BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Laclede Gas Company	)	
Concerning a Natural Gas Incident at	)	**File No. GS-2016-0160**
5730 Mango Drive in Oakville, Missouri	)	

STAFF GAS INCIDENT REPORT

COMES NOW the Staff of the Missouri Public Service Commission and states as follows:

1. On December 21, 2015, Staff filed *Staff's Motion to Establish a Case for Investigation of a Gas Safety Incident* ("Motion") which occurred on December 14, 2015, in Oakville, Missouri, an area served by Laclede Gas Company ("Laclede"). The Motion recommended that the Commission establish a case for purposes of receiving a report resulting from the investigation of the incident by the Commission's Safety Engineering Unit.

2. On January 6, 2016, the Commission issued an *Order Granting Motion and Directing Filing* in which the Commission opened this investigatory docket (GS-2016-0160).

3. On June 14, 2016, pursuant to a request by Staff, the Commission issued an *Order Granting Motion for Extension of Time* in which the Commission extended the deadline for Staff to file a report resulting from its investigation of this incident until October 21, 2016.

4. Pursuant to the Commission's Order issued on June 14, contemporaneously herewith Staff is filing its Gas Incident Report concerning the incident which is the subject of this investigatory docket.

WHEREFORE, Staff submits the accompanying Gas Incident Report.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing have been mailed, hand-delivered, or transmitted by facsimile or electronic mail to counsel of record this 21st day of October, 2016.

/s/ Jeffrey A. Keevil

Missouri Public Service Commission

Staff's Gas Incident Report

5730 Mango Drive
Oakville, Missouri
December 14, 2015

Laclede Gas Company
File No. GS-2016-0160

Commission Staff Division
Operational Analysis Department
Safety Engineering Unit
October 21, 2016
Jefferson City, Missouri

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I. EXECUTIVE SUMMARY

At approximately 6:00 a.m. Central Standard Time (CST) on December 14, 2015, a natural gas explosion and fire (Incident) occurred at the residential home of 5730 Mango Drive in Oakville, Missouri. The home was damaged as a result of the explosion and subsequent fire. When the Laclede Gas Company (Laclede or the Company) service technician arrived, the owners occupying the home had already evacuated the residence. There were no injuries requiring medical attention.

Laclede provides natural gas service in St. Louis, Missouri. The residence at 5730 Mango Drive was supplied natural gas through a 1/2-inch diameter polyethylene (PE) service line, connected to a 3-inch diameter PE main. The natural gas main was operating at approximately 21.5 pounds per square inch gauge (psig) at the time of the incident. Laclede conducted leak surveys after the explosion to determine the extent and migration of the leaking natural gas, and took steps to find and stop the flow of natural gas in the main.

Through its leak investigation and pressure tests of downstream piping, Laclede determined the source of the gas leak to be a butt heat-fusion joint[1] that failed on the 3-inch diameter PE main in front of 5730 Mango Drive (See Appendix C, Photographs 1 and 2). The Company's incident report indicated that natural gas escaping from the failed joint migrated into a nearby residential basement and ignited. The failed joint was located under a tree which was determined to be placing stress on the pipe and was a contributing factor to the joint failure.[2]

[1] Butt heat-fusion joint refers to a method of joining plastic pipe with a device that holds a heater element square to the ends of piping, compressing the heated ends together, and holding the pipe in proper alignment while the plastic cools.

[2] In accordance with 4 CSR 240-40.020(6), Laclede filed an Incident Report (Form PHMSA F 7100.1) with PHMSA, and Staff on January 13, 2016.

The Missouri Public Service Commission's Safety Engineering Unit (SEU) Staff (Staff) investigated the incident and generally agrees with the Company's determination of cause. In its investigation, Staff also reviewed the procedures Laclede used to install the failed butt heat-fusion joint for compliance with the contemporaneous regulatory requirements for installation of such joints. Staff also requested Laclede to excavate, examine and test additional heat-fusion joints installed at about the same time and in the same neighborhood as the failed joint to evaluate the strength of these joints.

The failed butt heat-fusion joint was installed in September of 1978. At that time, the regulatory requirements related to procedures for installing and joining plastic pipe were less stringent than today. Laclede had a written procedure for butt heat-fusion joining that complied with the regulatory requirements at the time the joint was made. The more stringent regulatory requirements that pertain to making butt heat-fusion joints today (e.g. requiring that joining procedures be qualified by testing specimens and that each person making a joint be qualified on the procedure) were published and became effective after 1978 and are not retroactive.

Based on Staff's visual examination of the butt heat-fusion joint involved in this incident, it was observed that there was a location of discontinuity in the roll back bead.[3] If this discontinuity had existed at the time the pipe was installed, it would not have met the requirements of the contemporaneous procedure which included observation of the joint formation while still applying pressure to ensure that a uniform double bead is forming all around the pipe. However, it is unknown if this discontinuity was present at the time of installation or resulted from later damage. Further, at this particular location (in the vicinity of

[3] Using the correct fusion pressure for butt heat-fusion will result in a double bead forming that is rolled over and contacts the pipe surface on both ends.

the bead discontinuity) on the pipe, the failure did not occur in the joint but rather in the body of the pipe. (See Appendix C, Photograph 1).

Additionally, since the pipe was bent and deformed by the force of tree root over time, it is unknown if the joined pipe would have presented a "well-aligned" appearance as required by Company's procedure effective at the time it was installed in 1978.

Since Staff has no way of determining the condition or appearance of the joined pipe at the time of installation, Staff cannot determine if there were any violations of applicable regulations for PE joining that were effective in 1978 when the pipe was installed. However, the failed joint would not have met current regulatory requirements for joining plastic, which result in making butt heat-fusion joints that are stronger than the body of the pipe.

Staff's investigation determined that there were three contributing factors to this incident: 1. the relatively weak butt heat-fusion joint that was susceptible to failure when placed in stress; 2. the presence of the tree root placing the joint in stress; and 3. a migration pathway for gas escaping from the failed joint to reach the residence.

In addition to determining the causes of failure, a purpose of performing an incident investigation is to evaluate and take steps to minimize the possibility of a recurrence. To evaluate the potential for recurrence, Laclede exposed and examined nearby heat-fusion joints installed at about the same time as the butt heat-fusion joint involved in this incident. Based on the results of examination and testing of these nearby heat-fusion joints, it is Staff's opinion that under similar circumstances (older vintage butt heat-fusion joint under stress from tree root, migration path to house) there is a possibility for reoccurrence of this type of failure.

The Company has implemented a Distribution Integrity Management Program (DIMP) in accordance with regulations[4] to identify and evaluate the relative risk of threats to its distribution pipelines and determine if additional corrective measures are warranted. However, prior to this incident occurring, older vintage PE heat-fusion joints had not been identified as a specific threat. Therefore, Staff has included 3 recommendations to the Company related to collection and evaluation of historical data as well as identification, monitoring and evaluation of this threat going forward in the STAFF RECOMMENDATION section of this report.

II. STAFF ANALYSIS OF INCIDENT AND CONCLUSIONS

A. Natural Gas Escape and Migration

Analysis:

The natural gas escaping from the failed butt heat-fusion joint on the 3-inch diameter PE gas main exited at a pressure of approximately 21.5 psig. Since natural gas is lighter than air,[5] it will tend to migrate along paths of least resistance through the soil and upward into the atmosphere; however, at the time of this incident the top surface layer of soil was saturated from recent rainfall, and this would have restricted the upward migration of the natural gas into the atmosphere. Because the water service line and gas main were near the location of the gas leak, and the water service line had direct path into the foundation underground, this would have been a possible path of least resistance for the gas to enter the home (See Appendix C, Photograph 2). The exact route the gas followed to reach the foundation of 5730 Mango Drive is unknown.

[4] 4 CSR 240-40.030(17).

[5] Natural gas has specific gravity of approximately 0.6 while air has a specific gravity of 1.0.

Conclusion:

Natural gas leaking from the gas main on Mango Drive migrated along unknown underground paths up to and into the foundation of the house at 5730 Mango Drive.

B. Natural Gas Entrance, Accumulation, and Ignition

Analysis:

The foundation wall for 5730 Mango Drive was constructed of concrete. Natural gas migrating to and along the concrete foundation could have entered the basement through any cracks or utility entrance holes in the foundation that were in the path of migration. Natural gas entering the structure at 5730 Mango Drive accumulated to an explosive mixture[6] and was ignited. The home was occupied at the time and contained several possible ignition sources.

Conclusion:

Natural gas entered the structure at 5730 Mango Drive through cracks or holes in the concrete foundation wall, accumulated, and were ignited by an undetermined source.

C. Plastic Pipe Joining Regulations

Analysis:

March 12, 1971 to July 1, 1980

On August 19, 1970, the U.S. Department of Transportation-Office of Pipeline Safety (DOT-OPS) promulgated 49 CFR part 192 and prescribed in §192.13(a) that the regulations regarding installation applied to pipeline segments "readied for service after March 12, 1971". The Missouri Public Service Commission (Commission) adopted 49 CFR part 192 after it was issued by DOT-OPS. Subpart F, titled *Joining of Materials Other Than by Welding*, contained §§192.271 through 192.281. In §192.273 titled *General,* paragraphs ((a), (b) and (c)) stated:

[6] The explosive range for natural gas in air is a mixture of between about 4.5 percent and 14.5 percent gas-in-air.

(a) The pipeline must be designed and installed so that each joint will sustain the longitudinal pullout or thrust forces caused by contraction or expansion of the piping or by anticipated external or internal loading.

(b) Each joint must be made in accordance with written procedures that have been proved by test or experience to produce strong gastight joints.

(c) Each joint must be inspected to insure compliance with this section.

In §192.281 titled *Plastic Pipe*, paragraphs (c)(1) stated:

(c) *Heat-fusion joints.* Each heat-fusion joint on plastic pipe must comply with the following:

(1) A butt heat-fusion joint must be joined by a device that holds the heater element square to the ends of the piping, compresses the heated ends together and holds the pipe in proper alignment while the plastic hardens.

A revision in January 1, 1980, added 49 CFR 192.285 requiring qualification of persons making plastic joints:

§192.285 Plastic pipe; qualifying persons to make joints.

(a) No person may make a joint in a plastic pipe unless that person has been qualified under the applicable joining procedure by:

(1) Appropriate training or experience in the use of the procedure; and

(2) Making a specimen joint from pipe sections joined according to the procedure, that is-

(i) Visually examined and found to have the same appearance as a joint or photographs of a joint that is acceptable under the procedure; and

(ii) In the case of heat fusion, solvent cement, or adhesive joint, cut into at least 3 longitudinal straps, each of which is -

(A) Visually examined and found not to contain voids or discontinuities on the cut surfaces of the joint area, and

(B) Destructively tested and found not to have failed in the joint area.

(b) No person determined to have made three or more unacceptable joints under an applicable joining procedure within any 12-month period may be considered qualified under that procedure in accordance with paragraph (a) of this section until that person has been requalified under paragraph (a)(2) of this section.

(c) Each operator shall establish a method to determine that each person making joints in plastic pipelines in his system is qualified in accordance with this section.

A revision in July 1, 1980, added a requirement to 49 CFR 192.283 that procedures for nonlateral pipe connections (e.g. butt heat-fusion) produce joints that withstand greater tensile force than the body of the pipe:

§192.283 Plastic pipe; qualifying joining procedures.

(a) Heat Fusion, Solvent Cement, and Adhesive Joints. Before any written procedure established under §192.273(b) is used for making plastic pipe joints by a heat fusion, solvent cement, or adhesive method, the procedure

must be qualified by subjecting specimen joints made according to the procedure to the following tests:

(1) The burst test requirements of Paragraph 8.6 (Sustained Pressure Test) or Paragraph 8.7 (Minimum Hydrostatic Burst Pressure) of ASTM D2513;

(2) For procedures intended for lateral pipe connections, subject a specimen joint made from pipe sections joined at right angles according to the procedure to a force on the lateral pipe until failure occurs in the specimen. If failure initiates outside the joint area, the procedure qualifies for use; and

(3) For procedures intended for nonlateral pipe connections, follow the tensile test requirements of ASTM D638, except that the test may be conducted at ambient temperature and humidity. If the specimen elongates no less than 25 percent or failure initiates outside the joint areas, the procedure qualifies for use.

Conclusion:

At the time the Company installed the gas main on Mango Drive, applicable regulations required that specific steps had to be followed to join pipe together in accordance with Company joining procedures. However, regulatory requirements for testing individuals to demonstrate their ability to join pipe correctly did not go into effect until January of 1980, and requirements that the joint be able to withstand greater tensile forces than the pipe body did not go into effect until July 1, 1980.

D. Laclede's Procedures for Joining Polyethylene Plastic Pipe

Analysis:

Regarding the regulation for joining plastic pipe**,** Laclede had an established written procedure for the installation of PE pipe, specifically related to butt heat-fusion joints in the Laclede Gas Company Standard No. 10503A, dated 5-25-78. The butt heat-fusion procedure contained eleven steps for properly making a butt heat-fusion joint. Steps 1-7 addressed the preparation of the pipe, which included proper facing and aligning of the pipe. Steps 8-10 addressed how to properly heat and bring the pipe ends together. Step 10 required that the double bead formed by the fusion "…should roll all the way over to the outer surface of the pipe. Observe the joint formation while still applying pressure to ensure that a uniform double bead is forming all around the pipe or tubing." Step 11 addressed leaving the pipe in place until it cooled, removing it from the alignment clamps, and visually inspecting the fusion joint for a uniform non-porous appearance, and well aligned around its entire circumference (See Appendix B, Figure 1).

Conclusion:

At the time the PE main was installed on Mango Drive (September, 1978), the Company's procedures met the regulations for joining pipe by the method of butt heat-fusion referenced above. Upon visually examining the fusion joint (See Appendix C, Photograph 1), it exhibited a void in the double bead which if present at the time the pipe was installed would not have met the requirements in step 10 of the procedure. Further, there was some visual evidence of joint misalignment. However, due to stresses placed on the pipe by the tree roots, it is not possible to determine the visual appearance of the joint alignment at the time it was installed, or if it would have met the procedural requirement for a "well aligned" appearance around its entire circumference.

Staff requested a copy of joining procedures from the pipe manufacturer. Laclede provided a copy of a document titled "Complete P.E. Pipe Systems Heat Fusion Procedures & Qualification Guide 1981, Continental Industries Inc.", and stated that this was the most relevant procedure the manufacturer could provide. The pipe manufacturer (Continental Industries, Inc.) document from 1981 recommended a practice with criteria for visual observation of a butt heat-fusion joint in the field. Items included for those criteria are: Non-uniform, porous, or voids in the melt beads, which is not inconsistent with the Company's written procedures.

While the present day appearance of the joint would not have met the contemporaneous requirements for visual observation, it is unclear how the joint appeared when it was installed in 1978.

E. Staff Investigation of Nearby Fusion Joints

Analysis:

During the investigation process, the Company and Staff agreed that other butt heat-fusion joints of similar age in the vicinity of the incident site should be dug up and examined for their integrity.

The Company researched its construction records and determined that between August 28, 1978 and September 13, 1978, approximately 789 feet of the 3-inch gas main was installed along Mango Drive under work orders (WO) 66273 and 66274 (See Appendix B, Figure 2). Based on this and the length of pipe sections used, the Company determined that there were approximately 21 3-inch fusion joints within the WOs. Of the 21 3-inch joints, Staff requested ten fusion joint locations be inspected. While searching for these 10 locations, the Company unearthed two other locations north of the incident site, which were installed in April of 1977, under fusion procedure 10503. This procedure was used prior to the procedure

used to create the joint involved in the incident. These locations were labeled 1NX and 2NX (See Appendix B, Figure 3).

On June 3, 2016, Staff personnel arrived at Mango Drive and all 12 of the excavation sites were dug, and the plastic main was ready to be inspected. Staff and Laclede examined each fusion joint location with a systematic approach which included:

1. Cleaning the exposed pipe of any residual mud.

2. Using a pipeline inspection mirror, and examining the whole circumference of the fusion.

3. Leak detecting soap solution was applied to the fusion area so any leaks, if present, would be evident.

4. Using a steel bar, pipe straps, and wooden blocks for leverage, the pipe was deflected latterly and then vertically by hand in an attempt to reveal any defects present.

5. Leak detecting soap solution was applied again, and the pipe was observed for any leaks. (See Appendix C, Photographs 3-5).

During the inspection process, Staff did not observe leaks at any of the exposed fusion joint locations. Based on the visual inspection of the fusion joints, five locations were selected to be removed, examined, and tensile tested at the Company's physical testing lab facility. Staff conferred with Company personnel after the inspection was completed, and fusion joint locations 1NX, 2NX, 1N, 1S, and 8S were selected to be removed for further examination and testing. Staff and Company representatives agreed on a testing protocol, which included measuring the bead height of the joints, pressure testing with air, and destructive tensile testing.

On August 9-10, Staff went to Laclede's physical testing lab facility to witness the examination and testing of the five removed fusion joints. The fusion joint bead height measurements were taken to observe any indication of misalignment in the pipe, and also observe any voids in fusion joints (See Appendix C, Photograph 6). Air pressure testing was performed on the five specimens to determine if any leaks existed in the pipe prior to destructive testing. The air pressure testing was conducted in two phases. The first air pressure test was conducted at 30 psig, and if there was no indication of leaks, the pressure was increased to 90 psig (See Appendix C, Photograph 7). The destructive tests were conducted in two different formats, depending on the pipe configuration. Specimen 1N was the only segment that consisted of one butt heat-fusion joint on the 3-inch pipe (See Appendix C, Photograph 8). This segment was cut into straps and tested using the facilities' tensile/torque testing machine (See Appendix C, Photograph 9). The other sections (1S, 1NX, 8S, and 2NX) consisted of 4 fusion joints (3 butt heat-fusion, and 1 socket heat-fusion[7]) (See Appendix C, Photograph 10). These sections were in a "T" configuration, where the trunk portion was 3-inch pipe with a manufactured 3-way connection, and either a 3-inch to 1¼ -inch manufactured reducer connected with a socket heat-fusion connection (1S, 1NX, and 2NX), or a 3-inch to 2-inch manufactured reducer connected with a socket heat-fusion connection (8S). These four test sections were kept intact, and tested with a floor to ceiling tensile testing machine designed for plastic pipe. Each of the four sections was tested in two directions. The first test on the 3-inch trunk section, and the second on either the 3-inch to 2-inch or 1¼ -inch T-connection with the socket fitting (See Appendix C, Photograph 11). All of the tests on this machine were done until a portion of the plastic pipe or joint yielded.

[7] A socket heat-fusion joint must be joined by a device that heats the mating surfaces of the joint uniformly and to essentially the same temperature.

Four of the five pipe segments contained joints with measurable differentials in bead height, and/or irregular fusion formation which were likely introduced at the time of installation. The exception was the 1N segment, which had one flaw in the fusion area that had likely resulted from post-installation excavation activity.

All segments passed the 30 and 90-psig pressure tests.

The four test section that were kept intact, and tested with a floor to ceiling tensile testing machine designed for plastic pipe passed the destructive tensile tests. Two of the four straps taken from the only in-line joint, sample 1N, failed the torsional tensile test. Prior to testing, the circumference of the pipe near the fusion was labeled with numbers 1-12, spaced approximately 1-inch apart. Regarding orientation, 12 was labeled at the top of the pipe, as if it was lying in the ground, and 6 at the bottom. During the tensile/torque test, the fusion failed between the #6 and #7 locations, and also at the #3 location (See Appendix C, Photograph 12).

Conclusion:

Based on observations from examining the plastic pipe from the incident site, the exposed fusion joint locations along Mango Drive on June 3, 2016, and testing the selected segments in the physical testing lab facility on August 9-10, Staff's opinion is that the PE plastic pipe installed by the Company using the Polyethylene Plastic Pipe Heat Fusion Procedure per Laclede Gas Company Standard No. 10503A, or prior Standard No. 10503, is susceptible to failure in the fusion area. Additionally, the risk of failure is increased when an outside force is introduced.

III. STAFF RECOMMENDATIONS

The PE heat-fusion joint involved in the incident as well as some of the additional nearby joints tested in this case were inferior in strength and quality to PE heat-fusion joints made in accordance with current-day joint procedures, joint inspections, and regulations[8] by joiners who have been annually qualified. It is not currently known how much similar vintage piping exists in Laclede's system in locations where the same or similar circumstances may exist (i.e., older heat-fusion joint under a tree root with migration route to building).

Gas Distribution Integrity Management (DIMP) regulations[9] require that each gas distribution operator develop and implement an integrity management program no later than August 2, 2011. Program elements must include a demonstrated knowledge of the system, identification of threats, evaluation and ranking of risk, identification and implementation of measures to address risks, measurement of performance, monitoring of results and evaluation of effectiveness. Sources of data to be considered in DIMP include incident and leak history. In implementation of DIMP, a baseline is established for threats to monitor the effectiveness of the program.

The specific system threats as identified for this incident are the relative weakness of older vintage heat-fusion joints and the exertion of forces by tree roots to PE pipe segments installed beneath trees. Laclede already monitors tree roots as a sub threat in its DIMP,[10] and is

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[8] The joint involved in the incident and the other joints tested in this case were made in accordance with a procedure dated 05/25/1978. In 1978, this procedure was compliant with the contemporaneous pipeline safety regulations, however the requirements for PE fusion joints were made more stringent in 49 CFR 192 Subpart F effective July 1, 1980. Missouri adopted these more stringent standards into 4 CSR 240-40.030(6). This revision to the regulations required among other things that PE heat-fusion joints be made in accordance with a procedure that produced joints that are stronger than the pipe.

[9] 4 CSR 240-40.030(17).

[10] GS-2016-0160, DR 0030 supplemental response 2.

knowledgeable regarding the date of installation of pipe segments in its system. However, prior to this incident, the need to evaluate the effect of tree roots on older vintage heat fusion joints and other potential failure mechanisms for these joints had not been identified.

Laclede has begun to monitor threats and sub-threats annually on a 5-year rolling average in its DIMP. Relevant to this incident, Laclede stated that it is planning to take actions to add the sub-threat categories of pre- and post- July 1981 plastic fusion joints to its DIMP, research Company records to determine when its plastic fusion joining procedures were revised to address the federal rule change related to fusion joining, and perform a 5-year review of leak history for this category of pipe for Laclede's system. Laclede further plans to: monitor the risk of the sub-threat of pre-July 1981 plastic fusion joints, document fusion failures by type (e.g. butt, socket, electrofusion), and evaluate failed fusion joints at a physical testing lab facility to confirm the type of fusion joint that failed[11]. Staff is in general agreement with the Company's planned actions and has developed a list of three specific recommendations listed below. Staff will review this new monitoring as part of its DIMP inspections of Laclede.

Staff recommends that the following be done to include identification, monitoring and evaluation of these threats going forward in the Company's DIMP:

1. Staff recommends that Laclede gather and provide to Staff the following information that will serve as a baseline to assess these threats going forward:
    A. Review its historical PE heat-fusion procedures to determine when the Company first required its PE joiners to be qualified to make PE heat-fusion joints in accordance with a procedure that produced joints

[11] GS-2016-0160, DR 0030 supplemental response 2.

stronger than the pipe.[12] If this date cannot be determined, a default of July 1, 1981, should be used.[13]

B. Review its past leak history on the PE pipe installed using heat fusion joining methods **prior to and including** the date determined in part A above (or July 1, 1981 if date cannot be determined) for a period covering the past five years of data and determine:

   i. Number of leaks attributed to joint failure per year;

   ii. Number of leaks with contributing factors of roots indicated per year; and

   iii. Number of leaks where the cause was not determined per year.[14]

C. Review its past leak history on the PE pipe installed using heat fusion joining methods installed **after** the date determined in part A above (or July 1, 1981 if date cannot be determined) for a period covering the past five years of data and determine:

   i. Number of leaks attributed to joint failure per year;

   ii. Number of leaks with contributing factors of roots indicated per year; and

   iii. Number of leaks where the cause was not determined per year.

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[12] Specifically, when the Company's procedures were revised to be consistent with the requirements of 49 CFR 192.281, 192.283 and 192.285 that were effective as of July 1, 1980.

[13] Staff added one year after the effective date requiring that the joint be stronger than the body of the pipe, assuming that some time would have been required for Missouri to adopt the federal regulation and for Laclede to implement revisions to its procedures.

[14] This recommendation is included to capture instances where pipe was not excavated to determine the cause of a leak, but instead repair was made by installing a replacement segment of pipe. Staff's opinion is that that may have been the case in the past when leaks occurred under trees. Rather than remove the tree to determine the cause of the leak, the Company may have installed replacement piping.

2. Staff recommends that going forward, the Company should:
    A. Revise its applicable procedures to require field personnel to remove and retain each PE pipe segment where tree roots could have contributed to the leak;
    B. Have knowledgeable personnel examine the segments in the field to determine and document if the tree roots contributed to the leak by exertion of force or were simply present in the excavation and did not contribute to the leak;
    C. For each instance where tree roots contributed to the leak, record where the leak occurred (e.g. body of pipe, heat-fusion joint);
    D. For each instance where tree roots contributed to the leak, determine and record the installation date of the pipe; and
    E. Compile the data on an on-going basis and evaluate annually to determine if there are any ascertainable trends in damages done by tree-roots.

Staff further recommends that this additional monitoring be incorporated into the Company's DIMP, and that the results be reviewed annually to evaluate the relative risk ranking and determine if additional corrective measures or accelerated actions are warranted.

3. Staff recommends that going forward, the Company should:
    A. Add a sub-threat of PE heat-fusion joints installed on or before July 1, 1981 (or other date as determined in recommendation 1 by review of procedures), under the Material/Weld/Joint category of its DIMP plan;

B. Revise its applicable procedures to require field personnel to remove and retain each PE heat-fusion joint that appears to have failed resulting in a leak;

C. Have knowledgeable personnel examine each retained PE heat-fusion joint to determine and document whether the failure occurred in the joint or in the body of the pipe;

D. For each instance where a failure occurred in a heat-fusion joint, record additional contributing factors (e.g., tree root, past excavation damage);

E. For each instance where a failure occurred in a heat-fusion joint, determine and record the installation date of the pipe; and

F. Compile the data on an on-going basis and evaluate annually to determine if there are any ascertainable trends in PE heat-fusion joint failures.

Staff further recommends that this additional monitoring be incorporated into the Company's DIMP, and that the results be reviewed annually to evaluate the relative risk ranking and determine if additional corrective measures or accelerated actions are warranted.

APPENDIX A

DETAILED DISCUSSION OF FACTS AND STAFF'S INVESTIGATION

NOTE: The information presented in Appendix A was obtained through Staff's on-site investigation; and records and reports of Laclede Gas Company and other entities.

A. The Incident

Between 6:00am and 6:10am[15] on December 14, 2015, a natural gas explosion and fire occurred at 5730 Mango Drive in Oakville, Missouri.

B. Damages

The two owners of the home at 5730 Mango Drive occupied the residence the morning of December 14, prior to the explosion and fire. Upon the Company's arrival, the local fire department had already evacuated the residence, shut off the gas / electric service, and begun to control the fire. No injuries requiring medical attention were reported.

The home at 5730 Mango Drive was damaged as a result of the natural gas explosion and subsequent fire (See Appendix C, Photographs 13-16). While not completely destroyed, due to the explosion, fire, and subsequent smoke damage, an estimated $300,000 in property damage was incurred[16].

C. Site Description

5730 Mango Drive is located in a residential neighborhood approximately twenty minutes south of the central St. Louis metro area. Mango Drive runs from north-northeast to south-southwest (See Appendix B, Figure 2). The structure was of cement foundation construction, with a basement, and first and second floor living levels. The area surrounding 5730 Mango Drive is zoned primarily for single family residences.

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[15] In response to GS-2016-0160, DR 0001, the Company stated that it believes the time of the incident was between 06:00 hours and 06:10 hours.

[16] Form PHMSA F 7100.1 Report ID 201600002.

D. Meteorological Data and Conditions

On Monday, December 14, 2015, the sky was mostly overcast / cloudy and there was light precipitation throughout the day. A total of 0.38 inch of rainfall for the day was reported from the local weather stations. The high, low, and mean temperature for the day was 57 ^{o}F, 46 ^{o}F, and 52 ^{o}F, respectively. None of the weather stations reported any snow or ice on the ground. The average wind speed on December 14 was 16 mph with maximum wind gusts up to 39 mph.[17]

E. Natural Gas System

Natural gas service in St. Louis, Missouri is provided by Laclede Gas Company. A 3-inch diameter PE natural gas main is located along the east side of Mango Drive; approximately five feet west of the east curb line (See Appendix B, Figure 2). The main was installed in 1978 and operates with a maximum allowable operating pressure (MAOP) of 60 psig. At the time of the incident, the main was operating at a pressure of approximately 21.5 psig.

F. Leakage Surveys

Laclede completed leak surveys of the gas distribution mains and service lines in the neighborhood including 5730 Mango Drive on September 25, 2013[18]. At the time of the leak surveys, Laclede did not detect any leaks on below ground facilities within a one-block radius of 5730 Mango Drive.

[17] Data obtained from Weather Underground historical weather data for Lambert International Airport.

[18] 4 CSR 240-40.030(13)(M)2.B. requires leak surveys of this type of distribution main at least once each third calendar year at intervals not exceeding 39 months. Laclede had not exceeded this interval at the time of the incident.

G. Odorization

The records of odor intensity tests performed by Laclede in the distribution system serving the incident location demonstrated that the natural gas was readily detectable at gas-in-air concentrations of approximately 0.35 percent[19] during the month prior to the incident. Following the incident on December 14, 2015 Laclede performed odorant intensity tests at locations surrounding 5730 Mango Drive and found the gas to be readily detectable at concentrations of 0.37-0.42 percent gas-in-air.

H. Laclede Notification and Actions

One of the occupants called 911 at about 6:11 a.m. and reported a house fire. At 6:26 a.m. on December 14, 2015, the Mehlville Fire Protection District reported a house fire at 5730 Mango Drive to a Laclede dispatcher. At 6:29 a.m. a Service Technician was assigned to respond to the order, and arrived at the location of the house fire at 6:58 a.m. The fire department was working at controlling the fire when the technician arrived, and notified the technician that it had turned off the electric and gas service at the meter. At the time of the Service Technician's arrival, there was no gas odor noted in the air and no signs of an explosion from the vantage point on the street. The Company was prevented from performing a full investigation due to ongoing Fire Department activities.[20] At 7:05 a.m. the technician performed a Combustible Gas Indicator (CGI) reading at the meter location, near the foundation, and at the service tee over the main at 7:10 a.m. Sustained gas readings were present at both locations. Readings were also taken at nearby homes on Mango Drive (5726, 5722, 5733, and 5738), at the outside walls, over

[19] MoPSC regulation 4 CSR 240-40.030(12)(P)1. requires the odorant in natural gas to be readily detectable at a concentration of less than 0.90 percent gas-in-air, assuming a lower explosive limit at 4.5 percent gas-in-air. Measured concentrations of 0.9 or lower therefore meet the regulatory requirement.

[20] GS-2016-0160, DR-0001.

gas service lines, service tee locations, and sanitary sewer locations. While no gas was found present at sanitary sewer locations, based on outlying bar-hole readings the technician determined that gas was migrating underground in the front yard of 5730 Mango Drive.

At 7:55 a.m. the Service and Inspection Department (SAID) technician determined with the fire department that house debris in the backyard was not from fire department activities and that the situation was more than a house fire; the SAID technician requested assistance from the department administrator; and at 8:03 a.m. additional leak truck support was requested. Leak investigations continued, and gas was found inside the homes of 5738 and 5730 Mango Drive. The gas readings ranged from 1.5 % to 3.0 % in localized areas (near sump and floor crack). Laclede's procedures require that when CGI readings greater than or equal to 1 percent gas-in-air are found inside a building, in the free air, a "safe zone" must be established where all customers, members of the public, and Laclede employees are kept out of an affected area. Since the readings inside the homes were not found in the free air, the residences were not evacuated, but the windows and doors were opened to ventilate, and then monitored routinely as a precaution.

Once the extent of the leak migration was determined along Mango Drive, the Company determined the origin of the leak. At 9:21 a.m. Laclede personnel contacted MO One Call to request emergency locates of underground facilities for excavations that were necessary to respond to the incident. At 9:45 a.m. the Company's Manager, Pipeline Safety Compliance notified the Commission's SEU Staff that an incident had occurred involving the Company's facilities and provided preliminary information.

At 10:15 a.m., the Company began "air-jacking"[21] at 5738 Mango Drive to remove gas from around the foundation. At 10:16 a.m. the Company notified the National Response Center of the incident. At 12:39 p.m. the Company dug up the service line to 5730 Mango Drive and conducted a pressure test of 18 psig with an air medium. The pressure held, and the Company eliminated it as a source of the leak. Similarly, at 1:30 p.m. the service tee to 5738 Mango Drive was exposed, and successfully passed a pressure test, which ruled it out as a source of the leak. The Company began isolating locations on the gas main, based on the highest gas reading locations; the gas main was excavated in several locations until the leak was pinpointed to a location in front of 5730 Mango Drive under an oak tree. At 9:30 p.m. the main was squeezed-off[22] (See Appendix C, Photograph 17) near the location of the leak, and two one-inch PE service lines were used to bypass the leak on the main and maintain service to customers downstream.

On the morning of December 15, a tree removal service removed the tree, which was over the PE main in the location of the leaking butt heat-fusion joint. After the tree top was removed, the Company began removing the base of the tree and the roots to expose the pipe. At approximately 1:30 p.m., the butt heat-fusion joint, and an approximately 20-foot section of pipe was removed and taken into custody by Laclede. The section removed between the squeeze off points was later replaced, and air-jacking continued in the leak migration area until December 29. At that point, no residual gas was remaining in the ground.

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[21] "Air-jacking" is a Laclede term used to describe the procedure of forced ventilation of the subsurface atmosphere. The purpose of the "air-jack" is to eject a volume of air out of a subsurface area that is to be ventilated. To draw natural gas from a subsurface area, a pipe connected to an air compressor is inserted into a bar-hole, excavation, man-hole, etc., and the air flow creates a venturi effect in the pipe that results in a vacuum in the space to be ventilated. This accelerates the removal of natural gas from the space to be ventilated.

[22] A squeeze-off tool is used to clamp the pipe shut, eliminating the flow of natural gas downstream.

I. MoPSC Reporting Requirements

The incident reporting requirements in 4 CSR 240-40.020(3), (4) and (5) were completed as follows:

1. Laclede was made aware of the fire at 6:26 a.m. and became aware of the presence of a gas leak at 7:10 a.m. The leak investigation continued, and after about 8:00 a.m., Laclede became aware that the leak was not localized. Laclede made the initial telephone notification of a possible natural gas incident to a Staff member at approximately 9:45 a.m. December 14, 2015.[23]
2. Laclede notified the National Response Center (NRC) of a natural gas incident at approximately 10:16 a.m. on December 14, 2015.[24]
3. DOT-PHMSA form PHMSA F 7100.1 titled "Incident Report – Gas Distribution System" was completed by Laclede and initially submitted to Staff on January 13, 2016. Laclede also submitted the form to DOT-PHMSA electronically.[25]

J. Missouri Public Service Commission Staff Investigation of Incident: December 14 and 15, 2015

Three SEU Staff members were in St. Louis for a routine safety inspection, and arrived at the incident scene at approximately 11:25 a.m. on December 14, 2015. Two additional Staff members were dispatched from Jefferson City, and arrived at the incident site at approximately

[23] MoPSC regulation 4 CSR 240-40.020(4)(A) requires the operator to notify designated commission personnel by telephone within two hours following discovery, unless efforts to protect life and property would be hindered, for each event which meets the natural gas incident reporting requirements.

[24] 4 CSR 240-40.020(3)(A) requires notification of federal incidents at the earliest practicable moment following discovery.

[25] 4 CSR 240-40.020(6)(A) requires submission of an incident report not later than 30 days following detection of a reportable incident.

1:00 p.m. on December 14, 2015. After the two additional Staff arrived, the three original SEU Staff left shortly after at approximately 1:30 p.m., so they could complete their routine safety inspection.

SEU Staff observed that the residence located at 5730 Mango Drive was damaged from the explosion and fire. In the rear portion of the house, glass and home debris were strewn into the back portion of the lawn. Fire damage was also evident around and on the inside of the home, but due to structural integrity concerns, Staff did not enter the residence. The Company informed Staff that gas readings were not isolated to 5730 Mango Drive. The leak cause and location were unknown at the time of Staff's arrival at approximately 11:25 a.m.

Most of the daytime hours of December 14th were spent monitoring the readings at and around the nearby homes of 5730 Mango Drive, and looking for the origin of the leaking gas.

At approximately 12:00 p.m. Staff took an odor intensity reading at 5738 Mango Drive and gas was readily detectable at a gas-in-air concentration of approximately 0.60 %**.** The odorant intensity readings may vary from person to person, based on their sensitivity to smell. However, as long as the reading taken is not greater than 0.9%, the odorant is at an acceptable level. Missouri's Rule 4 CSR240.030 (12)(P) requires that a gas must be odorized so that the presence of gas is readily detectible at 1/5 of the lower explosive level. The lower explosive limit of natural gas is approximately 4.5% gas-in-air.

As the excavation approached the vicinity of the leak location on the main, the soil in the excavation appeared to be dry and absent of moisture (See Appendix C, Photograph 18), a possible indication that a leak had been present at that location for an extended amount of time[26]. Once the leaking butt heat-fusion joint was exposed, a Laclede employee pulled up on the

[26] It is not possible to determine the exact time that the leak began, therefore there is no reason to question the accuracy of the leak survey of this main conducted by Laclede in September 2013.

exposed section of pipe, and an audible “pop” was heard near the butt heat-fusion joint location. Shortly after, the section of main that was beneath the tree and between the bypass locations was removed. Once the pipe section was removed and placed on the ground, the curvature of the pipe indicated that the tree root had exerted pressure on the pipe in the vicinity of the butt heat-fusion joint (Appendix C, Photograph 19).

APPENDIX B
FIGURES

VALVES

Valve installations in plastic pipe shall be made in such a manner as to protect against excessive torsional loads when the valve is operated. Care shall also be taken to guard against secondary stresses which might be exerted through the valve or its enclosure.

SECTION II - HEAT FUSION PROCEDURE

GENERAL

Before attempting to fuse plastic, check condition of tools and equipment. Heating irons should be clean. Use soft material such as a wooden paddle or white paper towel to clean the iron. Do not use metal scraper, steel wool or cloth.

Butt fusion machine should be cleaned and lubricated regularly. Slide should be free running and clamp jaws should be clean.

Facer cutting heads should be clean.

Surface temperature of the heating iron should be 490°F ± 10° F. Too hot an iron can scorch the plastic - too cool an iron can result in incomplete fusion. Correct heating iron temperature is a prime requisite for a soumd fusion joint.

NOTE: CHECK HEATING IRON SURFACE TEMPERATURE WITH PYROMETER BEFORE ATTEMPTING TO FUSE. DO NOT DEPEND ON THERMOMETER FURNISHED WITH IRON. THIS APPLIES TO ELECTRIC HEATING IRON AS WELL AS PROPANE FIRED IRON.

PREPARATION BEFORE FUSION

Inspect the ends of the pipe to see if they have flattened during storage. It may be necessary to cut back a foot or two to eliminate excessive distortion which otherwise could result in an incomplete melt pattern and poor fusion.

BUTT FUSION

A. INTRODUCTION

The Butt Fusion process consists of facing the polyethylene pipe ends and heat fusing them together. The necessary tools are:

1. Facing tool. This tool has a cutting head mounted on each side which enables the planing of both pipe ends simultaneously.

2. Heating platen with internal thermometer (gas fired or electrically heated)

3. Pyrometer, 250° to 600° F.

4. Pipe cutter, white paper towel, and cleaning solvent.

5. Butt fusion machine. The machine is a series of line-up clamps which allow movement at one end, enabling the facing, heating and joining processes to be accomplished while maintaining secure clamping and line-up of the pipe and fittings. The machine is a portable unit which accepts several sizes of pipe.

6. 20# propane gas tank and burner or generator.

BUTT FUSION PROCEDURE

1. Preheat the heater plate to a surface temperature of 490°F ± 10° F. Wipe each face of the heater plate with a clean paper towel to remove plastic stuck to the face and all other foreign material. To determine when the proper heater plate face temperature is reached, apply pyrometer to a spot on the heater face surface that is in the area where the plastic piping is to be heated.

2. Select the proper adapter inserts for the size of piping to be fused and insert them into the alignment clamps.

NO. 10503A	LACLEDE GAS COMPANY STANDARD	APPROVED BY	COMMITTEE
Date 5/25/78	POLYETHYLENE PLASTIC PIPE GENERAL SPECIFICATIONS AND HEAT FUSION PROCEDURE		Hofer Horowit Maag Vogel Vogt
Page 4 of 8			
Supersedes Std. Date 10503 8/25/76	BOOK TYPE [X][X][X][X] 5 [X] 7 8 9 10 F-869C-4-72		

3. Examine the ends of the piping for damage. Cut off any damaged ends as squarely as possible. Wipe the surfaces and face of the pipe with clean paper towels and solvent to remove dirt, water, grease or any other foreign matter.

4. Carefully place the facing tool into position between the alignment clamps and lock into position with the provided locking device.

5. Place the pipe in the fusion unit alignment clamps. Allow enough pipe to protrude from each clamp toward the facing tool to permit a clean face-off of each end. Clamp the pipe in place.

6. Move the actuating handle of the moveable alignment carriage until the pipe or tubing ends make contact with the facing tool. Apply light pressure on the actuating handle and at the same time operate the facing tool. Continue to apply pressure while facing-off until a continuous chip is being cut from circumference of pipe, release activating handle and allow facer to run freely for several revolutions before stopping.

7. Remove the facing tool and clean away all cuttings from the pipe. (NOTE - Due to the presence of natural oils and moisture in human skin, the freshly faced ends of pipe or tubing should not be touched with bare hands) Check the line-up of the pipe by butting the ends together. With correct facing the pipe ends should butt together without any gaps between the faces. If the line-up is not proper, reface the pipe.

8. Insert the clean heater plate between the pipe ends. The plate should be just short of contact with the face of the pipe in the stationery alignment carriage. Actuate the moveable alignment clamp until the pipe end makes contact and forces the heater plate against the stationary end with only slight pressure. Support iron to prevent movement. Do not put any added pressure against the plate as the necessary melt beads (approximately 1/16") will form on the heater plate from normal expansion of the plastic as it melts.

9. Retract the moveable alignment clamp. Carefully remove the heater plate. If the softened plastic adheres to the heater plate, discontinue the process and restart from step 4.

10. As quickly as possible after removing the heater plate, bring the pipe ends together and apply sufficient pressure to form the double bead (approximately 1/8"). The double bead should roll all the way over to the outer surface of the pipe. Observe the joint formation while still applying pressure to insure that a uniform double bead is forming all around the pipe or tubing. Maintain enough pressure so that the joint will not contract while cooling. The beads should have complete roll back.

11. Do not remove the pipe from the fusion unit until the fused joint is cool enough to touch. After the joint has cooled, remove the pipe from the alignment clamps and inspect the joint for a uniform non-porous, well aligned appearance around its entire circumference.

Figure 1-- Laclede Gas Company Standard for Fusing PE pipe No. 10503A, dated 5-25-78

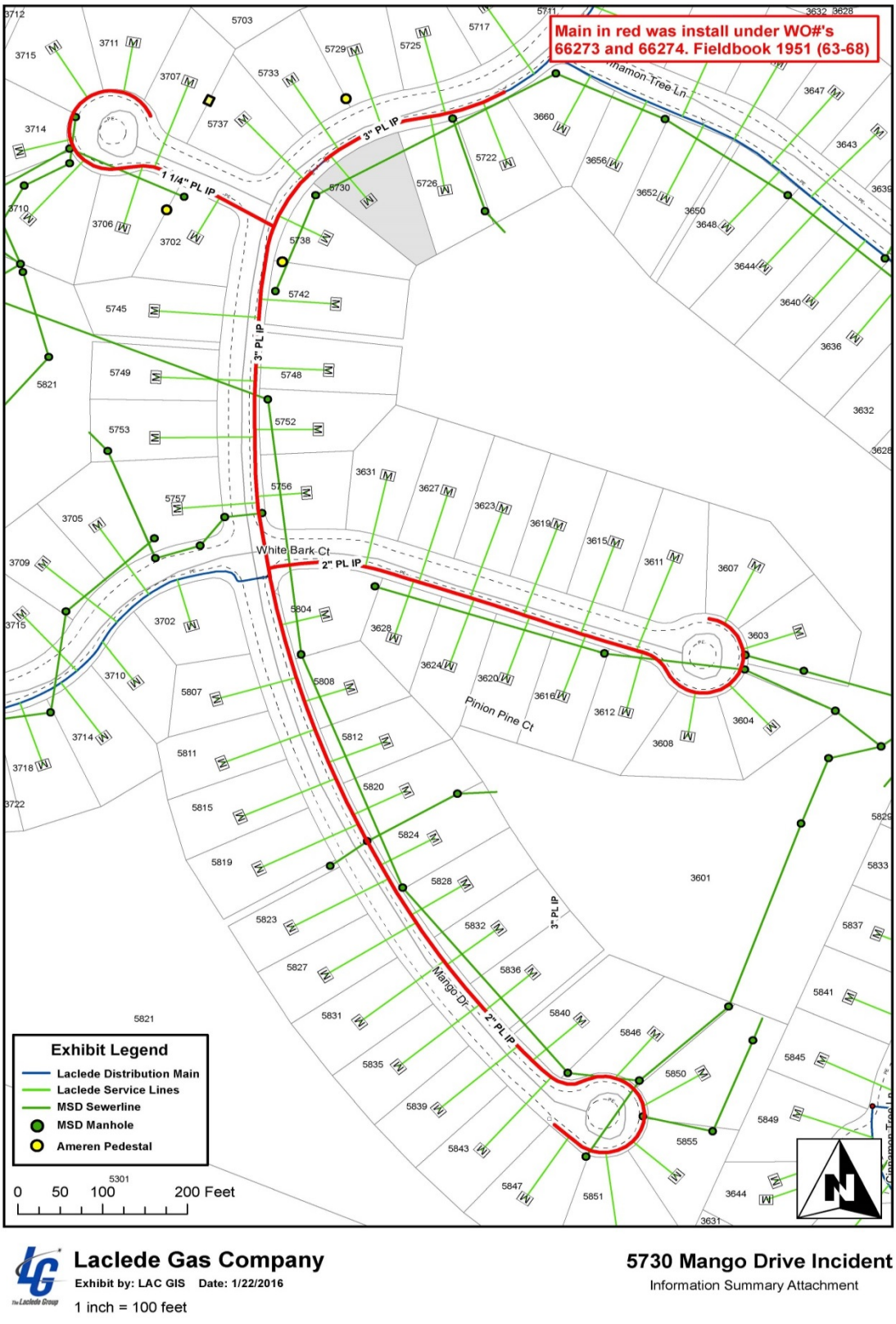


Figure 2 –Main Work Orders in Vicinity of 5730 Mango Drive (Provided by Laclede)

Figure 3 – Locations selected for fusion inspection on 3-inch PE main (Provided by Laclede)

APPENDIX C
PHOTOGRAPHS

Photograph #1 –Failed Butt heat-fusion joint showing void in fusion bead (upper part of photo) and failure in the fusion joint (lower part of photograph). The failure in the fusion joint indicates that the joint was not stronger than the body of the pipe at this location.
(Photograph taken by Staff, September 12, 2016).

Photograph #2 – The 3-inch PE main and subject butt heat-fusion joint were under this tree (Photograph by google maps).

Photograph #3—3-inch main fusion inspection (Photograph taken by Staff)

Photograph #4—3-in Main Fusion inspection (Photograph taken by Staff)

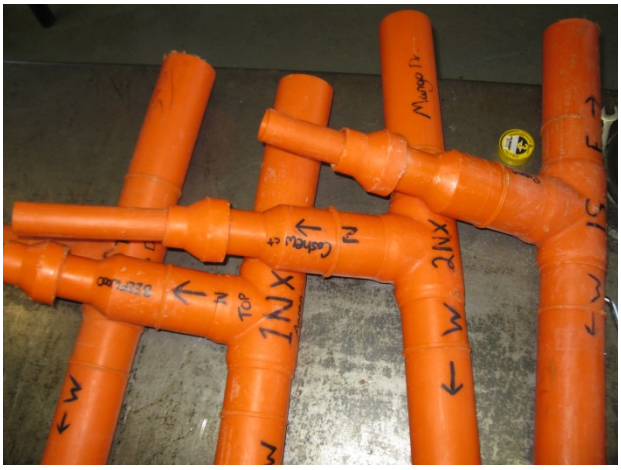
Photograph #5—3-inch main Fusion Inspection (Photograph taken by Staff)

Photograph # 6—Fusion bead height measurement testing (Photograph taken by Staff)

Photograph #7—Pressure test with air medium (Photograph taken by Staff)

Photograph #8—3-inch main segment (Photograph taken by Staff)

Photograph #9—Tension/Torque Test on 3-inch Pipe Segment (Photograph taken by Staff)



Photograph #10—T-main segments (Photograph taken by Staff)


Photograph #11 Pull testing T-main segments (Photograph taken by Staff)


Photograph #12 Segment 1N failure inside fusion area (Photograph taken by Staff)

Photograph #13 - Front Side of 5730 Mango Drive, showing damage at front of house (Photograph taken by Staff).

Photograph #14-- Showing damage at left front side (location of gas meter) of 5730 Mango Drive (Photograph taken by Staff).

Photograph #15—Showing damage to back side of 5730 Mango Drive (Photograph taken by Staff).

Photograph #16—Showing damage inside at front entrance to 5730 Mango Drive (Photograph taken by Staff).

Photograph #17–Viewing the squeeze off location just upstream of the leak location on the main (Photograph taken by Staff).

Photograph # 18 – 5730 Mango Drive, looking down at the leak location on the main. Note the dry soil around the leak location (Photograph taken by Staff).

Photograph #19– Leaking Section of 3-inch PE main removed from beneath the oak tree – note that section around the joint appears to be bent where tree roots exerted downward force. (Staff Photograph).

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Laclede Gas Company Concerning a Natural Gas Incident at 5730 Mango Drive in Oakville, Missouri	)))	Case No. GS-2016-0160

AFFIDAVIT OF BRIAN BUCHANAN

STATE OF MISSOURI	)	
	)	ss
COUNTY OF COLE	)	

COMES NOW Brian Buchanan and on his oath states that he is of sound mind and lawful age; that he contributed to the foregoing *Staff's Gas Incident Report*; and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

Brian Buchanan
Brian Buchanan

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this 20th day of October, 2016.

Dianna L. Vaught
Notary Public

DIANNA L. VAUGHT
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: June 28, 2019
Commission Number: 15207377

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Laclede Gas Company	)	
Concerning a Natural Gas Incident at	)	Case No. GS-2016-0160
5730 Mango Drive in Oakville, Missouri	)	

AFFIDAVIT OF DANIEL FITZPATRICK

STATE OF MISSOURI	)	
	)	ss
COUNTY OF COLE	)	

COMES NOW Daniel Fitzparick and on his oath states that he is of sound mind and lawful age; that he contributed to the foregoing *Staff's Gas Incident Report*; and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

Daniel Fitzpatrick

Daniel Fitzpatrick

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this 17th day of October, 2016.

Dianna L. Vaught

Notary Public

DIANNA L. VAUGHT
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: June 28, 2019
Commission Number: 15207377

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Laclede Gas Company Concerning a Natural Gas Incident at 5730 Mango Drive in Oakville, Missouri	)))	Case No. GS-2016-0160

AFFIDAVIT OF JOHN D. KOTTWITZ

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

COMES NOW John Kottwitz and on his oath states that he is of sound mind and lawful age; that he contributed to the foregoing *Staff's Gas Incident Report*; and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

John D. Kottwitz

John D. Kottwitz

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this 18th day of October, 2016.

Dianna L. Vaught
Notary Public

DIANNA L. VAUGHT
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: June 28, 2019
Commission Number: 15207377

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of Laclede Gas Company Concerning a Natural Gas Incident at 5730 Mango Drive in Oakville, Missouri	)))	Case No. GS-2016-0160

AFFIDAVIT OF KATHLEEN A. McNELIS

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

COMES NOW Kathleen A. McNelis and on her oath states that she is of sound mind and lawful age; that she contributed to the foregoing *Staff's Gas Incident Report*; and that the same is true and correct according to her best knowledge and belief.

Further the Affiant sayeth not.

Kathleen A. McNelis

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this 19th day of October, 2016.

Notary Public

DIANNA L. VAUGHT
Notary Public - Notary Seal
State of Missouri
Commissioned for Cole County
My Commission Expires: June 28, 2019
Commission Number: 15207377