National Transportation Safety Board
Washington, D.C. 20594

Office of Railroad, Pipeline and Hazardous Materials Investigations

Alagasco Natural Gas Release with Ignition, Birmingham, Alabama

January 26, 2016

Operations Group Factual Report DCA-14-MP-001

A. Accident:
Operator: Alabama Gas Company, Inc.
Location: Birmingham, Alabama
Date: December 17, 2013
Time: 2:29 a.m. (Central Standard Time)

B. Operations Group Members:

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Pipeline Accident Investigator
National Transportation Safety Board (NTSB)
Washington, DC

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Fred Culp, Member – Emergency Response
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Tyrone Fornest, Member – Public Awareness
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C. Accident Synopsis:

On December 17, 2013, about 2:29 a.m. (CST), apartment Unit 80, at 7546 64th Courtway South exploded following the ignition of natural gas in the Unit. The explosion and fire resulted in the complete destruction of the building and partial collapse of the adjacent Unit 79 as shown in Figure 1. This was a two-story duplex structure. Several nearby apartments located in the Charles P. Marks Village (Marks Village), a public housing project operated by the Housing Authority of the Birmingham District (HABD), in Birmingham, Alabama, were damaged. About 45 minutes after the fire department arrival, the structure fire was extinguished. Unit 80 riser fire continued burning for almost four hours after the explosion while Alagasco crews searched for the service line to the affected apartment. At approximately 6:14 a.m., Alagasco crews found the isolation riser valve and isolated the gas flow to the riser and stopped the fire.

The residents from several neighboring apartments evacuated and people sheltered at a nearby recreation center. The explosion caused one death, critically injured one adult and left seven others with minor injuries. The injured persons included four children. The estimated property damage was $505,350.[1]

Following the accident, bubbling found in nearby water pools due to fire suppression operations and subsequent bar hole tests revealed gas in the soil near a tree northeast of Unit 80. Alagasco excavated a 2-1/4-inch cast iron main in this area and found a crack in the bottom of the pipeline. A day after the accident, gas leaks were detected in a grassy area between the sidewalk and the east side of the destroyed building.[2] Additional leak surveys conducted after the accident revealed five other service line and cast iron main leaks unrelated to the incident in the Marks Village community.

[1] Attachment 1 - Alagasco response to NTSBIR061814

[2] Appendix 1 - Updated June 2015 13041_SCENE_SURVEY_PRELIM_3-7-14 (AL-GC-002305) as AL-GC-002342

Figure 1: Collapsed Units 79 and 80 apartments in Gate City Community.

D. Operator: Alagasco

Alagasco a subsidiary of The Laclede Group, Inc. (formerly a subsidiary of Energen Corporation at the time of the accident) and has been operating since 1852 when the company was known as the Montgomery Gas Light Company. Over the years and after several mergers, acquisitions, divestitures and name changes, Alabama Gas Corporation (Alagasco) emerged in 1953.

The holding company Alagasco, Inc. formed in 1979 is a publicly traded company, with Alabama Gas Corporation as the primary subsidiary. With over 1,100 employees, Alagasco is the largest natural gas distributor in the state serving approximately 425,000 customers in over 200 Alabama cities, towns and communities. Alagasco's natural gas distribution system contains 23,945 miles of pipes, all located within the State of Alabama. The pipeline sizes in the system range from 1/2-inch to 20-inches-diameter.[3]

E. Pipeline History

Natural Gas was delivered to the Marks Village community[4] through cast iron distribution mains. Most of the laterals were 2-1/4-inch-diameter cast iron with some mains as large as 6 inches. The cast iron main serving Unit 79 and Unit 80 was located about 47 feet north of the apartment alley way.

The cast iron distribution main line installation was completed on November 20, 1951, after the service lines to Units 79 and 80 were installed. Total main installations in the community were 1,100 feet of 6-inch cast iron, 3,000 feet of 4-inch cast iron, and 4,500 feet of

[3] Attachment 2 - Alagasco Response to NTSB IR036_Line and Corporate History

[4] Mark Village community; also known as The Gate City is located near Birmingham, AL

2-1/4-inch cast iron. The pressure test record, mill reports, and purchase records of all cast iron distribution system in the Gate City community are not available. The maximum allowable operating pressure (MAOP) of the subject pipeline was 25 psig and was established according to 49 CFR Parts 192.619 (3) of the grandfather rule by using the highest actual operating pressure to which the pipe segment was subjected to during the five year period preceding July 1, 1970.[5] According to Alagasco, no actual pressure test was performed at the time of installation since it was not required in 1951.[6]

Service line installation records for Units 79 and 80 shows the 1-1/2-inch steel branched service line with pipe enamel coating was installed on October 26, 1951.[7] The service record card showed that the branched service lines contained a common service curb valve. Emergency crews were not able to locate this curb valve following the explosion. The responding gas service mechanics and technicians did not have knowledge of the service pipeline configuration at this address and were not in possession of the service record card at the time of response.

The pipeline operating pressure in Marks Village on the day of the accident was remotely controlled with regulators located 1.5 miles from the incident properties and was set at 19.5 psig. The cast iron main and service pipeline operating pressure at the time of the accident was 19 psig. The operating pressure is adjusted seasonally to approximately 20 psig during winter and 14 psig for the remainder of the year. These pressures are monitored by low point pressure telemetry at different areas, and are achieved using remote controlled adjustment to the distribution system regulators located at various locations within the Birmingham districts.[8]

F. The Gate City Community

The Marks Village[9] public housing project that consists of 500 apartments is managed by the Housing Authority Birmingham District (HABD). The apartment buildings are brick and mortar construction with a concrete slab floor on the first and second floors. The interior walls are constructed of concrete and lath and mortar. The rafters and trusses that make up the roof are constructed of wood. The front and rear entry doors are steel. The floor is tiled.

The HABD employs a team of six maintenance technicians that take care of general repairs to the units that includes painting and plumbing. Work they cannot accommodate is contracted out. A technician told NTSB investigators that from time to time they may turn on or turn off gas to appliances for the residents. All community maintenance is logged on a central maintenance management system which indicates type of request made without detailed descriptions.[10]

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[5] Attachment 4 - Pipeline Summary Information

[6] Attachment 3 - Alagasco Response to NTSB IR035_Pipeline History and MAOP

[7] Attachment 5 - Service Line Records and Sketch File 17 AL-GC-001661_001662

[8] Attachment 3 - Alagasco Response to NTSB IR035_Pipeline History and MAOP

[9] Mark Village, also known as The Gate City

[10] Attachment 24 - Central Maintenance Management System - BHA work orders

When investigating gas odor complaints, the HABD technicians use a gas monitor and soap solution to check interior gas lines and fittings for leaks. Most of the gas related calls are to turn on appliances or relight pilots. Of the two HABD technician interviewed, neither technician recalled getting frequent complaints about gas odors from residents.[11]

When a HABD technician was asked if a gas odor could not be located, the technician replied:

"I wouldn't have ever left if I had smelled gas anywhere I went like that. I wouldn't have left. So I go check it out every time, and if I couldn't find it, we have them to call Alagasco."[12]

The HABD technician told NTSB investigators that if the source of a gas leak could not be found inside an apartment at a fitting or appliance, they would inform the HABD on-site property manager at the office and the resident would be advised to contact Alagasco.

Between 2010 and December 17, 2013, there were a total of 155 calls from Gate City community pertaining to gas odors to Alagasco; either inside or outside odors within a two block radius of the incident location. 70 of the calls were reported as inside leaks whereas 85 calls were reported as outside leaks. 12 of the 85 calls for outside leaks occurred in 2013. A total of 55 leaks were detected out of the 85 outside leak calls with four of these occurring in 2013. There were no leak calls of any type in December 2013 prior to the incident. Alagasco responded to each of the 155 calls.[13]

F.1. Apartment Gas Appliances

NTSB investigators visually examined the appliances recovered from the destroyed Unit 80 apartment; however, the appliances were not tested. The appliances included a gas heater unit, gas water heater, and gas oven. The heater unit was located in the living room and was found with its ignition control in the pilot position. The oven was found with the door open and the temperature control knob adjusted to approximately 350 degrees Fahrenheit. The gas water heater was found near its original location but crushed beneath a concrete beam.[14]

G. Utility Locations and Building Penetrations

NTSB investigators examined the destroyed Unit 80 apartment and found the customers' natural gas service line[15] downstream of the meter[16] consisted of threaded black iron pipe. It

[11] Attachment 6 - Interview of Brown 12-20-13

[12] Attachment 6 - Interview of Brown 12-20-13

[13] Alagasco email of June 6, 2010 – B. Gardner to R.Evans

[14] Further information on the appliances is contained in the fire examination factual report.

[15] Customers' natural gas service line or customers' gas service line is also defined by Alagasco as "natural gas fuel line."

entered the apartment through the exterior kitchen wall about 3 feet above the concrete slab on the northeast side of apartment.

The customers' natural gas service line ran as surface mounted then continued vertically up through the concrete slab between the first and second floors inside the ceiling until it dropped down and emerged from the wall behind the sink and the appliances.[17] The customers' natural service line ran south to connect to the oven. An additional customers' natural gas service line penetration was found in the center of the dwelling where it supplied the water heater and passed through an adjacent wall to the living room heater. Flues for the heater and water heater were ducted to a central chase in the closet with the water heater.

Two 4-inch cast iron sanitary sewer penetrations entered the north foundation wall of the property below the slab. Each of the connections made a 90 degree vertical turn beneath the slab and penetrated into the dwelling. These penetrations were about 29 feet apart and about 32 inches below the slab as depicted in Figure 2. Investigators observed gaps around the sanitary sewer pipe where it entered the building.

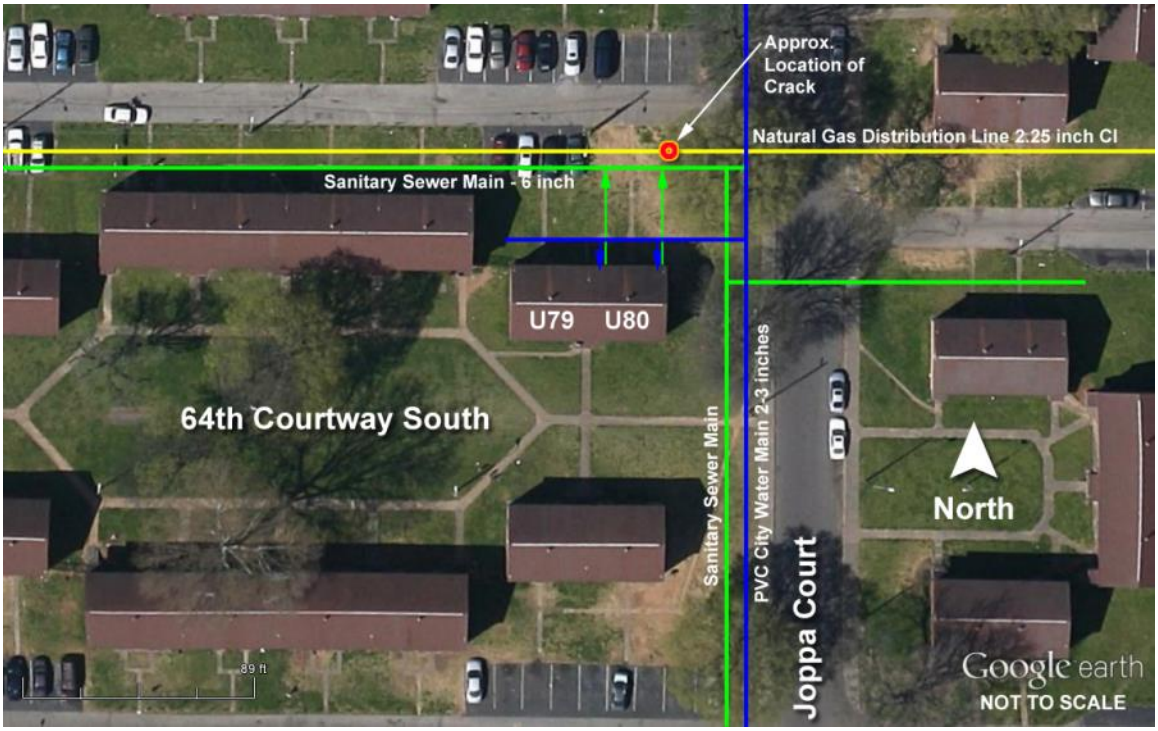

Figure 2: Aerial view showing utilities near Unit 80 in Gate City. Source: NTSB formatted

[16] Maintenance of the customers' natural gas service [fuel] line " is the responsibility of the BHA [HABD] and the customer."

[17] Customers' natural gas service line entered by surface into kitchen then went vertically into ceiling conduit to appliances.

H. Emergency Response

H.1. Fire Fighting

The Birmingham Fire Department received its first 911 call about 2:29 a.m. and firefighters arrived at the scene at 2:34 a.m. Upon their arrival the Birmingham Fire Department Captain established an incident command post on the east side of the demolished structure, and gave the initial briefing.[18] Seven engines and three rescue squads as well as several other emergency apparatus were dispatched to the scene over the course of the morning.

At the time of the firefighters arrival there were structure and service riser fires burning. Shortly after arriving, the fire department contacted Alagasco and considered the situation a recovery operation [no survivor was possible] until that changed about 6:30 a.m.[19] At 2:41 a.m. the Alagasco dispatcher notified the construction crew and service technician.[20] The Alagasco construction crew and service technician at this time were on a call in another location about 39 miles away from the accident site on the morning of December 17, 2013.

About 2:43 a.m. and 3:07 a.m. the fire department dispatcher made two calls. These calls were made to the Alagasco dispatcher requesting that gas company personnel cut off gas supply to the burning service riser on the northeast foundation wall of the destroyed apartment.[21]

By 3:16 a.m. the fire department extinguished the structure fire. Firefighters did not extinguish the service riser fire at the northeast foundation wall. This was left burning to avoid the formation of natural gas cloud that could possibly re-ignite. Heat from the riser fire prevented firefighters from closely approaching the collapsed property. The Alagasco service technician arrived at the scene about 3:23 a.m., followed by a Supervisor that arrived about 3:28 a.m.

About 4:00 a.m., second Alagasco service technician and the Alagasco construction crew arrived on site along with a supervisor. Although the field personnel did not receive the exact address from their dispatcher, they located the accident scene on approach to the area.[22]

The Alagasco supervisors evaluated the scene and requested additional construction crew and service technician assistance. The crew arrived at 5:20 a.m. Meanwhile the service technician sniffed with a gas measurement instrument (GMI) for gas at nearby sewer [covers][23] for possible gas migrations and determined there was no presence of gas in the area.

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[18] Interview of John Whitmer

[19] Interview of John Whitmer

[20] The construction crews are responsible for the gas mains and service lines up to the outlet of the meter and the customers' service line that extends from the meter into the house is managed by inside service department. See interview of Max Morrison

[21] Interviews of Max Morrison and John Whitmer

[22] Interview of Morrison, Whitmer and Maryland

[23] Sewer cover – manholes, and cleanouts

Descriptions of the leak survey by the Alagasco survey crew are contained in appendix 1[24]. The technician was approached by members of the public, the police at the accident scene, and his supervisor to alert him of gas odors discovered at various streets within the Marks Village development. Alagasco investigated all the inside and outside gas odor complaints. Other field personnel used flame ionization instruments (flame pack) to investigate reports of gas odor throughout the community. No leaks or excess levels of gas were detected inside the buildings.[25] Alagasco continued to get strong gas detection signals from outside, near the incident area from bar hole testing.

The service line was yet to be located at this time as the technician stated that debris in the area was making it difficult to access for testing. The crews continued to get gas detection signals in the immediate incident area. To further complicate the detection of the service line, the technician commented that the installation configuration of the service pipeline was not consistent with their standard installation.

The construction crew continued to excavate for the gas service line north of the incident property. The technician could not check the sewer line[26] at the incident property because of the riser fire. They assumed the gas service line was routed straight from the main directly to the meter location.[27] Without the use of a service installation map they theorized the pipe was installed according to most service line pipe routing.

After 4:00 a.m., Alagasco technicians utilized a line locater[28] and searched for the service lines to Unit 79 and Unit 80. There was no visible service curb[29]or main line valve near this location to turn off the gas supply feeding the riser fire. Additionally, there was no nearby main sectionalizing valve to isolate the gas service. The service technician turned off the riser valve to Unit 79 in case there were damaged gas lines inside that apartment. Since gas service was branched, turning off the Unit 79 riser valve did not have any effect on the Unit 80 riser fire. When crews could not locate the service lines feeding the riser fire, they began digging for them with a backhoe on the north side of the structure.[30] The construction crew dug open several holes without finding the service line.

Prior to the riser fire being extinguished, the fire department repeatedly contacted the Alagasco technician requesting that the riser fire be isolated. To facilitate this, the technician asked Alagasco supervisor for permission to wet the slab while the riser fire continued to burn. The technician requested permission to access the valve since it was still intact. The technician stated the application of water would allow the riser valve to remain cool and furthermore

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[24] Appendix 1 - Updated June 2015 13041_SCENE_SURVEY_PRELIM_3-7-14 (AL-GC-002305) as AL-GC-002342

[25] Interview of Max Morrison

[26] Sewer line check include the checking for gas at the clean-out

[27] Alagasco “standard installation route.”

[28] Line locator (later)

[29] Service curb (later)

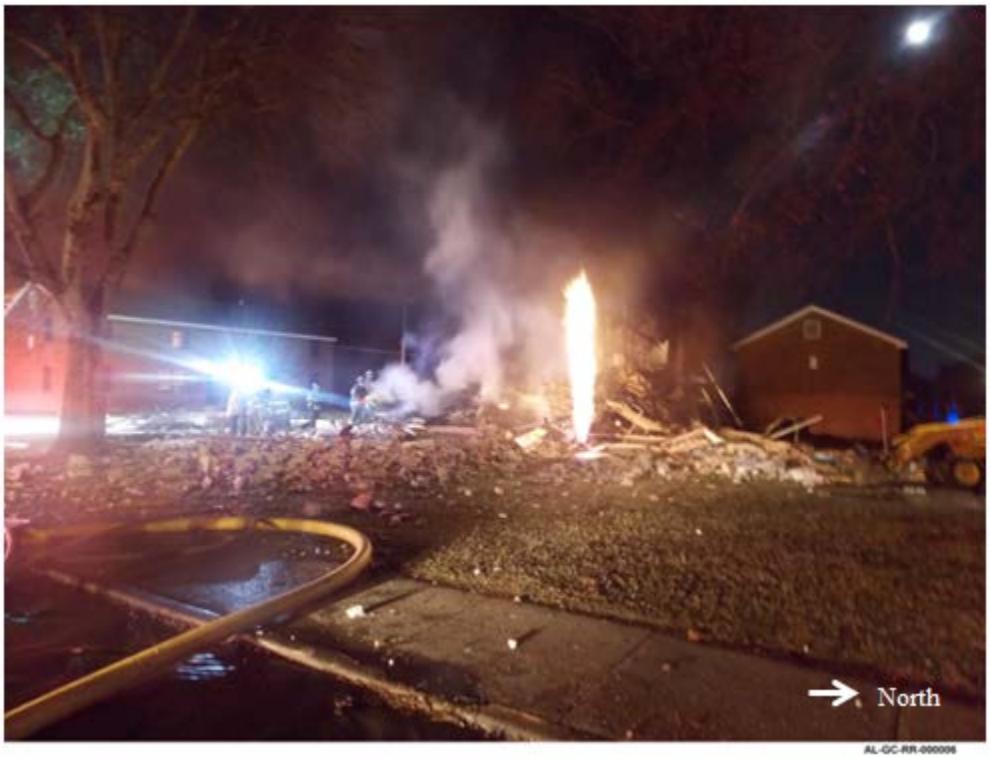
[30] Attachment 9 - Interview of John Whitmer

remarked to the supervisor that he had done this previously. The supervisor denied the permission since the action was not according to the company policy.

Prior to finding the service line, the first technician again requested permission from the supervisor to enter the scene and close the riser valve while the fire ensued. Again, permission was not granted.

The supervisor reluctantly approved the closure of the valve while the fire continued to burn. Prior to entering the area to address the riser valve, the technician requested the Birmingham Fire Department wet the entire collapsed slab on all surfaces and extinguish any noticeable embers.[31] He also asked that everything in the work area, including the riser be saturated with water for 15 minutes. The technician then requested the fire department to spray him with the high pressure water such that any natural gas presence would be less likely to re-ignite.

About 6:00 a.m., following the technician and his supervisor reaching an agreement on a proposed safety plan. Alagasco decided to shut off the gas at the burning service riser valve near the collapsed building. About 6:14 a.m. before the riser valve shut off, the small fires near the riser were extinguished. The firefighters then wet the slab and soaked the service technician with their water hose. This action allowed the flames to be pushed away from the technician. The technician then closed the riser valve thus stopping gas flow.



[31] Smoldering fire from burnt building materials

Figure 3: Destroyed Unit 80 with burning gas from the service riser and construction backhoe. Source: Alagasco emergency response.[32]

During the gas emergency situations Alagasco could not locate to operate the installed curb or maintenance valve required by Federal regulations. Figure 3 shows the incident unit riser valve fire that burned because the gas service curb valve or an alternative valve was not located. The Federal regulation requires that distribution system be equipped with valves as stated below:

> 49 CFR §192.747 - Valve maintenance: Distribution systems.
> (a) Each valve, the use of which may be necessary for the safe operation of a distribution system, must be checked and serviced at intervals not exceeding 15 months, but at least once each calendar year.
>
> (b) Each operator must take prompt remedial action to correct any valve found inoperable, unless the operator designates an alternative valve.

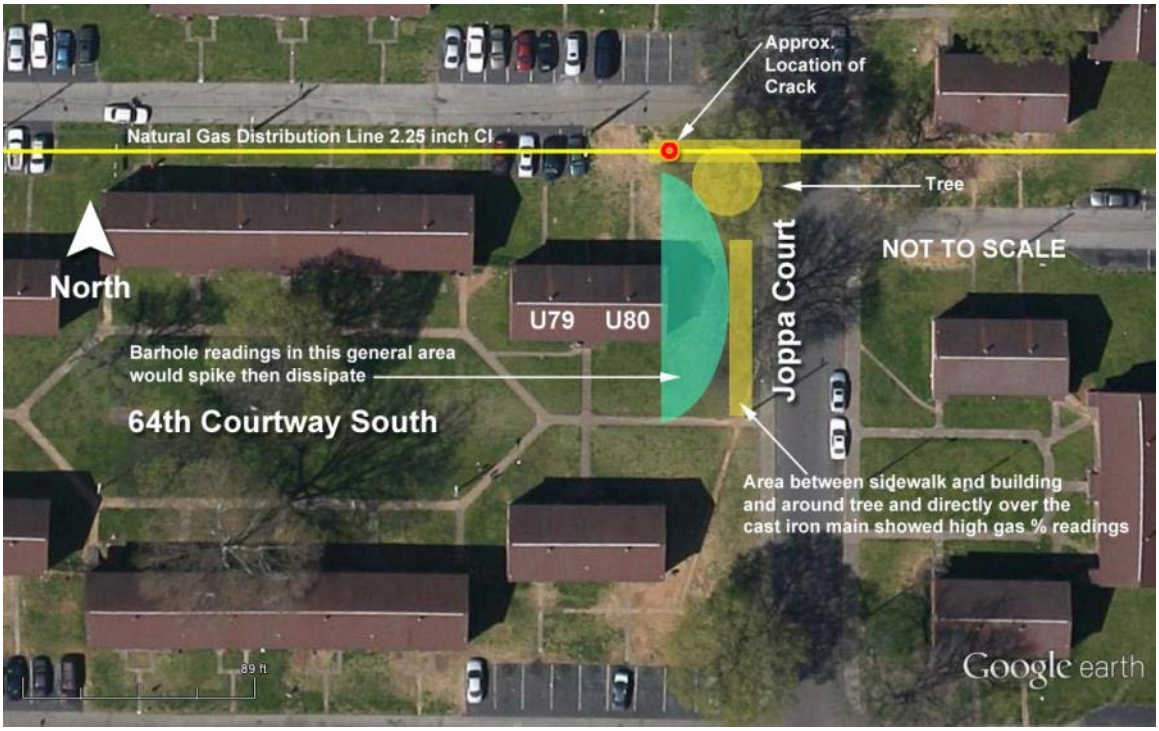


Figure 4: Bar hole test locations conducted during the emergency response. Source: NTSB formatted.

After the riser fire was extinguished, Alagasco construction crews conducted bar hole tests to locate the source of the gas leak and continued to search for the service line as shown in Figure 4. This involved checking for the presence of gas in the soil around the perimeter of the

[32] File19-D-AL-GC-RR-00001-000397

accident scene. Crews noticed bubbles near the road curb on the northeast side of the apartment. Digging revealed a 2-1/4-inch circumferential cracked cast iron distribution main.[33]

With an effort that included three technical crew members, the service line to apartment Unit 80 was finally located.

Alagasco construction crews and service technician have access to a truck-based computerized system capable of generating pipeline system maps and addresses. This computer-based pipeline information system contains the main line maps but does not contain maps for the individual service pipelines. The service line maps are available as hard copy service cards located within office files. The service card for the incident address was received in the field as a result of a supervisor contacting the Alagasco records center. The card containing the service line information was emailed to the first technician's truck computer following the closure of the riser valve.

According to the Alagasco Director of Quality Assurance and Compliance, the purpose of their mapping system is not for the location identification of service lines; but rather, for the main pipeline location identification; hence, service line locations are not intended to be accessible to field personnel via the on board (operation truck) computers system.

The promptness of the Alagasco crew response and arrival time log was reviewed. The first service technician at the scene stated that under emergency conditions the company has a policy for the timeframe for response to an incident. He stated it may differ for each situation, but for a "code 1" such as an inside gas leak or explosion, the response required is to arrive at the scene as soon as possible. In other instances, from the time the dispatcher receives a call to the time a technician reports onsite that may not exceed one hour. The dispatcher has 30 minutes to make contact with field personnel; the field personnel then have 30 minutes to be onsite.

Table 1: Emergency Response Timeline

Time	Event
12/17/2013 2:29 a.m.	Fire Department notification
12/17/2013 2:34 a.m.	Fire Department on-scene
12/17/2013 2:40 a.m.	Alagasco is notified by 911 of gas explosion
12/17/2013 2:42 a.m.	Alagasco dispatches service mechanic to site
12/17/2013 3:16 a.m.	Fire Department reports structure fire extinguished
12/17/2013 3:23 a.m.	Alagasco Service Mechanic on-scene

[33] According to Alagasco "a tree root wrapped around it. Wedged between the tree root and the cast iron pipe was a rock, and directly across from the root/rock a crack was found."

12/17/2013 4:00 a.m.	Alagasco construction crew arrives on scene
12/17/2013 5:20 a.m.	Additional Alagasco construction crew arrives on scene
12/17/2013 6:14 a.m.	Riser valve at Unit 80 meter is closed extinguishing the fire.
12/17/2013 6:30 a.m.	Alagasco identifies area of suspected leak
12/17/2013 7:14 a.m.	Alagasco excavated broken cast iron gas main
12/17/2013 9:30 a.m.	Alagasco completed cast iron gas main leak repair

H.2. Victim Recovery

About 3:00 a.m. the fire department searched the debris assuming there would be no survivors beneath the slab on the first floor. Three hours into the fire department rescue operation, there was still uncertainty over the number of victims. The only available information at that time was nine injured persons transported to the hospital, with all sustaining minor injuries.

The rescue team was called back to the scene after having been released. By 6:30 a.m., the fire department determined that two adults were still unaccounted for. About 6:45 a.m., one adult male and one deceased female were located in the rubble. The fire department found a critically injured, but conscious, adult male on the southeast end of the first floor pinned beneath the second floor slab. Alagasco's construction crew temporarily ceased their digging activities and assisted the Fire Department in the rescue efforts. The rescue team used airbags and hydraulic spreaders to raise the collapsed second floor enough to extract the critically injured man and recover the body of a deceased female.[34] The fire department report confirmed there were nine injured and one deceased as a result of this accident.[35]

I. Public Awareness

Alagasco submitted a copy of its Public Awareness Program (PAP) plan developed as required by the Pipeline and Hazardous Materials Safety Administration (PHMSA) regulatory mandate. Alagasco stated that it follows the Public Awareness Programs for Pipeline Operators; American Petroleum Institute (API) –*Recommended Practice 1162, First Edition* dated December 2003 that was incorporated by reference into the regulation, 49 CFR part

[34] Interview of John Whitmer

[35] Attachment 23 - Fire Investigations Bureau report

192.616. This plan is administered by the company's System Integrity Department with the assistance of the Corporate Communications Department. The primary person carrying out PAP implementation is the Coordinator of Damage Control under the director's oversight.

Alagasco summarized that the PAP goal is to enhance public safety and environmental protection through increased public awareness and knowledge and fulfilling 49 CFR part 192.616 and API RP-1162 requirements. In the PAP plan summary statement,[36] the company enumerated its baseline message topics as listed below:

1. Alabama Public Awareness Cooperative Training (APACT) for; Excavators, Emergency Responders and Public Officials:

• Natural Gas System purpose and reliability
• Awareness of hazards and prevention measures
• Emergency Preparedness and communications
• Pipeline location information including marker recognition
• How to get additional information

2. Customers:
• Natural Gas System purpose and reliability
• Awareness of hazards and prevention measures
• Damage Prevention awareness including One Call requirements
• Pipeline location information including marker recognition
• Gas Leak recognition and response
• How to get additional information

3. Non-Customers:
• Natural Gas System purpose and reliability
• Awareness of hazards and prevention measures
• Damage Prevention awareness including One Call requirements
• Pipeline location information including marker recognition
• Gas Leak recognition and response
• How to get additional information

Non-Customers: Other documents submitted by Alagasco under the PAP included the non-customer "Paradigm" brochures for the five years period 2009 – 2013. The paradigm messages provided the non-customers the following: an emergency number to reach the gas company; recognizing a suspected gas leak by sight, smell, and sound; what non-customers should not do if a leak occurs; what non-customers should do if a leak occurs; importance of pipeline markers and its informational limitations; information for emergency officials; and importance of 811 number for One Call Service.

Customer Awareness: In addition to the form of information contained in the Paradigm messages, the bill insert sent to customers by Alagasco also contains other messages and

[36] Alagasco Effectiveness Survey and Public Awareness Evaluation (Dated: June 17, 2010)

information such as: a 24 hour customer emergency number; efficient management of gas dependent home appliances and consequences of failure; carbon monoxide safety; explanation of customers' owned piping downstream of the meter and the company ownership of service pipes upstream of the meter; maintenance cost associated with repairs to customer lines; what customers should do when they smell strong odor of natural gas; and what customers should do if a leak occurs.[37]

Customer & Non-Customer Additional Awareness: Alagasco's other public awareness efforts that started in Birmingham include "special natural gas safety customer mailings twice a year," and provide safety brochures to customers at the time of certain service calls. This project is currently done state-wide, and offers safety information the company's website, blog and on YouTube. It also engages in community safety and awareness programs. Alagasco since 2012 partnered with Energy Underground to provide educational materials on natural gas safety to local schools.[38]

Annual Reviews: Documents submitted with the 2013 PAP plan showed seven annual reviews of this plan between 2006 and 2013. The documents identified the year of the review, but failed to indicate the specific dates such reviews were conducted. Each of the reviewed documents stated that "After a review of the Alagasco public awareness program, the program is meeting its intended targets. The program is reaching the appropriate audiences. The audiences understand the messages Alagasco is putting forth and the receivers of the message appear to be motivated to act in accordance with the information the program provides."[39]

Alagasco prides itself to have had "good public perception with stakeholders" in its public awareness program (PAP) and well-established relationships with the affected public; be it customer or non-customer, emergency officials, public officials and excavators. In addition they stated that they have low incidence of safety complaints with the State regulatory agency, based on the assessment of the company's PAP effectiveness.[40]

Four Year Effectiveness Reviews: Alagasco is required by regulation to conduct an Effectiveness Review of the PAP every four years. Alagasco utilizes Questfore to review the effectiveness of the PAP program to customers and non-customers. These surveys examine the audience content understanding and behaviors. In 2010 Effectiveness Review, Alagasco performed two types of surveys to evaluate the effectiveness of its program. These are stated as follows:

"A telephone survey of both customers and non-customers ("Questfore Survey") conducted in August 2007 and June 2010 showed that between 2007 and 2010 there was a +8[percent] change in the number of customers who received natural gas safety information, a +3[percent] change in the number of customers who know how to smell a natural gas leak, and

[37] Attachment 12 - 2009-2013 – Customer bill inserts and Paradigm from Alagasco.

[38] Alagasco Factual Submission on Public Awareness Regarding Natural Gas Safety (Dated: July 10, 2014) – AL-GC-002592 to 2601.

[39] Attachment 11 - Alagasco Effectiveness Survey and Public Awareness Evaluation (Dated: June 17, 2010)

[40] Attachment 11 - Alagasco Effectiveness Survey and Public Awareness Evaluation (Dated: June 17, 2010)

a +1[percent] change in the number of customers who reported having adequate gas safety information. For non-customers, the Questfore Survey showed a change of -3[percent] change in the number of non-customers who received information on natural gas safety, a +14[percent] change in the number of non-customers who know how to smell a natural gas leak, and a -6[percent] change in the number of non-customers who reported having adequate gas safety information.[41] Of all the survey recipients who responded (both customers and non-customers), there was a +3[percent] change in the number of people who knew how to smell a gas leak and a +1[percent] change in the number of people who said that they have adequate information about gas safety."

Also in Alagasco's 2014 four year effectiveness review, the analyses indicate the following: "An April 2014 Questfore Survey to customers and non-customers (analyzing change [from] 2007 to 2014), as well as analysis of Paradigm safety brochure response cards (analyzing change between 2012 and 2013). The Questfore Survey showed improvements in most of the categories between 2007 and 2010 [with a great improvement in non-customers awareness on the call before you dig number which went up by 15 percent]. The 2013 Paradigm Survey results similarly indicated improvement from 2012, specifically noting that more non-customers believed they have adequate information about natural gas safety."[42]

I.1. **The HABD**:

The NTSB requested that the HABD submit documentation to show information given to new tenants in the Gate City community to acquaint them with actions to take in emergency situations. In a welcome document the HABD provides to new tenants, the emergency number for tenants to use when experiencing a "maintenance emergency." Maintenance emergencies are those events that occur after hours, weekends, and holidays that may cause "harm to a person or to the building." Emergency situations are such things as a gas leak, fire, electrical outage (entire unit or building), electrical hazard (exposed wires), sewer line back-up (in unit only), flooded unit (burst hot water tank or pipeline), and blocked egress (blocked escape from any room). The welcome letter states that residents are required to have a reachable telephone number that can be used for service follow up. The HABD also included an after-hour emergency on-call telephone number.

According to the HABD, they require the resident to first call 911 in a situation of life threatening emergency.[43] However, the documents did not include what the resident should do for an emergency situation during day time.

[41] NTSB's Attachment 11 – Alagasco Effectiveness Survey and Public Awareness Evaluation (Dated: June 17, 2010)

[42] Alagasco 2014 Public Awareness Evaluation (May 19, 2014)(Appendix D)

[43] Attachment 13 - HABD – Public awareness materials to new tenants

J. Environmental Conditions and Forensic Excavations:

NTSB investigators were on-scene in December 2013, and witnessed the excavations of gas, sewer, and water piping to the Unit 80. In February 2014, NTSB investigators witnessed excavations that were conducted by the HABD insurance company to determine other likely migration paths for the gas to enter the home.

The excavations made on the east end of Unit 80 are shown in Figure 5, and 6 below. Figure 5 shows the entry of the first dedicated 4-inch sewer lateral, and 1-inch plastic water service pipe that transitioned to copper into the concrete slab. At the lower left corner of the picture a 2-inch Polyvinyl Chloride (PVC) water main is shown. A 4-inch PVC section of a sewer cleanout was located about 37 inches south of the 2-inch PVC water main. The water main was positioned about 104 inches north of the foundation wall.

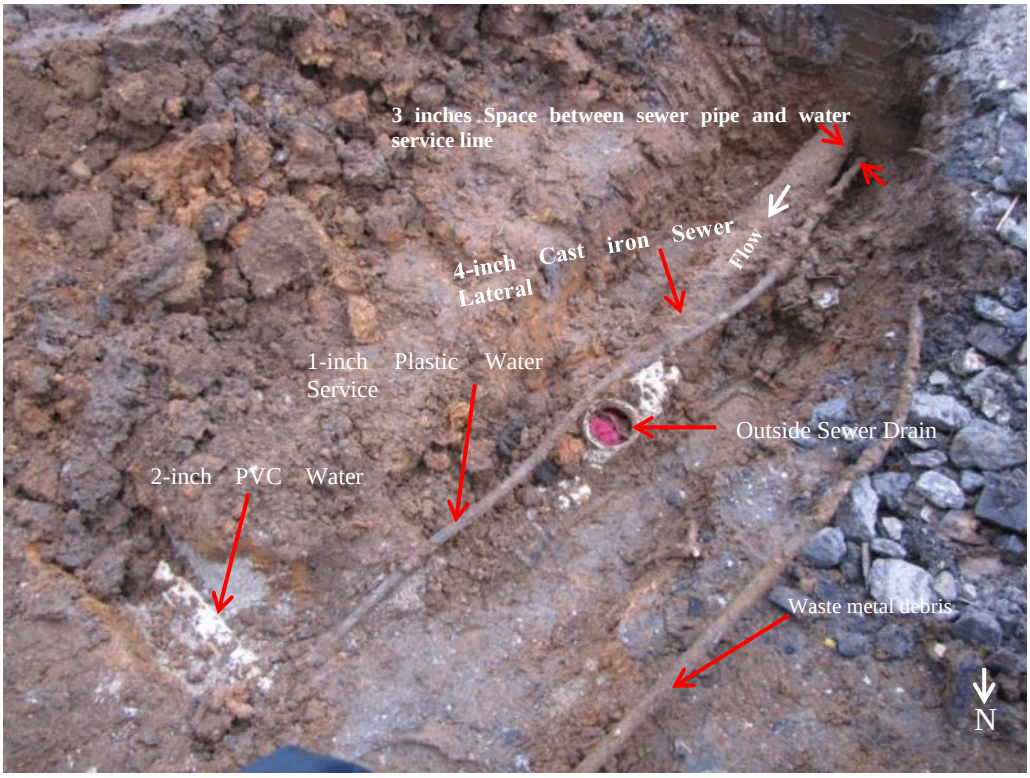


Figure 5: East side 2-inch PVC water main, 4-inch sewer lateral and a cleanout, and 1-inch plastic water service.

East foundation wall examinations:

The excavation in Figure 5 revealed that the 2-inch PVC water main pipe was above the Terracotta section of the 4-inch sewer lateral. The water main pipe was backfilled with sand along the exposed trench. The 4-inch sewer lateral of cast iron construction exited the Unit 80 foundation wall and transitioned to PVC pipe and sloped to the Terracotta pipe where it then turned north.

The east foundation wall of Unit 80 is where the sewer and water service pipe shown in Figure 6 entered the dwelling about 12 inches below grade. Openings were observed around the pipes at the entrance into the foundation wall.

Figure 6: Utilities enter at east foundation wall to Unit 80 containing opening.

Figure 7: Water closet drain is positioned about 30 inches from east foundation wall of Unit 80.

The dedicated water closet sewer drain Figure 7 for Unit 80 that serviced the first floor was located about 10 feet south of the 2-inch PVC water main pipe or about 30 inches from the east foundation wall corner.

West foundation wall examination:

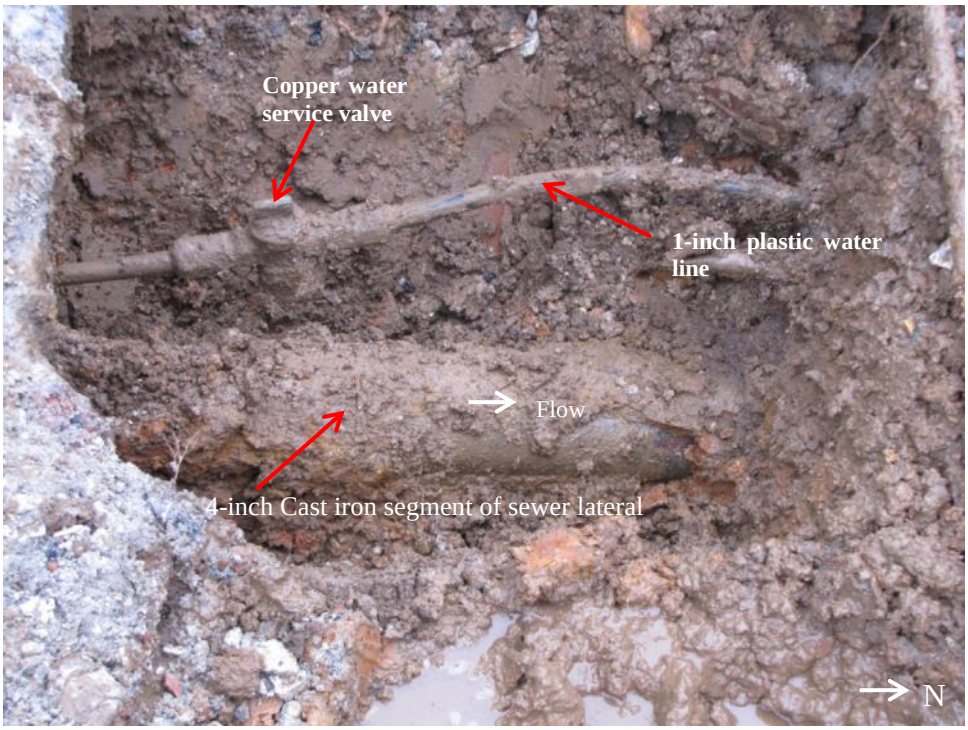


Figure 8: West foundation excavation with 4-inch sewer lateral and 1-inch water service.

Figure 8, the west end of Unit 80 excavations shows a 1-inch plastic water service line and a 4-inch sewer lateral. Both of these utilities were shared by the two adjacent units 79 & 80 to service part of the first and second floors of the apartments. The utilities entered at the point of the dividing wall between the units and about 29 feet from the east end services entry to Unit 80.

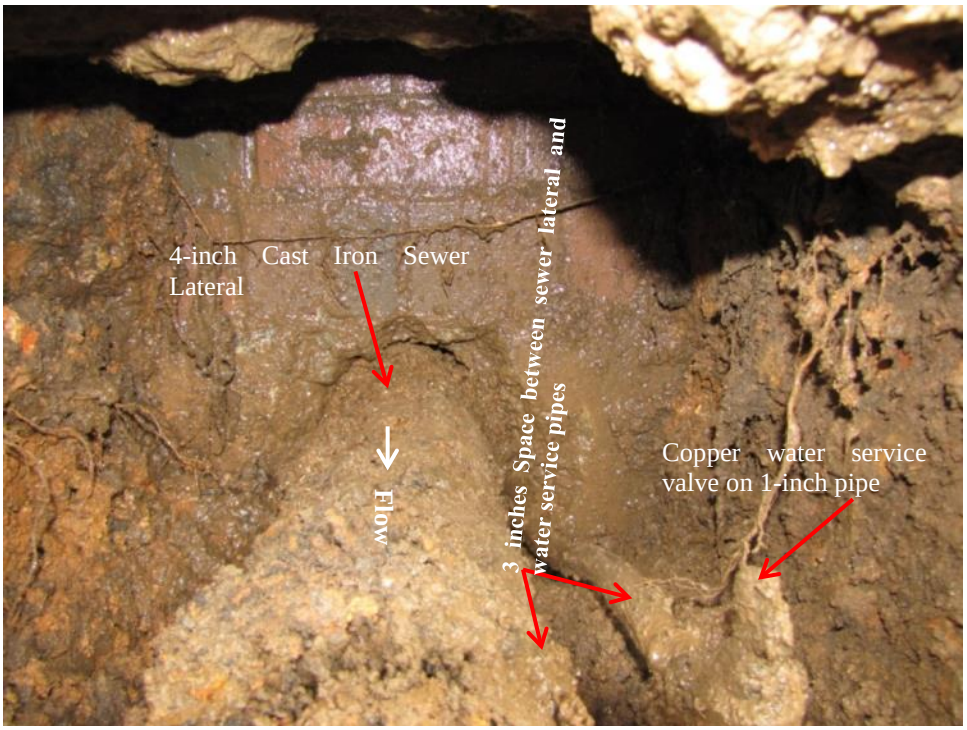


Figure 9: Entry of the west side 4-inch sewer lateral and 1-inch water service line serving Unit 79 and 80 looking south.

Figure 9 above shows the 4-inch sewer lateral passing through the foundation wall openings under the slab. This pipe also entered the wall with about 3 inches clearance from the 1-inch plastic water service pipe to its right (west side) similar to the east end utilities entries of the unit.

Close examination of east end sewer lateral main termination:

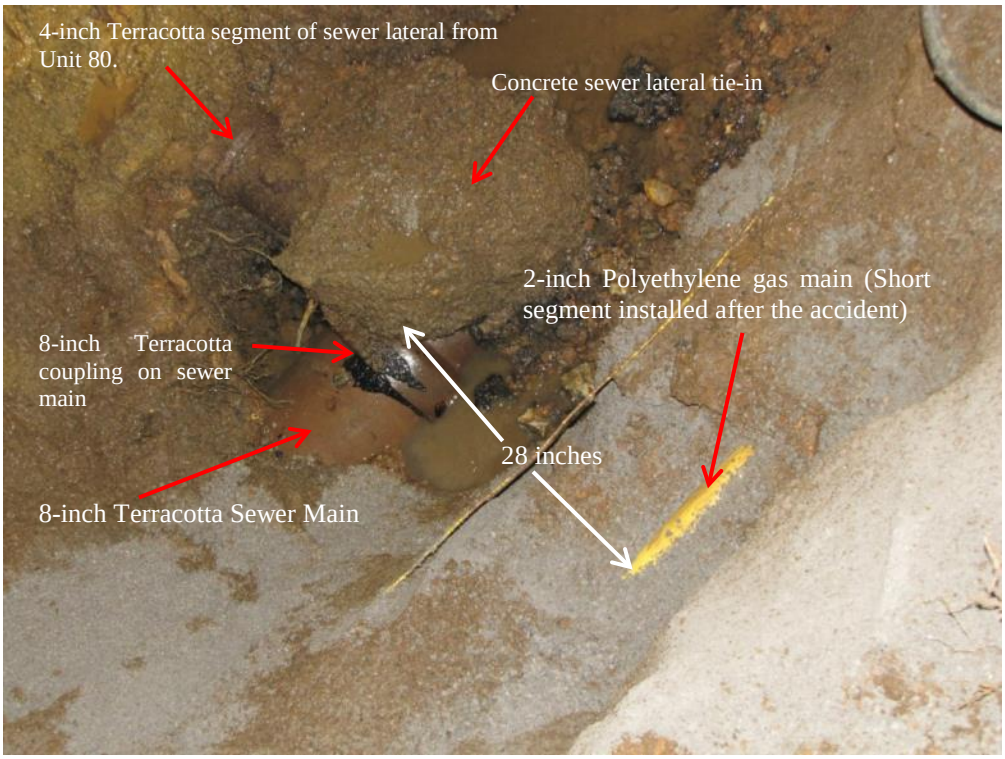


Figure 10: Tie-in for 4-inch east end sewer lateral to 8-inch sewer main with concrete and newly installed 2-inch polyethylene gas main segment.

Figure 10 above shows the east side 4-inch sewer lateral to Unit 80 that ran south to north and tied in with concrete to the 8-inch sewer main that ran east to west and perpendicular to the lateral. The sewer main also ran parallel with the newly installed section of 2-inch polyethylene gas pipeline that replaced the cracked 2-1/4-inch cast iron main located about 47 feet from north foundation wall of Unit 80. The sewer lateral tie-in position mirrored the location of the cracked cast iron pipe which was positioned about 18 inches below and about 28 inches south of the gas pipeline.

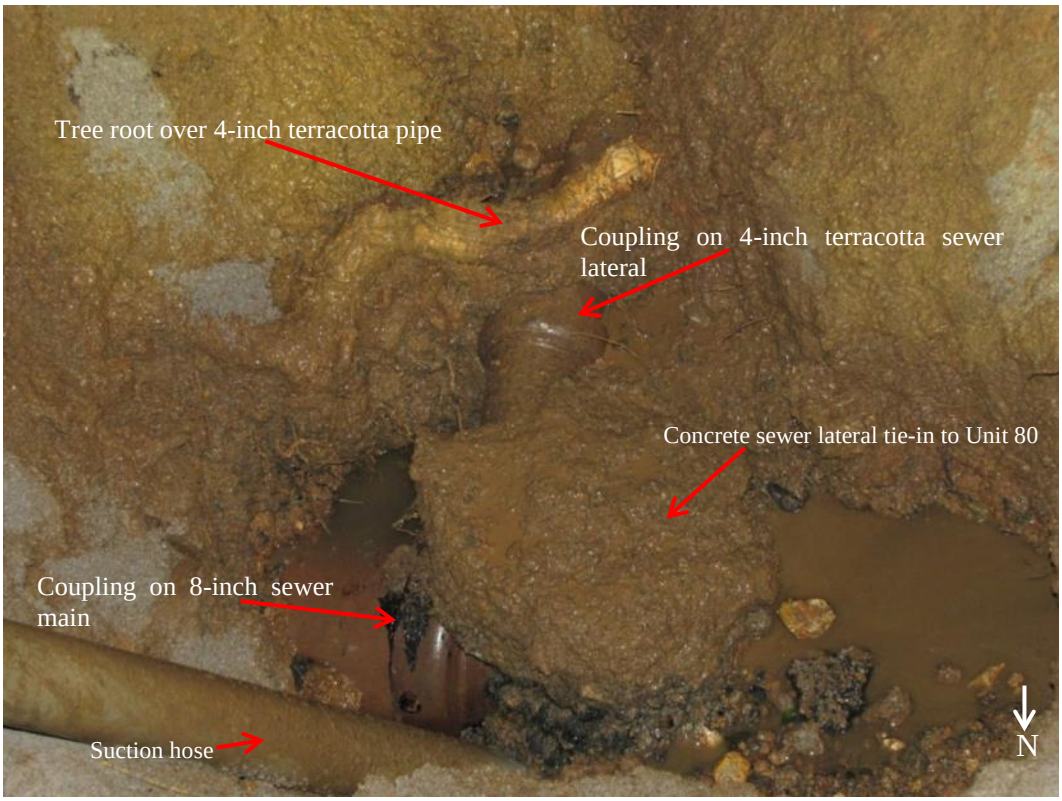


Figure 11: Two sewer couplings next to the east end sewer tie-in location of Unit 80.

Figure 11 shows the configuration of the 4-inch sewer waste connection from Unit 80 to the 8-inch sewer main. Note the mass of concrete at the location where the 4-inch sewer ties into the 8-inch sewer main. Approximately 2-1/2 inches tree root crosses about 6 inches from the male and female south facing lateral connection (Figure 12). The 8-inch sewer main male and female coupling was positioned directly beneath the concrete bond and showed indications of a black coal-tar-like compound around it (Figure 13).

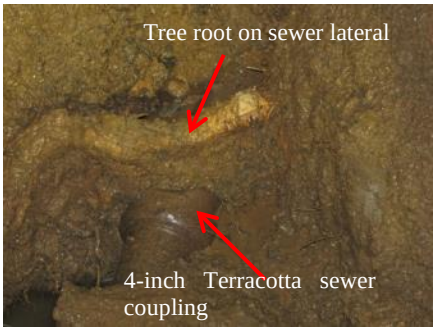


Figure 12: 4-inch sewer lateral, male and female coupling with tree root crossing over it.

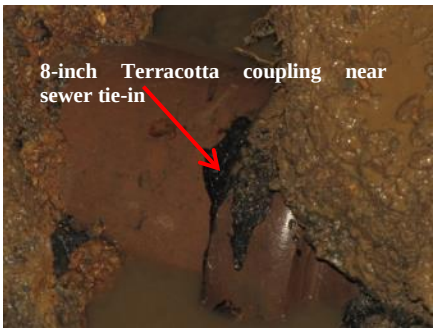


Figure 13: 8-inch male and female sewer main coupling with coal tar coating.

Figure 14: 8-inch sewer main with gap in the coupling. Source: HABD Insurance Forensic Excavations.

Figure 14 above, is a view of what is shown in Figure 13 but captured from different angle. During the HABD insurance forensic excavations in February 2014, a ruler was inserted into the 8-inch coupling where the compound used to join the coupling to the piping, the joint was not intact. The absence of a properly sealed joint presented a possible source of natural gas ingress and sewer content egress of the 8-inch sewer main and 4-inch sewer lateral tie-in.

Figure 15: Measured damage section on the 4-inch" east end sewer lateral to Unit 80.
Source: HABD Insurance Forensic Excavations

Figure 15 shows the condition of the 4-inch Terracotta sewer laterals on the east side of Unit 80 that were located about 20 feet from the foundation wall. This picture was taken during an HABD insurance forensic excavation in February 2014. According to the NTSB investigator on site at the time of this February 2014, field activity, the sewer lateral exposed in the trench contained broken and damaged sections about 20 inches in length with pieces missing.

K. Distribution Integrity Management

The integrity management requirements for distribution mains and service pipelines are outlined in 49 CFR 192.1001 Subpart P, *Gas Distribution Pipeline Integrity Management*.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) amended the Federal Pipeline Safety Regulations on December 4, 2009, and February 1 & 2, 2010, [Feb. 1, 2011] to require operators of gas distribution pipelines to develop and implement an integrity management (IM) program that includes a written integrity management plan. The regulations came into effect in 2011.[44]

The purpose of the IM is to improve safety by identifying and minimizing gas distribution pipeline integrity risks. Operators must consider reasonably available information about their pipeline to inform their risk decisions. The rules mandate operators to identify risks associated with their pipelines and to evaluate areas where an incident could cause serious

[44] The elements of Alagosco IM Plan had implementation date by August 2, 2011.

consequences. Once identified, operators are required to implement a program accordingly for such areas to provide greater assurance of the integrity for their pipelines. The IM program was designed so that operators engage in continuous improvement in pipeline safety and to go beyond the earlier known regulatory requirements of identifying and investing in risk control measures.[45] [IMP page 5]

Prior to 2011, Alagasco "had various integrity management processes to mitigate the risk on its system but following implementation of DIMP, formalized its integrity management processes into a single written plan." The DIM plan addresses multiple IM Rule which mandates operators to develop and implement and IM program that include the following elements; knowledge of the system, threat identification, evaluation and ranking of risk, measures to address risk, performance and effectiveness monitoring, periodic evaluation and improvement, and reporting results. .

According to Alagasco "because of the significant diversity of pipeline operators and pipelines, the requirements in the IM Rule are high-level and performance based." The requirement of the IM rule stipulated the program elements without prescription in methods of the implementation.[46] The purpose of Alagasco's IM claim is geared towards fulfilling the regulatory requirement as stated in 49 CFR parts 192.1005, 192.1007, 192.1009, and 192.1011, regarding the integrity management for gas distribution pipelines. The IM Plan "does not address how Alagasco may deviate from the required periodic inspections as provided for in 49 CFR part192.1013." [IMP page 5-6]

The DIM program states that the IM Plan records include such items as; incident and leak history, corrosion control records, continuing surveillance records, patrolling records, maintenance history, and excavation damage experience.[47][IM page 8] The DIMP Plan has the provision to manage the tracking of the entire system to include both the cast iron and the steel pipeline data. The plan depends on the evaluation of the system pipe data, in addition to feedback from operations personnel.

Current considerations in the plan to identify existing and potential threats on each gas distribution pipeline are categorized as follows: corrosion, natural forces, excavation damages, other outside forces, material, weld or joint failure, equipment failure, incorrect operation, and other issues that could threaten the integrity of the pipeline.[48]

For threat identification to its specific system, Alagasco analyses five years data about its system. This includes; leak history, incident reports, consequence factors, excavation damage and One Call data, knowledge of operating system reports, mapping system information (which includes type of pipe, size, installation information, etc.) and operating pressures.[49] Based on

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[45] 49 CFR part 192.1007; e-CFR data on August 13, 2015

[46] Attachment 14 - Distribution Integrity Management Plan of Alagasco Vol 1.2 – July 31, 2013 – DIM 1.2 Final Confindential

[47] DIM Plan – July 31, 2013 DIM 1.2 Final Confidential

[48] DIM Plan – July 31, 2013 DIM 1.2 Final Confidential

[49] DIM Plan – July 31, 2013 DIM 1.2 Final Confidential

Alagasco's analysis of this information, it identified the top five predicted threats to its system to be:

(1) Excavation damage
(2) Corrosion
(3) Natural forces
(4) Other outside force damage
(5) Equipment

In assessment of risks to cast iron pipelines under DIMP Alagasco considers several factors, such as: leak data, operating pressures, knowledge of operating personnel, and diverse operating issues such as the presence of water in low pressure mains.[50]

Alagasco states it "complied with regulatory requirements for implementation of its plan and put it into effect on July 29, 2011. The DIM regulations require operators to conduct program evaluations on an "appropriate period….based on the complexity of its system and changes in factors affecting the risk of failure" but at least once every 5 years. Alagasco performs a complete evaluation of its DIM plan on an annual basis. Alagasco's DIM plan is also periodically audited by the [ALPSC], most recently in March 2014. The 2014 audit provided four recommendations (some of which were not mandatory or required by the regulations) for additions to the plan, which Alagasco has addressed."

Pipeline Replacement Program

According to Alagasco its pipe replacement program "operates as a separate but related program from DIMP." The program is used as an identified mitigation tool for minimizing a specific DIMP threat such as corrosion. The program was in place prior to DIMP came into effect and it is aimed at identifying areas for replacement based upon evaluation of leak repair data and contribution from operational field personnel that determines which pipes to replace first ("priority list").

Alagasco pipe replacement analyses uses ten years of pipeline data and evaluate its priority list annually. This assesses all its operating system metallic pipelines which include cast iron. Alagasco's June 2013 priority list, the Gate City community was ranked 97 of the top 100 priority areas.[51] Alagasco completed replacement of the pipeline system in Gate City in March 2014.[52]

Alagasco operations procedures manual (OPM) contains specific guidelines for the management of steel and cast iron, such as the installation procedures during connection of existing cast iron, excavation near cast iron, remedial procedures, exposed pipe inspection, and leak survey frequency.[53]

[50] Attachment 15 - Alagasco Response to NTSB IR034 Integrity Management and Risk

[51] Attachment 15 - Alagasco Response to NTSB IR034 Integrity Management and Risk

[52] Appendix E - Notice of Pipeline Replacement in Gate City

[53] Attachment 15 - Alagasco Response to NTSB IR034 Integrity Management and Risk

K.1 Cast Iron Distribution Mains

Cast iron pipelines are not protected by cathodic protection as a general industry practice. Alagasco, system-wide, including the Gate City distribution main, does not employ any form of protection except conducting leak surveys, monitoring, and repair maintenance.[54]

Alagasco's cast iron management program has been on-going over the last three decades. Since1997, approximately 405 miles of cast iron piping, have been retired. The company also submitted to ALPSC in November 2012 a cast iron replacement forecast where they estimated a full replacement would require 20 years to complete. At the time of that submission they had an average replacement rate of about 41 miles of cast iron pipe per year over the prior five years. In 2013, Alagasco stated they replaced approximately 42 miles.[55]

Alagasco uses an electronic mapping system called MAGI to map out the entire distribution system. They employ attributes within the system to identify pipe material. Through these attributes, users can readily identify pipe by material type such as cast iron, plastic, and steel. In this electronic mapping system, Alagasco states that leakage data is extracted from their enterprise management system, SAP. The SAP system contains the leakage data for each record which is then geo-coded in MAGI, by the associated address. This data is sorted by geographical quarter sections allowing a "leak per mile" comparison. These data are filtered to include only metallic pipe and leak data within 150 feet of a metallic main. This reduces the possibility that leaks on plastic mains are considered in this analysis. Alagasco compares the quarter section leakage data with the different distribution systems that may be within that same quarter section (using MAGI), to narrow down a particular system replacement area. To assist Alagasco with resource limitations, the target size of a single project is approximately "250 customers and/or $250,000 main replacement expense." Because of distribution system designs, Alagasco scarcely reach this target, but has a goal to maintain their projects at a manageable form.[56] Stated below is the only regulatory requirement for cast iron pipe replacement.

49 CFR§192.489 Remedial measures: Cast iron and ductile iron pipelines.
(a) General graphitization. Each segment of cast iron or ductile iron pipe on which general graphitization is found to a degree where a fracture or any leakage might result must be replaced.

(b) Localized graphitization. Each segment of cast iron or ductile iron pipe on which localized graphitization is found to a degree where any leakage might result, must be replaced or repaired, or sealed by internal sealing methods adequate to prevent or arrest any leakage.[57]

[54] Atttachment 16 - Cathodic Protection Explanation – AL-GC-002338

[55] Alagasco Response to NTSB IR036_Line and Corporate History

[56] Attachment 17: CI-BS Main Replacement Process

[57] CFR – Code of federal regulation

K.2 Steel Service Pipelines

Prior to the incident, majority of gas mains in the Gate City community was cast iron. Most of the services connected to the mains were wrapped steel which were not cathodically protected, and therefore, not monitored for corrosion through test stations even when leaks were common in those installations. According to Alagasco, leaving service lines unprotected was consistent with "industry standards" whereas for the mains, test stations and a cathodic protection system are required. Alagasco's basis for not installing cathodic protection on the service lines was that these were installed prior to the regulatory requirements under 49 CFR parts 192.[58] Later Alagasco had stated that "over the years some services had anodes connected during repairs where corrosion was noted to add cathodic protection for an individual service line." Such action was not system-wide. The gas company continued to conduct leak surveys at every three year basis according to the requirement 49 §192.723 Distribution systems: Leakage surveys.

L. One Call Reports

Documentation associated with the Alabama 811 ticket query One Call program was requested from Alagasco in the vicinity of the cracked 2-1/4-inch cast iron main. Alagasco submitted documents that covered the period January 2011 to March 2014.

A review of this document for a section[59] that shows the period November 1, 2011 to August 21, 2012 indicated that out of 18 excavation tickets that were called in, one ticket, #122060427 was relevant for gas line repairs near the accident location. This was for a repair at 7527, 64th Courtway South for work date of July 24, 2012.[60] This address is approximately 150 feet from the incident scene.

M. Leak Surveys and repairs

49 §192.723 Distribution systems: Leakage surveys.

(a) Each operator of a distribution system shall conduct periodic leakage surveys in accordance with this section.

(b) The type and scope of the leakage control program must be determined by the nature of the operations and the local conditions, but it must meet the following minimum requirements:

(1) A leakage survey with leak detector equipment must be conducted in business districts, including tests of the atmosphere in gas, electric, telephone, sewer, and water system manholes, at cracks in pavement and sidewalks, and at other locations providing an opportunity for finding gas leaks, at intervals not exceeding 15 months, but at least once each calendar year.

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[58] "For the cast iron mains installed prior to August 1, 1971, a cathodic protection system and test stations are not required per 49 CFR 192."

[59] This was a section with useful relevant information.

[60] Attachment 25 – Copy of Alabama 811 tickets Jan. 2011 to March 2014 (AL-GC-XLS-005) REVISED

> (2) A leakage survey with leak detector equipment must be conducted outside business districts as frequently as necessary, but at least once every 5 calendar years at intervals not exceeding 63 months. However, for cathodically unprotected distribution lines subject to §192.465(e) on which electrical surveys for corrosion are impractical, a leakage survey must be conducted at least once every 3 calendar years at intervals not exceeding 39 months.

Alagasco manages leaks through leak surveys conducted at frequencies dictated under the regulation, by their integrity management plan, and their operations procedure manual. Leak survey in business districts are performed at intervals not exceeding 15 months, but at least once each calendar year. For cathodically unprotected lines falling under the jurisdiction of 49 CFR part 192.465(c), the surveys are performed at least every three calendar years at interval not exceeding 39 months. Leak survey of any remaining lines not mentioned heretofore are conducted at least once every five calendar years at intervals not exceeding 63 months [IMP page 130, OPM page 110]. Marks Village/Gate City was not in a business district and falls under the three year survey requirement. Alagasco employs a third party leak survey company; Southern Cross, to perform the majority of the leak survey on their system. Alagasco provided their procedures regarding leak survey to the NTSB.

The three-year leak survey in the Gate City community was performed using the Walking Leak Survey (WLS) method for the distribution service pipelines. The survey was completed on November 2, 2011, by Southern Cross Corporation. Included with the survey documentation were the records for the mapping of the main surveyed in May 19 & 20, 2011.[61] Lists of leaks found below ground and the repairs made following the findings at each respective service address were noted. A map that indicated path of the gas service piping from meter to the main pipelines was not used in the surveys. According to Alagasco "at the time of the 2011 leak survey, meter reading routes with customer addresses were used for the leak survey of service lines." Alagasco provided summarized information to the NTSB concerning this leak survey, with leaks plotted on a map of the community and a spreadsheet containing leak data summarizing the related data.[62]

This three-year leak survey conducted by WLS noted there was a leak found on the customers' service line[63] [fuel line] to Unit 79 and not Unit 80 where the incident occurred. This survey indicates that out of the 20 leaks found six leaks were detected below ground, four were above ground, and nine were discovered on customers' service lines.[64]

Alagasco provided to the NTSB non-emergency calls, odor calls and leak calls dating back three years. In addition, a leak survey map of the Marks Village community was given to investigators that indicated a ten year history of leak surveys with a GIS overlay.

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[61] Attachment 18 - 2011- 3 year leak survey File 9 AL-GC-000028_000042

[62] General Map Gate City 7-30-2014 Leak History.pdf

[63] Customer service line – pipeline downstram of the meter

[64] Attachment 18 - 2011 - 3 year leak survey File 9 AL-GC-000028_000042

Alagasco before 2008 performed mobile surveys for mains and walking surveys for service lines. Mobile surveys were conducted by a truck specially equipped with leak survey monitoring equipment. Walking surveys were conducted with hand held instruments. In 2008, Alagasco resumed a multi-year effort to move from mobile surveys to walking surveys for mains. In 2012 this new walking only survey method implementation was completed.[65] These walk only surveys are conducted over the mains and services in the area where mobile survey were once used, since its implementation it led to additional numbers of surveys, with possibilities of more leaks to be found.[66]

Alagasco's OPM states that these surveys are to be performed by qualified personnel using only the approved leak detection tools. Tools employed by Alagasco include the Heath GMI 526, and 11B, the Southern Cross Flame Pack 400 (flame ionization), and the Heath RMLD. All leaks detected under this procedure are meticulously classified into grades 1, 2 and 3 and are properly scheduled by the relevant supervisor for repairs. Leak grades and categories of interest are: Grade 1 which includes, among other things, any reading of 20 percent LEL or greater at the outside of a building or where gas would likely migrate to an outside wall of a building, Grade 2 – which includes, among other things, any reading of 40 percent LEL or greater under a sidewalk in a wall-to-wall paved area that does not qualify as a Grade 1 leak, and Grade 3 – which includes, among other things, any reading less than 100 percent LEL under a street without wall to wall paving where it is unlikely that gas could migrate into a building.[67]

In addition to the five leak locations found and excavated in the Gate City community at the time of the field investigation (see Figure 16). Southern Cross conducted other post-accident leak surveys on January 3-22, 2014, where at least 57 leaks were found. This includes five grade 1, fifteen grade 2, and zero grade 3 leak on mains, and twenty-nine grade 1, seven grade 2, and one grade 3 leak on the service lines.[68]

[65] Walking-only survey is Alagasco term. Leak survey method deployed on mains and services on areas they previously employed mobile leak survey.

[66] July 31 2013 DIM 1.2 Final Confidential

[67] Attachment 22: Operations Procedure Leak Management

[68] General Map Gate City 2-11-2014 January Survey Results

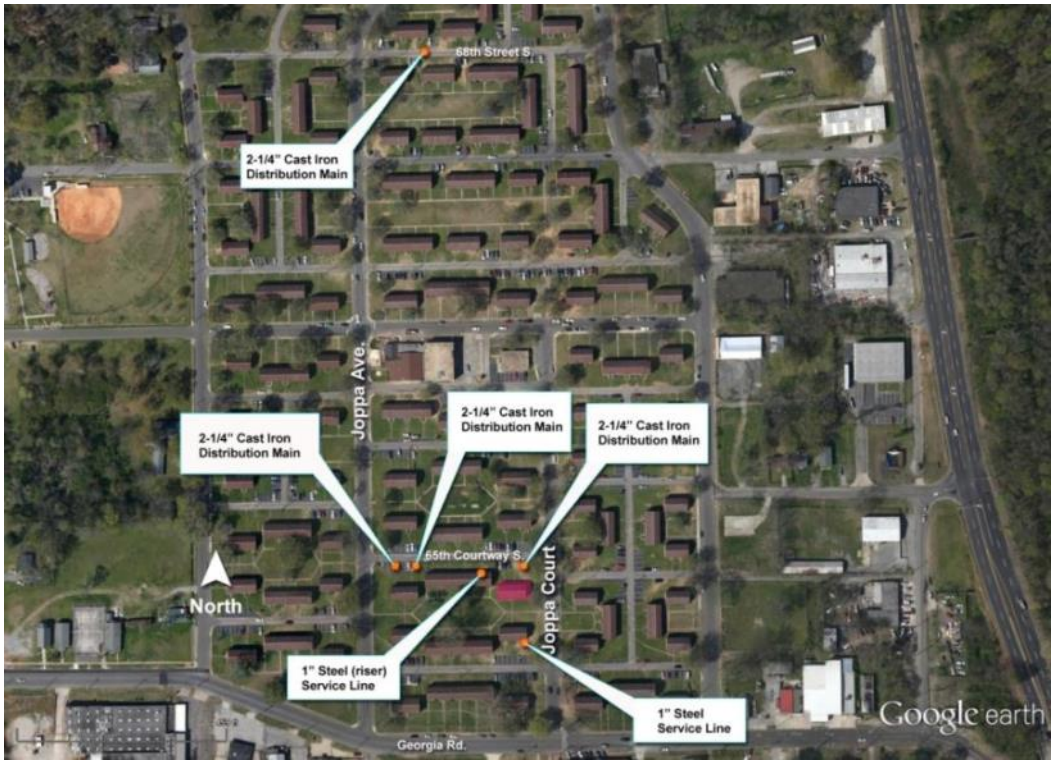

Figure 16: Locations of leaks discovered during post-accident survey near the accident site indicated in red.

Alagasco's ten year leak repair data for the Gate City community included the years 2003 to 2014 and indicated the leaks found and repaired that included leaks indicated in Figure 16 that occurred following the accident and in the first two months in 2014.[69] The six leak locations indicated in Figure 16 shows where pipe specimens were extracted for NTSB examinations, and are represented in the table 2 below.

Table 2: Description of As-received Pipe Segments

Pipe Segment	Diameter (inches)	Material	Length	House Unit# and Address
A	2-1/4 OD	Cast Iron Main Pipe	8	Unit #80 of 7546, 64th Court Way South
B	1 ID	Steel Meter Riser	1	Unit #72 of 7530, 64th Court Way South
C	1 ID	Steel Pipe	4	Unit #33 of 7547, 64th Court Way South
D	2-1/4 OD	Cast Iron Main Pipe	6	Unit #69 of 7524, 64th Court Way South
E	2-1/4 OD	Cast Iron Main Pipe	3	Unit #69 of 7524, 64th Court Way South
F	2-1/4 OD	Cast Iron Main Pipe	6.6	Unit #453, 6807 Joppa Avenue

[69] General Map Gate City 3-25-2014 Repair Year

Pre-accident leak repairs:

Alagasco leak data from 2003 to February 2, 2014, indicates that some previous leaks repaired near the area of the accident among others are; 2004 grade-2 leak Cast Iron 2-1/4-inch main at 7508 64th Courtway South, 2009 grade-2 leak Steel 1-1/4-inch service at 7515 64th Courtway South, 2009 grade-2 leak Cast Iron 2-1/4-inch main at 7524 64th Courtway South, 2010 grade-1 Steel 1-inch Service at 7544 64th Courtway South U139, 2010 grade-2 Steel ¾-inch service at 7547 64th Courtway South, 2012 grade-1 Steel 1-inch service at 7529 64th Courtway South, and 2012 grade-1 Service lines maintenance at 7527 64th Courtway South.[70]

N. Pipeline Failure

Alagasco exposed the cracked 2-1/4-inch cast iron main and installed a leak clamp to stop the leak between 7:14 and 9:30 a.m. on the day of the incident as shown in Figure 17. The following day after the incident, the repaired, cracked segment containing the leak clamp, was replaced using a 2-inch polyethylene plastic pipe. Interview statements of technicians[71] indicated that the cast iron line was wrapped in tree roots[72] had a rock resting over the location of the crack between the root about 2-inches-diameter at the top of the main.[73] The crack was described as running along the bottom of the pipe, extending from about 6 to 9 o'clock position (looking east).[74]

Construction personnel indicated that the cracked cast iron natural gas main (north of Unit 80) in Figure 17 had been cleaned using a paint scraper, paint brush, and soap solution prior to the NTSB taking possession of the accident scene. The cast iron section of the piping with the crack was cut, boxed and shipped to the NTSB lab for testing.

[70] Attachment 28 – Historical Leaks 6-19-2014 (Provided July 2014)

[71] Interview of Cameron Hyche

[72] See; photo 18: Tree roots and condition at the craked pipe location.

[73] Appendix 2 - Graphical Depiction of Root Rock and Incident Pipe Main near Unit 80.

[74] Refer to NTSB laboratory factual report for crack detailed information.

Figure 17: The cleaned cracked location on the 2-1/4-inch cast iron main opposite Unit 80 prior to being clamped. Source: Alagasco

Other main leaks identified on December 17, 2013 were a cracked 2-1/4-inch cast iron distribution main located on 68th Street (Marks Village community), and two leaks at 7524 64th Courtway South. One of the leak excavations revealed a previously repaired leak in the 2-1/4-inch cast iron pipe segment under asphalt that was located about 30 feet from the building wall. The leak detected at 68th Street was located just west of an existing gas main repair, as evidenced by an adjacent asphalt patch. A nearby resident stated that Alagasco had been dispatched and excavated the same line recently following calls about gas odors. These lines were cut, boxed, and shipped to the NTSB lab for examination. No cleaning or clamping of the crack was performed at the 68th Street or the crack at 7524 64th Courtway South.

The 10 year leak data for the Gate City indicates there were few leaks previously repaired including along 64th Courtway South on the gas main.[75] Figures 18 and 19 shows root growth from a nearby tree east of the incident pipe. The 2-1/4-inch cast iron pipe was found cracked west of this location. The tree root was cut and examined by the gas company personnel as shown in Figure 20.

[75] Attachment 28 – Historical Leaks 6-19-2014 (Provided July 2014)

Figure 18: Root crossing over 2-1/4-inch cast iron main about 4 feet east of the crack location opposite Unit 80. Source: Alagasco

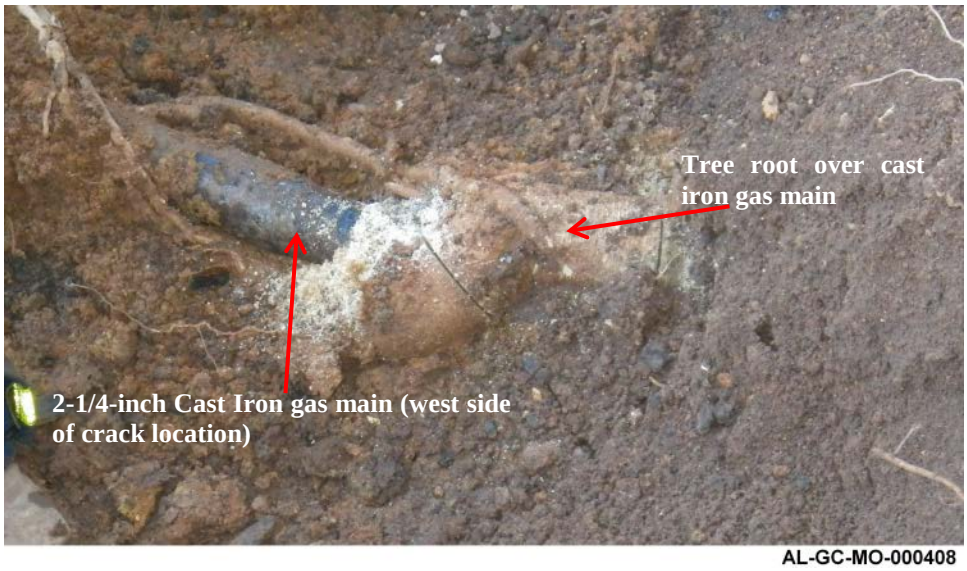

Figure 19: Tree root at the point of crossing 2-1/4-inch cast iron main opposite Unit 80. Source: Alagasco

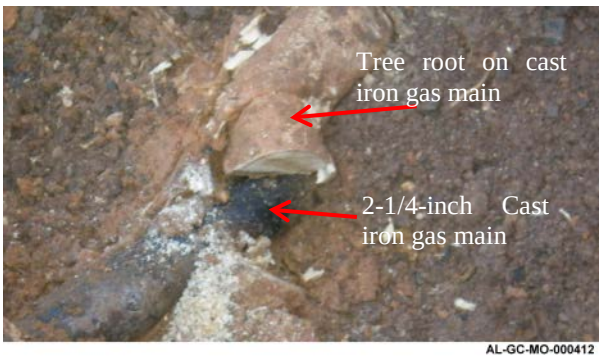

Figure 20: Surfaces of cut-out root where it rested on 2-1/4-inch cast iron main opposite Unit 80 (three photos shown). Source: Alagasco

O. Pressure Test

Alagasco on December 18, 2013 conducted a pressure test on the branched services to Units 79 and 80 (Figure 21). To facilitate this test the line was cut and tested at approximately 10 feet south of the 2-1/4-inch main and service tee connection. Both services were tested from this location down to their riser valves. Initial tests on these services detected leaks as observed from the pressure chart and pressure gauge used to monitor the test. A leak was detected at the riser valve outlet on up to the exploded Unit 80. A consensus of those conducting the test was reached where it was decided to remove the unit riser valve and cap it. This eliminated the leak and the pressure test conducted at operating pressure held. These tests were witnessed by the NTSB and Alabama Public Service Commission (ALPSC).

The steel service pipeline segment was cut at approximately 10 feet south of the 2-1/4-inch cast iron main, capped off and soap tested. No leaks were discovered by the leak test technicians in both the pressure gauge and the pressure test chart used as the second indicator of pressure test record; it marked-out indicated a stable pressure test result that started at 20 psig and remained at 20 psig at the end of the pressure test confirming no leak in the pipe. This location was where the branched service was isolated from the main after the riser valves were shut off during the emergency situation.

Figure 21: Gas flow isolation point where pressure tests of the branched services of Units 79 and 80 measured by pressure gauge and recorded on pressure chart.

P. Oversight

The ALPSC Office of Gas Pipeline Safety through agency agreement performs pipeline regulation and enforcement for the PHMSA. ALPSC is an intrastate regulator that oversees all operator distribution mains and service pipelines within the state of Alabama. Alagasco operates pipelines that fall under the jurisdiction of the ALPSC.

The ALPSC inspection of Alagasco encompasses the auditing of records, physical plants, corrosion control, operator qualification and field inspection. The ALPSC also conducts [training and qualification] inspection (OQ Protocol 9).[76] These inspections review all areas of the operation through all operational territories of the gas company. Review of the five years Department of Transportation (DOT) annual distribution report shows that the 2010 submission from when hazardous leaks became separately categorized, it indicates that Alagasco is a state wide operator with over 5,601 miles of steel pipe, 1 mile of ductile iron, 967 miles of cast iron pipes, 4,294 miles of polyethylene pipes, 42 miles of "other" pipes, and 541,045 service lines within the company. Documentation from the inspection conducted by ALPSC for the period 2009 to 2013 was requested for the Birmingham area.[77]

The ALPSC Notice of Probable Violation letter dated October 6, 2009 noted deviations in Alagasco's OPM, section MC 7.3.5. This section requires the company to re-inspect all underground areas considered critical areas on the pipelines within one month following the activities where leaks were detected. Ten such leaks, found through walking and nighttime mobile critical area surveys, were repaired within Alagasco's Birmingham Division, but were not re-inspected as required. Alagasco states it completed the re-inspections shortly after the audit

[76] Protocol 9 inspections

[77] Attachment 19: ALPSC Violation letters

and conducted additional training of employees regarding underground critical area leak repair checks.[78]

The ALPSC Notice of Probable Violation letter dated October 4, 2011 noted that Alagasco's critical valve # ALC-4 was not operational.[79] Consistent with 49 CFR part 192.747 (a) requires that "each operator shall, at interval not exceeding fifteen(15) months, but once each calendar year, check and service each critical valve that may be necessary for the safe operation of a gas distribution system." The company confirmed that they completed the repair on July 22, 2011.[80]

The ALPSC 2011 summary of violation orders to Alagasco show that most of the written violations were corrected before the next physical property inspection.[81]

The ALPSC audited Alagasco public awareness program implementation for the entire noted 24.8 miles distribution system then rated it "Satisfactory" to every program element. This audit was dated May 2012 and did not find the gas company lacking in any aspect of the program. It states that the program has consistently been reviewed and updated annually with minor changes to it due to employee reassignments and has not seen any major changes. The company's initial public awareness program was put in place June 20, 2006, with the last update made in March 2012.[82]

In 2012, the ALPSC sent letters[83] to all operators of natural gas pipelines in the State of Alabama as a result of an NTSB safety recommendation[84] following incidents in Allentown, PA, 1991 and 2011. The ALPSC in a letter dated August 23, 2012, to Alagasco noted that "cast iron pipe has for some time been considered a serious threat to natural gas distribution systems."[85]

The ALPSC stated that the agency "realizes that cast iron is a serious risk and should be one of the top threats in each operator's DIMP. We also realize that current economic conditions are not favorable for large-scale replacement projects, especially when those projects are mostly located within congested downtown areas where it is difficult, if not impossible, to undertake replacement projects. From a SAFETY perspective, cast iron replacement is something that should take top priority with every operator, especially when it is located within the confines of a downtown area where there is little or no way for the gas to vent without going into buildings,

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[78] Alagasco's Response to APSC's October 6, 2009 Notice of Probable Violation letter (January 29, 2010)(Appendix F)

[79] Appendix G – Complete_Corrected APSC Notice of Probable Violation Letters from 2010 and 2011

[80] Appendix H - Alagasco's Response to APSC's October 4, 2011 Notice of Probable Violation letter (March 8, 2012)

[81] Appendix G – Complete_Corrected APSC Notice of Probable Violation Letters from 2010 and 2011

[82] Attachment 20: ALPSC – Public Awarenes (PA) form

[83] The NTSB recommendation S P-91-12, 07/90, Allentown, PA, that stressed the need to replace cast iron pipes prompted this letter.

[84] The NTSB recommendation S P-91-12, 07/90, Allentown, PA

[85] Attachment 21: ALPSC cast iron letter dated August 23, 2012

sewer systems and other hazardous spaces. These replacements should be accelerated and addressed as soon as practical."[86]

The ALPSC congratulated Alagasco on the efforts the company had already made in removing cast iron pipe from their system. However, ALPSC noted that based on the percentage Alagasco was going with the cast iron replacement in the last four years, it would take years before cast iron pipelines are totally removed. The ALPSC therefore requested that Alagasco consider cast iron replacement as a top project priority and something of "utmost importance." The ALPSC requested the estimated miles (or percentage) of pipe that should be replaced per annum, and the time to complete all the cast iron replacement in their system.[87]

In response to the ALPSC in a letter dated September 21, 2012, Alagasco stated its commitment to operating their pipeline system at the highest level of system integrity, as it serves their customers in a safe, reliable, and efficient way. Alagasco elaborated that it performs a continuous analysis of their cast iron as part of their risk assessment. As a normal practice and risk assessment Alagasco engages in continuous cast iron pipe analysis and pipe is replaced as needed, based on factors such as repair history and field personnel recommendations.

Alagasco explained that though "cast iron pipe replacement has been designated as an important aspect of ensuring the integrity of a gas distribution pipeline operation", the other critical area of importance is protecting cast iron from third party damage. It had also designated cast iron replacement as an important aspect of ensuring the integrity of their gas distribution pipeline operation. Alagasco stated that in their 2011 DOT report "repairs for hazardous gas leaks due to excavation damages are over 300 [percent] greater than hazardous leak repairs due to corrosion."

In Alagasco's November 16, 2012 response letter to ALPSC, request for detailed information about mileage for forthcoming replacement projects, Alagasco reported that it has replaced an average of 41 miles of cast iron pipe per annum over the past five years. And based on their "Annual Report for Calendar Year 2011 Gas Distribution System, Alagasco reported 928 miles of cast iron pipe remaining in its system. Alagasco anticipated replacing 35 miles of cast iron pipe in 2012 and plans to replace approximately 51 miles in 2013. Based on available information and a number of assumptions which could change in the future, Alagasco currently estimates that it will have all of its cast iron facilities replaced in approximately 20 more years."[88]

Alagasco's annual reports for their gas distribution system submitted to the PHMSA and ALPSC, for the period 2008 to 2012, compared numbers of leaks (hazardous and non-hazardous) repaired on main and services based on corrosion vs. leaks from impacts due to excavation. According to Alagasco some of the repairs extended into 2013. These comparisons are represented in Tables 3 and 4 below:

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[86] Attachment 21: ALPSC cast iron letter dated August 23, 2012

[87] ALPSC cast iron letter dated August 23, 2012

[88] Alagasco cast iron letters dated September 21, 2012, and November 16, 2012. See Attachment 21.

Table 3: Comparison of total Corrosion versus Excavation leaks between 2008 and 2012 reports to regulators.[89]

Types of Leak	2008 Mains/Services	2009 Mains/Services	2010 Mains/Services	2011 Mains/Services	2012 Mains/Services
Corrosion	1006/1174	977/1203	808/1144	685/1039	804/983
Excavation	294/1929	229/1687	198/1577	200/1776	200/1766

Table 3 represents the total numbers for both hazardous and non-hazardous leaks for five years reviewed. However, according to Alagasco based on DOT requirements that began categorizing hazardous leaks in 2010. The numbers are represented in table 4.

Table 4: Comparison of Hazardous Corrosion versus Excavation leaks between 2010 and 2012 reports to regulators.[90]

Types of Leak	2010 Mains/Services	2011 Mains/Services	2012 Mains/Services
Corrosion	74/414	82/363	143/414
Excavation	188/1426	187/1630	188/1679

As part of the regulatory inspections the ALPSC 2013 audits of the Birmingham area cathodic protection monitoring showed that 12 test stations measured cathodic protection readings that were below the required- 0.85 volts for the pipe to soil potential. Consistent with 49 CFR parts 192.465(d) requires operators to take prompt action to ensure remediation to deficiencies found in cathodic protection monitoring.[91]

Q. Post-Accident Actions

Following the accident, between January 3, and January 22, 2014, Alagasco conducted additional leak surveys over the Gate City community distribution pipelines. Subsequent to these surveys, Alagasco went on a program to replace the distribution pipelines in the neighborhood. Documents submitted to the NTSB include maps of the newly installed and recently retired mains and services pipelines. These replacements started in January 2014 and were completed on March 26, 2014, and included all mains from 2-inch to 6-inch cast iron and steel services in the Gate City community. Alagasco stated they conducted an outreach with respect to leak notification and awareness.[92] In summary Alagasco states its post-accident initiatives and actions are as follows:

[89] 2008 - 2012 Annual Reports

[90] 2008 - 2012 Annual Reports

[91] Attachment 19 - Alabama PSC Violation Letters

[92] Alagasco Response to NTSB IR 06-10-14

- Replaced the cast iron pipe in Marks Village in early 2014.
  The cast iron mains were replaced with polyethylene pipe ranging from ¾-inch to 4-inch in diameter.[93] The majority of the service lines were replaced with polyethylene pipe of various lengths from the main lines to the meter locations. The completion reports indicate that 303 service lines were installed to serve a total of 520 meters that were replaced.[94] In addition, Alagasco designed and installed the pipeline system with the capability of stopping the flow of gas into this community through the use of new valves and other mechanical techniques if such an action is required in the future.

- Completed service card scanning and trained personnel on new system.
  Alagasco completed the scanning of all available service cards and trained its field personnel regarding the new service information now electronically available in trucks.[95]

- Initiated annual leak surveys for cast iron and unprotected steel mains serving multi-family residences.
  These surveys were previously conducted on a three-year cycle as per DOT 192 requirements. Alagasco now conducts these surveys annually. The first cycle of such surveys was completed in 2014.

- Met with the Birmingham Fire Department and created an "Emergency Response Lessons Learned" document.
  On August 25, 2014, Alagasco met with members of the Birmingham Fire Department involved in the emergency response for this incident. The purpose of the meeting was to discuss Alagasco's actions/response to the Marks Village incident and to allow the Birmingham Fire Department to provide its observations concerning the response efforts.[96]

- Revised Alagasco's evaluation process for future cast iron pipe replacement locations.
  Alagasco's evaluation process now includes analysis of leak history for both mains and services.

- Prepared a "special mailing" to customers in multi-family units.
  For customers in multi-family units who are served by a cast iron or unprotected steel gas main, a "special mailing" was sent to them in August 2014 that clearly instructs customers to call Alagasco or 911 first (rather than calling a landlord or maintenance department of the complex first) if a gas leak is suspected.[97]

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[93] The total of main installed to replace cast iron pipe was 20,154 feet, per Completion Report (Alagasco Response to NTSB IR 6-10-14)

MET14012 Georgia Rd. Replacement Plan; Alagasco Response to NTSB IR 06-10-14; Email from Bob Gardner/Alagasco to NTSB re: project completion (March 26, 2014)(Appendix E)

[95] Email from Bob Gardner/Alagasco to Roger Evans/NTSB (July 13, 2015)(Appendix A)

[96] AL-GC-002688

[97] AL-GC-002702 to 2703

- Changed processes for electronic bill customers.
  For customers who receive and pay their bills electronically, Alagasco now ensures that they receive the same safety information (by U.S. Mail) as those who receive their bills in paper format.[98]

- Ensured 24/7 electronic access to safety information.
  Alagasco is ensuring that customers have access at all times to a link to the safety information from customers' electronic Alagasco account page, including the Alagasco 16-75 safety brochure.[99]

- Revised the 16-75 safety brochures to include language specifically targeted to any customers living in rental properties (including multi-family units).
  The first semi-annual mailing of the revised 16-75 brochure occurred in April 2015.[100]

- Expanded the practice of distributing the 16-75 safety brochures to customers at service calls.
  For the Birmingham work location, 16-75 safety brochures were given to all customers during service calls in which the mechanic interacted with the customer, and Alagasco has expanded that practice into all of its service areas.[101]

[98] AL-GC-002701 to 2702
[99] AL-GC-002701 to 2702
[100] AL-GC-002701 to 2710
[101] AL-GC-002702

Attachments

Attachment 1: Alagasco Response to NTSB IR061814
Attachment 2: Alagasco Response to NTSB IR036_Line and Corporate History
Attachment 3: Alagasco Response to NTSB IR035_Pipeline History and MAOP
Attachment 4: Pipeline Summary Information
Attachment 5: Service Line Records and Sketch
Attachment 6: Interview of Brown 12-20-13
Attachment 7: Interview of Bend and Holmes 12-19-13
Attachment 8: Interview of Max Morrison
Attachment 9: Interview of John Whitmer 12-22-13
Attachment 10: Interview of Rochelle Maryland 12-21-13
Attachment 11: Alagasco Effectiveness Survey and Public Awareness Evaluation
Attachment 12: 2009-2013 (2009 attached) – Customer bill inserts and Paradigm from Alagasco
Attachment 13: HABD – Public awareness materials to new tenants
Attachment 14: Distribution Integrity Management Plan of Alagasco Vol 1.2 – July 31, 2013 – DIM 1.2 Final Confidential
Attachment 15: Alagasco Response to NTSB IR034_Integrity Management and Risk
Attachment 16: Cathodic Protection Explanation – AL-GC-002338
Attachment 17: CI-BS Main Replacement Process
Attachment 18: 2011- 3 year leak survey File 9 AL-GC-000028_000042
Attachment 19: Alabama PSC Violation Letter
Attachment 20: Alabama PSC Public Awareness Inspection Form
Attachment 21: ALPSC cast iron letter dated August 23, 2012
Attachment 22: Operations Procedure Leak Management
Attachment 23: Fire Investigations Bureau report
Attachment 24 - Central Maintenance Management System - BHA work orders
Attachment 25 - One Call Tickets File 10 AL-GC-000043_000044
Attachment 26 - Interview of Cameron Hyche 9-4-14
Attachment 27 – 2008 -2012 Department of Transportation Annual Reports
Attachment 28 – Historical Leaks 6-19-2014 (Provided July 2014)

Appendixes:

Appendix 1 - Updated June 2015 13041_SCENE_SURVEY_PRELIM_3-7-14 (AL-GC-002305) as AL-GC-002342
Appendix 2 - Graphical Depiction of Root Rock and Incident Pipe Main near Unit 80
Appendix A
Appendix B
Appendix C
Appendix D - Alagasco Public Awareness Evaluation (May 19, 2014)
Appendix E - Notice of Pipeline Replacement in Gate City
Appendix F - Alagasco's Response to APSC's October 6, 2009 Notice of Probable Violation letter (January 29, 2010)
Appendix G – Complete Corrected APSC Notice of Probable Violation Letters from 2010 and 2011
Appendix H - Alagasco's Response to APSC's October 4, 2011 Notice of Probable Violation letter (March 8, 2012)