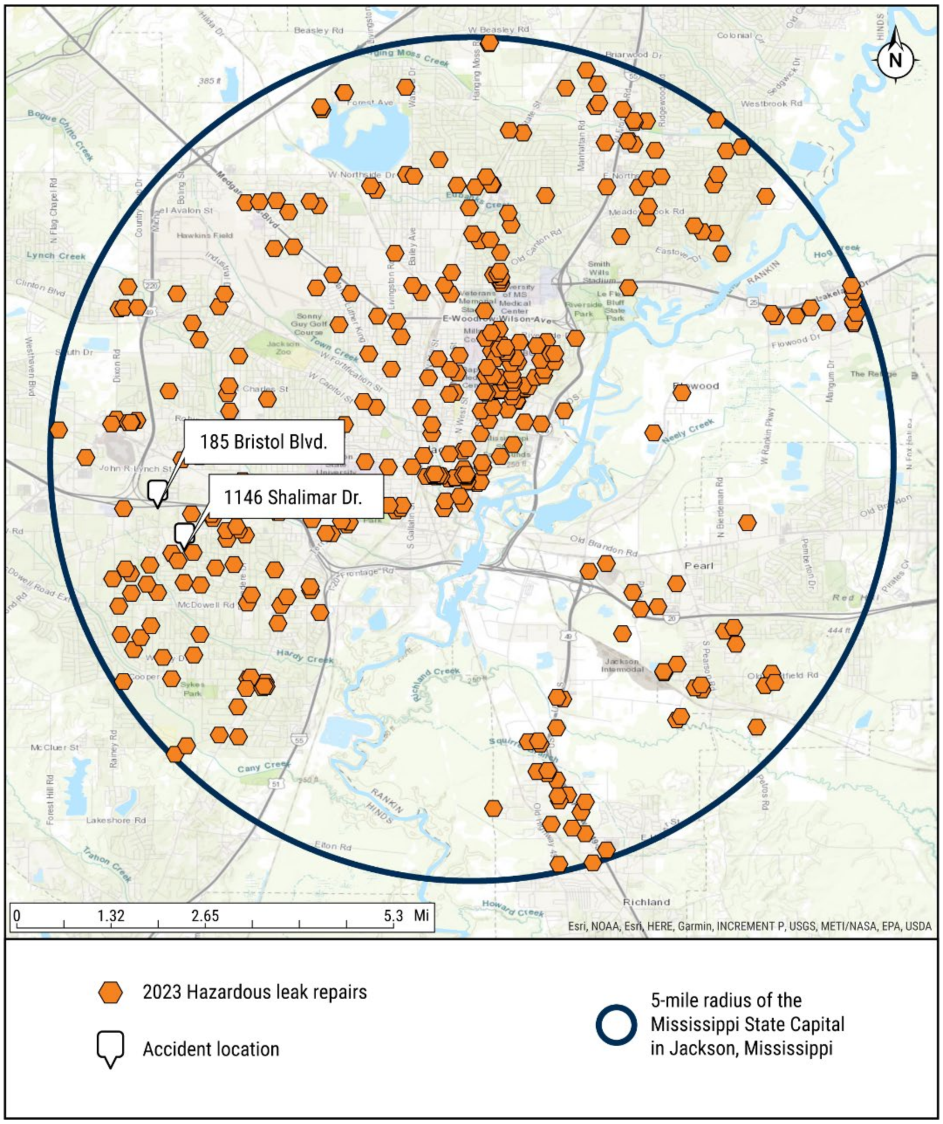

Figure 20. Map of hazardous leaks within a 5-mile radius of Jackson that Atmos repaired in 2023. (Courtesy of ESRI ArcGIS and Atmos with NTSB annotations.)

In 2024, as of the day of the Bristol Boulevard accident, January 24, 2024, Atmos had identified 289 leaks within a 5-mile radius of Jackson. Atmos classified these leaks as grade 2 (including the leak near the Bristol Boulevard accident home) or grade 3 (including the leak near the Shalimar Drive accident home) and therefore considered them nonhazardous.[71] After the two accidents, Atmos determined it had

[71] (a) Atmos's procedures required its technicians to repair grade 1 leaks immediately. (See section 1.9.1.2 for more information on Atmos's leak classification procedures.) (b) From January 1, 2024, to January 24, 2024, Atmos had not repaired any hazardous leaks within a 5-mile radius of Jackson.

classified several leaks as grade 3 leaks that upon reevaluation in the field met the criteria for grade 1 or grade 2 leaks.[72] Figure 21 shows a map of the 289 open leaks in Jackson as of January 24, 2024, including the two accident locations, and the grade 3 leaks that met the criteria for higher grade leaks when Atmos reevaluated them.[73]

[72] Five of the 228 leaks that Atmos had previously classified as grade 3 met the criteria for grade 1 leaks, and 29 of the 228 leaks that Atmos had previously classified as grade 3 met the criteria for grade 2 leaks. Therefore, about 15% of the grade 3 leaks Atmos had identified as of January 24, 2024, met the criteria for higher grade leaks when Atmos reevaluated them.

[73] Atmos considered a leak *open* if it met leak classification criteria and had not been repaired.

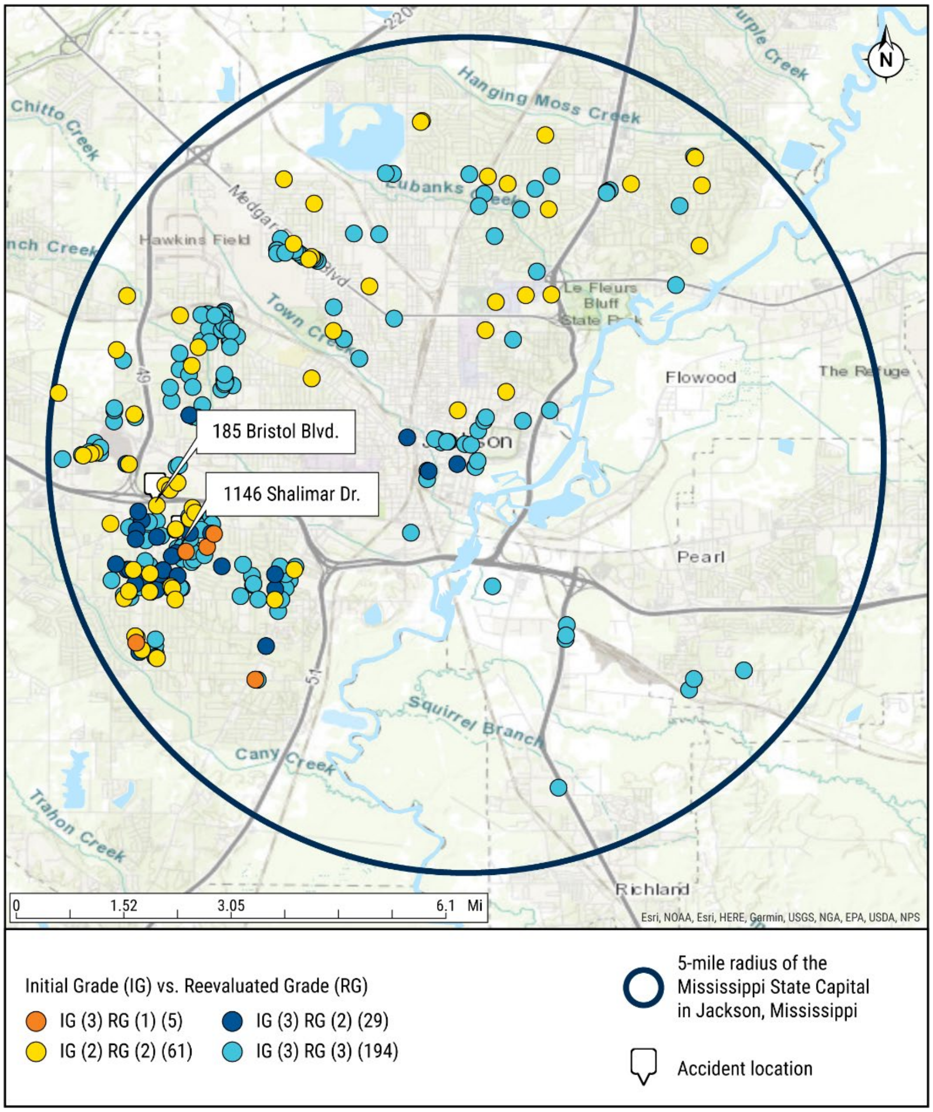

Figure 21. Map of open leaks within a 5-mile radius of Jackson on January 24, 2024, including leaks that later met criteria for higher grade leaks. (Courtesy of ESRI ArcGIS and Atmos with NTSB annotations.)

1.9.1.1 Leak Surveys and Leak Investigations

The NTSB's interviews with Atmos technicians indicated that the operator conducted mobile leak surveys at night to detect indications of natural gas. Technicians then investigated any indications during the day by conducting walking leak surveys. Atmos's contractors conducted the mobile leak surveys, and Atmos's employees conducted the leak investigations. Leak survey and leak investigation procedures for Atmos's employees and contractors were nearly the same, except that when Atmos's contractors discovered a hazardous condition, such as a grade 1 leak, Atmos required that they call 9-1-1 and Atmos, whereas Atmos required its employees who discovered a hazardous condition to perform what it called "continuing actions."[74]

1.9.1.1.1 Mobile Leak Surveys

Atmos's procedures required pipeline distribution system surveys, which included all mains and service lines and were typically performed with mobile technology, as frequently as necessary, but at least once every 5 calendar years at intervals not exceeding 63 months. The procedures stated that Atmos used advanced mobile leak detection technology, aerial leak surveys, and optical gas imaging to perform mobile leak surveys, and that such surveys may require subsequent leak surveys and leak investigations for subsurface natural gas.

1.9.1.1.2 Walking Leak Surveys and Leak Investigations

Atmos procedures required technicians to conduct leak surveys on foot using calibrated natural gas detection equipment to check for indications of gas. The procedures also required technicians to conduct an auditory, visual, and olfactory inspection to evaluate potential hazards. The procedures required technicians to look for indications of a natural gas leak, such as:

(1) bubbles in water, gas vapors, etc.;

(2) evidence of stunted [vegetation] growth, dead or yellowing grass, plants, trees, weeds, etc.;

(3) insect infestation along piping or meter sets;

(4) exposed pipe or atmospheric corrosion of exposed pipe;

(5) audible leaks, such as hissing or blowing; and

(6) the smell of natural gas odorant.

Atmos's emergency procedures required its emergency responders to, as soon as possible when arriving on the scene of an odor complaint or report of gas, conduct inside and outside leak investigations using combustible gas indicators to

[74] Continuing actions included evacuating occupants of affected structures, turning off gas at affected structures and securing meters, calling 9-1-1, notifying a supervisor, establishing a safety perimeter, and considering a request to the electric-utility provider to shut off service to affected structures.

detect natural gas.[75] The procedures also required Atmos's emergency responders to record and classify any leaks that they found. The procedures stated that responders "must be diligent, thorough, and persistent when conducting their leak investigations."

1.9.1.2 Leak Classification

As discussed in section 1.1, Atmos's procedures provided classification criteria for grade 1, grade 2, and grade 3 natural gas distribution pipeline leaks. Atmos classified leaks based on the American National Standards Institute/Gas Piping Technology Committee (GPTC) *Guide for Gas Transmission, Distribution, and Gathering Piping Systems* (GPTC 2023).[76] Table 3 shows a summary of Atmos's leak classification procedures at the time of the two accidents.

[75] Atmos's emergency responders included employees near the emergency location who were operator qualified in emergency response tasks.

[76] The GPTC is a consensus group composed of industry representatives and government regulators who develop guidance for natural gas operators on practices and procedures to comply with federal pipeline safety regulations.

Table 3. Atmos leak classification procedures.

Grade	1	2	3
Definition	Represents an existing or probable hazard to people or property.	Nonhazardous at the time of detection.	Expected to remain nonhazardous.
Requirements	Immediate repair.	Scheduled repair based on possible future hazard.	Monitor and repair.
State-specific requirements	Kansas and Tennessee.	Kansas,Tennessee, and Texas.	Kansas,Tennessee, and Texas.
Example criteria	Escaping gas that has ignited. Any indication of gas which has migrated into or under a building or into a tunnel. Any reading of 4% gas in air or greater in a confined space (such as a tunnel, manhole, catch basin) or small substructure (such as a telephone or electric conduit).	Leaks requiring scheduled repair before ground freezing or other adverse changes in venting conditions. Any leak, which under frozen or other adverse-soil conditions, would be likely to migrate to the outside wall of a building. Any reading less than 4% gas in air in small substructures (other than gas-associated substructures) from which gas would likely migrate creating a probable future hazard.	Any reading of less than 4% gas in air in small gas-associated substructures. Any reading under a street in areas without wall-to-wall paving where it is unlikely the gas could migrate to the outside wall of a building. Any reading of less than 1% gas in air in a confined space.

1.9.1.3 Leak Reevaluation and Leak Repair

Atmos's classification procedures, which could vary based on state regulatory requirements (some states had more stringent pipeline safety standards than others), included reevaluation and repair timelines for grade 1, grade 2, and grade 3 natural gas distribution pipeline leaks. At the time of the two accidents, in most states where Atmos operated, including Mississippi, when an Atmos technician (an employee or contractor) classified a leak as grade 1, Atmos required immediate repair or continuous action until the technician determined that the conditions were no longer hazardous. Atmos's procedures included specific requirements for grade 1 leaks identified in Kansas and Tennessee to comply with regulations in those states. For example, Atmos's procedures for Kansas required a grade 1 leak to be replaced, repaired, or removed from service within 5 days from the date the operator became notified of the leak.

In most states where Atmos operated, including Mississippi, when an Atmos technician classified a leak as grade 2, Atmos required the leak to be reevaluated at least once every 6 months until it was repaired or cleared.[77] Atmos required employees to consider soil conditions, including soil moisture, when determining grade 2 leak repair priority. Atmos required the leak to be repaired within 1 calendar year (but no later than 15 months) from the date the technician reported the leak. Atmos's procedures also included specific requirements for grade 2 leaks identified in Kansas, Tennessee, and Texas to comply with regulations in those states. For example, Atmos's procedures for Kansas required a grade 2 leak to be repaired within 6 months.

In most states where Atmos operated, including Mississippi, when an Atmos technician classified a leak as grade 3, Atmos required the leak to be reevaluated during the next scheduled survey or within 15 months, whichever came first, until the leak was repaired, regraded (or reclassified), or no longer resulted in a reading. Atmos required the leak to be repaired or cleared within 36 months. Atmos's procedures also included specific requirements for grade 3 leaks identified in Kansas, Tennessee, and Texas to comply with regulations in those states. For example, Atmos's procedures for Kansas required a grade 3 leak to be repaired within 30 months.

1.9.1.4 Leak Monitoring

Atmos's classification procedures, which could vary based on state regulatory requirements, included leak monitoring timelines for grade 1 and grade 2 natural gas distribution pipeline leaks. At the time of the two accidents, Atmos's procedures for most states, including Mississippi, required technicians to monitor a grade 1 leak every 15 days (until it was repaired) if it could not be repaired immediately.[78] Atmos procedures for most states, including Mississippi, did not include monitoring timelines for grade 2 or grade 3 leaks. However, Atmos procedures for Kansas stated that under adverse-soil conditions, which included flooding, drought, frozen ground, and settlement, a grade 2 leak must be monitored weekly to ensure that the leak would not represent a probable hazard and that it reasonably could be expected to remain nonhazardous.

[77] Atmos considered a leak *cleared* when it no longer existed or no longer met leak classification criteria.

[78] Atmos's procedures required technicians to have management approval when they did not repair a grade 1 leak immediately.

1.9.1.5 Leak Record Keeping

Atmos procedures stated that all leaks reported or discovered required sketches on the appropriate form that were clear, legible, and included the information specified in the section, such as the natural gas migration pattern and the location of the highest sustained gas reading.[79]

1.9.2 Public Awareness

As discussed in section 1.7.1.1, federal regulations require natural gas distribution operators to educate the public on pipeline safety. Atmos's public awareness program procedures included a communication plan for addressing each of the required target audience groups (the affected public, emergency response officials, excavators, and public officials). Within the affected public group, Atmos's procedures identified subgroups, including (1) local distribution company customers (distribution customers) and (2) adults (people 18 years and older) in its service area, including noncustomers.[80] For its distribution customers, Atmos's procedures stated that it would deliver pipeline safety content twice a year, including messages on natural gas leak recognition and response, which included how to respond to a suspected natural gas leak. The procedures noted that the messages would be delivered in a variety of ways, including paid advertising (through platforms such as television), social media, and bill inserts.[81] For adults in its service area, Atmos's procedures stated that it would deliver pipeline safety content once a year, including messages on natural gas leak recognition and response. The procedures noted that the messages would be delivered in a variety of ways, including paid advertising (through platforms such as television), social media, and community events.[82]

The emergency response official target audience group included emergency operating centers and 9-1-1 call centers; fire and rescue departments; law

[79] Atmos's procedures required sketches of known leaks whether they had changed in hazard level or not.

[80] Other affected public subgroups identified in Atmos's procedures included businesses; schools, colleges, and universities; places of worship; and hospitals. (This is not a complete list of these subgroups.)

[81] Atmos's public awareness program plan current at the time of the two accidents noted 257,214 distribution customers in its Mississippi service area.

[82] Atmos's public awareness program plan current at the time of the two accidents noted 705,512 adults in its Mississippi service area.

enforcement agencies; local county emergency planning commissions; and local county emergency management agencies. For emergency response officials, Atmos's procedures stated that it would deliver pipeline safety content once a year, including messages on natural gas leak recognition and response, which included how to respond to a suspected natural gas leak.[83] The procedures noted that the messages would be delivered in a variety of ways, including group meetings, training, and tabletop emergency preparedness exercises.[84]

1.9.2.1 Public Awareness Program Effectiveness

1.9.2.1.1 Affected Public

Atmos's public awareness plan required that at least every 4 years, the plan administrator oversee an effectiveness assessment of the program's overall results. The last program effectiveness assessment before the accidents was May 9, 2022. The 2022 assessment surveyed 1,000 members of the affected public, which included customers and noncustomers, who lived in the Atmos-serviced regional areas, including Mississippi. Sixty-two percent of the people surveyed said that they would leave the area and then call 9-1-1 or the gas company if they suspected a natural gas leak. Twenty-four percent indicated that they would call 9-1-1 or the gas company first and then leave the area. Twelve percent said that they would call 9-1-1 or the gas company but not leave until help arrived. One percent of people surveyed indicated that they would leave the area and take no further action.[85] The safest way to respond to a suspected natural gas leak is to leave the area (evacuate) and then call 9-1-1 and the gas company.

1.9.2.1.2 Emergency Response Officials

Atmos's 2022 public awareness program effectiveness assessment surveyed 300 emergency response officials who lived in the Atmos-serviced regional areas, including Mississippi. Sixty-five percent of emergency response officials surveyed said that they had knowledge of the number to call to alert Atmos in case of a natural gas

[83] Other message topics included emergency preparedness communications, pipeline location information, and how to contact Atmos or 9-1-1.

[84] Atmos's public awareness program plan current at the time of the two accidents noted 1,160 emergency response officials in its Mississippi service area.

[85] (a) The survey had a margin of error of +/-3.1 and a 95% confidence level. (b) Survey percentages are not complete (do not total 100%), likely because of rounding or incomplete responses.

leak. Seventy-six percent said that their agency had sufficient knowledge, training, and equipment to respond to a natural gas emergency. Of the 24% of emergency response officials who indicated that they did not have sufficient knowledge to respond to a natural gas emergency, 38% said that they needed more training.

As Atmos's procedures required, the operator provided emergency response officials with annual pipeline safety training, which discussed topics such as how to respond to a suspected natural gas leak.[86] Atmos's last emergency response official training that occurred before the two accidents was on February 7, 2023, and included emergency response officials from the city of Jackson. However, after the two accidents, several emergency response officials in Jackson told the NTSB that it had been years since they had Atmos's pipeline safety training, or that they needed more training on how to respond to natural gas emergencies. The district fire chief that responded to the Bristol Boulevard accident said that Atmos had provided training "years and years ago," but that she could not recall any recent Atmos training.[87] The district fire chief that responded to the Shalimar Drive accident said that it had "probably been over 10 years" since he had Atmos's natural gas emergency training.[88] In addition, at a community town hall on the two accidents, which the NTSB attended, the Jackson Police Department assistant chief said that the police department had received natural gas-leak calls in the year before the accidents, and that police officers and fire investigators needed more training and resources on how to respond to natural gas leaks.[89] The NTSB's review of Jackson dispatch center records showed 161 natural gas-leak calls in the year before the two accidents.[90] (See section 1.9.2.2 for more information on natural gas-leak calls, also called "odor complaints".)

[86] Atmos notified local emergency response officials of the training date, and emergency response officials attended based on their availability. At the time of the two accidents, Atmos did not have a mechanism to monitor the effectiveness of the training.

[87] The district fire chief who responded to the Bristol Boulevard accident had served 24 years on the Jackson Fire Department.

[88] The district fire chief who responded to the Shalimar Drive accident had served 20 years on the Jackson Fire Department.

[89] (a) US Representative Bennie Thompson hosted the town hall on April 24, 2024. Along with the NTSB, Pipeline and Hazardous Materials Safety Administration, the Mississippi Public Service Commission, and Atmos attended this event. (b) The Jackson Police Department assistant chief had served 30 years on the Jackson Police Department.

[90] The Jackson dispatch center served both the Jackson Fire Department and the Jackson Police Department.

1.9.2.2 Odor Complaints

The Bristol Boulevard accident homeowner smelled natural gas odorant and reported the odor to Atmos on November 20, 2023. He told the NTSB that he and his wife had continually smelled natural gas odorant around their home in the months before the accident (he was unaware of pipeline safety guidance to continually report the smell of natural gas odorant). Notably, the Atmos technician who responded to the Bristol Boulevard accident homeowner’s odor complaint told the NTSB that he told the accident homeowner that he was “safe,” but that the homeowner should call Atmos again if he felt it were necessary. The Bristol Boulevard accident homeowner told the NTSB that he “took [Atmos’s] word for it” when Atmos told him there was “no problem.”

As discussed in section 1.7.1.1, the purpose of natural gas distribution pipeline public awareness programs is to educate the public on pipeline safety, including how to respond to suspected natural gas leaks. After the two accidents, multiple people in both accident neighborhoods told the NTSB or the Mississippi Public Service Commission (MS PSC) that they smelled natural gas odorant in their neighborhood before the accidents or knew people who had. They were unaware of pipeline safety guidance to evacuate and then immediately report the smell by calling 9-1-1 and the gas company (Atmos in this case) and therefore did not make official reports. Two Bristol Boulevard affected home residents reported smelling natural gas odorant in the months before the accident (they did not have natural gas service to their home). A Bristol Boulevard affected home resident recalled that before the accident, she would avoid certain parts of her home where the smell of natural gas odorant was particularly strong. She also reported that some of her holiday guests (either Thanksgiving or Christmas) smelled natural gas odorant. Another Bristol Boulevard resident did not report having smelled natural gas odorant; however, he told the NTSB that guests visiting the Bristol Boulevard accident home said they smelled it. In addition, a tree trimmer told the MS PSC that he smelled natural gas odorant near the Bristol Boulevard accident home around November 20, 2023, told the Bristol Boulevard accident homeowner, and the homeowner called Atmos. Lastly, the Shalimar Drive resident did not report having smelled natural gas odorant; however, she told the MS PSC that her husband and her adult son had smelled it (the night before the accident and 2 weeks before the accident, respectively). The woman’s adult son said that when he smelled natural gas odorant near the Shalimar Drive accident home weeks before the accident, he “didn’t think much of it.” In an interview with the NTSB, an Atmos operations manager who oversaw leak management in Jackson indicated that, as a general practice, when Atmos received repeated odor complaints for the same natural gas leak, it often repaired the leak more quickly than it otherwise would have. The accident homes and the affected homes in this investigation did not have natural gas alarms installed.[91]

1.9.3 Distribution Integrity Management

As discussed in section 1.7.1.2, federal regulations require natural gas distribution operators to have integrity management programs to manage the risks to their pipeline systems. Atmos used a qualitative element, subject matter expert (SME) input, and a quantitative element, a risk assessment tool (risk model), to identify, assess, and rank the risk in its system.[92] The primary inputs to the Atmos risk model were (1) system data (such as leak cause, pipe age, and pipe type); (2) system threats (such as equipment, corrosion, and natural forces); and (3) SME input.

1.9.3.1 System Data

System data is the first required element for operator distribution integrity management programs and includes information about the assets in an operator's pipeline system (such as asset size, material, and location).[93] In postaccident correspondence, Atmos told the NTSB that it did not have installation records (documents that provide system data) for 63% of the service lines in its Mississippi Division.[94] This investigation also discovered significant shortfalls in service-line data at several other Atmos divisions.[95] Atmos said that SME system knowledge on installation practices, materials used, and other system characteristics supplemented asset records.

[91] Natural gas alarms can notify building and residence owners and occupants with physical alerts (such as flashing lights and audible sounds), digital alerts (such as text messages and emails) or both when natural gas reaches a hazardous level.

[92] Atmos defined a *SME* as any person knowledgeable about the design, construction, operations, maintenance activities, or the system characteristics of Atmos's distribution systems.

[93] Federal regulations use the term "system knowledge."

[94] (a) In linear pipeline footage, Atmos was missing 72% of its service-line data for the Mississippi Division. (b) Natural gas distribution operators may not have installation records for all their assets because federal regulations did not require operators to keep installation records until the mid-1970s.

[95] Atmos's reported percentages of missing service-line data ranged from 17% at its Colorado/Kansas Division in Colorado to 73% at its Kentucky/Mid-States Division in Kentucky. Visit http://www.ntsb.gov to find additional information in the public docket for this NTSB accident investigation (case number PLD24FR003).

Atmos's procedures stated that as a general practice, it would make no attempt to specifically search for unknown design, construction, or operations and maintenance (O&M) records to augment missing (system) data. The procedures stated that missing data or data gaps may have originated from differences in historical O&M and construction practices and differences in the data management processes of the companies that Atmos had acquired over the years. In addition, the procedures stated that going forward, recognizing the data gaps that existed, Atmos would continue to build its system knowledge by capturing data as it became available during routine construction and O&M activities.[96]The procedures noted that Atmos would gather and consider any information about its infrastructure from existing records of design, construction, and O&M activities; One Call system information; excavation damage; and SME input.[97]

Atmos's procedures stated that Atmos would not expose (deliberately excavate) buried facilities to obtain additional system data. However, excavation is not the only approach available to gain missing system data. For example, when the Missouri Public Service Commission recommended that a natural gas distribution pipeline operator gain additional service-line data, the operator reduced its missing system data with several methods, including:

(1) paper records research;

(2) service-line replacement;

(3) targeted investigations of service lines with missing information using utility-maintenance technicians; and

[96] In correspondence with the NTSB, Atmos said that it used a geographical information system to map and store system data. Atmos stated that it adjusted previously missing, unknown, or incorrect system data with what it called a "map data correction process." In this process, which occurred during routine monitoring and maintenance activities, an employee who identified an opportunity for system data correction or completion gathered details on the asset or assets in question and sent it to the local geographical information system team who reviewed it and made updates in the system of record as appropriate.

[97] *One Call* systems provide customers, contractors, and excavators with a single phone number to call, 8-1-1, before excavation or construction, which allows utility companies to mark the location of their underground lines.

(4) investigating the location of physical assets through routine maintenance activities (such as leak investigation and repair, locating, and inactive service cutoffs).[98]

The American Society of Civil Engineers' (ASCE) *Standard Guideline for Investigating and Documenting Existing Utilities* also offers pipeline operators options for gaining additional system data.[99] In the guide, ASCE indicates that utility-locating personnel can use technologies, such as ground penetrating radar and acoustic emission, to gain system data, providing positive and negative attributes of these and other utility-locating options (ASCE 2022).

1.9.3.2 Risk Model

Natural gas distribution pipeline operators often use risk models, software that employs quantitative methods to evaluate system threats, to help manage risks to their pipeline systems. An independent contractor developed Atmos's web-based risk model, a relative-risk type model. Atmos's risk model took the data inputs (system data, threats, and SME input) and calculated a numerical risk factor based on the likelihood of failure and the consequence of failure for selected regions for each threat category and then estimated the risk within 2000-foot-by-2000-foot location grids (risk grids).[100] In postaccident correspondence with the NTSB, Atmos stated that its risk model mathematically accounted for missing service line and other system data using appropriate factor weighting.[101] Atmos's risk model output included identification of high-relative risk grids (high-risk grids), grids that posed a high risk to the integrity of the pipeline system. Notably, a high-risk grid did not increase the risk level of other grids in its geographic proximity. Atmos's SMEs reviewed the risk model's high-risk grids and adjusted the grids, as appropriate, before finalizing them. Figure 22 shows the high-risk grids that Atmos's risk model produced that were current on January 24, 2024, the day of the Bristol Boulevard accident, which did not

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[98] For more information, see the Missouri Public Service Commission investigation of a 2015 compression coupling failure that resulted in a natural gas-fueled fire that destroyed a restaurant building in Louisiana, Missouri (Missouri Public Service Commission 2017).

[99] The ASCE represents civil engineers worldwide and provides technical expertise, developing codes and standards on various engineering topics.

[100] Atmos annually updated the data inputs for its risk model.

[101] Atmos applied additional "weight," a numerical value or factor, to asset types that it considered high risk (such as older pipe or assets missing the installation year date), so that its risk model treated the assets as higher risk.

identify the accident locations as high risk.[102] The risk model output was a listing of high-risk grids, not a pictographic display as shown below. The NTSB developed this figure using a listing of the high-risk grids in Jackson.

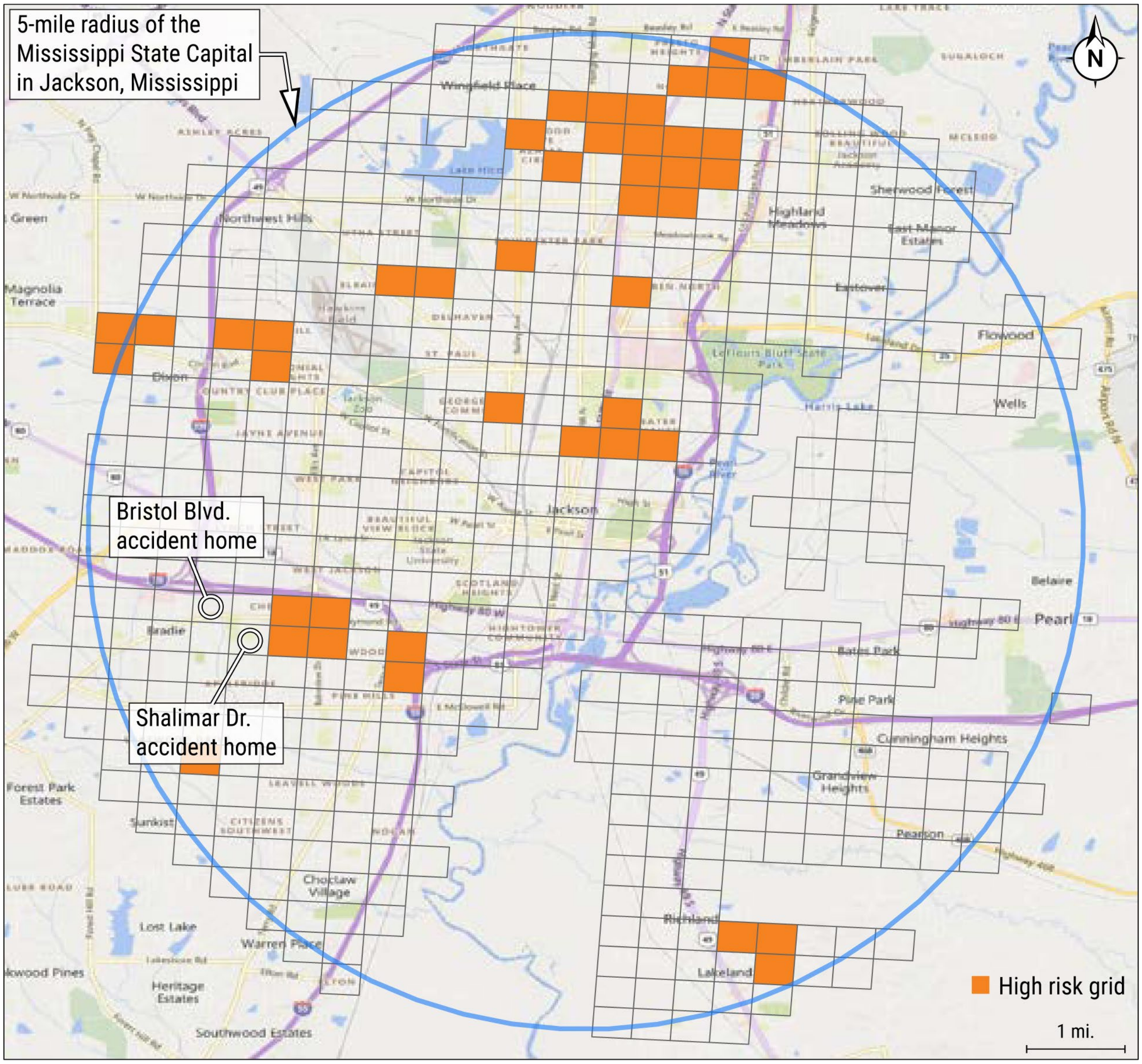

Figure 22. Map of the Atmos risk model's high-risk grids in Jackson as of January 24, 2024. (Courtesy of Atmos with NTSB annotations.)

[102] (a) High risk was the only designator that Atmos's risk model used; the model considered risk grids that were not identified as high risk, such as the two accident location grids, as normal risk. (b) The Atmos risk model's high-risk grids that were current on January 24, 2024, were the same high-risk grids that were current at the end of 2023.

1.10 Relevant Atmos Accidents

1.10.1.1 Avondale, Louisiana

In December 2024, the NTSB opened an investigation into a natural gas-fueled home explosion that occurred in Avondale, Louisiana, which resulted in one fatality, five injuries, and the displacement of residents from a neighboring home (NTSB 2024).[103] After the accident, Atmos reported that it had met with local emergency response leadership and discussed collaboration during accidents, and that it had provided training to local emergency response officials.[104] The NTSB's investigation is ongoing.

1.10.1.2 Farmersville, Texas

In June 2021, the NTSB investigated a natural gas–fueled explosion that occurred in Farmersville, Texas, which resulted in two fatalities and two injuries (NTSB 2022). The NTSB determined that the probable cause of the accident 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's procedures and training practices that did not prepare workers to recognize and safely respond to abnormal operating conditions. After the accident, Atmos revised its procedures, established additional protections for its workers, and developed training to address the safety issues uncovered during the investigation.

1.10.1.3 Dallas, Texas

In February 2018, the NTSB investigated a natural gas-fueled explosion in Dallas, Texas, which resulted in 1 fatality; 4 injuries; a destroyed home; and the evacuation of 300 homes, 250 apartment units, and 600 students (NTSB 2021). The NTSB determined that the probable cause of the accident was the ignition of natural gas that leaked from a gas main that was damaged 23 years earlier and was undetected by Atmos's investigation of the two related incidents that occurred in the 2 days before the explosion. The investigation found that while Atmos's periodic leak survey methodology and frequency complied with the minimum state and federal

[103] (a) An Atmos gas main was involved in this accident. (b) Visit http://www.ntsb.gov to find additional information in the public docket for this NTSB accident investigation (case number PLD25FR002).

[104] In response to NTSB inquiries, Atmos also reported that it provided the public with information, through its website, on the availability of natural gas alarms.

requirements, it did not identify the degraded system that was found after the explosion. As a result, the NTSB issued Safety Recommendation P-21-2 to PHMSA to evaluate industry's implementation of the gas distribution pipeline integrity management requirements and develop updated guidance for improving their effectiveness.[105]

The investigation found that had the Dallas Fire-Rescue Department arson investigators been adequately trained on natural gas systems, their investigation findings may have provided more timely and accurate assistance to Atmos in locating the source of the gas leak. As a result, the NTSB issued Safety Recommendation P-21-8 to Atmos to provide initial and recurrent training to the Dallas Fire-Rescue Department arson investigators and firefighters on the local natural gas distribution system and associated hazards. In 2022, the NTSB classified Safety Recommendation P-21-8 Closed—Acceptable Action when Atmos detailed the initial and recurrent training it had provided to the Dallas Fire-Rescue Department and indicated that it would continue its outreach and training to those emergency response officials.

The investigation found that Atmos did not adequately consider or mitigate against threats that were degrading its pipeline system, the likelihood of failure associated with the threats, or the potential consequences of such a failure as required by gas distribution integrity management requirements. As a result, the NTSB issued Safety Recommendation P-21-12 to Atmos to assess its distribution integrity management program, paying particular attention to the areas identified in the NTSB investigation, and revise the program to appropriately consider: (1) threats that degrade a system over time, and (2) the increased risk that can result from factors that simultaneously increase the likelihood and consequence of failure. In 2023, the NTSB classified Safety Recommendation P-21-12 Closed—Acceptable Action when Atmos reported that it had enhanced its distribution integrity management risk model in several ways, including enhancements that provided notice of areas where rain or other weather conditions could be causing soils to shrink or swell and therefore increase the potential for pipeline stress.

The investigation also found that had methane detectors been installed at the accident homes, an alarm would have alerted residents to a gas release, reducing the potential for and consequences of the resulting natural gas fires and explosions.[106] As a result, the NTSB reiterated recommendations to the International Code Council, the

[105] Safety Recommendation P-21-2 is currently classified Open—Acceptable Response.

[106] Over the years, the NTSB has referred variously to these systems as "methane detectors;" "methane detection systems;" and, as in this report, "natural gas alarms."

National Fire Protection Association, and the Gas Technology Institute to develop requirements and standards for residential natural gas detection alarms (Safety Recommendation P-19-6, Safety Recommendation P-19-7, and Safety Recommendation P-19-8, respectively).[107]

1.11 State and Federal Oversight

Federal pipeline safety statutes allow US states, through certifications and agreements with PHMSA, a Department of Transportation agency and the federal regulator for pipelines, to assume regulatory authority and oversight of intrastate natural gas pipelines and hazardous liquid pipelines.[108] States must adopt the minimum federal pipeline safety regulations but may pass more stringent intrastate pipeline safety regulations through their state legislatures. As discussed in section 1.8, at the time of the two accidents, Atmos operated in Colorado, Kansas, Kentucky, Louisiana, Mississippi, Tennessee, Texas, and Virginia. As such, agencies in those states oversaw Atmos's operations while PHMSA oversaw the state agencies.[109]

1.12 Postaccident Actions

1.12.1 Pipeline and Hazardous Materials Safety Administration

PHMSA initiated a joint assessment of Atmos's natural gas distribution and natural gas transmission operations with assistance from the NTSB and the eight state partners that regulate Atmos's facilities. PHMSA opened the assessment to learn more about Atmos's pipeline systems, its approach to safety management, and its safety performance. PHMSA's assessment is ongoing.

[107] Safety Recommendation P-19-6 is currently classified Open—Unacceptable Response. Safety Recommendation P-19-7 is currently classified Open—Acceptable Alternate Response. In 2022, the NTSB classified Safety Recommendation P-19-8 Closed—Acceptable Action when the Gas Technology Institute issued a new standard for fuel gas detection and warning equipment.

[108] See Title 49 *United States Code* 60105 and 60106.

[109] The state agencies responsible for overseeing Atmos included the Colorado Public Utilities Commission, the Kansas Corporation Commission, the Kentucky Public Service Commission, the Louisiana Department of Energy and Natural Resources, the Mississippi Public Service Commission, the Tennessee Public Utility Commission, the Railroad Commission of Texas, and the Virginia State Corporation Commission.

1.12.2 Mississippi Public Service Commission

The Mississippi Public Service Commission (MS PSC) Pipeline Safety Division reviewed Atmos's repaired and active leaks in Jackson, focusing on the areas near the accident homes, and reviewed Atmos's leak classification procedures. The MS PSC also collaborated with the Jackson police dispatch center and Atmos to identify the natural gas-leak calls that came into the dispatch center in the 18 months before the two accidents. In addition, the MS PSC reviewed Atmos's public awareness program's effectiveness. In November 2025, the MS PSC began reviewing Atmos's integrity management program. The MS PSC's investigation is ongoing.

1.12.3 Atmos Energy Corporation

Atmos reported that it has taken the following actions:

- Identified 2,206 natural gas leaks within the Jackson city limits from January 29, 2024, to April 29, 2025, reporting to have repaired all of them. Of the repaired leaks, Atmos identified 403 leaks where the source of the leak was either from a mechanical fitting or a mechanical coupling. Of the 403 leaks from fittings or couplings, Atmos identified 78 as "Dresser."[110] (Dresser manufactured the compression couplings in the two Jackson accidents.)

- Updated its leak management program companywide to reduce the reevaluation and repair timelines for grade 2 natural gas leaks. Atmos reduced the reevaluation timeline for grade 2 leaks from every 6 months to every 30 days. Atmos reduced the repair timeline for grade 2 leaks from within 1 year (but no later than 15 months) to within 6 months.

- Updated its leak management program companywide to reduce the reevaluation and repair timelines for grade 3 natural gas leaks. Atmos reduced the reevaluation timeline for grade 3 leaks from within 15 months or during the next scheduled survey (whichever came first) to every 30 days. Atmos reduced the repair timeline for grade 3 leaks from within 36 months to within 6 months.

- Modernized natural gas distribution pipeline assets in Jackson. Atmos reported that it replaced about 21 miles of main and replaced or retired about 2,600 service lines. Atmos reported that in Jackson it had 930 total miles of

[110] Atmos did not indicate whether all the repaired compression couplings described as "Dresser" were seal-only type couplings.

distribution pipeline and approximately 52,000 total service lines. Atmos also reported that since 2013, it has had a companywide program requiring mechanical fittings on steel or polyethylene pipe (the accident mechanical couplings, which are a type of mechanical fitting, met this criteria) that were damaged, leaking, or lacking a seal and restraint to be repaired or replaced when such fittings were exposed during routine operations and maintenance.

- Provided leak management refresher training to its employees and contractors. Atmos delivered leak survey refresher training to 209 Atmos leak survey technicians and Atmos compliance supervisors. Atmos also delivered this training to 190 contractor employees. In addition, Atmos delivered leak classification and emergency response training to 1,110 Atmos employees holding the "Leak Classification" operator qualification and Atmos operations supervisors. (Atmos reported that it had not changed the substance of this training, only the format.)

- Enhanced its distribution integrity management program. Atmos refreshed the data sets for its geologic risk-factor model, which accounts for and quantifies certain static risks for potential differential movement, including expansive soils and soil hydrology. Atmos also implemented a soil-stability alert system for its Mississippi Division. The system considers changes in soil moisture relative to the underlying soil type and provides notice of areas where rain or other weather conditions could cause soil to shrink or swell and therefore increase the potential for pipe stress and susceptibility leakage.[111] Atmos also reported that it was increasing the influence of the presence and failure of mechanical fittings in its risk model's calculation, effectively increasing the risk weighting on mechanical fittings in its risk model (mechanical fittings, which include compression couplings, were involved in the two Jackson accidents).

- Increased its emergency response official coordination. Atmos provided additional training to 112 emergency response officials, including members of the Jackson Fire Department, the Jackson Police Department, and the Jackson 9-1-1 dispatch. This training included topics on understanding valves and pipelines. Atmos also reported that after the April 24, 2024, townhall meeting (see section 1.9.2.1.2 for more information on this town hall), it had met with

[111] Atmos reported that the system used soil-moisture data that was updated daily to capture the impact of current weather events. Upon receiving a system notification, Atmos reviewed assets that the distribution integrity management program risk model identified as high-risk. Atmos then deployed a leak survey team to assess the area and determine whether additional mitigations were necessary.

the Jackson Police Department assistant chief on topics that included coordination on 9-1-1 calls related to natural gas emergencies and emergency response official training. Atmos reported that it provided the Jackson Police Department with a dedicated phone number to support more effective coordination between the two organizations.

- Expanded its public outreach efforts in Jackson. Atmos reported that it participated in several community events, meetings with public officials, and meetings with neighborhood associations.

- Focused on advancing its Pipeline Safety Management Systems (PSMS). As discussed in section 1.8.2, PSMS is a framework that assists pipeline operators in improving their safety performance. Atmos reported that it engaged a third-party consultant to conduct an independent review of its PSMS program and planned to develop an action plan to advance its PSMS maturity based on the review. In addition, Atmos, with the assistance of a third-party consultant, conducted an in-depth safety culture survey that included all its employees. Atmos reported that 91% of survey respondents indicated that Atmos's senior leadership quickly responds to reports on asset safety and pipeline integrity hazards, and that 81% of respondents indicated that Atmos's senior leadership was committed to safety.

2 Analysis

2.1 Introduction

On January 24, 2024, about 8:14 a.m. local time, natural gas leaked from a service-line pipe, which had partially pulled out of a compression coupling, into a home on Bristol Boulevard in Jackson, Mississippi, causing an explosion and fire that resulted in one fatality, one injury, and a destroyed home. Three days later, on January 27, 2024, about 4:34 a.m., natural gas leaked from a service-line pipe, which had partially pulled out of a compression coupling, into a home on Shalimar Drive, about 0.7 miles from the first explosion, causing an explosion and fire that destroyed two homes.

The analysis will discuss the following safety issues:

- Compression coupling leaks that the natural gas distribution operator had identified and left unrepaired. (See section 2.2.)
- Insufficient leak management program, which did not determine appropriate monitoring timelines for leaks in adverse-soil conditions. (See section 2.3.)
- Ineffective public awareness program, which did not adequately educate the public or emergency response officials on how to respond to a suspected natural gas leak. (See section 2.4.)
- Inadequate distribution integrity management program, which did not appropriately assess and address risk in its pipeline system. (See section 2.5.)
- Absence of natural gas detection alarms in buildings, which left occupants vulnerable to the dangers of unrecognized gas leaks. (See section 2.6.)

The NTSB established that the following factor did not contribute to the accidents:

- Pipeline overpressurization. The pressure at the Bristol Boulevard accident home at the time of the Bristol Boulevard accident was estimated to be operating about 36.5 pounds per square inch, gauge (psig); the pressure at the Shalimar Drive accident home at the time of

> the Shalimar Drive accident was estimated to be operating about 36.6 psig. Both pressures were lower than the system's maximum allowable operating pressure of 40 psig. The operating pressure histories for both accident locations were also below 40 psig.

Therefore, the NTSB concludes that at the time of the two explosions, natural gas pressure was at acceptable levels and did not contribute to the accidents.

2.2 Compression Coupling Leaks

After the accidents, Atmos conducted pressure testing at both accident locations and identified leaks on compression couplings. These couplings were seal-only, meaning they were not designed to resist pipe pullout and hold the service-line pipe in place. NTSB pressure testing on both accident pipeline assemblies identified leaks on the compression couplings between the couplings and the rest of the service lines.[112] At both accident locations, leaks occurred on compression couplings that were part of the service lines to homes that were across the street.[113] Thus, near the accident homes, natural gas leaked from compression couplings that were part of nearby service lines.

Before the accidents, Atmos leak surveys identified leaks near the accident homes. Atmos technicians classified the leaks as grade 2 (near the Bristol Boulevard accident home) and grade 3 (near the Shalimar Drive accident home) based on natural gas migration patterns present at the time of the leak survey and Atmos leak classification criteria (such as percentages of any gas detected in the air).[114] This

[112] The NTSB Materials Laboratory could not pressure test the Bristol Boulevard accident main and service line because they separated during excavation. However, NTSB Materials Laboratory pressure testing of the service-tee assembly and service-line pipe indicated that the leak was on the connection between the compression coupling and the service-line pipe, meaning the leak was on the compression coupling.

[113] At the Bristol Boulevard location, the accident compression coupling was on the service line to the home at 190 Bristol Boulevard. At the Shalimar Drive location, the accident compression coupling was on the service line to the home at 1147 Shalimar Drive.

[114] (a) The term "Atmos technicians" describes both Atmos employees and Atmos contractors. (b) Atmos technicians documented these leak surveys with sketches as Atmos procedures required.

meant that Atmos considered the leaks nonhazardous and therefore did not repair them right away.[115]

Atmos performed a leak investigation at the Bristol Boulevard accident home 3 days after its leak survey there because the Bristol Boulevard accident homeowner had smelled natural gas odorant and called Atmos. The technician's leak investigation determined that there was no natural gas migration, which would have indicated that the leak had become a hazard to people or property. Because Atmos's leak investigation technician did not reclassify or sketch (document the natural gas readings taken) the leak, as Atmos procedures required, the NTSB could not assess any change in the leak's gas migration pattern that may have occurred between the leak survey and the leak investigation. After the accident, Atmos provided refresher training to its technicians qualified to perform leak surveys, leak classification, and emergency response, which includes leak investigations.

Bar-hole testing conducted shortly after the Bristol Boulevard accident identified explosive levels of natural gas around the Bristol Boulevard accident home and the Bristol Boulevard affected home. Similarly, bar-hole testing conducted shortly after the Shalimar Drive accident identified explosive levels of natural gas around the Shalimar Drive accident home, the Shalimar Drive affected home, and another nearby home. In addition, bar-hole testing conducted days after the two accidents identified explosive levels of natural gas around both accident homes.[116] Atmos had not restored natural gas service at the time, so these tests measured the residual gas that was still present in the soil in the days after the accidents.

Atmos technicians did not report natural gas migration during their initial assessment of the accident leaks, and postaccident bar-hole testing showed natural gas migration. In addition, between the time Atmos first identified the accident leaks and the time the accidents occurred, the city of Jackson experienced a period of heavy rainfall, which likely oversaturated the soil and caused the natural gas to migrate.[117] Therefore, the NTSB concludes that near the accident homes, natural gas

[115] (a) Atmos required its employees to repair grade 1 leaks immediately. Atmos scheduled grade 2 leaks and grade 3 leaks for repair according to timelines established in its leak classification procedures. (b) Atmos's initial classification of the accident leaks was consistent with the operator's leak grading procedures, documented leak sketches, and NTSB interview testimony.

[116] This bar-hole testing occurred 5 days after the Bristol Boulevard accident and 2 days after the Shalimar Drive accident.

[117] See section 1.4 for more information on how natural gas can migrate (especially when heavy rains oversaturate soil) and become hazardous.

leaked from service-line pipes that had partially pulled out of compression couplings and migrated through the ground and into the homes where it fueled the explosions.

The NTSB examination of the Bristol Boulevard accident service line (the service line to the home at 190 Bristol Boulevard) found scratch marks on the outside of the pipe where it had been inserted into the compression coupling. The scratch marks had the same spacing as the metal-coil armor located in the toe of the gasket. Thus, it is likely that the gasket armor left these scratch marks on the pipe as the pipe pulled out of the compression coupling. The scratches started 2 inches from the end of the pipe and extended 0.5 inches toward the end. The NTSB observed surface rust in the scratch marks on the outer lip of the service-line pipe, indicating that the scratches occurred before Atmos excavated the assembly. Therefore, the Bristol Boulevard accident service-line pipe had likely been inserted into the compression coupling to a depth of 2.8 inches and pulled out over time. (This calculation accounts for the 2.0-inch distance from the end of the service line and the 0.8-inch distance from the gasket armor to the service-line pipe insertion point.) (See figure 15.) The examination also noted that the rubber in the gasket had not significantly degraded. Thus, the Bristol Boulevard accident service line had, at one point, been inserted into the accident compression coupling to a depth of at least 2 inches (the manufacturer's current recommended installation insertion depth) and then pulled out 0.5 inches over time, leaving gasket armor scratches on the service line.[118] The service line continued to pull out over time (but did not leave marks), nearly coming out of the compression coupling (partially pulling out), as evidenced by the armor scratches near the end of the service-line pipe.

On the Shalimar Drive accident service line, the NTSB found scratch marks starting 1.75 inches from the end of the pipe and extending approximately 0.5 inches toward the end. (See figure 18.) The examination also noted that the rubber in the gasket had not significantly degraded. Thus, the Shalimar Drive accident service line likely had, at one point, been inserted into the accident compression coupling to a depth of about 2.55 inches. (This calculation accounts for the 1.75-inch distance from the end of the service line and the 0.8-inch distance from the gasket armor to the service-line pipe insertion point.) The examination also showed that the Shalimar Drive accident service line was not fully inserted into the compression coupling, indicating that the pipe had partially pulled out of the coupling. Based on the markings on the Shalimar Drive accident service line, it pulled out in the same manner as the Bristol Boulevard service line. Therefore, the NTSB concludes that

[118] As discussed in section 1.5, the NTSB did not observe installation insertion-depth markings on either of the accident service lines.

technicians had likely properly installed the accident compression couplings at both locations, and the couplings had not degraded; however, the service-line pipes at both locations had, over time, partially pulled out of the compression couplings.

The city of Jackson's landscape contains expansive soil. Expansive soil is a threat to pipelines because it shrinks as it dries and swells as it becomes wet, resulting in soil movement (MSU MAFES 1993). Atmos was aware, at the corporate level and in the field, of the threat that expansive soil posed to its pipeline systems. In 2023, the year before the accidents, Atmos told the NTSB that it had updated its distribution integrity management risk model to account for expansive soil. (See section 2.5.2 for more information on Atmos's risk model.) In addition, two Atmos managers with over 20 years of experience with the operator told the NTSB that complete compression coupling failures often occurred in Jackson during cycles of dry and wet weather because of the soil movement associated with expansive soil.

In 2008, a PHMSA advisory bulletin alerted pipeline operators to compression coupling failure from pipe pullout resulting from soil movement associated with heavy rains (PHMSA 2008). Also in 2008, the Railroad Commission of Texas, the state pipeline safety regulator responsible for overseeing Atmos's West Texas and Mid-Texas Divisions, issued a study on compression coupling failure, highlighting the impacts of heavy rains (Railroad Commission of Texas 2008). In the months before the accidents, Jackson experienced cycles of dry and wet weather, known throughout the pipeline industry to create hazardous conditions for pipelines in expansive soil and likely to cause a service-line pipe pullout from a compression coupling during heavy rains. At the time of the accidents, the local climate in Jackson was conducive to this type of compression coupling failure. Based on the rust in the scratch marks on the service-line pipes, any wet and dry weather cycles that Jackson experienced between the time technicians installed the accident pipeline assemblies and the time the two accidents occurred may have contributed to the pipe pullout.

The NTSB investigated whether a copper-water pipeline buried near the accident compression coupling or a surface load (specifically, a vehicle) on the belowground accident compression coupling were factors in the Bristol Boulevard accident.[119] The NTSB determined that there was no damage to the copper-water

[119] (a) Atmos provided photographs showing tire marks, likely made by a large vehicle (a surface load), in the approximate location of the belowground Bristol Boulevard accident service line. As discussed in section 1.1, visit http://www.ntsb.gov to find additional information in the public docket for this NTSB accident investigation (case number PLD24FR003). (b) The Bristol Boulevard accident compression coupling was the coupling on the service line to the home at 190 Bristol Boulevard.

pipeline or the Bristol Boulevard accident compression coupling that indicated a level of contact that would have diminished the working lifetime of either component. Accordingly, there was no evidence that the copper-water pipeline near the accident compression coupling contributed to the service-line pipe partially pulling out of the coupling. The NTSB also determined that the Bristol Boulevard accident service line likely would, without being damaged, withstand a theoretical downward pressure of the heaviest allowable vehicle in Mississippi driving over it. Theoretical downward-soil shift (and corresponding shift of the accident pipeline assembly) would not have been significant. Further, the NTSB's examination of the Bristol Boulevard accident service-line pipe and compression coupling did not reveal any damage that could be attributed to shifting because of surface loads. Thus, the copper-water pipeline and surface load were not factors in the Bristol Boulevard accident. Therefore, the NTSB concludes that leaks near the accident homes were the result of expansive clay soil movement that caused the service-line pipes to, over time, partially pull out of the compression couplings.

At the time of the two accidents, Atmos lacked service-line installation records (system data) for most of the service lines in its Mississippi Division. (See section 2.5 for more information on Atmos's lack of system data.) Because it lacked system data for its Mississippi Division, Atmos did not know the number of compression couplings in that system, where those couplings were located, or when they had been installed. Thus, Atmos had several unknowns concerning the compression couplings in its Mississippi pipeline system, a system that contained expansive soil, which was known to increase the likelihood of compression coupling failures.

The 2008 PHMSA advisory bulletin on compression coupling failures recommended that natural gas distribution operators consider adopting a full replacement program if there were "too many" unknowns related to couplings in service. While PHMSA's advisory did not define how many unknowns were too many, the two accidents in Jackson indicate that Atmos's Mississippi Division has unknowns related to compression couplings in service that pose risks to that system and to public safety. Atmos reported that since 2013, it has had companywide procedures requiring certain mechanical fittings (a category that includes compression couplings, the type of coupling involved in the two Jackson accidents) that were damaged, leaking, or lacking a seal and restraint to be repaired or replaced when such fittings were exposed during routine operations and maintenance. Atmos's program, while encouraging, did not prevent the accidents in this investigation, which occurred in expansive-soil environments, possibly because Atmos has not, as PHMSA advised, adopted a full replacement program. Therefore, the NTSB recommends that Atmos develop and implement a program to locate and replace all mechanical couplings and mechanical joints located in expansive soils that are not resistant to pipe pullout with couplings and joints developed specifically for those conditions. The program should establish and make public the project milestones and timeline.

2.3 Insufficient Leak Management Program

2.3.1 Leak Repair and Leak Reevaluation

The leaks Atmos identified and classified on Bristol Boulevard (a grade 2 leak) and Shalimar Drive (a grade 3 leak) became hazardous before Atmos's leak management program procedures required them to be reevaluated or repaired. Atmos's Mississippi procedures required a grade 2 leak to be reevaluated at least once every 6 months and repaired within one calendar year (but no later than 15 months). The accident on Bristol Boulevard occurred about 2 months after Atmos identified the grade 2 leak there, which was about 4 months before Atmos procedures required its technicians to reevaluate the leak and about 13 months before Atmos procedures required its technicians to repair it.

Atmos's Mississippi procedures required a grade 3 leak to be reevaluated during the next scheduled survey or within 15 months, whichever came first, and repaired or cleared within 36 months. The accident on Shalimar Drive occurred about 2 months after Atmos identified the grade 3 leak there, which was about 13 months before Atmos procedures required its technicians to reevaluate the leak and about 34 months before Atmos procedures required its technicians to repair or clear it. After the two accidents, Atmos updated its companywide leak management program to reduce the reevaluation and repair timelines for all nonhazardous natural gas leaks to every 30 days and within 6 months, respectively.

2.3.2 Leak Monitoring

Between November 2023 and January 2024, when weather conditions in Jackson adversely affected the soil, changing the natural gas migration patterns of at least 2 of the 289 open (unrepaired) leaks in the city (leaks open on the day of the Bristol Boulevard accident), Atmos's Mississippi leak management program procedures did not prompt employees to monitor the open leaks. However, unlike Atmos's Mississippi procedures, Atmos's procedures for classifying grade 2 leaks in the state of Kansas included adverse-soil considerations. These procedures stated that under adverse-soil conditions, which included soil affected by flooding, drought, frozen ground, and settlement, a grade 2 leak must be monitored weekly to ensure that the leak would not represent a probable hazard and that it reasonably could be expected to remain nonhazardous.

In the nearly 2.5 months between the time Atmos first identified the grade 2 leak at Bristol Boulevard and the time the leak became hazardous, Jackson experienced drought conditions, which Atmos's Kansas procedures would have considered adverse. During that time, Jackson also experienced a period of heavy rains that resulted in water-saturated soil, something Atmos's companywide procedures required employees to consider when determining grade 2 leak repair priority but did not require them to consider when determining grade 2 leak monitoring frequency because it did not have companywide leak monitoring procedures for grade 2 leaks or grade 3 leaks.[120]

Atmos's Kansas leak management program procedures applied only to grade 2 leaks, not grade 3 leaks. However, after the two accidents, Atmos found that nearly 15% of the grade 3 leaks open on the day of the Bristol Boulevard accident met the criteria for grade 1 or grade 2 leaks upon reevaluation. This indicates that Atmos's classifications of leaks can change over time, in some cases, because of environmental factors, including soil conditions. As such, the operator's more stringent leak monitoring procedures should apply to all nonhazardous leaks in adverse-soil conditions, no matter the grade. Therefore, the NTSB concludes that Atmos's lack of companywide leak management procedures requiring employees to frequently monitor open, belowground natural gas leaks located in adverse-soil conditions permitted the accident leaks to become hazardous before Atmos repaired them. After the two accidents, Atmos reduced the reevaluation and repair timelines for all nonhazardous leaks companywide. Atmos has not updated its leak management program procedures companywide to include frequent monitoring of natural gas leaks in adverse-soil conditions, as included in its Kansas procedures. Therefore, the NTSB recommends that Atmos update its companywide leak management program procedures to require weekly monitoring of nonhazardous (grade 2 or grade 3) belowground leaks identified in locations with adverse-soil conditions (such as water-saturated soil, flooding, drought, frozen ground, or settlement). The NTSB also recommends that Atmos, after completing the action

[120] Additionally, because Atmos lacked system data for most of the service lines in its Mississippi Division (and several other of its divisions), it could not effectively prioritize the grade 2 leaks that required repair. (See section 2.5.1 for more information on Atmos's lack of service-line data.)

described in P-26-4, implement a training program to maintain employee and contractor proficiency on the updated procedures.[121]

Atmos operates in eight states, and this investigation determined that the state-specific pipeline requirements in Kansas could have prevented the two accidents in Mississippi. Atmos's siloed state operations, including leak monitoring procedures that differed by state, demonstrate that Atmos has not applied lessons learned in one state to the other states it operates in. In addition, we found that Atmos is missing substantial portions of service-line data across its system, and that its distribution integrity management program did not adequately assess risk to its system. (See section 2.5 for more information on these topics.) Further, as discussed in section 1.10, in the last 8 years, the NTSB has investigated several Atmos accidents. Although each state provides regulatory oversight of Atmos's operations within their state, and PHMSA monitors each state oversight program, Atmos has had significant safety shortfalls in recent years. Thus, Atmos's multistate operations require broader oversight.

After the two accidents in Jackson, PHMSA initiated a joint assessment of Atmos with assistance from the NTSB and the eight state partners that regulate Atmos's facilities. To ensure that this assessment identifies any gaps in the oversight of Atmos's multistate operations, the NTSB recommends that the Department of Transportation Office of Inspector General audit PHMSA's ongoing joint assessment of Atmos (with the eight state partners that regulate Atmos's facilities), including a review of Atmos's approach to the safety management of its pipeline and how it applies lessons learned across all its operating divisions.

2.4 Ineffective Public Awareness Program

2.4.1 Public Awareness Program Effectiveness

2.4.1.1 Affected Public

Atmos's public awareness program's effectiveness scores indicated that about 62% of the affected public within Atmos distribution areas, including areas in Mississippi, knew that they should leave the area and then call 9-1-1 or the gas company during a suspected natural gas leak. About 37% of those surveyed were

[121] See section 4 for a full listing of the recommendations in this report.

unaware of how to safely respond to a suspected natural gas leak.[122] Atmos's public awareness program communication plan required the operator to educate members of the affected public (customers and noncustomers) on safety topics that included how to respond to a suspected natural gas leak. Atmos's plan required the operator to communicate to customers twice a year and noncustomers once a year through delivery channels such as bill inserts (for customers) and television (for customers and noncustomers). However, several people smelled natural gas odorant before the accidents occurred but were unaware of pipeline safety guidance to respond to the smell of natural gas odorant by evacuating and then immediately calling 9-1-1 or the gas company (Atmos in this case). According to NTSB and Mississippi Public Service Commission interviews, at least three people smelled natural gas odorant on Bristol Boulevard before the accident and were unaware of the need to immediately report it, and at least two people smelled natural gas odorant on Shalimar Drive before the accident and were unaware of the need to immediately report it. Thus, Atmos's public awareness program was ineffective at educating the public.

In addition to this investigation, several NTSB investigations in the last 15 years have determined that the natural gas distribution operator's public awareness program was a factor in the accident. For example, the NTSB's Birmingham, Alabama, investigation of an accident that resulted in one fatality and three injuries determined that residents had smelled natural gas odorant 2 weeks before the explosion but had not informed the gas company or local authorities (NTSB 2016). In addition, the NTSB's New York City, New York, investigation of an accident that resulted in 8 fatalities, over 50 injuries, and the displacement of 100 families from their homes determined that the operator's public awareness program did not effectively inform customers and the public about both the importance of reporting the smell of natural gas odorant and the number to call to report the smell of odorant (NTSB 2015). Similarly, the NTSB's San Bruno, California, investigation of an accident that resulted in eight fatalities and many more injuries determined that the operator's public awareness program had left the affected public unaware of pipeline safety (NTSB 2011). Therefore, the NTSB concludes that in the accidents in Jackson, Mississippi, and in several natural gas accidents that the NTSB has investigated, the operator's public awareness program was ineffective at educating the public on how to safely respond to the smell of natural gas odorant.

In March 2023, the NTSB investigated a natural gas-fueled explosion and fire that occurred in West Reading, Pennsylvania, which resulted in 7 fatalities, 10 injuries,

[122] As discussed in section 1.9.2, survey percentages are not complete (do not total 100%), likely because of rounding or incomplete responses.

a destroyed building, and the displacement of 3 families from a neighboring apartment building (NTSB 2025). In the West Reading accident, the NTSB determined that natural gas distribution operators have ample room and ability to improve upon their public communications regarding natural gas safety. As a result, the NTSB recommended that PHMSA:

> Identify effective means for natural gas distribution pipeline operators to communicate with people who live, work, or congregate within the coverage area of a natural gas distribution pipeline system and implement a plan to help operators drive continuous improvement in public awareness of natural gas safety. (P-25-3)[123]

In September 2025, during a meeting with the NTSB, PHMSA reported that it had created a working group with the Pipeline Association for Public Awareness to develop strategies to improve public awareness of natural gas safety.[124] PHMSA also agreed to work with stakeholders, such as the American Petroleum Institute and state partners, to address Safety Recommendation P-25-3. Notwithstanding the previous NTSB investigations in which an ineffective natural gas distribution operator public awareness program was a factor in the accident, including the West Reading investigation, the NTSB investigation of the two Jackson accidents has again identified the need for natural gas distribution pipeline operators to effectively communicate with the affected public. Therefore, the NTSB reiterates Safety Recommendation P-25-3 to PHMSA.

2.4.1.2 Emergency Response Officials

The Atmos public awareness program's effectiveness scores indicated that about 76% of emergency response officials in Atmos distribution areas, including areas in Mississippi, reported that their agency had sufficient knowledge, training, and equipment to respond to a natural gas emergency. Of the emergency response officials who indicated that they did not have sufficient knowledge to respond to a natural gas emergency, 38% said that they needed more training. Atmos's public awareness program communication plan required the operator to educate emergency response officials on safety topics, including how to respond to a suspected natural gas leak, once a year through delivery channels such as meetings

[123] Safety Recommendation P-25-3 is currently classified Open—Acceptable Response.

[124] The Pipeline Association for Public Awareness is a nonprofit corporation that provides pipeline safety and emergency preparedness information to residents, businesses, farmers, excavators, emergency responders, and public officials.

and training. However, the two district fire chiefs who responded to the Jackson accidents, both with at least 20 years with the Jackson Fire Department, told the NTSB that it had been years since they had Atmos's training on how to respond to a natural gas emergency. In addition, after the two accidents, at a community townhall meeting, the Jackson Police Department assistant chief, who had 30 years with the Jackson Police Department, reported that the police department had received gas leak calls in the year before the accidents, and that police officers and fire investigators needed more training on how to respond to natural gas leaks.

After the two accidents, Atmos provided training to emergency response officials in Jackson, including members of the Jackson Fire Department, the Jackson Police Department, and the Jackson 9-1-1 dispatch. Atmos also met with the Jackson Police Department assistant chief to discuss coordination on 9-1-1 calls related to natural gas emergencies. However, the two Jackson accidents were not the only recent Atmos accidents that resulted in the operator providing additional training to emergency response officials. As discussed in section 1.10.1.3, the NTSB's Dallas investigation determined that Dallas Fire-Rescue Department arson investigators had not been adequately trained on natural gas systems. Atmos satisfied NTSB Safety Recommendation P-21-8 by providing training, and committing to continue its outreach and training, to the Dallas Fire-Rescue Department. In addition, as discussed in section 1.10.1.1, after the Avondale accident, Atmos provided outreach and training to local emergency response officials. Therefore, the NTSB concludes that in the accidents in Jackson, Mississippi, and in previous Atmos accidents in Dallas, Texas, and Avondale, Louisiana, emergency response officials were not sufficiently trained on how to respond to a natural gas leak, despite being offered annual natural gas safety training, demonstrating that Atmos missed an opportunity to effectively educate and prepare emergency response officials in its service areas to address natural gas emergencies.

It is in the interest of public safety for Atmos to ensure that all the emergency response officials in its distribution areas know how to respond to natural gas emergencies before they occur. Atmos currently provides emergency response officials with annual training. However, more frequent training would ensure that Atmos has multiple opportunities throughout the year to adequately prepare emergency response officials to address natural gas emergencies. More frequent training on natural gas emergencies not only gives emergency response officials multiple opportunities to attend the training; it also supports more efficient responses to emergencies and stronger relationships between natural gas distribution operators and local law enforcement and safety personnel. Therefore, the NTSB recommends that Atmos develop and implement a program to provide more frequent training to emergency response officials in all the distribution areas that it serves, including training on how to respond to natural gas-leak calls, and monitor the program for effectiveness.

2.4.2 Odor Complaints

Although the Bristol Boulevard accident homeowner made a natural gas odor complaint 2 months before the Bristol Boulevard accident, he was not aware of the need to submit subsequent complaints, even when the smell of natural gas odorant persisted for months. The Atmos technician who responded to the Bristol Boulevard accident homeowner's odor complaint reported that he told the Bristol Boulevard accident homeowner that he was safe but to call Atmos again if necessary. The Bristol Boulevard accident homeowner reported that when Atmos told him there was no problem, he took Atmos's word for it. Although he continued to smell natural gas odorant for months after the Atmos technician left, he likely believed no additional action was required of him because the Atmos technician had assured him that he was not in danger. In addition, Atmos did not communicate about the unrepaired gas leak with residents near the leak. Thus, Atmos's communication with the Bristol Boulevard accident homeowner and residents near the unrepaired leak did not effectively detail the safety information that they should have been aware of and any necessary actions that they should have been prepared to take in response to the unrepaired natural gas leak.

In an interview with the NTSB, an Atmos operations manager who oversaw leak management in Jackson indicated that, as a general practice, when Atmos received repeated calls about the same leak, it repaired the leak more quickly than it otherwise would have. Therefore, had the people who smelled natural gas odorant in the accident neighborhoods been aware of pipeline safety guidance to evacuate and then immediately report the smell of natural gas odorant by calling 9-1-1 and the gas company and aware of the need to report the odor every time they smelled it, Atmos likely would have repaired the leaks at the accident locations before they became hazardous. Thus, Atmos's failure to communicate with the public promptly and effectively about the unrepaired leaks near them did not give the public the resources to contact local emergency response agencies and Atmos, responsible authorities that could have resolved the safety issue. Therefore, the NTSB concludes that Atmos's ineffective communications regarding the need to report any smell of natural gas odorant inhibited necessary reporting from residents who continued to smell natural gas odorant in and near their homes.

As discussed in section 1.8.3, Atmos's reported safety incident rates between 2018 and 2022 were higher than those for similarly sized natural gas distribution operators. In addition, NTSB investigations of Atmos accidents in Dallas, Texas; Farmersville, Texas; and Avondale, Louisiana, suggest that in recent years, Atmos has had several accidents that resulted in catastrophic consequences and needs to take additional measures to ensure public safety.[125] Therefore, the NTSB recommends that Atmos require its technicians who identify but do not repair a belowground natural gas leak to immediately notify people near the unrepaired leak that (1) the hazard potential of a leak can change over time, and (2) they should evacuate and then call 9-1-1 and Atmos every time they smell natural gas odorant.

2.5 Inadequate Distribution Integrity Management Program

2.5.1 System Data

As discussed in 1.7.1.2, over 15 years ago, the Pipeline and Hazardous Materials Safety Administration introduced distribution integrity management requirements to enhance safety by identifying and reducing pipeline integrity risks. The first required element for natural gas distribution pipeline integrity management programs is *system data* (or system knowledge), and Atmos lacked system data for its Mississippi Division. After the Jackson accidents, Atmos told the NTSB that it did not have service-line installation records for over 63% of the service lines in its Mississippi Division. Therefore, at the time of the accidents, Atmos did not have system data for over 193,024 of the 306,387 service lines in its Mississippi Division, including the accident service lines.

Atmos's lack of system data for its Mississippi Division affected its leak management program and its risk model. The lacking system data affected Atmos's leak management program because, despite Atmos's knowledge of the threat of compression coupling failure in expansive-soil environments, like Jackson, Mississippi, (see section 2.2 for more information on this), its lack of system data for its Mississippi Division service lines prevented it from identifying the locations of most of the compression couplings in that system, including the accident couplings. The lacking system data affected Atmos's risk model because system data was a primary input in the model. Although Atmos's risk model assigned higher risk-factor weights

[125] As discussed in section 1.8.2, improved safety performance is the goal of Pipeline Safety Management Systems (PSMS). As discussed in section 1.12.3, after the accidents, Atmos reported that it focused on maturing its PSMS (as it had after accidents in Dallas, Texas, and Farmersville, Texas). Several recommendations in this report support improving Atmos's PSMS.

to service lines that were missing system data (see section 1.9.3.2 for more on this), the model was incapable of determining which of the data-lacking service lines posed the greatest threat to the system because of all the missing data. (See section 2.5.2 for more information on how Atmos's lack of system data impacted its risk model.)

As of this report, Atmos is still missing about 63% of the service-line data for its Mississippi Division. As discussed in section 1.9.3.1, Atmos also has significant shortfalls in service-line data at several other divisions, including its Kentucky/Mid-States Division, which is missing 73% of the service-line data in Kentucky. Atmos has acquired legacy pipeline systems from companies that may not have kept records of their pipeline assets (federal regulations did not require operators to keep installation records until the mid-1970s). However, as the current owner of property that provides hazardous materials to the public, Atmos has a responsibility to learn about its system, so it can appropriately assess and address the risk to that system and to public safety. Therefore, the NTSB concludes that Atmos's failure to gather relevant information about its service-line records prevented it from effectively assessing the risk to its assets.

The two accidents in Jackson and Atmos's reported rates of missing service-line data in its other divisions indicate that Atmos needs to take a more focused approach to gain data about its system. Atmos currently gathers system data through routine operations and maintenance activities, including when an employee identifies an opportunity to correct or complete a pipeline-asset record. In addition to administrative strategies, some of which Atmos currently employs, technology-based strategies, some of which the ASCE guide describes, offer other methods of gaining system data that do not involve excavating buried pipelines. A natural gas distribution pipeline operator in Louisiana, Missouri, developed a plan that allowed it to gain additional service-line data, and Atmos could do the same. Therefore, the NTSB recommends that Atmos develop and implement a program to proactively identify and collect missing service-line information for all its operating divisions. The program should (1) identify one or more methods for gaining additional system data and (2) establish and make public the milestones and timeline for acquiring the unknown system data.

2.5.2 Risk Model

As discussed in section 1.7.1.2, federal regulations required natural gas distribution pipeline operators to *evaluate and rank risk* in their pipeline systems, and Atmos did not effectively evaluate and rank system risk in its system. In 2023, the year before the two accidents, Atmos repaired 182 hazardous (grade 1) leaks in Jackson. Although the repaired hazardous leaks were confirmed risks to Atmos's system, its risk model, in large part, did not rank the locations of the hazardous leaks as high risk. Figure 23 shows the hazardous leaks that Atmos repaired in 2023 within a 5-mile radius of Jackson overlaid with the Atmos risk model's high-risk grids that were current on that date; not many of the hazardous leaks are in high-risk grids.

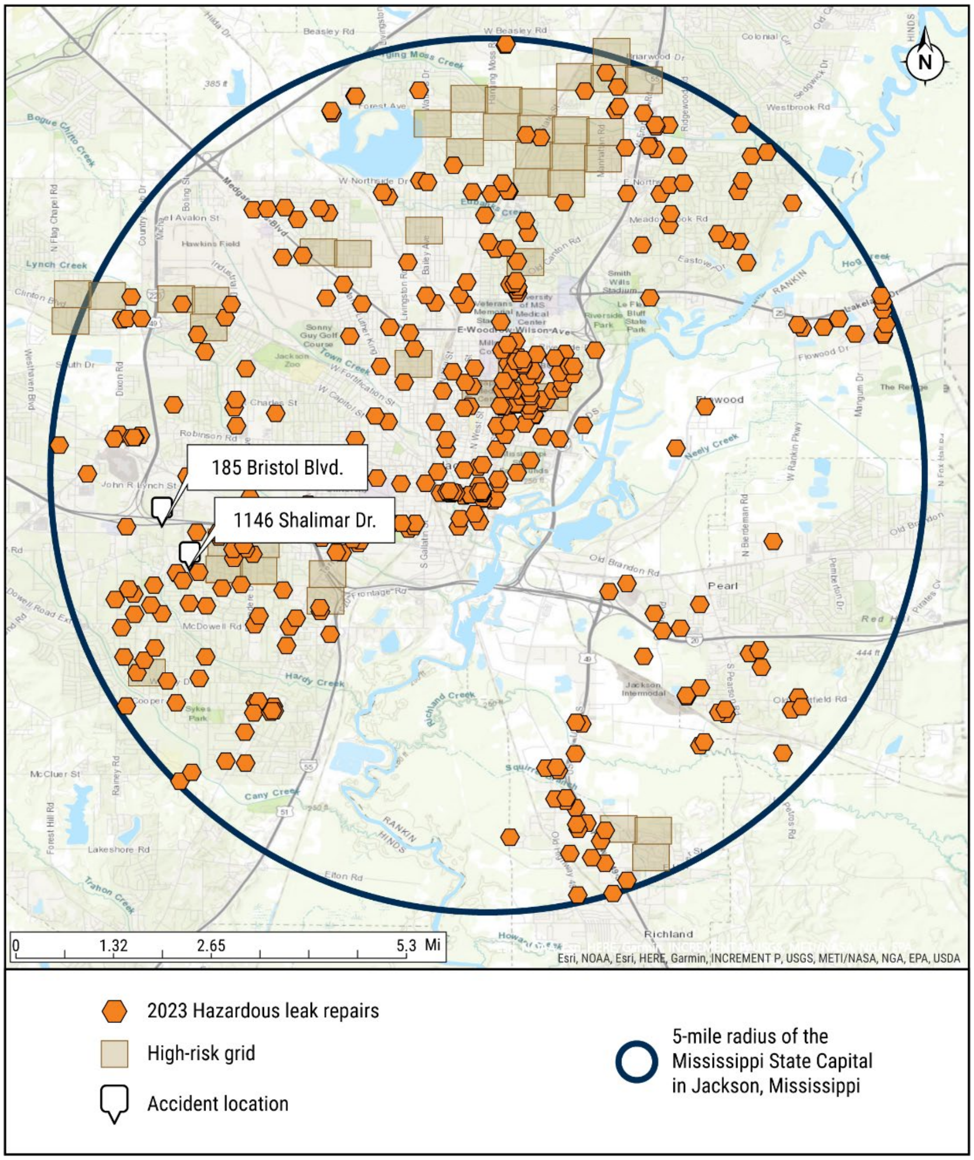

Figure 23. Map of hazardous leaks within a 5-mile radius of Jackson that Atmos repaired in 2023 overlaid with Atmos high-risk grids current on that date. (Courtesy of ESRI ArcGIS and Atmos with NTSB annotations.)

On January 24, 2024, the day of the Bristol Boulevard accident, there were 289 open, nonhazardous leaks (unrepaired leaks that Atmos knew about) in a 5-mile radius of Jackson, including the accident leaks. On January 24, 2024, the Bristol Boulevard accident occurred. Three days later, on January 27, 2024, the Shalimar Drive accident occurred. Although these two catastrophic accidents were confirmed risks to Atmos's system, resulting from (open) leaks that Atmos was aware of, its risk model did not rank the accident locations as high risk. Figure 24 shows the open, nonhazardous leaks within a 5-mile radius of Jackson as of January 24, 2024, overlaid with the Atmos risk model's high-risk grids that were current on that date; not many of the open, nonhazardous leaks, including the accident leaks, are in high-risk grids. The figure also shows the grade 3 leaks that met the criteria for higher grade leaks (grade 1 and grade 2 leaks) when Atmos reevaluated them.[126]

[126] As discussed in section 1.9.3.2, the Atmos risk model's high-risk grids that were current on January 24, 2024, were the same high-risk grids that were current at the end of 2023.

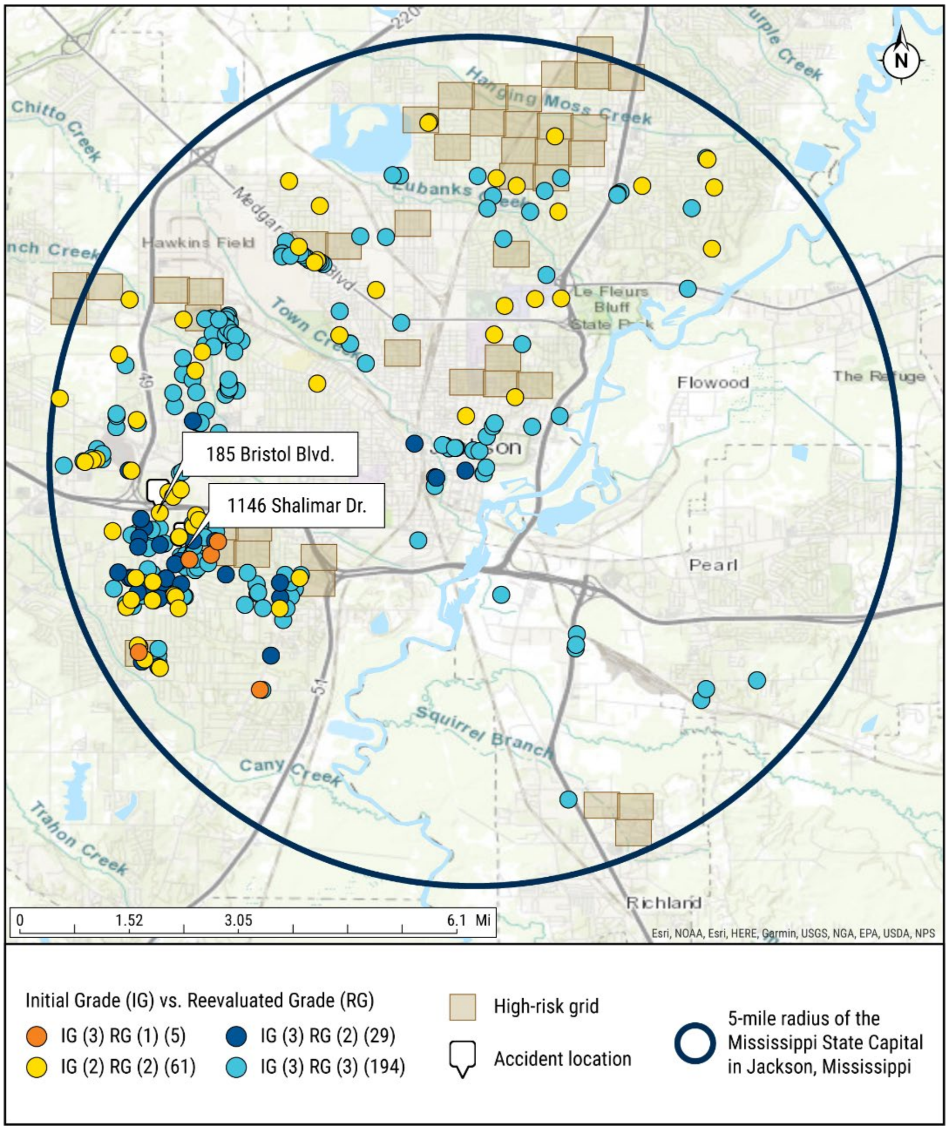

Figure 24. Map of open, nonhazardous leaks within a 5-mile radius of Jackson as of January 24, 2024, including leaks that later met criteria for higher grade leaks, overlaid with Atmos high-risk grids current on that date. (Courtesy of ESRI ArcGIS and Atmos with NTSB annotations.)

In 2023, the year that Atmos's risk model did not identify many of the areas with hazardous leaks as high risk, Atmos told the NTSB that in response to Safety Recommendation P-21-12, it had updated its risk model to consider threats posed by expansive soil, like the soil in Jackson, a factor that the NTSB determined played a role in Atmos's 2018 accident in Dallas. The NTSB closed Safety Recommendation P-21-12 based on the information that Atmos provided. However, in light of the two accidents in Jackson and the number of leaks that became a higher grade before Atmos repaired them (about 15% of the leaks Atmos knew about as of the day of the Bristol Boulevard accident), it is likely that the updates that Atmos reported to have made to its risk model, whether to address expansive soil or any other threat, did not result in an effective model.[127] A distribution integrity management risk model that effectively evaluated and ranked risk would have produced results that helped Atmos identify potentially hazardous leaks and take corrective actions before the leaks became hazardous, which Atmos's risk model did not do.

In addition to Atmos's risk model not adequately evaluating the risks to its system, this investigation found that shortfalls in Atmos's leak management program contributed to the two Jackson accidents (see section 2.3 for more information on this), and federal regulations require distribution integrity management programs to have effective leak management. Thus, Atmos's entire distribution integrity management program, not just its risk model, was inadequate. Therefore, the NTSB concludes that Atmos's distribution integrity management program was inadequate because it did not effectively identify and then mitigate the risks to its system.

While the ineffectiveness of Atmos's risk model may have been caused by several factors, the evidence suggests that Atmos's lack of system data is one reason that the model did not adequately evaluate system risk. (See section 2.5.1 for more information on this.) Another reason that Atmos's risk model did not adequately evaluate system risk is that Atmos used a relative-risk type model. As discussed in section 1.7.2.2, in 2020, after reviewing the four types of pipeline risk models, PHMSA released a report stating that probabilistic risk models were a best practice for large, complex systems and provided greater capabilities for decision-making support than the other types of risk models (PHMSA 2020). In addition, PHMSA's report noted that relative-risk models were best suited for small, less complex pipeline systems. Atmos, the largest natural gas distributor in the states of Louisiana, Mississippi, and Texas, did not have a small pipeline system, and it used a relative-risk model.

The two accidents in Jackson resulted in a fatality and three destroyed homes and severely impacted the city of Jackson. With a more effective distribution integrity management risk model, a model capable of accurately evaluating and ranking risk, like a probabilistic-type model, Atmos would be better positioned to optimize safety outcomes for the communities they service. Therefore, the NTSB recommends that Atmos transition from a relative-risk model to a probabilistic distribution integrity management risk model. PHMSA's report on the risk model types indicated that probabilistic models were more robust than qualitative and relative-risk models and

[127] The two accidents in Jackson indicate that Atmos's risk model did not adequately consider expansive-soil risks, contrary to Atmos's correspondence with the NTSB regarding Safety Recommendation P-21-12. This investigation did not evaluate the reason for the discrepancy between Atmos's statements about the updates to its risk model and the model's performance.

thus equipped pipeline operators to make better safety-related decisions. Natural gas distribution pipeline operators should be reminded of the superior decision-informing capabilities that probabilistic models can provide. Therefore, the NTSB recommends that PHMSA issue an advisory bulletin urging operators to adopt probabilistic risk models for distribution integrity management where appropriate.

As a result of our Dallas investigation, the NTSB recommended that PHMSA:

> Evaluate industry's implementation of the gas distribution pipeline integrity management requirements and develop updated guidance for improving their effectiveness. The evaluation should specifically consider factors that may increase the likelihood of failure such as age, increase the overall risk (including factors that simultaneously increase the likelihood and consequence of failure), and limit the effectiveness of leak management programs. (P-21-2)

In 2021, PHMSA reported that it would analyze data and trends to evaluate the industry's implementation of the gas distribution integrity management program requirement to address Safety Recommendation P-21-2. Two years later, in September 2023, PHMSA published a notice of proposed rulemaking to revise pipeline safety regulations to require operators of gas distribution pipelines to update their distribution integrity management programs; the NTSB provided comments that supported the proposal (88 *Federal Register* 61746). In March 2025, the NTSB's investigation of the West Reading accident indicated that the natural gas distribution pipeline operator involved did not have an effective integrity management program, and the NTSB reiterated Safety Recommendation P-21-2 to PHMSA. In recent meetings with PHMSA, the NTSB has discussed how the regulator could meet the intent of the recommendation by developing and sharing best practices and updated integrity management guidance with pipeline operators. The NTSB's investigation of the two Jackson accidents has again identified the need for natural gas distribution pipeline operators to have effective distribution integrity management programs. Therefore, the NTSB reiterates Safety Recommendation P-21-2 to PHMSA.

2.6 Absence of Natural Gas Detection Alarms in Buildings

The Bristol Boulevard accident home and the Shalimar Drive accident home did not have natural gas alarms installed. For nearly 50 years, the NTSB has been recommending natural gas alarms for the early detection of natural gas leaks. In the West Reading accident, several candy factory employees told the NTSB that they had smelled natural gas odorant and did not call 9-1-1 or the gas company but stayed in the building until the explosion occurred. Some of the employees inquired with their managers about what to do, and their managers were equally unaware of the actions to take during a suspected natural gas leak. In the two Jackson accidents, and in many of the pipeline accidents the NTSB has investigated for the last 5 decades, people smelled natural gas odorant and either did not know what actions to take, or they knew the actions necessary to address a potential natural gas emergency but did not execute them.

Natural gas distribution pipeline operators must educate the public on pipeline safety through public awareness programs. It is also necessary, however, to have safeguards in place when members of the public (1) smell natural gas odorant and do not take the appropriate safety actions and (2) do not smell natural gas odorant, as was the case in the NTSB investigation of the Dallas accident, and therefore do not take appropriate safety actions.[128] Natural gas alarms are safeguards in protecting the public, which is why the NTSB has recommended their installation after many of our pipeline accident investigations. The NTSB found that natural gas alarms likely would have prevented or reduced the consequences of the Dallas and West Reading accidents, and the evidence in this investigation suggests the same. The Shalimar Drive accident home was empty at the time of that accident; however, when the explosion in the Bristol Boulevard accident home occurred, two people were inside. Therefore, the NTSB concludes that had a natural gas alarm been installed inside the Bristol Boulevard accident home, it could have alerted occupants that natural gas was present, prompting them to evacuate and report the leak, making Atmos aware that the leak had likely worsened and required corrective action. As a result of the West Reading investigation, the NTSB recommended that the 50 States, the Commonwealth of Puerto Rico, and the District of Columbia:

> Require the installation of natural gas alarms that meet the specifications of National Fire Protection Association 715 in businesses, residences, and other buildings where people congregate that could be affected by a natural gas leak. (P-25-5)[129]

[128] The NTSB's Dallas investigation determined that the occupants in the accident homes did not smell natural gas odorant because it was absorbed and depleted in the soil.

[129] Safety Recommendation P-25-5 is currently classified Open—Await Response.

As of this report, 7 states and the District of Columbia have provided an initial response; 43 states and the Commonwealth of Puerto Rico have not responded.[130] The NTSB investigation of the two Jackson accidents has again identified the critical importance of natural gas alarms to alert occupants to natural gas leaks. Therefore, the NTSB reiterates Safety Recommendation P-25-5 to 50 States, the Commonwealth of Puerto Rico, and the District of Columbia.

As discussed in section 1.10.1.1, after the Avondale accident, Atmos reported that it provided the public with information, through its website, on the availability of natural gas alarms. However, Atmos can do more to safeguard the public in its distribution areas. The NTSB is aware of multiple natural gas distribution operators that have made natural gas alarms available to people in their service areas.[131] Therefore, the NTSB recommends that Atmos develop and implement a program that makes natural gas alarms available to members of the public who reside in its distribution areas.

[130] The seven states that have provided an initial response include Colorado, Connecticut, Kansas, Nevada, North Carolina, Virginia, and Wyoming. Mississippi, the state where the two Jackson accidents occurred, is one of the 43 states that have not provided an initial response.

[131] Visit http://www.ntsb.gov to find additional information in the public docket for this NTSB accident investigation (case number PLD24FR003).

3 Conclusions

3.1 Findings

1. At the time of the two explosions, natural gas pressure was at acceptable levels and did not contribute to the accidents.

2. Near the accident homes, natural gas leaked from service-line pipes that had partially pulled out of compression couplings and migrated through the ground and into the homes where it fueled the explosions.

3. Technicians had likely properly installed the accident compression couplings at both locations, and the couplings had not degraded; however, the service-line pipes at both locations had, over time, partially pulled out of the compression couplings.

4. Leaks near the accident homes were the result of expansive clay soil movement that caused the service-line pipes to, over time, partially pull out of the compression couplings.

5. Atmos Energy Corporation's lack of companywide leak management procedures requiring employees to frequently monitor open, belowground natural gas leaks located in adverse-soil conditions permitted the accident leaks to become hazardous before Atmos Energy Corporation repaired them.

6. In the accidents in Jackson, Mississippi, and in several natural gas accidents that the NTSB has investigated, the operator's public awareness program was ineffective at educating the public on how to safely respond to the smell of natural gas odorant.

7. In the accidents in Jackson, Mississippi, and in previous Atmos Energy Corporation accidents in Dallas, Texas, and Avondale, Louisiana, emergency response officials were not sufficiently trained on how to respond to a natural gas leak, despite being offered annual natural gas safety training, demonstrating that Atmos Energy Corporation missed an opportunity to effectively educate and prepare emergency response officials in its service areas to address natural gas emergencies.

8. Atmos Energy Corporation's ineffective communications regarding the need to report any smell of natural gas odorant inhibited necessary

reporting from residents who continued to smell natural gas odorant in and near their homes.

9. Atmos Energy Corporation's failure to gather relevant information about its service-line records prevented it from effectively assessing the risk to its assets.

10. Atmos Energy Corporation's distribution integrity management program was inadequate because it did not effectively identify and then mitigate the risks to its system.

11. Had a natural gas alarm been installed inside the Bristol Boulevard accident home, it could have alerted occupants that natural gas was present, prompting them to evacuate and report the leak, making Atmos Energy Corporation aware that the leak had likely worsened and required corrective action.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the two explosions at two separate homes in Jackson, Mississippi, was Atmos Energy Corporation's inadequate leak management program, which allowed for known natural gas leaks, from service-line pipes that had partially pulled out of compression couplings due to soil movement, to be left unrepaired for at least 8 weeks, resulting in gas leaking from the compression couplings and then migrating to the nearby homes and igniting. Contributing to the explosions was Atmos Energy Corporation's inadequate integrity management program, which did not appropriately assess and address risk in its pipeline system. Also contributing was an ineffective public awareness program, which did not adequately educate the public or emergency response officials on how to respond to a suspected natural gas leak.

4 Recommendations

4.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendations.

To the Department of Transportation Office of Inspector General:

Audit the Pipeline and Hazardous Materials Safety Administration's ongoing joint assessment of Atmos Energy Corporation (with the eight state partners that regulate Atmos Energy Corporation's facilities), including a review of Atmos Energy Corporation's approach to the safety management of its pipeline and how it applies lessons learned across all its operating divisions. (P-26-1)

To the Pipeline and Hazardous Materials Safety Administration:

Issue an advisory bulletin urging operators to adopt probabilistic risk models for distribution integrity management where appropriate. (P-26-2)

To Atmos Energy Corporation:

Develop and implement a program to locate and replace all mechanical couplings and mechanical joints located in expansive soils that are not resistant to pipe pullout with couplings and joints developed specifically for those conditions. The program should establish and make public the project milestones and timeline. (P-26-3)

Update your companywide leak management program procedures to require weekly monitoring of nonhazardous (grade 2 or grade 3) belowground leaks identified in locations with adverse-soil conditions (such as water-saturated soil, flooding, drought, frozen ground, or settlement). (P-26-4)

After completing the action described in P-26-4, implement a training program to maintain employee and contractor proficiency on the updated procedures. (P-26-5)

Develop and implement a program to provide more frequent training to emergency response officials in all the distribution areas that you serve, including training on how to respond to natural gas-leak calls, and monitor the program for effectiveness. (P-26-6)

Require your technicians who identify but do not repair a belowground natural gas leak to immediately notify people near the unrepaired leak that (1) the hazard potential of a leak can change over time, and (2) they should evacuate and then call 9-1-1 and Atmos Energy Corporation every time they smell natural gas odorant. (P-26-7)

Develop and implement a program to proactively identify and collect missing service-line information for all your operating divisions. The program should (1) identify one or more methods for gaining additional system data and (2) establish and make public the milestones and timeline for acquiring the unknown system data. (P-26-8)

Transition from a relative-risk model to a probabilistic distribution integrity management risk model. (P-26-9)

Develop and implement a program that makes natural gas alarms available to members of the public who reside in your distribution areas. (P-26-10)

4.2 Previously Issued Recommendations Reiterated in This Report

The National Transportation Safety Board reiterates the following safety recommendations.

To the Pipeline and Hazardous Material Safety Administration:

Evaluate industry's implementation of the gas distribution pipeline integrity management requirements and develop updated guidance for improving their effectiveness. The evaluation should specifically consider factors that may increase the likelihood of failure such as age, increase the overall risk (including factors that simultaneously increase the likelihood and consequence of failure), and limit the effectiveness of leak management programs. (P-21-2)

Safety Recommendation P-21-2 is reiterated in section 2.5 of this report.

Identify effective means for natural gas distribution pipeline operators to communicate with people who live, work, or congregate within the coverage area of a natural gas distribution pipeline system and implement a plan to help operators drive continuous improvement in public awareness of natural gas safety. (P-25-3)

Safety Recommendation P-25-3 is reiterated in section 2.4 of this report.

To 50 States, the Commonwealth of Puerto Rico, and the District of Columbia:

> Require the installation of natural gas alarms that meet the specifications of National Fire Protection Association 715 in businesses, residences, and other buildings where people congregate that could be affected by a natural gas leak. (P-25-5)

Safety Recommendation P-25-5 is reiterated in section 2.6 of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JENNIFER L. HOMENDY
Chairwoman

MICHAEL GRAHAM
Member

THOMAS CHAPMAN
Member

Report Date: March 12, 2025

Appendixes

Appendix A: Investigation

The National Transportation Safety Board (NTSB) was notified of the Bristol Boulevard accident on January 26, 2024, and arrived on the scene on January 27, 2024. The NTSB added the Shalimar Drive accident to the investigation on January 28, 2024. The NTSB team consisted of an investigator-in-charge, an emergency response investigator, a fire investigator, a human performance investigator, integrity management investigators, a materials laboratory investigator, and pipeline operations investigators. The team also included NTSB staff from the Office of Research and Engineering, the Office of Safety Recommendations and Communications, and the Transportation Disaster Assistance Division. The Pipeline and Hazardous Materials Safety Administration, the Mississippi Public Service Commission, and Atmos Energy Corporation were parties to the investigation.

Appendix B: Consolidated Recommendation Information

Title 49 *United States Code* 1117(b) requires the following information on the recommendations in this report.

For each recommendation—

(1) a brief summary of the Board's collection and analysis of the specific accident investigation information most relevant to the recommendation;

(2) a description of the Board's use of external information, including studies, reports, and experts, other than the findings of a specific accident investigation, if any were used to inform or support the recommendation, including a brief summary of the specific safety benefits and other effects identified by each study, report, or expert; and

(3) a brief summary of any examples of actions taken by regulated entities before the publication of the safety recommendation, to the extent such actions are known to the Board, that were consistent with the recommendation.

To the Department of Transportation Office of Inspector General:

P-26-1

Audit the Pipeline and Hazardous Materials Safety Administration's ongoing joint assessment of Atmos Energy Corporation (with the eight state partners that regulate Atmos Energy Corporation's facilities), including a review of Atmos Energy Corporation's approach to the safety management of its pipeline and how it applies lessons learned across all its operating divisions.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.3, Insufficient Leak Management Program. Information supporting (b)(1) can be found on pages 68–70; (b)(2) and (b)(3) are not applicable.

To the Pipeline and Hazardous Materials Safety Administration:

P-26-2

Issue an advisory bulletin urging operators to adopt probabilistic risk models for distribution integrity management where appropriate.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.5, Inadequate Distribution Integrity Management Program.

Information supporting (b)(1) can be found on pages 75–81; (b)(2) can be found on page 79; and (b)(3) is not applicable.

To Atmos Energy Corporation:

P-26-3
Develop and implement a program to locate and replace all mechanical couplings and mechanical joints located in expansive soils that are not resistant to pipe pullout with couplings and joints developed specifically for those conditions. The program should establish and make public the project milestones and timeline.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.2, Compression Coupling Leaks. Information supporting (b)(1) can be found on pages 63–68; (b)(2) can be found on page 90; and (b)(3) is not applicable.

P-26-4
Update your companywide leak management program procedures to require weekly monitoring of nonhazardous (grade 2 or grade 3) belowground leaks identified in locations with adverse-soil conditions (such as water-saturated soil, flooding, drought, frozen ground, or settlement).

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.3, Insufficient Leak Management Program. Information supporting (b)(1) can be found on pages 68–70; (b)(2) and (b)(3) are not applicable.

P-26-5
After completing the action described in P-26-4, implement a training program to maintain employee and contractor proficiency on the updated procedures.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.3, Insufficient Leak Management Program. Information supporting (b)(1) can be found on pages 68–70; (b)(2) and (b)(3) are not applicable.

P-26-6
Develop and implement a program to provide more frequent training to emergency response officials in all the distribution areas that you serve, including training on how to respond to natural gas-leak calls, and monitor the program for effectiveness.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4, Ineffective Public Awareness Program. Information supporting (b)(1) can be found on pages 70–75; (b)(2) and (b)(3) are not applicable.

P-26-7
Require your technicians who identify but do not repair a belowground natural gas leak to immediately notify people near the unrepaired leak that (1) the hazard potential of a leak can change over time, and (2) they should evacuate and then call 9-1-1 and Atmos Energy Corporation every time they smell natural gas odorant.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4, Ineffective Public Awareness Program. Information supporting (b)(1) can be found on pages 70–75; (b)(2) and (b)(3) are not applicable.

P-26-8
Develop and implement a program to proactively identify and collect missing service-line information for all your operating divisions. The program should (1) identify one or more methods for gaining additional system data and (2) establish and make public the milestones and timeline for acquiring the unknown system data.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.5, Inadequate Distribution Integrity Management Program. Information supporting (b)(1) can be found on pages 75–81; (b)(2) and (b)(3) are not applicable.

P-26-9
Transition from a relative-risk model to a probabilistic distribution integrity management risk model.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.5, Inadequate Distribution Integrity Management Program. Information supporting (b)(1) can be found on pages 75–81; (b)(2) can be found on page 79; and (b)(3) is not applicable.

P-26-10
Develop and implement a program that makes natural gas alarms available to members of the public who reside in your distribution areas.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.6, Absence of Natural Gas Detection Alarms in Buildings.

Information supporting (b)(1) can be found on pages 81–82; (b)(2) and (b)(3) are not applicable.

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