

A. Accident Information

Accident Number	DCA16FP003
Type of System	Natural Gas Distribution Pipeline
Accident Type	Building Explosion and Fire at 8701 Arliss Street, Silver Spring, MD (Flower Branch Apartment Building)
GPS Coordinates of Accident	Long. 38.59.54.36 N and Lat. 77.00.03.98 W
Date	August 10, 2016
Time	About 11:53 p.m. ¹
Pipeline Owner / Operator	Washington Gas
Material Released	Natural Gas
Pipeline pressure at time of release	About 20 Psig on main and 7-inches of water column downstream of service regulators and outlet of the building meter sets.
MAOP	25 Psig
Pipeline Material	Steel
Pipeline Outer Diameter	2-inch main, 2-, 1-, 3/4-inch services and 1-inch house piping. ²
Pipeline Year of Installation	1955
Buried Main and Service Pipeline Coating Type	Black Wrapped Coated Steel.

¹ All times in this report are in eastern standard time (EST).

² Sizes of the installed pipes were information based on the service record card and construction record. All pipe sizes are nominal pipe size (NPS). The short segments of the inlet and outlet pipes to the service regulators were 3/4-inch pipes.

Group Members

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B. Accident Summary

For a summary of the accident, refer to the *Accident Summary* in the docket.³



Figure 1: shows the standing remnants of 8701 Arliss Street (to the right) and the adjoining 8703 Arliss Street on the left.

C. Details about the Operator

Washington Gas (WG) is a regulated public utility that sells and delivers natural gas to retail customers in accordance with tariffs approved by regulatory commissions in the District of Columbia, Maryland, and Virginia.

³ See docket DCA16FP003.

D. Pipeline System

Jurisdictional

WG operates and maintains transmission and distribution pipelines, gate stations, pressure regulators and peak shaving plants. The utility operations facilities include the following:

Transmission Pipelines: DOT: 181.46 miles and high consequence area (HCA): 79.43 miles.

Distribution Pipelines: Miles of Distribution Main: 13,483; Miles of Service Pipeline: 13,467; Gate Stations: 33, four suppliers; Pressure Regulating Stations: 1500
Propane-Air Peak Shaving Plants

Ravensworth, Virginia (Cavern)

- Propane Storage = 11.5 million gallons (Solid granite cavern, 440 feet below the surface)
- Propane Send-out = 7.5 KDth/hr, and 180 KDth total

Rockville, Maryland (Tanks)

- Propane Storage = 3.2 million gallons (115 - 30,000-gallon storage tanks)
- Max Propane Send-out = 5.3 KDth/hr
- 128 KDth total

8701 Arliss Street Building Customer-Owned Gas Piping

The building in question, 8701 Arliss Street, is one of 26 buildings in a complex managed by Kay Management that are relatively similar in layout. The meter rooms have similar meter set and regulator configurations, except where some of the original mercury regulators have been replaced over time. In addition, 8701 Arliss Street contained a working storage area for the maintenance personnel. There was 1-inch customer-owned house piping that ran to/from the outlet of each of the 15 meters in the meter, utility, and storage room in the basement; 13 of these 1-inch house lines ran to the appliances in each apartment unit, one ran to the management rental office in the basement, and one ran to the common water heater. The house piping was installed during the construction of the building in 1955 and are the responsibility of Kay Management.

8701 Arliss Street Building Explosion

On August 10, 2016, at 11:53 p.m., the building located at 8701 Arliss Street exploded. The impact from the explosion damaged the nearest buildings on Piney Branch Road, located opposite side of the Leasing Office, and partially destroyed the adjoining building 8703 Arliss Street that shared a common masonry wall from the bottom foundation area to the top on Arliss Street for half the width of the building. The fire that erupted also consumed part of this adjoining building. Half of the incident building was destroyed following the explosion and its collapse. The debris field from this explosion scattered the surrounding area, spread between the buildings on Piney Branch Road located on the opposite of side the Leasing Office, and between the building, the roadway and

open areas on Arliss Street. Attachment A shows some of the debris.⁴ A metal door from one of the unit at 8701 Arliss Street was blown across Arliss Street, and the parking lot to an open field as shown in figure 2.

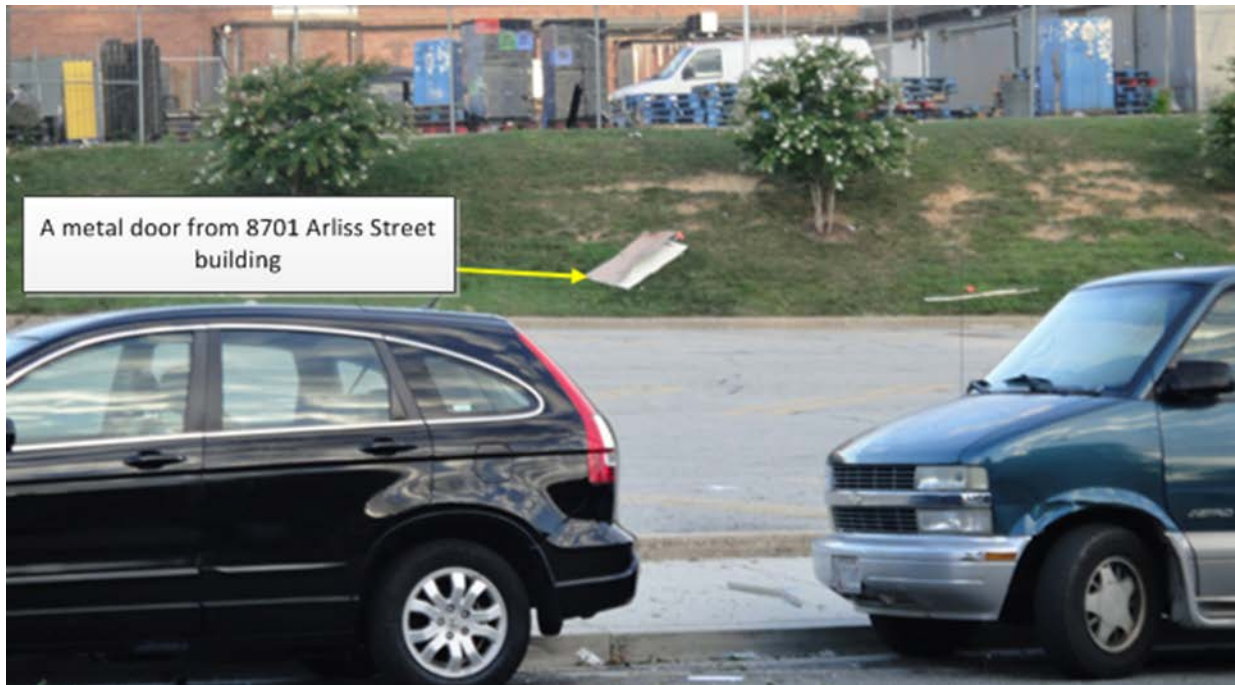


Figure 2: metal door from 8701 Arliss Street building blown to an open field across the street and a parking lot.

One witness stated about 11:30 pm he was in his car parked in front of the building. He did not smell any gas odor that evening while he sat in the car; however, his car windows were closed. He saw a sudden white flash, and saw [felt] a little shock wave that came toward him, and shattered all the windows on the right side of his car and pushed in the right side of the car door.⁵

He stated that when he saw the shock wave coming, he did not try to get out of the car, because the wave was coming “sideways to the car, it wasn’t coming straight.” He saw pieces of glass from the damage; however, he was not wounded except for near his right ear. He became “confused and surprised” as to what had happened, got out of the car, looked at the scene, and went back into the car at least twice.

He restated that “there was a flash, there was shock wave. The apartment that was on top of the apartment then blew up, basically it went down on the building. It is a building that has... I think, two or three...floor.” He continued “I must tell you that the explosion came from the apartment on the first floor. There were two apartments on top of it that basically went down on it.” He restated he saw the white flame, then it became “kind of yellow, red, you know little of everything.”

⁴ Attachment A: Photo taken by the Maryland Public Service Commission of the accident site moments after the explosion at 8701 Arliss Street.

⁵ Interview of Patrick Francisque

A second witness, and resident of the incident building on the third-floor, stated about 11:30 p.m., he smelled natural gas odor in the stairwells a few minutes before the explosion and stated it intensified coming from the second floor-below. He stopped to investigate the source of the smell by going down to the basement area. He noticed the doors were locked and assumed the rooms to be apartment units and did not knock. He believed he heard a hissing noise, walked up the stairs to go outside of the building from the first floor, and used his cell phone to tell a friend about the gas smell.

While he walked away from the building to the recycle bin, he heard the building explode behind him. He turned around, called 911-emergency but quickly ended the call before they could answer. He concluded the emergency responders would come-by anyway. He took a picture of the erupting fire that showed flames shooting up, and went back into the burning building to rescue his family members.⁶

He stated on July 25, 2016, he called 911-emergency for perceived gas odor.⁷

Gas main and service line pressure testing

On August 11, 2016 at 5:29 p.m., WG isolated gas supplies to the buildings and pressure tested the segment of pipeline involved in the accident. WG tested the 2-inch main on Arliss Street with 10 psig to test the gas valve in front of 8701 Arliss Street building; it held. The pressure on the main was increased from 10 psig to 22 psig which was the operating pressure at the time of accident. This pressure test also included a portion of the 2-inch service line to the incident building, which was capped at the curb stop. At 7:12 p.m., the pressure test was completed and no leak was found.

1. Building Piping, 8701 Arliss Street

In addition to performing a leakage survey for the entire area around the Flower Branch complex and adjacent roadways, the sections of the pipeline network serving 8701 Arliss Street was investigated as the possible source of the leak. On August 15, 2016, at 5:57 p.m., WG conducted a pressure test of the remaining section of service line to 8701 Arliss Street from the curb stop to the point where the 1-inch riser pipe in the basement was severed at the 2-inch by 1-inch reducer. The line was tested to 22 psig for 15 minutes and no leak was found. Neither the meter set piping nor houseline piping was pressure tested for leaks.

⁶ Interview of Adriane Boye

⁷ Interview of Adriane Boye

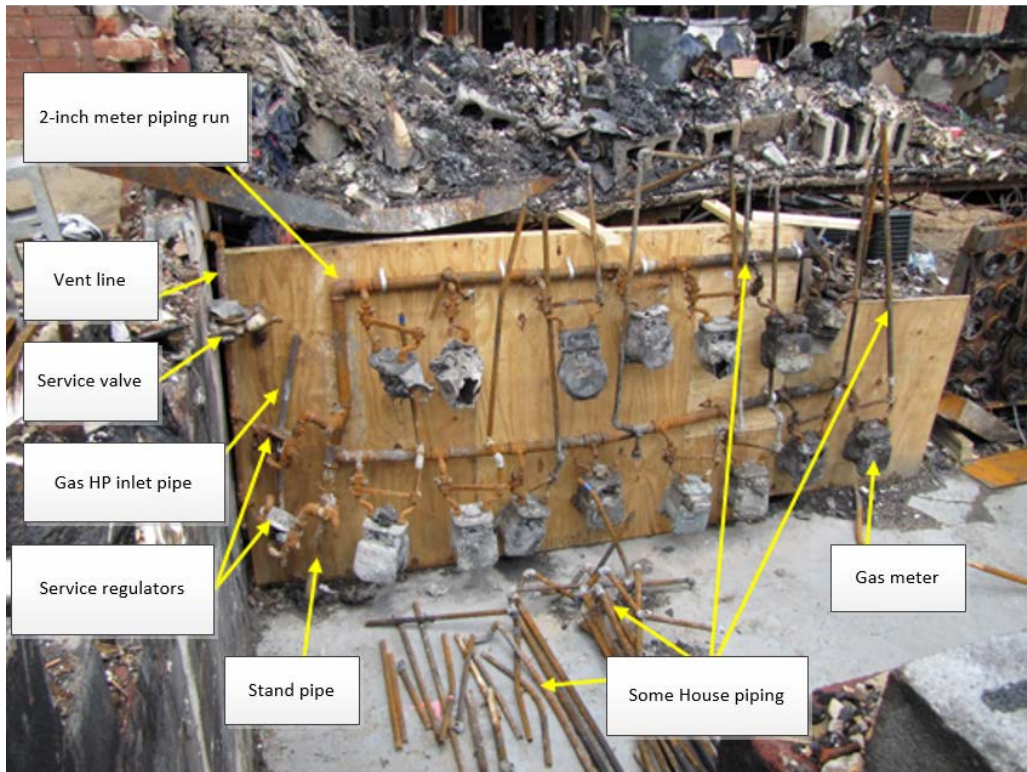


Figure 3: ATF reconstructed 15 meters of piping of gas services in the basement of 8701 Arliss Street, Silver Spring.

The Bureau of Alcohol Tobacco, Fire-Arms and Explosives (ATF) reconstructed the damaged natural gas meter sets, piping and appurtenances, including the water heater, that were damaged at 8701 Arliss Street as shown in figure 3. This comprised the vent pipe entrant, the gas service pipe entrant, positions of the service regulators, meters and service inlets and outlets piping. It also contained some of the 1-inch house piping which was gathered together on the basement floor after the accident. The operations group observed this process. See attachment A for pictures showing accident location before the debris were cleared.

Off-scene tests observed

Integrity tests and examinations were conducted outside the incident location and observed by the operations group. These tests comprised of the damaged regulator and regulator vent pipe unions at the NTSB laboratory and the WG vintage mercury-sealed regulators tests for the regulators removed intact at other buildings immediately after the accident at Spring Field, VA. The test results showed soundness in the regulators' operations. The water heater showed extensive burn marks. No test was conducted on the house piping collected in the basement. All NTSB materials testing are included in the metallurgical reports and the water heater examination in the fire-forensic report contained in the docket.



Figure 4: Gas meter piping, appurtenance and damaged adjoining wall to 8701 and 8703 Arliss Street following the explosion. Sources: WG

Figure 4 is the damaged wall separating 8701 and 8703 Arliss Street buildings in the basement. The damaged wall held the gas service meters and piping in the meter, utility, and storage room that served 8701 address. For more photographic documentation in this area, see attachment A.



Figure 5: The meter and piping orientation before reconstruction by ATF. Source: WG

Figure 5 shows the gas meter piping orientations after the explosion and after partial debris removal by investigators, but before the reconstruction conducted by the ATF. It shows breakings in the service pipelines, the service entrant pipe and appurtenance exposed at the time of the photograph.



Figure 6: Close up view of two service regulators and the two 2-inch piping runs connected to customer meters.

Figure 6 shows a closer view of the first two connected gas service meters, the two regulators, and service pipe entrant as reconstructed. Figures 7, 8, 9, 10 and 11 show a close view of other reconstructed gas service components and piping. Additionally, conditions and positions of other utilities within this basement location (water heater, electric meters and electric switch box, and 1-inch house piping) were observed by the team. The pictures show the items the team observed from these inspections.

The operations group members observed the meter set assembly and saw that the left two customer meters connected to the upper piping run meter arrangement had a greater degree of fire damage compared to the remaining meter sets. The 1-inch gas service inlet pipe connected to the service regulators was found broken from the 2-inch gas service pipe reducer. After the accident, the reducer end of the service pipe was plugged for pressure testing. The group observed heavy fire damage to the right of the meter rack, which included, 4 gas meters, the electric meters and the water heater. The group also observed numerous breaks in the piping and appurtenances on the meter rack and customer house piping.



Figure 7: The 2-inch gas service entrant pipe, service valve, 2-inch reducing tee with capped 3/4-inch elbow, 2-inch downward facing elbow with plugged 1-inch service pipe connection.

Figure 7 shows the 2-inch gas service entrance pipe through the 12-inch external wall, first in place was the service valve before the regulators, and followed by the 2-inch 90-degree ell with capped 3/4-inch elbow⁸, then the 2-inch 90-degree ell, then by 2-inch by 1-inch reducer (plugged). Discs and parts damaged by the fire were placed on top of the service valve and piping after the accident as indicated with the yellow arrow.

⁸ Capped 3/4-inch elbow – This is normally used for gas line service purging and pressure testing.



Figure 8: Damaged upper service regulator found broken from the vent pipe, and connected to the gas inlet service pipe and outlet service pipe.

Figure 8 shows the upper service regulator that was found broken and separated from the gas service vent pipe below the union connection. The regulator was connected to the 1-inch gas service inlet pipe by a 3/4-inch pipe segment and to the 1-inch gas service outlet pipe connected to the gas meter set piping.



Figure 9: Damaged lower service regulator disconnected from the vent pipe at the union, and connected to the inlet service pipe and outlet service pipe.

Figure 9 shows the lower service regulator that was found disconnected from the regulator vent pipe at the union as indicated with the yellow arrows. This union was installed in a different configuration than that of the upper regulator shown in figure 8. The regulator was connected to the 1-inch gas service inlet pipe by a 3/4-inch pipe segment and to the 1-inch gas service outlet pipe connected to the gas meters piping.



Figure 10: Female connection to the 1-inch vent pipe and the second damaged lower service regulator at 8701 Arliss Street.



Figure 11: Male union connection to the 1-inch vent pipe and the second damaged lower service regulator at 8701 Arliss Street.

Figures 10 and 11 show a close-up view of the female and male union threads respectively of the lower connected gas service regulator vent pipe. The operations group members visually inspected the disconnected vent pipe at the union and observed the threads were covered with rust, likely the result of the firewater and high temperature exposure, but otherwise appeared undamaged. Laboratory testing of the threads observed by operations group showed some minor deformation of threads on both the male and female sides of the unit nut, including the follower nut (female side). (See the Materials Laboratory Factual Report in docket for additional information.)

The operations group members determined that besides the previously conducted service inlet piping pressure test, no additional field-testing of the gas meter piping, house piping, and other appurtenances found in the meter, utility and storage room and throughout the building was possible at the accident site. However, sections of the service pipes were secured and transported to the NTSB laboratory for further examinations. These comprised of the entire vent line and unions, the two damaged service regulators, 2-inch service and reducer service line, 1-inch service inlet pipe and the sections of the pipes from 3/4-inch by 1-inch outlets of the service regulators connected before the first installed gas service meter.

Some of the 1-inch house piping, the reconstructed meter set, and the water heater were also secured and transported to the WG Springfield facility for secured storage.

The NTSB requested WG perform a Laser, 3-D Focus survey of the basement, meter, utility, and storage room at 8701 Arliss Street, where the service line piping, and meter sets, customer-owned house piping, water heater, electric meters, and main electric switch box were located. These surveys included the laundry room, similar meter room and its contents located at 8709 Arliss Street. This set-up and location was an exemplar to the damaged incident apartment meter room and gas service meter setting; however, no other meter room in the complex was used for storage as was the meter, utility, and storage room at 8701.

In addition to the 3-D focus surveys coverage described, Attachment A contains the Maryland Public Service Commission photos of the accident site moments after the accident. Attachment B contains Kay Management's photos of the basement perimeter and surrounding area after the clean-up and reconstruction a few days after the accident. The photographs include the foundation block walls at the basement, meter, utility and storage room. Portions of the masonry wall sides without earth support gave way outward from the impact with some resultant debris that came to rest in 8703 Arliss Street.

2. Pipeline History

According to WG's construction and service record card for 8701 Arliss Street, the gas main pipeline along Piney Branch Road that initially supplied this address was a medium pressure steel main constructed of 6-inch wrapped steel. The service pipeline off of the main that supplied 8701 Arliss Street was a 2-inch wrapped steel service line, connected to a 1-inch inlet pipe, and a 1-inch outlet pipe after the regulator. The record shows there were 15 meters installed to serve the building and two service regulators connected in parallel. The records show the service line construction was completed on May 31, 1955 and the meter build up and regulators installations were completed on June 15, 1955. The gas main pipeline and service pipeline were installed about 3 feet below the surface.

The 2-inch service pipeline ran along the front of the apartment buildings including 8701 Arliss Street. On September 25, 1969, the service pipe was relocated about 80 feet from the 6-inch medium pressure wrapped steel main on Piney Branch Road to a 4-inch medium pressure wrapped steel main that ran along Arliss Street.

3. Accident Site Description

Kay Management submitted a sketch of the Flower Branch Apartment complex, shown in figure 12.



Figure 12: Layout of Flower Branch Apartments. 8701 Arliss Street is located in the southwest corner.

As shown in figure 12, the accident building, 8701 Arliss Street, and the apartment complex is bordered on the south by Piney Branch Road. Piney Branch Road is intersected on the east by University Boulevard and to the west by Flower Avenue. Arliss Street runs along the west side of the apartment complex.

E. Distribution Pipeline Maintenance

The NTSB reviewed the maintenance records for the WG distribution main and service pipeline in the Flower Branch Apartment. To ensure the distribution pipeline integrity of the main and services according to Title 49 Code of Federal Regulations (CFR) Department of Transportation (DOT) part 192 regulations, WG periodically conducts cathodic protection⁹ tests and leak surveys of its pipelines, as demonstrated with the following:

1. Cathodic Protection

WG provided the incident property Cathodic protection (CP) system records for the following period:

- November 29, 2005
- November 03, 2006
- November 08, 2007
- December 02, 2008
- November 20, 2009
- November 08, 2010
- November 17, 2011
- November 30, 2012
- November 13, 2013
- January 31, 2014
- November 10, 2014
- November 16, 2015

Records of the CP system shows that pipe-to-soil potential readings were above the regulatory requirement of -0.85 milli-volts which indicated the pipelines' proper cathodic protection in this area.

2. Leak Survey

WG conducted outside leak surveys for the Flower Branch Apartment, that includes 8701 and 8703 Arliss Street on June 15, 16, and 17, 2011; February 12, 14, and 15, 2013; and January 12, and 19, 2016.

The 2011 outside leak survey was conducted on 301 service pipelines. The result from the survey showed that on June 16, 2011 at 9005 Glenville Road, one below ground, grade-3 leak was found. This leak was 1-percent of gas in air at the curb about 10 feet from the service tee.¹⁰

The 2013 outside leak survey was conducted on 330 service pipelines. The result from the survey showed that on February 12, 2013 at 8703 Gilbert Place 3 one below ground, grade-3 leak was found. This leak was described as 3-percent of gas in air in a valve box. In addition, there were five above ground leaks detected at different addresses, with three grade-2, and two grade-3 leaks.

⁹ Cathodic protection – buried pipelines are prevented from corrosion by burying sacrificial anode that corrodes instead of the pipe under protection.

¹⁰ DCA16FP003-OPS-Five Year Outside Leak Survey History for Flower Branch and 8701 and 8703 (2011)

The leaks were not repaired during this period.¹¹ According to WG's Operations and Maintenance manual, Section 3220, grade-3 leaks do not need immediate repair but are monitored.¹²

WG stated, "the 2014 outside leak survey were conducted on 295 service pipelines. The result from the survey showed that on July 3, 2014 at 8909 Glenville Road, one below ground, grade-2 leak was found. This leak was described as 20 percent of gas in air on main. This leak was repaired on August 3, 2015. In addition, there was one above ground grade-3 leak detected at 8908 Glenville Road."

The 2016 outside leak surveys were conducted on 313 service pipelines. The result from the survey showed that on January 12, 2016 at 8312 Greenwood Avenue, one below ground, grade-2 leak was found. This leak was described as 50 percent of gas in air on main. This leak was repaired on April 13, 2016.¹³

None of the leaks found through the leak surveys were near 8701 or 8703 Arliss Street.

F. Operations

The multi-story, multi-apartments Flower Branch residents are direct-billed customers of WG. The management company is also a direct billed customer for services pertaining to the rental office and areas of common facilities: laundry, natural gas meter, electric meters and storage rooms throughout the buildings.

Maintenance work on the pipeline facilities in these apartment buildings was performed by two organizations. Inspection, repair, and service work on the gas, mains, services, regulators, and meter sets up to the outlet of the meters serving all the apartments is the responsibility of WG. This was regulated under 49 CFR 192 and Code of Maryland Regulation (COMAR). Work downstream of the meter outlet fitting including all house-lines, flex lines, and the appliances is the responsibility of Kay Management maintenance.

F.1.1. Jurisdictional piping (Upstream of meter outlet)

WG customers at the incident building received natural gas supply from their individual gas meter outlet serving their respective apartments. The natural gas is supplied at utilization pressure to each individual meter through two Reynolds mercury-sealed regulators connected in parallel. The parallel connection allows the regulators to work independent of each other with the outlet supplying a common header, and over-pressure protection provided by either or both. The mercury sealed over-pressure relief ports are piped into a common vent pipe that extends outside of the building for safe venting. Some apartment buildings in the complex were served through one installed service regulator. The gas inlet pressure was about 20 psig and the outlet was about 5 to 7-inches of water column.¹⁴

¹¹ DCA16FP003 -OPS- Five Year Outside Leak Survey History for Flower Branch and 8701 and 8703 (2013)

¹² WG – Operations and maintenance manual – leak investigations (section 3220). Effective date: 05/19/2016

¹³ DCA16FP003-OPS- Five Year Outside Leak Survey History for Flower Branch and 8701 and 8703 (2016)

¹⁴ Regulated installations under 49 CFR part 192 and COMAR.

F.1.2 Customer Piping (Downstream of meter outlet)

The apartment buildings' pipeline codes and standards, from the outlet of the gas meters, all house-lines, flex lines, and the appliances are enforced by the local jurisdiction. The responsibility for the maintenance of the apartment buildings' house lines, flex lines and appliances belongs to Kay Management.

F.1.3 Mercury-Sealed Regulators

The mercury-sealed regulators installed in the basement of the apartment buildings in Flower Branch Apartments were in service since the pipeline gas service installations following the buildings construction in 1955. However, spring controlled regulators replaced the majority of the mercury-sealed regulators in the other buildings, including those immediately removed or replaced following the accident.

Once installed, regulators, including Mercury-sealed regulators, remain in service until they are replaced if they are unable to pass required tests, are venting gas, the customer has added load requiring more capacity than the current regulator is designed for, or in the case of Mercury sealed regulators, for environmental reasons.¹⁵ When an "associated meter is set, reset, or replaced," the regulator is tested (when possible) in accordance with the WG operations and maintenance manual.¹⁶ The tests are:

- A vent-line pump test
- Low load test
- High load test
- Lock-up test

When a WG site visit is required to initiate service for a customer, the meter and associated piping is visually inspected for abnormal operating conditions. During a service initiation or reactivation call (turn-on), such a visit could lead to the meter being set, reset, or changed. The meter is replaced when there is an identified operational issue with the meter or the meter is removed as part of the annual meter testing sampling program. Also, if in this process there is an interruption to the gas supply, which impacts the regulator, the regulator is then tested and, if necessary adjusted.¹⁷

The WG procedure states:

A gas meter may only be set or reset and the gas left on, if the connected piping it will serve is gas tight, has been properly tested, and any connected appliances are operating properly and safely vented. Meter set orders that do not meet these requirements may only be set if a meter outlet valve is installed.¹⁸

¹⁵ Section 5125 of WG O&M manual (page 1 of 3)

¹⁶ DCA16FP003-OPS- O&M Regulator Operations (section 5125 page 1 of 3)

¹⁷ DCA16FP003 – OPS - O&M Actions Installing Gas Meters (section 5121 page 1 of 3)

¹⁸ DCA16FP003 – OPS – O&M Manual (Section 5102 – Setting, Resetting, and Turning on Meters – General).

Note: This meter outlet valve would not allow gas into the house line.

F.2. Conditions for Testing and adjusting service regulators

The WG operations and maintenance procedure states that company personnel working on customer gas meters, are also trained on testing and adjusting service regulators as part of certain meter tasks, and are required to complete the following¹⁹:

Regulator with vent-line inspection

The scope of WG procedure requires that each service regulator must be tested and, if necessary, adjusted each time the meter that it serves is set, reset, or changed. Therefore, in general, a service regulator must be tested and, if necessary, adjusted each time the meter is set, reset, or changed. A vent line must be inspected and tested anytime gas to the regulator has been shut off.²⁰

In the case of a meter bank installation such as served the incident building, regulator testing requirements according WG O&M Section 5132 requires the test should follow Section 5121. Thus,

Mercury Regulator Vent-line Pump Test

When a vent line is disconnected from a mercury regulator (to perform a vent-line pump test), a WG approved container must be in place under the vent-line union or any other disconnected vent piping, to contain mercury or other debris that may fall from inside the vent piping.

WG employees' statements indicated that the mercury-sealed regulators are changed or adjusted, and the vent-line disconnected and reconnected for test as part of the gas service pipeline routine operations. The meter outlet operating pressure was checked and the regulator adjusted appropriately in a multi-dwelling building with multiple meter arrangement, anytime that gas reactivation (gas service turn-on) activity involved the first nearest meter to the mercury-sealed regulator as described and indicated in figure 13 shown below. Adjustment is needed when there is a pressure difference between measured pressure and required metering pressure. To ensure that the vent line was open to venting gas outside an air pump attached to the disconnected union was used. The technicians disconnect the union for the test and reconnects the union after the vent-line test.²¹

¹⁹ DCA16FP003 – OPS – O&M Regulator Operations (Section 5121)

²⁰ Engineering and operating standards – operations and maintenance manual (Revision 2, Effective date: 09-10-2015) (Section 5121)

²¹ Interview of Mike Williams, Robert Francis Land and Edwin Allen Jackson

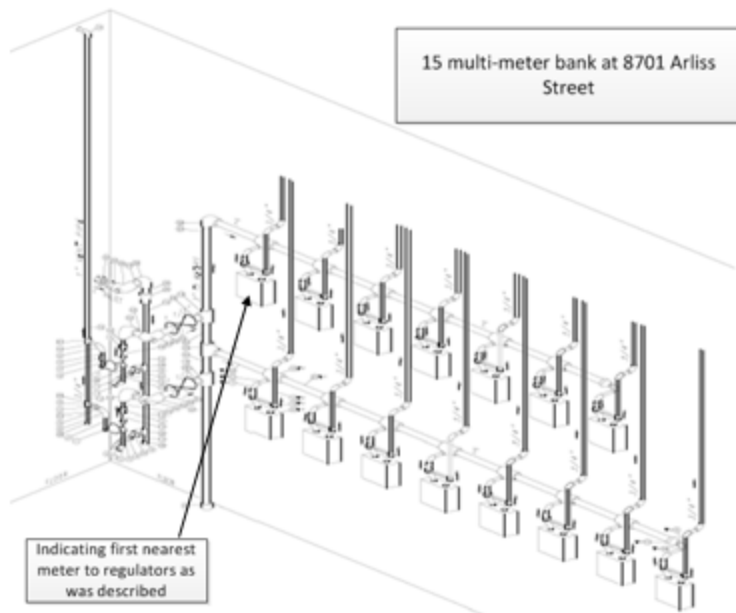


Figure 13: Schematic of 15 multi-meter bank at 8701 Arliss Street. Source: WG

Activities

WG work order records for 8701 Arliss Street in the five years prior to the incident, show that gas service work was performed among others the following:

September 27, 2012, unit 201, due to turn-on service. A technician conducted a regulator test and noted the low-load pressure test at 5.5 inches of water column. The technician also noted the regulator vent-line was clear and ell was okay.²²

July 7, 2014, unit 104, due to turn-on service. A technician conducted regulator tests and noted the high-load pressure test at 5.0 inches of water column, low-load pressure test at 5.5 inches of water column and the lock-up test at 7.5 inches of water column. The technician noted the regulator vent-line was clear and ell was okay.²³

The WG records shown above indicate regulator tests were performed but do not indicate that gas service was interrupted to the regulators. In both cases, and in accordance to WG procedure, the vent line pump tests would not be required if the gas supply to the regulators was not turned off.

WG performed additional gas service work in the meter room at the incident location which include:

- February 9, 2011, a grade-3 leak was detected on the meter rack, by meter outlet swivel and was repaired in the meter room (Kay Management rental office called-in this work and

²² Kay Management as WG customer (turned on new customer)

²³ DCA16FP003 - OPS - Meter Room Activity in total for 8701

no unit was attached). Odor of gas was prevalent in the meter, utility-storage room, no appliance or plumbing work was involved, as indicated in the completion record.

- June 30, 2014, gas turned-off, and disk installation on outlet of meter (unit 104)
- August 25, 2015, gas meter turn-off and installation of disk on outlet of meter (unit 104)
- August 26, 2015, gas meter turn-on, meter test, and houseline test. This work extended to the relight of appliances by the gas company and was completed as a service line with low pressure remarked (unit 104).²⁴

F.2.1 History of WG Mercury-Sealed Regulators Removed and in Service

WG data related to mercury-sealed regulator installations, indicated that approximately 175,000 mercury regulators were replaced throughout the system over the years and about 125,000 remain in service.²⁵ The majority of the regulators have been replaced through replacement program. WG records of regulator installations, maintenance, and replacement do not comprehensively document each specific mercury sealed regulator. This number is an approximate.

F.2.1.1 Flower Branch Apartments Mercury-Sealed Regulator History

WG stated that when removing and replacing a mercury-sealed regulator from service, technicians are required to follow their operations and maintenance manual (Section 5125), procedures; however, the identified reason may not be documented in their Computer Aided Dispatch (CAD) system for each regulator removed.

According to WG records, between 1955 and 1956 WG installed two Reynolds Model 30 #1 mercury-sealed regulators in each of the 26 buildings of the Flower Branch Apartments. Some mercury-sealed regulators removed prior to the incident and some after the incident. These regulators removed were:

- October 7, 2009, two regulators were removed from one building;
- August 27 and 31, 2010, six regulators were removed from three separate buildings, two from each building;
- September 2 and 20, 2010, four regulators were removed from two separate buildings, two from each building;
- August 11 and 25, 2016 (post-accident), WG removed four regulators from two separate buildings, two from each.

In addition, two regulators were destroyed in the accident and removed. Except for the removal dates listed above, and the record of those destroyed in the fire, the dates and causes of removal for the remaining regulators from other buildings were not documented.²⁶

²⁴ DCA16FP003 - OPS - Meter Room Activity in total for 8701

²⁵ DCA16FP003-OPS-Number of Mercury Regulators

²⁶ DCA16FP003-OPS-Number of Mercury Regulators

WG submitted records from 2011 – 2016 of mercury-sealed regulators removed in its system. This record identified four categories that necessitated the removals. These four categories shown below include three failure conditions and one company policy decision. Thus:

- 1 Regulator leaking, leaking from body/connections or overpressure protection engaged and venting
- 2 Replaced according to WG practice during the course of other work
- 3 Failed to hold set point or wouldn't lock up during testing associated with a service visit
- 4 Improperly returned to service, Mercury blown out of reservoir

Removed regulators by period were as follows in tables below:

Table 1: October 2011 –September 2012

Removal reason (category)	Number of regulator removed (count)
1	124
2	3086
3	20
4	70
Total regulator removed	3300

Table 2: October 2012 – September 2013

Removal reason	Number of regulator removed (count)
1	121
2	2733
3	13
4	68
Total regulator removed	2935

Table 3: October 2013 – September 2014

Removal reason	Number of regulators removed (count)
1	125
2	2076
3	10
4	52
Total regulator removed	2263

Table 4: October 2014 – September 2015:

Removal reason	Number of regulators removed
1	143
2	2163
3	15
4	52
Total regulators removed	2373

Table 5: October 2015 – September 2016:

Removal reason	Number of regulators removed
1	118
2	1124
3	10
4	51
Total regulators removed	1303

Mercury-sealed regulator failures

WG witness interviews indicated that they have experienced mercury-sealed regulators malfunction [fail] while in service.²⁷ Previously WG diagnosed failed mercury regulators, fixed and continue to use them. However, such practices have ceased (according to WG “past practices allowed technician to perform simple repairs to a malfunctioning/failed mercury regulator when such repairs would restore it to normal operating condition”) and currently WG replace failed mercury regulators at every opportunity sometimes without the cause of malfunction/failure documented.

Some of the witnessed malfunction/failure conditions experienced as described by witnesses were as follows:

1. Weeping regulator due to mercury displacement from rapid turn-on of gas service.
2. Inadequate pressure to the customers, regulator will not regulate pressure as designed.
3. Leaking or torn diaphragm, regulator cannot maintain set pressure and over pressurization causes the mercury relief to vent gas through the vent-line.
4. Regulator pin[key] breaks or bent; doesn’t remain in position to operate properly
5. Orifice valve not closing properly, that may lead to over pressurization and venting (i.e. when disc pushes against the orifice).
6. Leaking regulator body, sometimes the housing leak stopped when the nuts were re-tightened.

According to WG, including remarks that documented causes of mercury-sealed regulator failures is not a requirement in the company work orders and procedure. Recording and review of this type of information is not always included on the records in the system.²⁸

²⁷ Interview of Mike William, Robert Francis Land, and Edwin Allen Jackson

²⁸ Interview of Mike Williams, Robert Francis Land and Edwin Allen Jackson

F.3 Locating of Regulator and Procedures

Current regulation regarding the siting of service meters and regulators to buildings is not prescriptive, this determination is left to the discretion of the builders, property owner(s) and utility company. However, 49 CFR part 192.353 states they must be installed in a readily accessible location, be protected from corrosion and other damages regardless of whether they are located inside or outside a building. Title 49 CFR part 192.355 states that each regulator that might release gas in its operation must be vented to the outside atmosphere. Also, when regulators are located inside a building, they are required to be installed nearest to the service line entrance.²⁹ The service line and inside meter installations at the Flower Branch complex are permitted and meet current regulations.

In addition, there is no regulatory requirement for the removal of mercury-sealed gas service regulators in distribution pipelines. However, WG operations and maintenance manual (section 5125) require that a mercury-sealed regulator should be removed if: it is “weeping [passing] gas through the vent, is not functioning properly, when the system is updated to a MAOP beyond 25 psig, the service is replaced, the connecting piping is altered or replaced, or due to a scheduled removal as part of a programmatic replacement program based on environmental reasons.”

According to current WG procedures, meters and regulators “shall not be installed inside buildings or other structures unless there are no other practical alternatives.” For installations placed inside a building, the operator procedure requires that beyond ensuring proper clearance and accessibility for these gas equipment, as required by 49 CFR 192, the relief valve vent and regulator breather vents should be piped outside.³⁰

F.4 Employees’ Training and Procedures

F.4.1 WG personnel

WG requires that its personnel who work on gas meters, regulators and pipelines be trained using specific written procedures for an applicable task. Personnel that performed work at the incident property had received training under the operator qualifications (OQ) requirement in the federal regulation. The NTSB interviewed and reviewed training documents of the WG personnel and contractors who performed work at the incident building. These reviews indicate that the workers were qualified at the time gas service, meters, and regulators work were done.³¹

F.4.2 Kay Management Maintenance Work and Training

Maintenance activities at the Flower Branch Apartment are in two groups, those performed in-house (customers gas odor calls inside the apartments, and appliance services) by Kay Management maintenance employees and other activities performed by contractors hired by Kay Management (water heater installation and maintenance, fire alarms, and smoke detectors, access

²⁹ Title 49 CFR §192.353, Customer meters and regulators: Location, and CFR 49 §192.355, Customer meters and regulators: Protection from damage

³⁰ DCA16FP003 – OPS- O&M Regulator Operations (Section 5111) Revision 05192016

³¹ WG employees and contractors’ interviews – August 19 and 20, 2016

security, key replacements, and painting works etc.). Kay Management is responsible for verifying contractors' qualifications and licenses.

Conversely, according to Kay Management, they do not maintain records for any Kay Management maintenance personnel training who work in their communities, including Flower Branch Apartments. Kay Management employees' interviews show that training for in-house maintenance personnel are conducted through on-the-job training and shadowing.³²

Kay Management conducted periodic safety briefings for their maintenance personnel. Such briefings occurred on June 9, 2016, March 17, 2016, and December 21, 2015.³³ However, safety briefing contents, itemized in a safety material and equipment checklist, does not include gas odor investigation, emergency, or equipment used to detect natural gas release. Kay Management provided employees with a Combustible Gas Indicator (CGI) operating manual to be used in their work. However, there was no calibration record for the CGI available.³⁴

F.4.2.1 Flower Branch Apartment Other Facility Activities

Kay Management work-order records of a plumbing contractor shows that from August 1, 2013 to August 15, 2016, the company performed two water-plumbing tasks at 8701 Arliss Street. On January 23, 2015, a water valve leak reported by Kay Management was repaired inside the meter, utility and storage room. On May 29, 2015, a bathroom leak was repaired in unit 11, both at 8701 Arliss Street. This plumbing company that performed the work also installed the 2012 gas water heater examined as part of the evidence in this investigation.³⁵

F.5 Prior leakage reports

F.5.1 WG Gas repair activities

The NTSB reviewed WG leak history reports for building 8701 and 8703 Arliss Street, from February 9, 2011 to August 19, 2016. On February 9, 2011, there was a meter rack leak repair as a result of a reported slight odor conducted inside 8701 Arliss Street building meter, utility and storage room. The work involved repair on the meter outlet swivel where the caller reported that there was a slight odor inside the meter room. The technician repaired the leak and re-lighted the customer appliances after the work was completed.³⁶

The closest leak repairs to this service address was on February 1, 2013 at 8703 Arliss Street, where an inside gas leak was found on a 1-inch union in the meter/laundry room.³⁷ The repair was completed on February 1, 2013 by re-tightening the fitting, followed by soap test. On September 5, 2013, another natural gas leak with indication of 85-percent [Low Explosive Limit (LEL) of gas in air was found outside, on the 2-inch wrapped steel service pipeline to this address. This leak

³² Kay Management personnel interviews - August 20 and 27, 2016

³³ Kay Management response to NTSB (October 13, 2016)

³⁴ Kay Management Safety Briefing – June 9, 2016, March 17, 2016, and December 2015

³⁵ DCA16FP003 - OPS - Associates Plumbing Invoices & Log.pdf

³⁶ DCA16FP003 - OPS - Meter Room Activity in total for 8701

³⁷ DCA16FP003-OPS- Five Year Aboveground Leak Repair History for Flower Branch and 8701 and 8703.REVISED - 2 of 2

was repaired on September 5, 2013 by tightening of a 2-inch steel coupling. In addition, the repair crew referred the completed work to construction team for service replacement at later date.³⁸

Review of WG records, indicated that there was no reported leak on the underground pipeline around the accident in the 12 months preceding the accident.³⁹

F.5.1.2 Third-Party Excavation Tickets

WG provided utility locate request tickets for excavations for the entire Flower Branch Apartment complex.

Records of recent excavation activities in the incident area showed that there were 17 related tickets reported. Fifteen of such tickets related to soil boring activities which were reported by three different companies that worked on Arliss Street on government projects between July 14 and August 8, 2016. No gas odor calls or repair resulted from these activities. Two tickets were reported by WG for gas pipeline excavation related activities on August 11 and 15, 2016 following the accident.⁴⁰

F.6 Pre-accident emergency response and gas odor calls to WG

There was no record of an odor call or complaint to WG from 8701 and 8703 Arliss Street, Silver Spring, MD in the 30 days prior to the accident. Also, in 5 years before the accident, no one called WG regarding 8701 Arliss Street to report a natural gas odor.

Furthermore, post-accident WG natural gas odorant check which included the incident building, monitored from three test locations which included two regulator stations, indicated that there was sufficient odorant in the pipeline which met regulatory requirement at the time of the accident.

F.6.1 Flower Branch Apartment incident building 8701 Arliss Street gas odor call activities for one year

Records show that from August 1, 2015 to August 25, 2016, Kay Management maintenance personnel responded to the incident building for gas odor calls. On September 3, 2015, gas odor call in apartment 202, which resulted in replacement of an oven knob; on October 16, 2015, gas odor call in apartment 202, that required appliance repair; on November 12, 2015, gas odor call in apartment 201, which reported intense smell of gas when someone walked into the room; however, the maintenance personnel could not detect any leak at the stove and furnace, no work was performed.

On May 28, 2016, a gas odor call was made from apartment 202, the maintenance personnel corrected it by checking the stove. On June 6, 2016, a gas odor call made from apartment 302, resulted in replacement of stove knob that was not turning off the stove. None of these gas odor

³⁸ DCA16FP003-OPS-Outside Leak Repair on Service at 8703 Arliss St 9.5.2013

³⁹ DCA16FP003-OPS-Leak Repair History for one year in vicinity of incident

⁴⁰ DCA16FP003- OPS- Miss Utility Tickets_811 tickets

calls work order indicated that Kay Management personnel visited the utility, meter and storage room in the basement.⁴¹

On July 25, 2016, a resident at the incident building had called 911-emergency to report a gas odor due to the smell of natural gas. The responding Montgomery Fire Department Unit did not detect natural gas with a Combustible Gas Indicator (CGI); however, the caller stated he could smell natural gas, and one of the firemen believed he could smell something.⁴² According to the Montgomery County Fire Marshall, the firefighters checked the exterior of the structure and all levels of the interior with an Industrial Scientific iTX multi-gas monitor. After checking all levels of the building and finding no readings on the monitor, the crew returned to service.⁴³

The crew leader (Lieutenant with Montgomery Fire and Rescue Squad, Fire Station 16) of the 911-emergency responders stated that a few weeks prior to the explosion his crew responded to an odor call at 8701 Arliss Street⁴⁴. He remembered being on-air to finish an earlier emergency call when the crew was dispatched to this address. He had a four-man crew: himself, the lineman, the paramedic, and the driver. The lineman brought 4-gas iTX meter which he turned on during the trip to this address and calibrated the meter to a zero reading. As they walked up to the building they did not notice odor of gas and saw a few people sitting in front of the building. The crew leader explained to them that someone called to report an odor of gas, then asked if they smelled anything, which they responded “No.”

As the crew walked into the front door of the building, they were met by an occupant who stated that he smelled gas around the area of the mailboxes. The crew leader stated they did not smell anything with their “natural nose or sort of say.” And the lineman came in with the meter, didn’t pick up reading with it. The crew leader “thought” he sent the lineman and the paramedic up to the top floors, they walked their way down and he asked them to check the apartments. The crew leader went to the Terrace level and knocked on some doors to try to get an idea if he could smell anything down there, but didn’t. He met the two crew members on his way up-stairs, and inquired about their investigation, they reported not detecting any odor or readings, did knock and gained access to some main level doors. However, the paramedic crew member stated that “he smelled something but wasn’t sure if it was gas or not.”

The crew leader stated his crew then went to couple of other apartments, and the lineman knocked on one door in which he could smell an odor which he wasn’t sure what it was. According to the crew leader, he carried aluminum wedges,⁴⁵ so they started using these wedges, flexing the corner of some metal door frames to gap the doors then insert their iTX meter probe to sense for gas, the lineman didn’t pick up any gas reading. One of this crew members said they thought “they smelled something from the apartment.” So, the crew prepared to force the door open, fortunately the occupant of that apartment came back from groceries-shopping... but they couldn’t communicate to the resident due to language barrier; however, the occupant opened the door and allowed them

⁴¹ All work orders August 01, 2015 to August 25, 2016 at Flower Branch Apartment, incident building.

⁴² Interview of Adraine Boye.

⁴³ Montgomery County Fire Marshall comment to the operations factual report.

⁴⁴ The crew leader could not recall the date; the investigation determined it occurred on July 25, 2016

⁴⁵ Wedge – this is a triangular aluminum metal piece used to force a closed door open to create air-passage.

inside. They monitored the apartment on every corner and found nothing, except for the smell of plugged in air-freshener, but with the meter there was no gas detected.

In addition, the crew retrieved the key to the 8701 Arliss Street meter, utility and storage room from a Knox-Box which was only accessible by the fire department. However, the key could not open the room which indicated the lock was changed. Again, they used the wedge to gap the metal frame and door, inset the test probe, that showed no gas reading. The crew then exited the building.

In addition, the fire department crew driver who did not enter the building with other three-crew members walked round the outside perimeter of the two buildings, 8701 and 8703 Arliss Street and did not smell natural gas. He asked other people he met outside if they smelled an odor of gas, and they said no. The crew then marked the incident as nothing found and went back in service.⁴⁶

Montgomery County emergency dispatch records were provided to the NTSB. Review of these records identified three recorded gas odors calls at 8701 Arliss Street: October 4, 2015, January 12, 2016 and July 25, 2016 (see attachment C). However, there were several other gas odor emergency calls investigated at the entire apartment complex between September 26, 2014 to December 17, 2016 with majority of the gas emergency calls made after the accident.

F.7 Gas Leak detection inside building

Building 8701 Arliss Street was equipped with limited fire alarm system, commonly known as “ring and run” which was pull stations and fire alarm boxes as switches. These types of installations are in places in the Flower Branch Apartment buildings, with the pull stations installed near the buildings front entrance doors. 8701 Arliss Street had a fire alarm bell located at the entrance level, the second floor, and one manual fire alarm box at the entrance level. There were no alarm control panels, backup batteries and backup power in any of the buildings. According to Kay Management fire alarm contractor there were no smoke detectors installed in the utility rooms and hallways, and he was not sure whether smoke detectors were installed in the Flower Branch apartment buildings. Kay Management service contractor maintains the fire alarm system.⁴⁷

There was no combustible gas (propane, methane) detector installed in Flower Branch Apartments, nor were such devices a requirement by local, state, or federal regulations.

Research by the NTSB showed that there are currently several combustible gas (propane, methane) detectors available for household and commercial use. These combustible gas detectors performance varies, as does the respective alarm alerts generated by each, spanning from high-pitch to siren blaring sounds, depending on the product. Some of these household and commercial gas detectors are operated by dry-cells, whereas others are plugged into a 110 -120 volts, alternate current electrical source.⁴⁸

In response to an NTSB inquiry, WG indicated that it actively participates in industry research and development organizations which includes research and development of methane detectors in

⁴⁶ Interview of Lt. Chase Fabrizio and Christopher Kain

⁴⁷ Interview of David Mandel

⁴⁸ Internet research for combustible gas (propane methane) detector

buildings. WG further asserts that the current odorization of gas is the method WG uses to create awareness of the presence of gas in air.

Since 2015, WG indicated it engaged in industry exploration of reliable residential gas detection technology, which has led to the WG's involvement in Research and Development initiative with Gas Technology Institute (GTI), particularly the Residential Methane Detector Program. The purpose of such initiatives is to create a "comprehensive program for achieving full customer adoption of cost effective, reliable, accurate and readily available residential methane detectors."⁴⁹ According to WG, the program comprises technology development and evaluation, codes and standards development, stakeholder engagement and economic and market analysis. In addition, WG is currently supporting a field pilot program to evaluate the commercially available detectors that performed well during an earlier laboratory evaluation.

Current available detectors have an alarm alert at 25 percent of the lower explosive limit (LEL), which is above the federal odorant detection code requirement of 20 percent LEL.⁵⁰ A few states have lower detection limits, such as Maryland and New York which require an odor detection threshold at 10 percent of LEL, while Massachusetts requires threshold of 3 percent LEL.⁵¹

A GTI study in this area, which WG continues to review, reveals that methane detector use is currently affected due to identified issues. This includes consumer behavior, the fitness for purpose of available equipment based on the reliability in detection level, false positives, repeatability, the effect of location of devices within premises on performance, and the adequacy of existing standards like the Underwriter's Laboratory (UL).

WG believes that an improved understanding of how these methane detectors would perform and be used will enable them to determine the proper part of this technology in their safety public awareness program, when technically validated information with respect to the reliability and improved safety that in-home methane detectors would afford.⁵²

The GTI study highlighted the necessity for safety considerations due to the following reasons:

- That gas customers' attitudes indicate that odorant alone is not enough for the customers to report leaks;
- Recent occurrences have shown that attention on how unreported leaks can result in tragic outcomes;
- That gas industry has the window of opportunity to work around existing safety programs and increase proactivity in regard to the detection of gas in homes; and
- That the possession of an alert system as a methane detector is of importance to both the customer and the utility companies.

This study further revealed that there is no current framework to promote the installation of residential methane detectors in homes and therefore, it lacks the required public awareness. There

⁴⁹ Paul Armstrong Residential Methane (Gas Technology Institute)

⁵⁰ Title 49 CFR part 192.625 - Odorization

⁵¹ Paul Armstrong Residential Methane (Gas Technology Institute) and COMAR - 20.55.09.06. - Odorization

⁵² DCA16FP003-OPS-DR.001.Methane Detectors [1]

are currently low customer adoptions. Recent improvement in methane detectors suggested that the newer sensors would overcome the false positive and lower sensitivity levels; however, it would not be available in the near future.⁵³ (For more detailed information, see the Regulatory Oversight Factual Report.)

F.8 Other Flower Branch Apartment Facility Activities

F.8.1 Access to meters, utility and storage room

The WG service line, regulators, regulator vent line, meter rack and gas meters, and part of the house-piping located inside the basement at 8701 Arliss Street, are accessible to Kay Management managers and maintenance personnel. Kay Management contractors are given access to this location when their work required this location. Provided the correct key is available in the “Knox Box”, the firefighters can go into it during gas emergency response to the building.⁵⁴ When contractors to Kay Management work required access to utility room the location door was opened. In addition, at least six months before the accident, no contractor (third party) was given access to this location.⁵⁵

The same master key was used by Kay Management employees to gain entrance to the meters, utility and storage room, maintenance shop, and the Leasing Office; however, an additional key is needed to access the building main stairwell entrance (see figure 14). This key is also provided to the tenants for building entry. There are no records or logs for key collection or issuance to Kay Management managers and maintenance employees, or for the master key required to access locations. However, Kay Management employees had assigned keys to these areas.⁵⁶

⁵³ Paul Armstrong Residential Methane (Gas Technology Institute)

⁵⁴ Interview of Chase Fabrizio

⁵⁵ Kay Management October 21, 2016 Response Letter

⁵⁶ Kay Management response letter to NTSB (October 21, 2016)

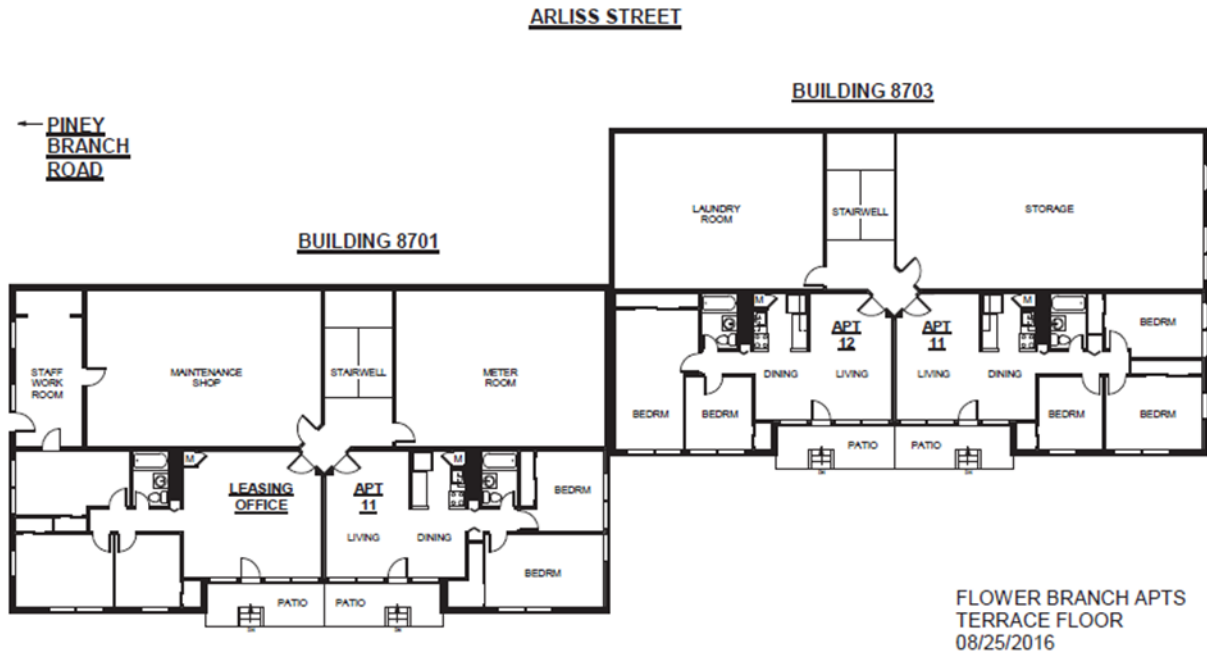


Figure 14: Adjoining buildings, 8701 and 8703, basement floor plans showing the incident building meter room and adjacent rooms on the left.

Comparing other buildings floor layout in the entire complex to the incident structure. Kay Management stated that:

The floor plans for 8701 and 8703 Arliss Street provides a good comparison of the general similarities and differences between the layouts of 8701 Arliss Street as compared to the other buildings in Flower Branch Apartment complex. The building foot print and general layout of the buildings at the complex are similar from building-to-building, that is four floors for each building, a central stairwell, and with the exception of 8701 Arliss Street, two apartments are located on the lowest level of each building, and generally four apartments on each of the upper three levels in each building.

Variation exist in each building with regards to the mix of one, two, and three-bedroom apartment, which differs from building-to-building with several different floor plans in this mix.

8701 Arliss Street layout differs in a major way from the other buildings on the Terrace level shown in figure 14. This level had only one apartment compared to two in other buildings due to Kay Management Leasing Office located on this level. In addition, the Terrace level included the maintenance shop that was storage room in other buildings. The space that served as laundry room in all other buildings was used as storage room at 8701 Arliss Street. As a result, this building did not have a common “washers and dryers” equipment location. The entry door to the meter, utility and storage room was locked at all times.⁵⁷

⁵⁷ Kay Management response and letter to NTSB (March 9, 2016)

Each of the Utility, Storage, Laundry room, in 8701 Arliss Street, has an open vent to the outside made of plywood with a series of holes drilled into it to allow ingress and egress of air into the room.

F.8.2 Access Key Replacement

Kay Management records showed that their contractor's key replacement information identified Flower Branch Apartments. However, the work orders referenced only the Leasing Office address and not the actual serviced location. Identification of where and when the key to the meter, utility and storage room located at 8701 Arliss Street changed was undocumented.

F.8.3 Security Access Activation and Deactivations

Kay Management provided security system data for events that occurred from July 30, 2016 to August 11, 2016. These records were obtained from an automatic system test event report that was performed monthly to demonstrate if the access control alarms were working properly. The records indicated access activation and deactivation alarm to the meter, utility and storage room, occurred in conjunction with access to the maintenance shop, and the Leasing Office shown in figure 14. These entry alarms do not occur discretely and cannot be uniquely identified to a door.⁵⁸ In addition, there was no documentation to show who entered the rooms.

F.8.4 Painting of apartment units within the incident building

Prior to the accident, some maintenance activities that generated reported chemical odors-effluence within the building were the result of painting works that occurred at both upper 300's units and the lowest 010's basement apartments units, in 2015 and 2016. Most recent were painting work in January 2016, from the basement apartments 011 and 012, in April 2016, from apartments 012 and 203. Apartment 011 was located adjacent to the meter room.

Interview records of Kay Management personnel revealed that they believed smell from paint could be miss-construed as the sense of smell for natural gas in this incident area. Numerous residents reported gas odor following the painting.⁵⁹

F.8.5 Building Inspection by Montgomery Department of Permitting Services

On March 23, 2016, the Department of Permitting Services, Division of Fire Prevention and Code Compliance, conducted building inspections of the entire complex of Flower Branch Apartments (8701-8711 Arliss Street, 8851-8857 Garland Avenue and 8628-8674 Piney Branch Road) that include building at 8628 Piney Branch Road / 8701 Arliss Street.

Result of the inspection that indicated conditions contrary to law and were in violation required Flower Branch Apartment/Kay Management to remove all gas-powered items out of storage rooms

⁵⁸ Kay Management response and letter to NTSB (March 21, 2016) and Vector Security Report on Doors Access.

⁵⁹ Painting work orders

in buildings, and that any paint storage room need to have a vent system installed to prevent the high concentration of fume build-up.⁶⁰

At the time of the accident, Kay Management stored items in 8701 Arliss Street storage room among other things include items listed in the table below:

Table 6: Inventory of 8701 Arliss Street, meter, utility and storage room⁶¹

Approximate quantity	Item Description
7 to 8	Gas Furnace
3 to 4	Air-Condition Condenser
7 to 8	A-Coils for air-conditions
1	Roll of copper air-condition pipe (tubing)
1	Roll of B-X wire
1	Roll Romex wire
20	$\frac{3}{4}$ -inch by 10-foot polyvinyl chloride (PVC) pipe
4 to 6	Condenser pump
5 to 6	Box Fans
2	Portable air-conditions
2	Case of spray nine
2	Case of Windex cleaner
10	Bathroom mirrors
2	Case of paper towels
1	Case of toilet paper
20	File Boxes
5	Salt spreader
2	Boxes of air fresheners
8	Cases of brown caulk
3	Ceiling fans
5 each	Top and bottom refrigeration gaskets
4	Range tops
3 to 4	Air-condition pans
4	Thermo-coupling (oven)
7	Yellow boots
7	Rain coats
1	Box of shoe booties
2	Box of pipe insulation
1	Box floor tiles
1	Dehumidifier
2	Case return grill air-condition
1	File cabinet
1	Trash can full snow shovels
1	New chain saw in a box

⁶⁰ Montgomery County Fire Prevention Code Compliance (5-9-16)

⁶¹ 8701 Meter Room Inventory provided by Kay Management

1	Back pack blower almost empty
1	Pressure washer almost empty
1	Empty gasoline can

On August 8, 2016, the maintenance supervisor for Kay Management visited the 8701 Arliss Street, meter, utility and storage room. Per his communication to the company president on August 19, 2016, the supervisor advised he had visited the “meter room” in 8701 Arliss Street and stated the room was “immaculate, spotless.”

The Kay Management president stated in an interview that the maintenance supervisor informed him that “there was no equipment, nothing within 15 feet of the meters, and there were two shelves on the left side, and maybe there were two snow blowers in there.”⁶²

No reason was given why the maintenance supervisor visited the room that day. This communication between the Kay Management president and the maintenance supervisor was neither recorded nor was any note taken for transcription purposes, and the room visit was undocumented.⁶³

F.9 Post Accident Activities and Field Tests

F.9.1 Emergency Response and Timeline of Events

The stated operations timelines are a combination of the WG and the Maryland Public Service Commission field documentation.

August 11, 2016

At 12:07 a.m., WG received a call from the Montgomery County Fire Department and, three minutes later, dispatched first responders to 8644 Piney Branch Road. Responders arrived at 12:36 a.m. to the incident site at 8701 Arliss Street.

At 12:52 a.m., the WG technician, assisted by a WG supervisor, closed the curb box valve at 8701 Arliss Street which turned off the natural gas. WG later conducted post-accident pressure test of the regulated distribution pipeline.

At 1:21 a.m., Public Service Commission of MD Engineering Division (MDPSC) Assistant Chief Engineer received notification of an explosion and fire at 8701 Arliss St. from the WG Supervisor, DOT Pipeline Compliance. At 2:41 a.m. MDPSC arrived on site and met with WG personnel to get an update of the situation.

⁶² Interview of Clark Mellilo on August 20, 2016. The NTSB was not able to interview the maintenance supervisor due to health issues.

⁶³ Kay Management response letter to NTSB (March 9, 2017)

Between 2:15 and 3 a.m., the WG field operations crew performed a bar-[hole]⁶⁴ and tested the trunkline for leaks and services at 8701, 8703, 8707, 8709, and 8711 Arliss Street.

At 3:45 a.m., WG personnel, under the observation of the MDPSC, conducted an odorant check at 8609 Piney Branch Rd. The odorant checks revealed that the odorant level was at 0.5 percent LEL of natural gas and was compliant with COMAR regulations.

Between 3:45 a.m. and 4:40 a.m., the MDPSC joined WG personnel for a leak survey of the gas main in front of 8707 and 8709 Arliss St. The only indication found was in front of the building entrance at 8709 Arliss St., 0.2 percent LEL. The indications dropped very quickly after being detected. No leak indications were found at the building wall.

Between 4:40 and 7:05 a.m., the leak survey technicians performed a leak survey throughout the entire Flower Branch Community of 26 buildings, and, between 9:20 a.m. and 11:20 a.m. performed a second leak survey throughout the entire Flower Branch Community of 26 buildings and the adjacent area. Three leaks were found in the adjacent area outside of the Flower Branch property and they were addressed according to protocol.

At 11:30 a.m., the WG field operations crew capped off the service to 8701 Arliss Street. The WG leak survey technicians performed bar and testing on the trunkline and services in front and back of 8701 and 8703 Arliss Street between 1:30 p.m. and 2:45 p.m.

At 5:25 p.m., WG began the process of testing the 2-inch gas main in front of the apartments on Arliss St. Four minutes later, WG raised the pressure in the main to 10 psig and held it there to verify that the gas valve in front of 8701 Arliss St. was not allowing gas to pass through it and that the valve was functioning properly.

Between 6:12 p.m. and 7:12 p.m., the field operations crew leak tested the trunkline and services up to the inside shut off valves at 8703, 8707, 8709 and 8711 Arliss Street. At 6:12 p.m., WG increased the pressure on the main from 10 psig to 22 psig to establish a pressure test of the main at the pressure the system was operating at the time of the explosion. At 6:35 p.m., WG personnel performed a sub-surface leakage survey of the gas main in front of 8701 and 8703 Arliss St. No leak was found during the survey.

At 7:12 p.m., WG completed the pressure test of the 2-inch gas main. No leak was found during the pressure test. The 8701 line, which was previously capped, was also included in this test according to the “Washington Gas Arliss Street 2 [-inch] Steel Main Pressure Test & Reactivation Procedures” dated August 11, 2016. NTSB, MDPSC, ATF and WG personnel witnessed the test. Field operations crew capped off the service to 8703 Arliss Street at 7:12 p.m.

⁶⁴ Bar-hole – A process of making holes in the ground directly over the pipeline that are used to insert the CGI test probe for gas detection.

August 12, 2016

WG personnel backfilled the holes in front of 8701 and 8703 Arliss St. to make the site safe. The excavations were made to perform the previous day's pipeline test. The pipe was wrapped where the service lines were cut and capped, and an anode was attached to the remaining active portion of the service stub to 8703 Arliss St.

August 15, 2016

Between 4:35 p.m. and 6:20 p.m., the WG field operations crew leak tested the meter rack at 8703 Arliss Street. According to the "Leak Test Procedure for Meter Rack at 8703 Arliss St" dated August 15, 2016, the crew did not detect any leak. At 5:57 p.m., WG personnel performed a pressure test on the remaining section of service line (building side of the cut) for 8701 Arliss St. The service line was pressure tested to 22 psig for 15 minutes. The service line passed the pressure test. The WG field operations crew leak tested the remaining portion of the service line to 8701 Arliss Street between 6 p.m. and 6:15 p.m. and capped off to inside valve) according to the "Leak Test Procedures for Service Pipe at 8701 Arliss St" dated August 15, 2016. NTSB, MDPSC, ATF and WGL personnel witnessed this test.

August 16, 2016

Between 10 a.m. and 10:12 a.m., the WG field operations performed the regulator vent line test for 8701 Arliss Street according to the "Vent Line Inspection and Test Procedures for 8701 Arliss Street" dated August 15, 2016. The vent line did not show any indications of any obstructions. This was witnessed by NTSB, MDPSC, ATF and WGL personnel.

G. Onsite Evidence Collection



Figure 15: Evidence sent to NTSB Laboratory

Figure 15 shows two sections of 2-inch pipe cut outs from 8701 and 8703 Arliss Street service pipeline of about 12-inches each. These pipe pieces were cut out during the incident investigate,

after the gas was shut off by valves to isolate these two apartment buildings from the distribution system.

Evidence shown in figure 15 obtained from 8701 Arliss Street, Silver Spring, was sent to the NTSB laboratory in Washington DC. This comprised of the following items:

1. Two sections of 2-inch pipe cut outs from 8701 and 8703 Arliss Street service pipeline of about 12-inches each. These pipe segments were cut out during the investigation, after the gas was shut off by valves to isolate these two apartment buildings from the distribution system.
2. A section of 2-inch service pipeline with about 40 inches initially buried in the ground and about 14 inches inside the basement containing the main service head valve, and retrieved from 8701 Arliss Street, Silver Spring.
3. A section of the regulator assembly that comprised of two damaged and burned mercury-sealed regulators, 2-inch service inlet pipeline, and unions. Included with these are three discs documented at the incident locations.
4. Segments of the regulator vent pipe of about 25 inches, 58 inches and 62 inches connected together.

Other evidence shown in figures 16, 17, 18 and 19 were collected from the scene, and taken to the WG facility in Springfield, VA.



Figure 16: Reassembled meter rack containing 15 damaged customer meters and piping from 8701 Arliss Street, Silver Spring, MD.

Figure 16 is the 8701 Arliss Street customers meter sets, including some parts of the customers' gas piping retrieved from the incident building and loaded on truck bed. Figure 17 below shows the house piping retrieved from the incident building meters, utility and storage room located in the basement and loaded on a trailer bed for transportation to WG, Springfield, VA.



Figure 17: 8701 Arliss Street Silver Spring, Apartment Customers Gas Piping on Trailer bed.



Figure 18: 8701 Arliss Street Silver Spring Apartment Building Water Heater, Electric Meters and Switch Box.

Figure 18 shows the 8701 Arliss Street damaged water heater shown loaded on a WG contractor pick-up truck for transportation to Springfield, VA (top left) and in the basement of the meters, utility and storage room where it once was located about 6 feet from the customers' meter sets (top right). It was also about 3.5 feet from the electric meters and switch box at the bottom left of the pictures. See NTSB Fire and Forensic Report for more information on the water heater.



Figure 19: 8703 Arliss Street Silver Spring WG meter set piping, meters prior to and post removal.

The 15 meter sets displayed in figure 19 were removed from 8703 Arliss Street and taken to the WG Springfield, VA office location for NTSB storage.

The evidence shown above comprised of the following items:

1. The 8701 Arliss Street, Silver Spring house piping about 268 inches each and seven in number bundled as part #1.
2. The 8701 Arliss Street Silver Spring house piping of about 13 inches each and 13 in number bundled as part #2.
3. 8701 Arliss Street Silver Spring house piping from about 17 inches to 47 inches each and 13 in numbers bundled as part #3.
4. The 8701 Arliss Street Silver Spring piping of about 17 inches, 55 inches, 120 to 216 inches each and 14 in number bundled as part #4.
5. The 8701 Arliss Street Silver Spring natural gas 15 damaged customers and house meters and connecting piping.
6. The 8701 Arliss Street Silver Spring apartments building Hot Water Heater assembly.
7. The 8703 Arliss Street Silver Spring apartments building 15 customers and house meters.

The evidence in figures 15 through 18, were secured and transferred to WG facility for storage.

H. Public Awareness

H.1 Kay Management

According to Kay Management employee interviews, when customers have issues related to their gas service such as smell of gas odor within and outside their apartments, the first point of contact is to call the apartment maintenance office; however, during after-hour, when the apartment office is closed, the residents are instructed to call 911. Kay Management also stated there are no written instructions issued requiring the apartment residents to call the gas company, but they may call the WG at-will.

No public awareness education materials, that relates to natural gas use and odor reporting is given to tenants (customers) by Kay Management in its communities, including Flower Branch Apartments.⁶⁵

H.2 Washington Gas

WG developed its public awareness program (PAP) according to 49 CFR 192, Public Awareness following the American Petroleum Institute (API) Recommended Practice (RP1162). The program version was dated December 14, 2015.

The requirement in this regulation states that the operator's program must specifically include provisions to educate the public, appropriate government organizations, and persons engaged in excavation related activities on:

- (1) Use of a one-call notification system prior to excavation and other damage prevention activities;
- (2) Possible hazards associated with unintended releases from a gas pipeline facility;
- (3) Physical indications that such a release may have occurred;
- (4) Steps that should be taken for public safety in the event of a gas pipeline release; and
- (5) Procedures for reporting such an event.
- (6) The program must include activities to advise affected municipalities, school districts, businesses, and residents of pipeline facility locations.
- (7) The program and the media used must be as comprehensive as necessary to reach all areas in which the operator transports gas.
- (8) The program must be conducted in English and in other languages commonly understood by a significant number and concentration of the non-English speaking population in the operator's area.

In addition, 49 CFR part 192.616 requires that WG should have a written procedure that provides its customers public education messages twice annually to describe the reliability of the pipeline, explaining possible hazards from pipeline, prevention measures, damage prevention, recognition

⁶⁵ Kay Management response to NTSB (October 13, 2016)

and response to a gas leak, and how to acquire more information. This is consistent with customer public education.

According to WG, their public education materials for customers such as Flower Branch Apartments includes, but is not limited to the following:

- Customer newsletters with safety messages
- Damage prevention presentations used during excavators' and contractors' training
- Letters in English and Spanish to contractors and excavators who damage WG distribution facilities.
- Citizen Emergency Response Training (CERT) presentation to help teach volunteer emergency responders about natural gas properties and safety
- Photographs of damage prevention logo placement on WG trucks
- "What To Do If You Smell Natural Gas" safety ads in area newspapers.

The WG customer education program meets the regulatory requirement for local gas distribution companies (LDC) customers. Both the baseline frequency which is twice a year and the baseline activities, which they fulfill through bill inserts.⁶⁶

According to WG, they communicate their public awareness materials through direct mail to their paper-billed customers and electronically to customer that opt for electronic delivery of correspondences. In addition to delivery, customers' information is resident on the company website. The WG includes specific safety messages on quarterly basis in their customer newsletter, and in Maryland customer handbook.

The NTSB reviewed the public education materials and information contents overview. These include the Maryland handbook sent by WG to its customers which showed the contents covered information gas customers should know about natural gas safety. For example, how natural gas smells, action to take should they smell natural gas (recognize, react, and respond), signs of the presence of natural gas, gas migration patterns, and how customers may receive natural gas safety brochures (e.g., mercaptan scratch-n-sniff).⁶⁷ WG provided customers with copies of the public education customers' materials that were sent out to customers for the five years prior to the accident.

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Electrical (Power System) Engineer/Pipeline Failure Accident Investigator
Operations Group Chairman

⁶⁶ DCA16FP003-OPS-DR.001-PAP (Program) [1]

⁶⁷ DCA16FP003-OPS-0verview PAP Materials Narrative