DUKE ENERGY OHIO EXHIBIT ___

BEFORE

THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Duke Energy Ohio, Inc., for Approval of an Alternative Rate Plan Pursuant to Section 4929.05, Revised Code, for an Accelerated Service Line Replacement Program.	))))))	Case No. 14-1622-GA-ALT

DIRECT TESTIMONY OF

EDWARD A. McGEE

ON BEHALF OF

DUKE ENERGY OHIO, INC.

October 23, 2015

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I. INTRODUCTION AND PURPOSE

Q. **PLEASE STATE YOUR FULL NAME, ADDRESS, AND OCCUPATION.**

A. My name is Edward A. McGee. My business address is P.O. Box 1659, Bethany Beach, Delaware. I am a Principal Consultant of McGee Consulting, LLC, and I am currently working as a Gas Utility Consultant with Lummus Consultants International, Inc. (Lummus).

Q. **COULD YOU PLEASE DESCRIBE LUMMUS?**

A. Lummus is an independent company in Chicago Bridge & Iron's (CB&I) Lummus Technology operating group. Predecessor companies absorbed into the present-day Lummus include Stone & Webster Management Consultants, Inc., and Shaw Consultants International, Inc., both with extensive experience in the utility consulting industry.

Q. **DO YOU HOLD ANY ACADEMIC DEGREES?**

A. Yes. I graduated from the University of Notre Dame with Bachelor and Master Degrees in Chemical Engineering. I also graduated from the University of Chicago with a Master's Degree in Business Administration (MBA). Attachment EAM-1 provides my academic vita that includes a listing of my experience as a gas practice consultant and related positions in the energy industry.

Q. **WHAT IS THE SCOPE OF YOUR TESTIMONY IN THIS PROCEEDING?**

A. Duke Energy Ohio, Inc., (Duke Energy Ohio or the Company) requested that I provide an expert opinion to the Public Utilities Commission of Ohio (Commission) on the current condition of the Company's Ohio service lines following an analysis of the service lines conducted by Lummus. I was also asked to render an opinion on whether a portion of the service lines should be replaced and, if so, whether they would qualify for an Accelerated Service Line Replacement Program (ASRP) where these services are replaced in a more rapid fashion, and whether the selected service lines are consistent with the examples, recommendations, and rules provided by the Department of Transportation (DOT).

Q. WAS THE LUMMUS STUDY OF THE CONDITION OF THE COMPANY'S SERVICE LINES CONDUCTED BY YOU?

A. Yes. I directly participated in a study prepared by Lummus, called Accelerated Service Replacement Program (Lummus Study), along with the assistance of others under my direct supervision. A true and accurate copy of the Lummus Study, dated March 10, 2014, is included as Attachment EAM-2.

Q. WAS THE LUMMUS SUPPLEMENTAL STUDY OF THE CONDITION OF THE COMPANY'S SERVICE LINES ALSO CONDUCTED BY YOU?

A. Yes. I directly participated in the Lummus supplemental study, called Supplement to the March 10, 2014 Accelerated Service Replacement Program Report (Lummus Supplement), along with the assistance of others under my direct supervision. A true and accurate copy of the Lummus Supplement, dated August 19, 2015, is included as Attachment EAM-3.

Q. WHAT WAS THE PURPOSE OF THE LUMMUS SUPPLEMENT?

A. The Lummus Supplement updated all of the service line and leak data in the earlier Lummus Study to include information for 2013 and 2014, in order to provide the most current information.

Q. HOW IS THE REMAINDER OF YOUR TESTIMONY ORGANIZED?

A. Following this Introduction, my testimony is organized into the following sections:

- Section II: Summary of Findings and Conclusions
- Section III: Overview of the Service Condition Study
- Section IV: Composition of Duke Energy Ohio's Service Lines
- Section V: Analysis of Condition of Service Lines
- Section VI: Comparison of Number of Risk Factors on Services Against Number of Risk Factors on Mains
- Section VII: Analysis of Commission Staff Report
- Section VIII: Analysis of Pipeline and Hazardous Materials Safety Administration (PHMSA) Recommendations for Pipe Replacement
- Section IX: Findings and Conclusions

II. SUMMARY OF FINDINGS AND CONCLUSIONS

Q. PLEASE SUMMARIZE YOUR FINDINGS AND CONCLUSIONS REGARDING THE COMPANY'S SERVICE LINES.

A. The primary conclusion contained in the Lummus Study is that a small portion (57,805 services or 14.3% of the total 404,762 services) of the Company's Ohio service lines require replacement, which consists of services that are the metallic types of pipe materials. Additionally, services without adequate records of their type of material should also be investigated and replaced, if necessary. This amounts to an additional 2,978 services, or 0.7% of the total Ohio service lines.

Q. CAN YOU STATE THE PRIMARY REASONS WHY THESE SERVICES REQUIRE REPLACEMENT?

A. A key finding by Lummus was that the number of service line leaks has far exceeded the number of leaks on mains in recent years. Also service leaks caused by factors such as corrosion or materials and welds have not necessarily been declining as expected, given the accelerated main replacement program (AMRP), which included replacement of associated service lines. These factors directly relate to metallic types of pipe materials that continue to corrode over time. The corrosion can result in pinhole leaks on the wall of the service line as well as joint leaks where sections of the service line are fastened together. For safety reasons, services whose material type cannot be ascertained also require investigation and potential replacement.

Q. ARE THERE OTHER REASONS WHY THESE SERVICES REQUIRE REPLACEMENT?

A. Yes. The number of repaired service line leaks has decreased on the M-C (main to curb) segments of these lines but not on the C-M (curb to meter) segments. Thus, the proportion of service line leaks is increasing on the segments of the service lines (C-M segments) that are closest to buildings. Accordingly, we conclude that Duke Energy Ohio has service-line safety risks that need to be addressed.

Q. HOW ARE RISKS DEFINED?

A. Safety risks include risks to the general public, to Company employees, and to first responders. Risks to the general public arise primarily through risks to building occupants and passersby.

Q. CAN THE RISK FACTORS ON SERVICE LINES IN DUKE ENERGY OHIO'S SYSTEM BE COMPARED TO THE RISK FACTORS ON MAINS?

A. Yes. Overall, the Lummus analysis found a number of factors that contribute to risks on service lines:

- Service line risks are greater than risks on mains, in five areas: 1) service lines in Duke Energy Ohio's system were found to have higher numbers of leaks, 2) service lines have higher numbers of hazardous leaks, 3) service line leaks are closer to buildings and their occupants, 4) some service lines have incomplete records of age and material types, and 5) service lines have thinner pipe walls than mains, which makes them more susceptible to corrosion pits penetrating through the wall of the pipe.
- Service line risks are less than risks on mains in only one respect: mains have larger pipe sizes, which contain more gas.
- Risks are about equal on service lines and mains in three respects, as age, mileage of pipes, and pressure levels are nearly the same for both service lines and mains.

Q. DID THE LUMMUS STUDY CONTAIN ANY FINDINGS REGARDING THE APPLICABILITY OF AN ACCELERATED SERVICE REPLACEMENT PROGRAM?

A. Yes. We compared the six characteristics of pipes that the DOT recommends for accelerated replacement programs against the composition of Duke Energy Ohio's service lines. Duke Energy Ohio's current service lines, particularly the metallic service lines, contain five of the six characteristics that would suggest that these service lines should be replaced on a rapid basis.

III. <u>OVERVIEW OF SERVICE CONDITION STUDY</u>

Q. CAN YOU DESCRIBE LUMMUS' OBJECTIVES FOR THE SERVICE LINE STUDY?

A. Yes. Lummus was retained by Duke Energy Ohio to analyze the current inventory and leak history of the Company's Ohio service territory service lines in order to develop an independent opinion regarding:

- Whether Duke Energy Ohio is having integrity issues with its service lines;
- The cause of any identified service line issues;
- The extent of the identified service line issues; especially whether safety is a concern; and
- The need for an ASRP.

Q. HOW WAS THE LUMMUS STUDY CONDUCTED?

A. Primarily the study encompassed a detailed analysis of leak repairs contained in Duke Energy Ohio's Enterprise Geographical Information System (EGIS) data base. Leak repairs were categorized by year and by type of material of which the pipe is composed; cause of each leak requiring repair; portion of the service line where the leak occurred; and age and pressure of the pipes upon which the leaks occurred. Additionally Lummus reviewed Duke Energy Ohio's Distribution Integrity Management Plan (DIMP) and the data base of annual gas distribution reports maintained by the DOT from reports submitted by all gas distribution utilities, including Duke Energy Ohio. Lummus also analyzed the recommendations of the DOT for the development of ASRPs in order to determine whether the materials that were specified for replacement were included in the DOT's list of materials to be replaced under accelerated programs.

IV. COMPOSITION OF DUKE ENERGY OHIO'S SERVICE LINES

Q. HOW MANY SERVICE LINES ARE IN DUKE ENERGY OHIO'S SERVICE TERRITORY?

A. Duke Energy Ohio operated 404,762 service lines in the State of Ohio at year-end 2014. The vast majority of these lines (343,979 or 85%) are composed of plastic (polyethylene), many of which were installed during Duke Energy Ohio's AMRP.

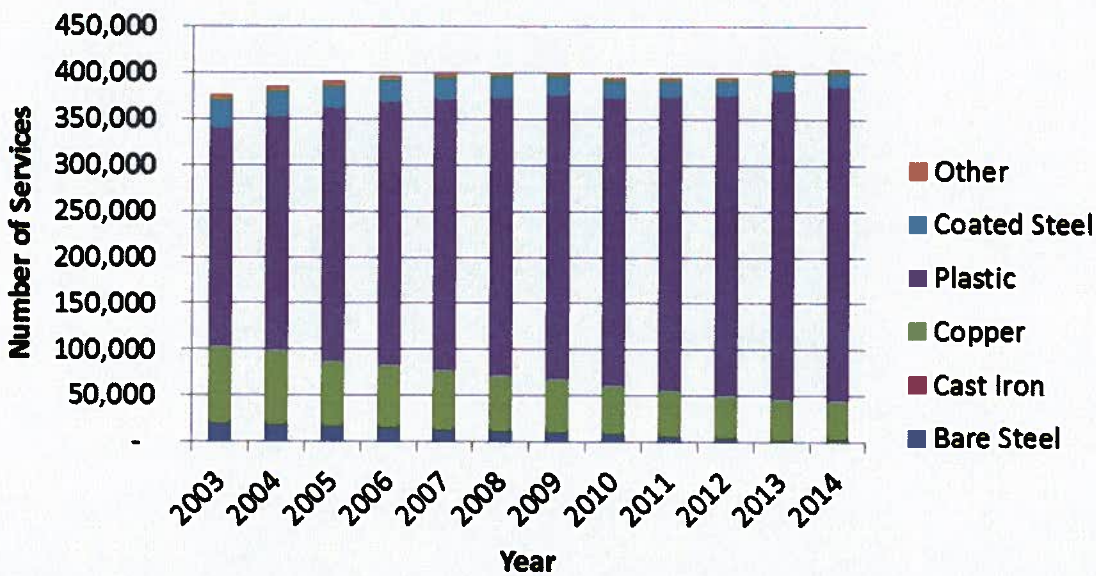
Q. HAS THE COMPOSITION OF MATERIALS USED FOR SERVICE LINES CHANGED IN RECENT YEARS?

A. Yes. Many of Duke Energy Ohio's metallic service lines were removed from its system in recent years. This was accomplished primarily through replacement of service lines that were attached to mains that were replaced under Duke Energy Ohio's AMRP. A smaller number of services have also been removed under Duke Energy Ohio's annual replacement policy based on their condition and

Ohio's AMRP. A smaller number of services have also been removed under Duke Energy Ohio's annual replacement policy based on their condition and judged level of obsolescence. However, a number of service lines (57,805) composed of metallic materials remain since these were not associated with the replaced mains. The change in composition in the past twelve years is pictured in Figure EAM-1 shown below (and also appears in the Lummus Supplement as Figure 3):

Figure EAM-1

Number of Services by Material Type for Duke Energy Ohio (2003-2014)



Data Source: Annual DOT Reports, PHMSA Form 7100.1-1

V. ANALYSIS OF CONDITION OF SERVICE LINES

Q. HAS THE NUMBER OF LEAKS ON THE COMPANY'S SERVICE LINES DECREASED SIGNIFICANTLY FOLLOWING DUKE ENERGY OHIO'S AMRP?

A. No. Leaks on service lines have not shown the significant decrease that has been accomplished for main leaks (see Figures 4 and 5 in the Lummus Supplement for the annual number of reported leaks on mains and services, respectively, for the time period 2005 through 2014). Over this ten-year period, annual reported leaks on mains have decreased by 55% (from 769 to 349). Over the same period, annual reported leaks on services have not shown a comparable decrease.

Q. YOU MENTIONED THAT LEAKS ARE MORE NUMEROUS ON SERVICES. WHAT ARE THE RELATIVE NUMBERS FOR LEAKS ON SERVICES VERSUS LEAKS ON MAINS?

A. The number of reported leaks on services for 2014 was 4,174 (as shown graphically in Figure 5 in the Supplemental Report) versus 349 leaks reported on mains (as shown in Figure 4). Thus for the current year services have about twelve times the number of reported leaks that have been reported for mains.

Q. IS IT POSSIBLE THAT THE HIGHER NUMBER OF LEAKS ON SERVICES THAN ON MAINS IS DUE TO THEIR MILEAGE?

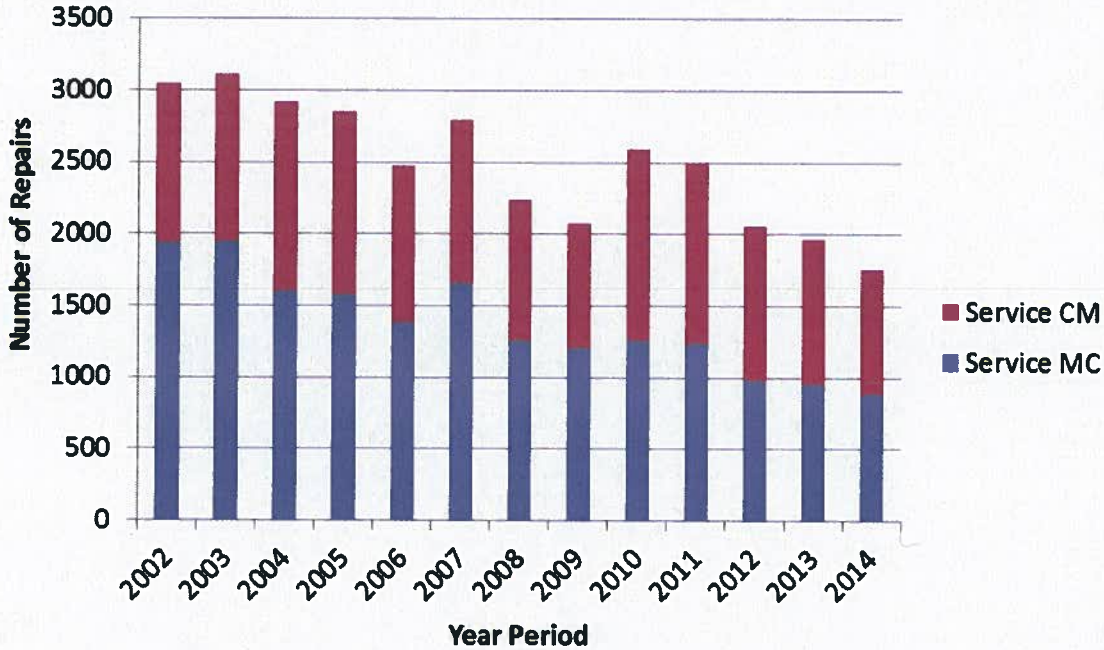
A. No. There are 5,607 miles of mains (Supplement Report Figure 2) in Duke Energy Ohio's piping system. Duke Energy Ohio's approximately 404,000 services, averaging 65 feet each (per Duke Energy Ohio's 2014 DOT report), are equivalent to 4,983 miles of piping, which is a slightly smaller mileage than the miles of mains. Therefore, the greater number of leaks on services cannot be explained due to their mileage.

Q. CAN THE REPORTED LEAKS ON SERVICES BE BROKEN DOWN FURTHER BY PORTIONS OF THE SERVICE LINES?

A. No, not for reported leaks, as the DOT reports do not carry this breakdown. However, the information maintained by Duke Energy Ohio for repaired leaks that was analyzed by Lummus does contain information on the portion of the service line where the leak was repaired. Figure EAM-2, below, shows the history of leaks repaired between 2002 and 2014 on the underground portions of the service lines. Leaks are identified separately as M-C (leaks that developed on the underground portion of the service line stretching from the main to the curb box) and C-M (leaks that developed on the underground portion of the service line leading from the curb box toward the meter).

Figure EAM-2

Duke Energy Ohio's Repaired Leaks on Services (Repairs per Year)



Data Source: Duke Energy Ohio EGIS Repairs

Q. **DOES FIGURE EAM-2 INDICATE ANY OTHER LEAK TRENDS?**

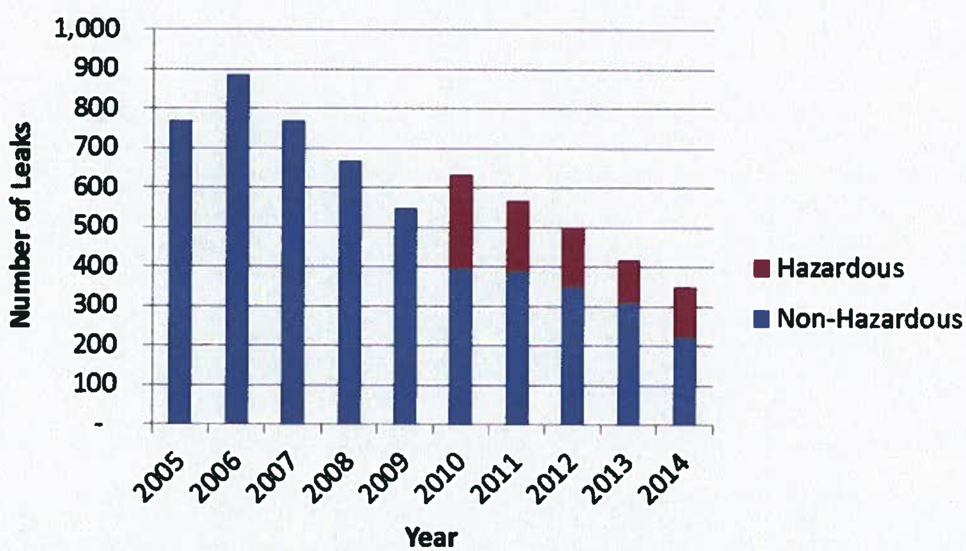
A. Yes. Figure EAM-2 also demonstrates that, in particular, the number of repaired leaks on the C-M portion of service lines, which is closest to buildings and their occupants, has grown in proportion to the number of repaired leaks on the M-C portion of service lines, which is furthest from the buildings. In 2002, the number of repaired leaks on the C-M portion of the service lines was 36% of the total leaks. Currently (2014) the C-M portion of the service lines accounts for 49% of the total repaired service leaks. The number of leaks repaired per year on the M-C portion of the service lines has been reduced by 54% over the thirteen year period, whereas leaks on the C-M portion of the service line have been reduced a significantly smaller amount (22%) over the latest thirteen year time period, during the AMRP.

Q. HOW HAZARDOUS ARE THE LEAKS ON MAINS AND SERVICES?

A. The DOT has only been classifying leaks as hazardous or non-hazardous for the past five years. Hazardous leaks are Grade 1 leaks that must be repaired immediately. The following chart (EAM-3) shows the hazardous leak trends on Duke Energy Ohio's mains for the past five years, as well as all mains leaks for ten years.

Figure EAM-3

Reported Leaks on Mains (2005-2014)

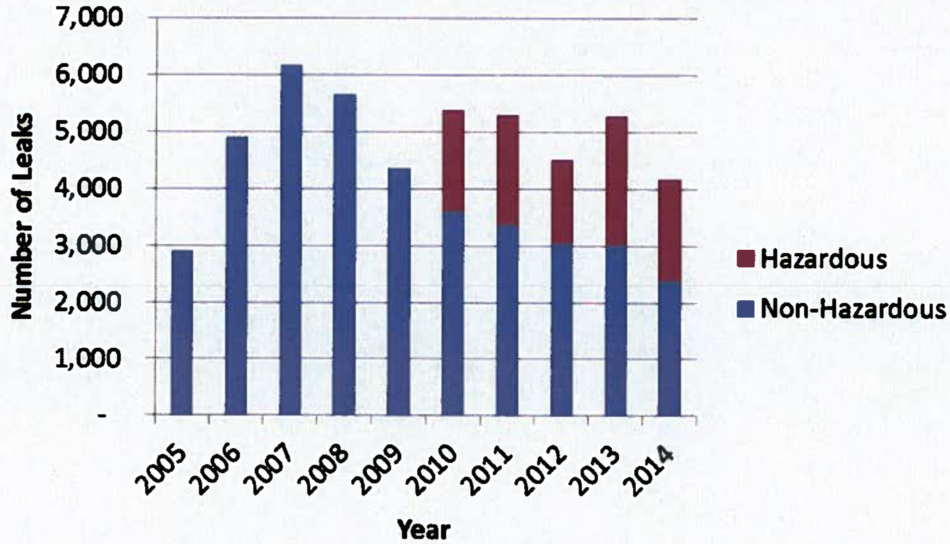


Data Source: Annual DOT Reports, PHMSA Form 7100.1-1

The next chart (EAM-4) shows the hazardous leak trends on Duke Energy Ohio's services for the past five years, as well as all service line leaks for ten years.

Figure EAM-4

Reported Leaks on Services (2005-2014)



Data Source: Annual DOT Reports, PHMSA Form 7100.1-1

For the most recent year (2014), the number of hazardous leaks on Duke Energy Ohio's services amounted to 1,776 leaks. The number of hazardous leaks on Duke Energy Ohio's mains was 125. Therefore the number of hazardous leaks on service lines for the most current year was fourteen times as great as the number of hazardous leaks on mains.

Q. ARE THERE ANY FACTORS CAUSING THE CONTINUING OCCURRENCE OF LEAKS ON SERVICE LINES?

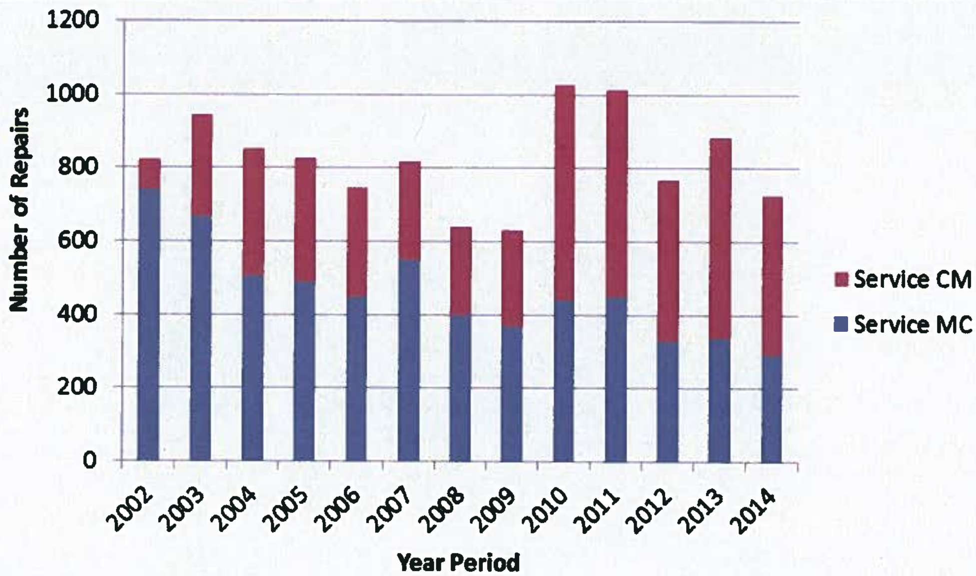
A. Yes. The analysis performed by Lummus indicated that there are two primary causes of continuing leaks: 1) leaks due to corrosion and 2) leaks due to materials and welds. Both of these causes are likely related to metallic pipes.

Q. CAN YOU SHOW THE CORROSION TRENDS?

A. Yes. The trend of corrosion-caused leaks is shown in Figure EAM-5. In this figure, leaks seem to be increasing in some recent years; particularly on the C-M portion of the service line, which is closest to buildings and their occupants.

Figure EAM-5

Repaired Leaks on Services (due to Corrosion)



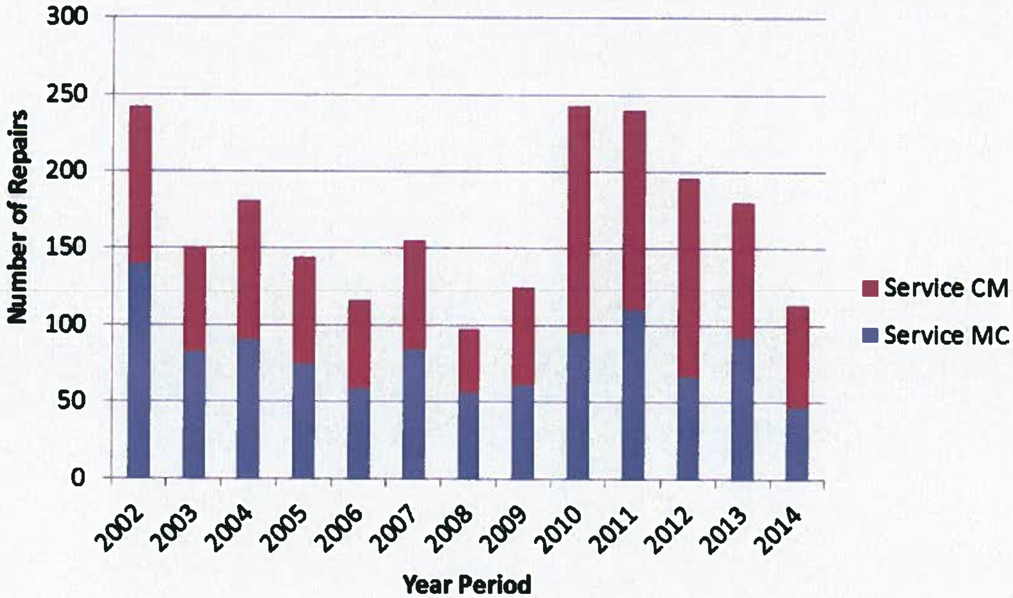
Data Source: Duke Internal EGIS Leak Repaired Data

Q. CAN YOU ALSO SHOW THE TRENDS FOR MATERIALS & WELDS?

A. Yes. The trend of material and welds-caused leaks is shown in Figure EAM-6. This figure shows an unstable pattern of leaks over the thirteen-year period shown. The number of leaks from this cause of leak surprisingly did not decline during the period the AMRP was undertaken. In the latest year, leaks from this cause may be starting to decline, but a longer time period may be required to be certain, due to the unstable patterns exhibited in earlier years.

Figure EAM-6

Repaired Leaks on Services (due to Materials and Welds)



Data Source: Duke Energy Ohio Internal EGIS Leak Repaired Data

VI. COMPARISON OF SAFETY RISK FACTORS ON SERVICE LINES AGAINST RISK FACTORS ON MAINS{ TC "VI. COMPARISON OF SAFETY RISK FACTORS ON SERVICE LINES AGAINST RISK FACTORS ON MAINS" \F C \L "1" }

Q. **CAN THE NUMBER OF RISK FACTORS ON SERVICE LINES IN DUKE ENERGY OHIO'S SYSTEM BE COMPARED AGAINST THE NUMBER OF RISK FACTORS ON DUKE ENERGY OHIO'S MAINS?**

A. Yes. Overall, the Lummus analysis found the number of risk factors on service lines to be greater than the number of risk factors on mains in five respects. The number of risk factors on mains was higher in one respect. And the number of risk factors was about equal in three respects. These risk factors are discussed in the next four questions and answers.

Q. PLEASE IDENTIFY THE FIVE FACTORS FOUND TO CONTRIBUTE TO A GREATER NUMBER OF RISKS ON SERVICES.

A. Service line risks were found to be greater due to:

1. Pipe walls are thinner on service lines;
2. The annual number of leaks is higher on service lines;
3. The annual number of hazardous leaks is higher on service lines;
4. Service line piping is closer to buildings than mains piping; and
5. There are a number of services having unknown ages and unknown material types.

Q. PLEASE ELABORATE ON THE SIGNIFICANCE OF LUMMUS'S FINDING THAT THERE ARE SEVERAL FACTORS THAT INDICATE SERVICES POSE A GREATER RISK THAN THAT OF GAS MAINS.

A. While all of the aforementioned factors are significant, the location of services to that of an actual building structure is perhaps the most noteworthy insofar as potential impact to the general public. Services are attached directly to homes and businesses such as hospitals, nursing homes, places of worship, shopping malls, or movie theaters and therefore, in my mind, pose an even greater potential for harm if a catastrophic failure occurs. The risk posed by the failure of these services not only affects Company employees working on the system, but also first responders (fire/police departments), families, and the unsuspecting public.

Q. PLEASE IDENTIFY THE ONE FACTOR FOUND TO CONTRIBUTE TO GREATER RISKS ON MAINS.

A. Risks on mains were found to be greater due to the greater size (diameter) of the mains, allowing more gas to be released from a leak in a given amount of time.

Q. PLEASE ALSO IDENTIFY THE THREE FACTORS FOUND TO CONTRIBUTE NEARLY EQUAL RISKS ON BOTH SERVICES AND MAINS.

A. Risks were found to be comparable on both mains and services due to:

1. Pipe mileage for service lines is comparable to mileage of mains;
2. The age of service lines is comparable to age of mains; and
3. Pressure levels are identical on mains and on service lines that are connected to them.

Q. PLEASE EXPLAIN WHY THIS COMPARISON OF SERVICE LINE RISK FACTORS TO GAS MAIN RISKS FACTORS IS SIGNIFICANT IN YOUR OPINION.

A. This comparison is significant since it helps explain why the majority of leaks (and the majority of hazardous leaks) are occurring on services as opposed to mains. Therefore, it is important to not overlook services when replacement programs are being considered or implemented.

Q. ARE YOU AWARE OF ANY REPORTED INCIDENTS THAT ILLUSTRATE SAFETY PROBLEMS THAT OCCURED WHEN OLDER METALLIC SERVICES WERE NOT REPLACED?

A. Yes. There have been several reported incidents involving hazardous accidents that occurred on steel service lines. Most noteworthy are recent events in the greater Dallas/Fort Worth area over a period of several years.[1] These accidents, all attributed to corrosion on the couplings used in older installations of steel service lines, reportedly occurred in Wylie, Texas, in 2006; in Cleburne, Texas, in 2007; in Mesquite, Texas, in 2009; in Irving, Texas, in May 2009; and again in Irving in August 2010. Two building occupants reportedly died in the Wylie incident, two more died in the Cleburne incident, and two residents were hospitalized with extensive burns in the most recent Irving explosion. These incidents prompted response by both the state legislature and regulatory authorities.[2] In fact, the Texas Railroad Commission, recognizing the risks associated with the failure of natural gas service lines, adopted a new pipeline safety rule applicable to all regulated natural gas utilities in the state. The new rule directly addresses the potential risks associated with service lines and is even more stringent than the federal government's Gas Distribution Integrity Management rule (49 CFR Subpart P) in that it mandates the replacement of pipelines or facilities that pose the greatest potential threats for failure.[3]

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[1] Source: http://www.wfaa.com/story/news/local/investigates/2014/08/06/13490520/
[2] Id.
[3] http://www.rrc.state.tx.us/all-news/022511c/

Q. FROM A STATISTICAL STANDPOINT, IS THE NUMBER OF HAZARDOUS LEAKS ATTRIBUTED TO SERVICE LINE FAILURES ON DUKE ENERGY OHIO'S SYSTEM SIGNIFICANT?

A. Yes, Figure EAM-4 depicts this.

Q. DO YOU BELIEVE THAT THE LIKELY GAINS IN TERMS OF SAFETY, RELIABILITY, AND LEAK REDUCTIONS, ACHIEVABLE THROUGH A TEN-YEAR REPLACEMENT PROGRAM, ARE CONSISTENT WITH DOT AND PHMSA RECOMMENDATIONS?

A. Yes. From a risk perspective, considering that the proportion of hazardous leaks occurring on service lines is growing and that the proportion of service leaks is increasing on the section of the service line closest to buildings, the sooner the Company replaces these service lines, the better. From a pure timing perspective, a ten-year replacement period seems reasonable and within the spirit of DOT and PHMSA regulations and guidance and is consistent with the Company's demonstrated capabilities. The service lines that have been identified and are now targeted for replacement would likely be similar in material and age to those replaced as part of the Company's AMRP. The number of service lines currently identified and targeted for replacement (approximately 58,000) is about half the number of service lines that were replaced under the AMRP (more than 110,000), so a comparable reduction in time would be consistent.

VII. ANALYSIS OF COMMISSION STAFF REPORT

Q. HAVE YOU REVIEWED THE REPORT PREPARED BY STAFF ON JUNE 5, 2015, IN WHICH THEIR INVESTIGATION FINDINGS AND RECOMMENDATIONS ARE PRESENTED?

A. Yes, I have.

Q. DO YOU HAVE ANY RESERVATIONS CONCERNING THE STAFF'S FINDINGS AND RECOMMENDATIONS?

A. Yes, I have three major reservations.

Q. WHAT IS THE FIRST STAFF FINDING WITH WHICH YOU HAVE RESERVATIONS?

A. The first covers Staff's contentions on ASRP Safety Enhancements.[4] In this section of their report they contend: "Over the 11-year 2004 through 2014 period, Staff learned that nationwide there were 12 reportable incidents attributed to corrosion, 22 for material & welds and 28 for natural forces." From this Staff concludes that: "Dividing the 62 total reportable incidents caused by corrosion, materials & welds, and natural forces by the 11 years covered in the PHMSA database of Reportable Incidents during the 2004 through 2014 period yields 5.64 incidents per year. Dividing this number into the 67,118,840 total number of service lines yields 11,900,504. This means that, based on actual results from the most recent 11 years, there is only a 1 in 11,900,504 chance of a reportable incident caused by one of the three factors that the ASRP is designed to eliminate occurring anywhere in the country in any given year. Duke is proposing to spend

[4] Staff Report, page 7.

$320 million over ten years in an attempt to avoid incidents where the odds of such an incident actually occurring are infinitesimally small. In the Staff's opinion, the proposed ASRP is considerably more than is necessary to address the identified safety concerns associated with the service lines that it will replace. Stated simply, the ASRP will vastly over fix the potential concerns."

Q. WHAT RESERVATIONS DO YOU HAVE PERTAINING TO THE ABOVE STAFF FINDING?

A. There is a major statistical error in the above calculation. The service line risk of 1 in 11.9 million only represents the chance of the three causes of incidents occurring for a particular service line in a given year. It is not correct to state that there is only a 1 in 11.9 million chance of a reportable incident (of these three causes) occurring anywhere in the country in any given year. These reportable incidents occur 5.64 times a year throughout the U.S.

It is also incorrect to state there is only a 1 in 11.9 million chance of a service line incident (of the three causes) occurring on Duke Energy Ohio's system. To calculate the chance of it happening in Duke Energy Ohio's system, this risk must be multiplied by the number of services in Duke Energy Ohio's system (404,762 at year-end 2014). This gives a chance of 1 in 29 that such an incident would occur each and every year in the Duke Energy Ohio's system. A prudent operator would not ignore such a risk.

Q. WHAT IS THE SECOND STAFF FINDING WITH WHICH YOU HAVE A RESERVATION?

A. Staff explains: "On average for the period 2010-2014, excavation damage (or "dig-ins") accounted for 33.8 percent of all hazardous service line leaks on Duke's system, which was considerably more than any of the categories that the ASRP is intended to address."

From this Staff finds: "Staff believes that Duke could garner greater safety improvements at much less cost by addressing the risks to its system caused by excavation damage."[5]

Q. WHAT RESERVATIONS DO YOU HAVE PERTAINING TO THIS SECOND STAFF FINDING?

A. Staff's opposition can fairly be summarized as follows: The Company should focus its efforts on preventing third-party excavation damage and ignore its aging infrastructure. But this is not consistent with PHMSA's regulations for DIMPs or its recommendations for accelerated replacement programs. Under DIMP, a local distribution company must identify and rank the risks on its system. It must respond to those risks and mitigate them. As there will necessarily be different types of risks, there necessarily will be different types of risk mitigation. Thus, how a local distribution company seeks to mitigate the risks associated with excavation damage resulting from activity outside of its control is different than how it undertakes to reduce or remove the risk associated with its aging infrastructure. Simply ignoring aging facilities that are known to fail is not

[5] Staff Report, page 5.

consistent with DIMP. Focus should be on the risk and the appropriate ways to mitigate that risk.

Furthermore, this Staff finding focuses only on service line leaks and, thus, fails to recognize that the situation is no different for leaks on mains. That is, there are also more hazardous mains leaks caused by excavation damage than by the categories an AMRP is intended to address (See Figure EAM-7, below). This is the case not only on Duke Energy Ohio's system but on all U.S. distribution utility systems.

Finally, it must be noted that this has never been a factor in PHMSA's recommendations for AMRPs, nor has it been a factor in the approval of AMRPs by state utility commissions throughout the U.S. (including the Commission).

Figure EAM-7

Causes of Hazardous Leaks on Systems of Duke Energy Ohio and All U.S. Utilities (2010-2014)

	EXCAVATION DAMAGE CAUSE	3 CAUSES: CORROSION, MAT'L & WELDS, NATURAL FORCES	ALL OTHER CAUSES	TOTAL ALL CAUSES
SERVICES:				
1) 5-YEAR TOTAL NUMBER OF HAZARDOUS LEAKS:				
DUKE ENERGY OHIO	3,097	2,685	3,390	9,172
ALL U.S. UTILITIES	53,547	47,862	56,093	157,502
2) PERCENTAGE OF HAZARDOUS LEAKS				
DUKE ENERGY OHIO	34%	29%	37%	100%
ALL U.S. UTILITIES	34%	30%	36%	100%
MAINS:				
1) 5-YEAR TOTAL NUMBER OF HAZARDOUS LEAKS:				
DUKE ENERGY OHIO	383	344	63	790
ALL U.S. UTILITIES	19,046	13,288	16,120	48,454
2) PERCENTAGE OF HAZARDOUS LEAKS				
DUKE ENERGY OHIO	48%	44%	8%	100%
ALL U.S. UTILITIES	39%	27%	33%	100%

Data Source: Annual DOT Reports, PHMSA Form 7100.1-1

Utilities (including Duke Energy Ohio) use a different variety of techniques and programs to increase public safety, depending on each possible leak cause. They use educational-based, mark-out-based, and surveillance-based programs, for instance, to combat excavation damage causes. Detection-based, repair-based, and replacement-based programs are used to combat actual and potential leakage problems. Together these programs combine to protect public safety.

Q. COULD YOU PLEASE EXPLAIN YOUR THIRD RESERVATION?

A. Yes. Staff contends "Importantly, nowhere in the DIMP regulations does PHMSA prescribe the specific measures that a distribution system operator such as Duke implements to address potential risks to its distribution system. Operators are only required to develop and implement measures to address known risks. PHMSA does not mandate what those measures might be."[6]

However PHMSA has published guidelines for accelerated replacement of pipeline infrastructure in documents other than those outlining DIMP regulations. The Lummus Report, Attachment EAM-2, cited a key explanatory PHMSA document. In the Lummus Report, Sections 5.2 (entitled PHMSA Justification for Accelerated Replacement Programs) and 5.3 (Analysis of PHMSA's Recommendations for Accelerated Service Line Replacement Program) explain in detail PHMSA's recommendations for ASRPs as presented in non-DIMP correspondence.

PHMSA's guidelines are also presented in the following section of this testimony (Section VIII), below.

VIII. ANALYSIS OF PHMSA RECOMMENDATIONS FOR PIPE REPLACEMENT

Q. DID THE LUMMUS STUDY CONTAIN ANY FINDINGS REGARDING THE APPLICABILITY OF AN ACCELERATED SERVICE REPLACEMENT PROGRAM?

A. Yes. We compared the six characteristics of pipes that the DOT recommends for accelerated replacement programs against the composition of the service lines we

[6] Staff Report, page 5.

recommend for replacement by Duke Energy Ohio. Duke Energy Ohio's service lines that are proposed for replacement contain five of the six characteristics recommended for expeditious replacement by the DOT.

Q. WHAT IS PHMSA's POSITION ON PIPE REPLACEMENT?

A. PHMSA has stated: "We believe that the timely repair, rehabilitation, and replacement of high-risk gas pipeline infrastructure are critical to ensuring public safety."[7]

Q. DOES PHMSA APPLY THIS POSITION ON PIPE REPLACEMENT TO INCLUDE SERVICE LINES?

A. Yes. PHMSA specifically uses the words "infrastructure" or "pipe" rather than "mains" or any other subcategory of infrastructure.

Q. DOES PHMSA ONLY CONSIDER PIPELINE INFRASTRUCTURE THAT HAS ACTUALLY EXPERIENCED SOME SORT OF LEAK TO CONSTITUTE A HIGH-RISK PIPELINE INFRASTRUCTURE THAT SHOULD BE REPLACED?

A. No. In general, PHMSA's recommendations and regulations are designed to identify gas integrity risks and address them before a catastrophic event occurs. Key to that evaluation is consideration of all aspects of the risks, including, but not limited to, history of integrity of the system. A thorough review of the history of piping failures helps guide the response.

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[7] http://opsweb.phmsa.dot.gov/pipelineforum/docs/PHMSA%20111011-002%20NARUC.pdf

Q. HOW DOES PHMSA DEFINE THE TERM "HIGH-RISK GAS PIPELINE INFRASTRUCTURE" THAT SHOULD BE REPLACED?

A. PHMSA has stated: "High-risk pipeline infrastructure is piping or equipment that is no longer fit for service. As discussed below, that lack of fitness can be the product of a variety of factors.

1. Cast iron gas mains and service lines can be prone to failure as a result of graphitization or brittleness.
2. Certain vintages of plastic pipe are susceptible to premature failures as a result of brittle-like cracking.
3. Mechanical coupling installations are devices that are used for the joining and pressure sealing of two pieces of pipe. These devices are prone to failure under certain conditions.
4. Pipelines lacking adequate construction records or assessment results to verify their integrity.
5. Other kinds of pipe installations, including bare steel pipe without adequate corrosion control (*i.e.*, cathodic protection or coating) and copper piping, are also more susceptible to failure.
6. Age of pipe should be considered in determining whether pipeline infrastructure is vulnerable to failure from time-dependent forces, like corrosion, stress corrosion cracking, settlement, embrittlement, or cyclic fatigue."[8]

These factors are key to evaluating not only the integrity risk itself, but also the urgency of the need for replacement.

[8] Ibid 2.

Q. WHICH OF PHMSA'S SIX CRITERIA FOR REPLACEMENT APPLY TO DUKE ENERGY OHIO'S SERVICE LINES?

A. Our analysis found that the following five of PHMSA's criteria for replacement apply to Duke Energy Ohio's service lines:

1. Cast iron service lines (Duke Energy Ohio has twelve remaining in Ohio);
2. Mechanical coupling installations;
3. Pipelines lacking adequate construction records;
4. Bare steel pipe without adequate corrosion control (*i.e.*, cathodic protection or coating) and copper piping; and
5. Age of pipe.

IX. FINDINGS AND CONCLUSIONS

Q. PLEASE STATE YOUR OVERALL FINDINGS AND CONCLUSIONS.

A. The primary conclusion is that a small portion (57,805 services or 14.3% of the total 404,762 services) of the Company's service lines require replacement. The services that require replacement are comprised of the metallic types of pipe materials. Additionally, services without adequate records of their type of material should be researched and replaced if necessary. This amounts to an additional 2978 services, or 0.7% of the total Duke Energy Ohio service lines.

Q. CAN YOU STATE THE PRIMARY REASONS WHY THESE SERVICES REQUIRE REPLACEMENT?

A. A key finding by Lummus was that the number of service line leaks, especially the number of hazardous service line leaks, has far exceeded the number of leaks on mains in recent years. Also, service leaks caused by factors such as corrosion or materials and welds have not been declining as expected, throughout the AMRP. These factors directly relate to metallic types of pipe materials that continue to corrode over time. The corrosion can result in pinhole leaks on the wall of the service line, as well as joint leaks where sections of the service line are fastened together. For safety reasons, services whose material type cannot be ascertained also require investigation and replacement if necessary.

Q. ARE THERE OTHER REASONS WHY THESE SERVICES REQUIRE REPLACEMENT?

A. Yes. We compared the number of safety risk factors for services against the number for mains and determined that the number of risk factors on services is greater than the number on mains. Specifically, risks were greater for services in five safety areas:

1. Pipe walls are thinner on service lines;
2. Annual number of leaks is higher on service lines;
3. Annual number of hazardous leaks is higher on service lines;
4. Service line piping is closer to buildings than mains piping; and
5. There are a number of services having unknown ages and unknown material types.

These five factors compare against only one risk factor that is greater for mains (larger main pipe sizes); and three risk factors that are about equal for services and mains (mileage, age, and pressure levels).

Q. IN YOUR OPINION, WOULD DUKE ENERGY OHIO'S PROPOSED REPLACEMENT PROGRAM FOR OHIO SERVICE LINES BE CONSISTENT WITH PHMSA'S RECOMMENDATIONS?

A. Yes. Lummus Consultants found that the following five PHMSA criteria for replacement would apply to Duke Energy Ohio's proposed service line replacement program:

1. Cast iron service lines (Duke Energy Ohio has twelve in Ohio);
2. Mechanical coupling installations;
3. Pipelines lacking adequate construction records;
4. Bare steel pipe without adequate corrosion control (*i.e.*, cathodic protection or coating) and copper piping; and
5. Age of pipe.

Additionally, considering that hazardous leaks are increasing on the portion of services nearest a building and its occupants, the sooner these service lines are replaced, the better. Given these factors and for the reasons articulated throughout the Lummus Study, a customized response, where these services are replaced in an expeditious manner is appropriate, warranted, and supportable under federal regulations and guidance in the interests of safety and from an overall integrity management perspective.

Q. WERE ATTACHMENTS EAM-1, EAM-2, AND EAM-3 PREPARED BY YOU OR UNDER YOUR DIRECTION AND CONTROL?

A. Yes.

Q. DOES THIS CONCLUDE YOUR PRE-FILED DIRECT TESTIMONY?

A. Yes.

PROFESSIONAL CAREER

2012 - present **Lummus Consulting International, Inc.**
Gas Utility Consultant

As a Gas Utility Consultant for Lummus Consulting, I am responsible for assisting in studies performed in the gas utility and other energy areas.

1999 - present **McGee Consulting**
Principal Consultant and Engineer – Energy Industry

As Principal Consultant and Engineer I am responsible for assisting larger consulting firms in their studies performed in the utility field.

1985 - 1999 **Stone & Webster Management Consultants, Inc.**
Vice President/Director

As Vice President of Stone & Webster Management Consultants, I was responsible for consulting studies in the Gas Practice area, where I performed consulting analyses in the gas planning and gas operations areas for gas utility companies and public utility commissions.

1982 - 1985 **Stone & Webster Engineering Corporation**
Business Development Manager

As Business Development Manager at Stone & Webster Engineering Corp., I was responsible for the construction of investment models for feasibility studies on large-scale chemical and refining complexes.

1982 & earlier **W. R. Grace & Co.**
Director of Energy Resources
Manager of Chemical Development

As Director of Energy Resources for W. R. Grace, I advised the Chief Operating Officer on corporate energy consumption and production. I also assisted operating divisions in securing long-term energy resources.

As Manager of Chemical Development at W. R. Grace, I analyzed potential acquisition targets in specialty chemical and high technology fields, developing corporate strategies for selected expansions.

AMOCO Oil
Supervisor of Technical Computer Programming
Internal Operations Research Consultant

In a variety of engineering and computer modeling capacities at AMOCO Oil, directed a staff of professionals in the development of technical programs in the refining, distribution and marketing areas.

EDUCATION

University of Chicago, Master of Business Administration, Quantitative Analysis and Computers
University of Notre Dame, Master of Science in Chemical Engineering
University of Notre Dame, Bachelor of Science in Chemical Engineering

LICENSES & CERTIFICATES

Licensed Professional Engineer - State of Indiana (Expired)
U.S. Patent Holder - Refinery Treating Process

PROFESSIONAL AFFILIATIONS

American Institute of Chemical Engineers
The Institute of Management Sciences

SAMPLE PUBLICATIONS AND PAPERS

"Using a Personal Computer as a Gas Supply Planning Tool." <u>Gas Industries</u> lead article.

"Personal Computers and the Natural Gas Industry." <u>Public Utilities Fortnightly</u>.

"Personal Computer-Based Long-Range Planning for Natural Gas Development and Supply Management." Presented at the International Gas Union's <u>18th World Gas Conference</u>, Berlin, Germany.

"Role of Optimization Models in Dispatching Gas Supplies." Presented at AGA <u>Distribution/Transmission Conference</u>, Toronto, Canada.

"Experience With Gas Supply Optimization Models at Inland Natural Gas." Presented at IGT symposium on <u>Personal Computers in the Gas Industry</u>, Chicago, Illinois.

Final Report

Accelerated Service Replacement Program

DUKE ENERGY®

Prepared for

Duke Energy

March 10, 2014

LUMMUS CONSULTANTS
INTERNATIONAL

A World of Solutions™

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ABOUT LUMMUS CONSULTANTS

Lummus Consultants International, Inc. (Lummus Consultants), through its legacy companies, including Stone & Webster Management Consultants, Inc. and Shaw Consultants International, Inc., has a history of over 100 years of providing engineering, construction, and consulting services to the energy industry. Stone & Webster Management Consultants was part of Stone & Webster, Inc., a preeminent engineering and construction firm established in 1889 that specialized in the energy industry. Stone & Webster, Inc. was purchased by The Shaw Group in 2000, and subsequently Stone & Webster Management Consultants, Inc. was renamed Shaw Consultants International, Inc.. In February 2013, the Shaw Group was acquired by Chicago Bridge & Iron Company N.V. (CB&I) (NYSE: CBI). The combination of CB&I and The Shaw Group under the CB&I brand creates one of the world's largest engineering, construction, and consulting companies focused on the global energy industry. Shaw Consultants has become Lummus Consultants International, Inc., an independent company in CB&I's Lummus Technology operating group.

Lummus Consultants provides technical advisory and due diligence services to investment firms, project developers, and plant owners in the power, gas delivery, process, petrochemical, and refining industries. Our services include:

- Independent Lenders' Engineer / Technical Review
- Project Identification and Development
- Operating Portfolio Review and Optimization
- Financial Model Development and Review
- Performance Projections
- Environmental Compliance and Planning
- Contracts Review
- Condition Assessment and Replacement Programs Review
- Owner's Engineer
- Technology Assessment and Project Feasibility
- Remaining Life Evaluations
- O&M and Capital Expenditures Assessments
- Fleet Benchmarking and Analysis
- Construction and Operations Monitoring
- Transmission Interconnection and Expansion Plans
- Testimony

ACRONYMS, ABBREVIATIONS, AND UNITS

The following table is a listing of acronyms, abbreviations, and measurement units used in this report.

List of Acronyms and Abbreviations	
Acronym	**Name**
ADB	Advisory Bulletin
AGF	All Gas Facilities
AIRP	Accelerated Infrastructure Replacement Program
AMRP	Accelerated Mains Replacement Program
APRP	Accelerated Pipe Replacement Plan
ASRP	Accelerated Service line Replacement Program
CIMOS	Cast Iron Maintenance Optimization System
C-M	Curb to Meter portion of Service Line
CP	Cathodic Protection
DIMP	Distribution Integrity Management Plan
DOT	U.S. Department of Transportation
HCA	High Consequence Area
HP	High Pressure
IP	Intermediate Pressure
LDC	Local Distribution Company
M&R	Meter and Regulator
M-C	Main to Curb Portion of Service Line
MP	Medium Pressure
NARUC	National Association of Regulatory Utility Commissioners
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
PUCO	Public Utility Commission of Ohio
SME	Subject Matter Experts
SP	Standard Pressure
TIMP	Transmission Integrity Management Plan

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1 Executive Summary

1.1 Introduction

Lummus Consultants International, Inc. (Lummus Consultants) was retained by Duke Energy Corporation (Duke Energy) to analyze the leak history on Duke Energy's service lines in its Ohio service territory. The review was to determine whether conditions exist warranting the implementation of an accelerated service replacement program (ASRP). Lummus Consultants performed an independent third party review of the service lines in the Ohio service territory including the types of material and the leak history associated with those service lines.

Lummus Consultants, through its legacy companies, including Stone & Webster Management Consultants, Inc. and Shaw Consultants International, Inc. has a history of over 100 years of providing engineering, construction, and consulting services related to the energy industry. There is no phase related to the transportation and distribution of natural gas that has not been handled fully and satisfactorily by Lummus Consultants from the earliest days of manufactured gas to the modern era of transcontinental and international gas projects. Lummus Consultants participated in the development of the Texas Gas Transmission, Transcontinental Pipeline Company, and TransCanada Pipeline Company systems. These assignments began with the original market analysis through regulatory hearings to construction and operation. Furthermore, Lummus Consultants has extensive experience in natural gas distribution.

Lummus Consultants has several engineers with experience working with gas utilities including consulting, design, procurement, and construction management services. We have completed assignments for Vectren, Columbia Gas of Kentucky, Columbia Gas of Pennsylvania, Cinergy, Iroquois, Con Edison, KeySpan, WE Energy, Tennessee and Gulfstream. Our work for Cinergy, Vectren, Columbia Gas of Kentucky, and Columbia Gas of Pennsylvania included an independent technical review of the gas distribution system condition with recommendations for their replacement strategy. As part of our review, we researched utilities that have undergone replacement programs and regulatory bodies that have reviewed proposals within or outside of rate cases. We have compared our clients' replacement strategies to similar industry peers. Our independent reports have been used to support our clients' replacement strategy documentation for rate case purposes.

Lummus Consultants was selected to provide consulting services in conjunction with the potential acquisition of the gas and electric utility in Montana by Babcock & Brown, the pipeline assets owned by El Paso Merchant Energy by WestLB, and most recently the gas utility in New Mexico.

1.2 Overview

In 2005 Duke Energy and Cinergy Corporation (Cinergy) merged to create an energy company with a portfolio of electric and gas businesses. Cinergy had been formed in 1994 by the merger of Cincinnati Gas & Electric (CG&E) and PSI Energy, Inc. (PSI). This review consists of an analysis of Duke Energy Ohio's service lines in the former CG&E service territory for the purpose of developing an independent opinion on whether a portion of the service lines should be considered for replacement and whether an accelerated replacement program would be appropriate for the targeted service lines. The Ohio service territory includes about 400,000 service lines that are comprised of steel, copper, cast iron, plastic, and other materials.

At the end of 2015 Duke Energy will have completed an Accelerated Main Replacement Program (AMRP) in the Ohio service territory. Duke Energy has also recently concluded an AMRP in its Kentucky service territory, where it is now observing an increase in the number of leaks on its service lines. Duke Energy is investigating whether there is a potential for similar increases in leaks on its service lines in Ohio following completion of the Ohio AMRP. Based on the new regulations regarding Distribution Integrity Management Programs (DIMPs), Duke Energy and other local distribution companies (LDCs) are being asked to rank threats to their systems and to structure a plan to handle each potential threat.

1.3 Findings and Conclusions

Lummus Consultants analyzed the trends in replacing mains and service lines in Duke Energy's Ohio distribution piping system. We also reviewed Duke Energy's recent DIMP plans and the current inventory of service lines. Repaired leaks on Duke Energy's Ohio service lines were analyzed in detail to determine the number of leaks and the specific cause for each type of leak. Trends in leaks were further analyzed by cause to determine whether they were declining as service lines were replaced.

Lummus Consultants suggests that the key consideration for service line pipe replacement programs should be the safety risks to the general public and to Duke Energy employees. Risk to the public from gas piping is typically the result of, and possibly even the product of, three factors:

- The integrity or condition of the pipe segment – its propensity for leakage or breakage
- Likelihood that gas escaping from the pipe may enter occupied areas or building - urban locations do not always have open areas for gas to dissipate should the leaking gas travel from the pipe in the street or in the yard to buildings and accumulate there (particularly older service lines)
- Potential for serious consequence -- larger diameter pipes and higher-pressure gas within the pipes raise the stakes considerably for potential serious consequences

A key finding by Lummus Consultants was that the number of leaks caused by factors such as corrosion or materials and welds, were not necessarily declining as expected. We found that this particularly related to metallic types of pipe materials. Based on our review of the pipe categories recommended for accelerated replacement programs by Pipeline and Hazardous Materials Safety Administration (PHMSA), Lummus Consultants concludes that Duke Energy's service lines (in particular their metallic service lines) would qualify for accelerated replacement, in adherence to five out of six of PHMSA's priority categories. Accordingly, we recommend that Duke Energy Ohio petition the Public Utility Commission of Ohio (PUCO) for permission to conduct an ASRP. The ASRP should consider the following:

- Service lines that present the highest risk to the public, taking into consideration factors relating to integrity of the pipe, access to occupied buildings, and likelihood of serious consequences.
- Considering pipe integrity, material types showing high leak rates (such as cast iron, bare steel, and copper) should be replaced with modern materials.
- Further considering pipe integrity, service lines having the earliest installation dates should be considered for replacement preferentially, when all other considerations are equal.
- Considering consequences, service lines that have the highest pressures should also be considered for replacement preferentially, when all other considerations are equal.

In summary, Lummus Consultants suggests that leak rates on the underground portion of the service lines (excluding riser assemblies, meters, and regulators) be used as the primary metric for prioritization of service line replacements. The two secondary factors for further prioritization that are listed above include age and pressure.

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2 Background

2.1 Approach

Lummus Consultants analyzed the leak history on Duke Energy's Ohio service territory service lines in order to develop an independent opinion regarding:

- Whether Duke is having integrity issues with its service lines,
- The cause of any identified service line issues,
- The extent of the identified service line issues – especially whether safety is a concern, and
- The need for an accelerated service line replacement program.

Duke Energy provided Lummus Consultants the latest information on the service lines in the Ohio service territory, including such items as location, pressure rating, year installed, pipe diameter, segment length, district, joint type, and material. We analyzed the leaks per service line for each different type of pipe material (bare steel, coated but unprotected steel, cathodically protected steel, plastic, copper, and cast iron). We compared the leak data for multiple years (for 2002 to 2013) to analyze its trend. The data included the number of service leaks by cause, as defined by PHMSA standard classifications. The cause of leaks typically includes factors such as corrosion, material and welds, natural forces, incorrect operations, excavation by others, construction failure, etc. (see Duke Energy's standard definitions of leak causes in Appendix B, attached).

2.2 Duke Ohio AMRP Program

The PUCO has approved AMRP for the state's four major gas utilities to gradually update old metallic mains (cast iron and bare steel) with more modern protected steel and plastic lines. These accelerated replacement programs are not required by Federal Code; however they are encouraged by PHMSA and approved by the PUCO as proactive measures to improve the safety of the state's underground pipelines. As shown in Table 1, Duke Energy will complete a 15-year AMRP in 2015, during which a major number of service lines have been replaced, along with the main lines. For comparison, Table 1 also identifies the main replacement programs for other major LDCs within Ohio.

Table 1. Ohio Main Replacement Programs (Cast-Iron/Bare-Steel)

Company	Duke Energy	Columbia Gas	Dominion East Ohio	Vectren
Term of the program	15 years	25 years	25 years	20 years
Current year of program[1]	13	6	6	5
Estimated program cost	$716 million	$1.8 billion	$3.4 billion	$337.5 million
Proposed replacement mileage	1,200	4,153	5,572	708
Miles replaced to date[1]	1,014	656	622	113
Dollars spent to date[1,2]	$550.5 million	$359.2 million	$447.6 million	$52.7 million

[1] As of December 31, 2012
[2] Dollars include only the cost of main replacements and related service lines

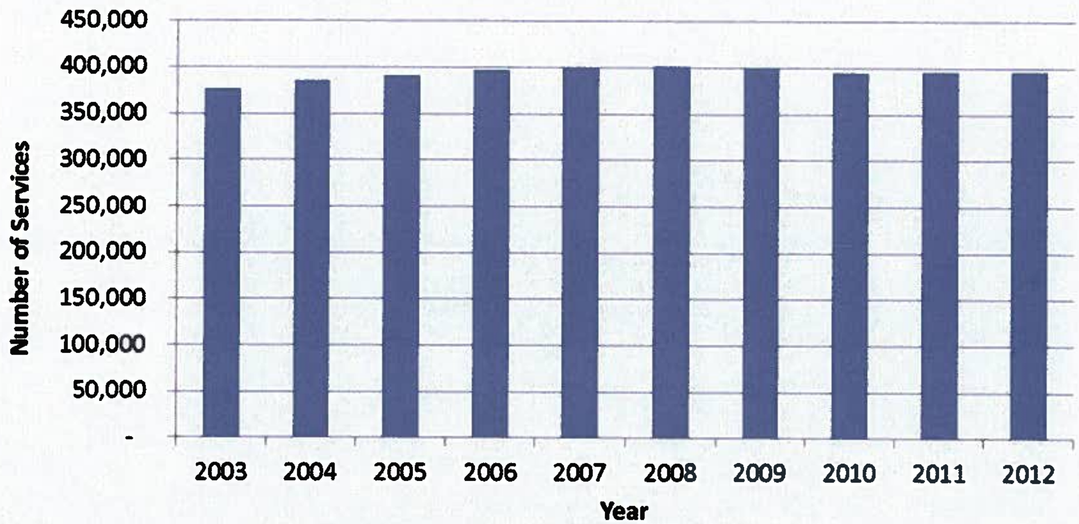
Data Source: http://www.puco.ohio.gov/puco/index.cfm/media-room/media-releases/puco-ensuring-natural-gas-pipeline-safety-in-ohio/

Duke Energy recently completed a similar AMRP program in their Kentucky service area and observed that service line leaks in the Kentucky service area increased after the conclusion of the AMRP program. This pattern has led Duke Energy to investigate whether a similar situation could occur in their Ohio service area following the current AMRP program, and, if so, develop a plan to minimize the leaks.

2.3 Number of Service Lines

Duke Energy and its predecessor gas distribution companies have served the greater Cincinnati, Ohio area for more than 175 years. Recent counts of its customers show a stabilizing market, as indicated in Figure 1.

Figure 1. Total Number of Services (2003-2012)



Data Source: Annual DOT Reports

A stable customer count is typical of urban-centered LDCs. In contrast to some suburban-based LDCs that have substantial customer growth into new or growing areas, and are able to maintain a newer piping system partially through growth, Duke Energy relies on replacement to maintain the reliability of its piping system. Pipe replacement is generally considered to be a more cost-effective way of controlling leaks than continuosly repairing leaks as they occur.

2.4 Duke Energy's Integrity Management Program

Duke Energy, as with all other U.S. LDCs, has recently been required (in Federal Code 49 CFR §192.1007) to establish a DIMP of its distribution piping systems. These regulations require each LDC to conduct the following measures:

- more fully understand its gas system,
- identify the most significant risks to the system,
- develop and implement plans that mitigate these risks,
- measure performance, and
- continuously improve system performance.

In its DIMP, Duke Energy recognizes that managing leaks from its distribution system is an important part of addressing the integrity of its system, and involves identification and potential replacement of certain types of pipes (as guided by its DIMP) in addition to the repair of leaks when they are found.

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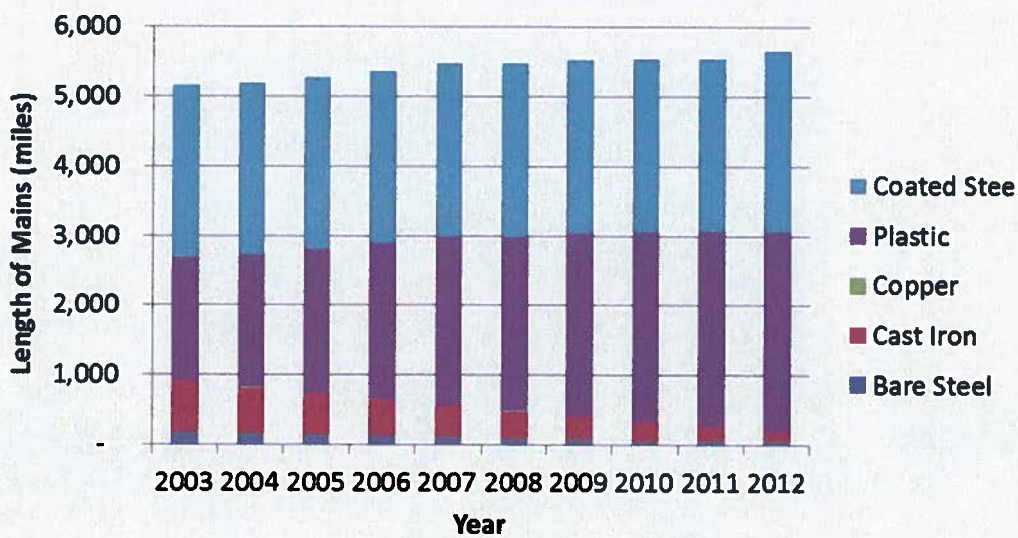
3 Historical Trends

3.1 Main Line Replacements

Over the past decade (year 2003 through year 2012), Duke Energy has replaced a substantial number of obsolete types of main lines with modern materials – primarily through its AMRP program. As a result of this replacement, bare steel mains have been reduced by 114.6 miles, cast-iron mains have been reduced by 622.2 miles, and copper mains have been reduced by 2.2 miles. Through replacement of the older metallic mains, as well as the installation of entirely new mains, plastic mains have increased by 1,102.6 miles and coated steel mains have increased by 146.7 miles[1]. Lummus Consultants considers these replacement mileages to be commendable, both in terms of Duke Energy's accomplishment and the PUCO's authorization to implement this accelerated program. These changes in mains mileage are shown in Figure 2.

Figure 2. Length of Mains (2003-2012)



Data Source: Annual DOT Reports

As shown in the above chart, Duke Energy has nearly eliminated its cast-iron and bare steel mains (). In their place, Duke Energy has installed the most modern materials (plastic and cathodically-protected coated steel).

3.2 Service Line Replacements

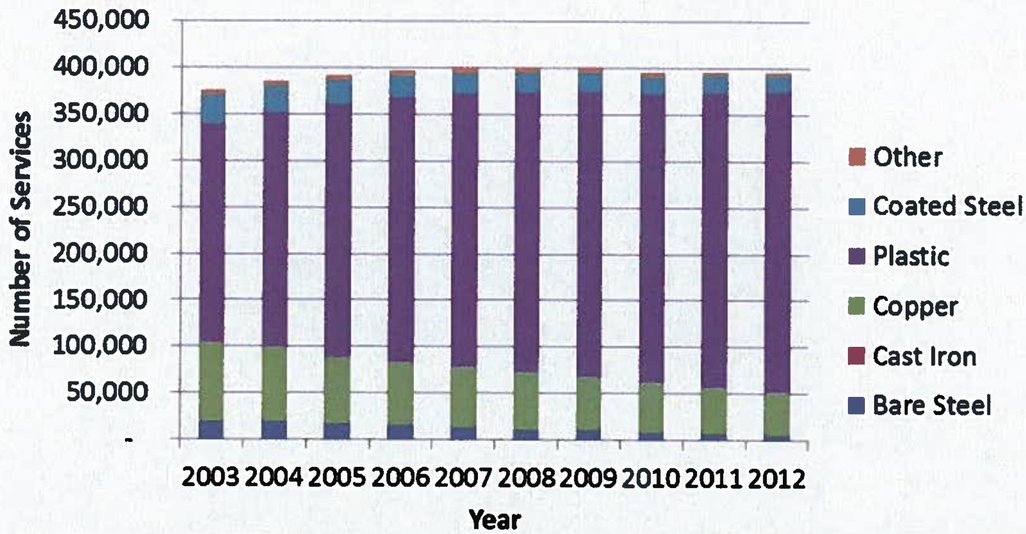
Over the same decade (year 2003 through year 2012) a large number of obsolete service lines have also been replaced. The majority of these were replaced since they were attached to the main lines that were replaced under Duke Energy's AMRP program. A much smaller number have been replaced as part of

[1] Duke Ohio Annual Distribution DOT Reports

Duke Energy's continuing service replacement policy, where scattered service lines are routinely replaced due to condition.

Under Duke Energy's program, the amount of bare steel service lines were reduced by 14,308; cast-iron service lines were reduced by 42; coated steel service lines were reduced by 13,694; copper service lines were reduced by 38,171; and "other" service lines were reduced by 1,634. During the same decade the number of plastic service lines in the Ohio system was increased by 87,416[2]. Figure 3 illustrates the changes in service line materials.

Figure 3. Number of Services (2003-2012)



Data
Source: Annual DOT Reports

As shown in the above chart, corrosion-prone materials such as cast-iron and bare steel have been reduced in number. At the same time the percentage of the system that contains plastic has increased. However, the system still contains a substantial number of lines with older, corrosion-prone material, such as copper.

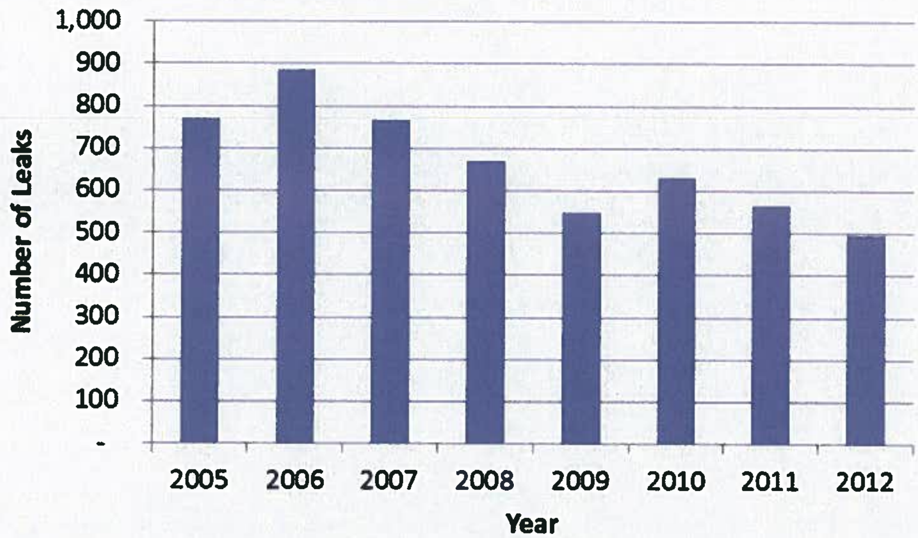
3.3 History of Reported Mains Leaks

Over the past eight years (year 2005 through year 2012), Duke Energy has experienced declining numbers of reported leaks[3] on its mains. During this period a substantial number of miles of obsolete mains with typically high leak rates have been replaced under Duke Energy's AMRP program. As shown in Section 3.1, above, these mains have been replaced with modern materials having improved, long-lived properties, and therefore much lower leak rates. Figure 4 illustrates the recent reduction in mains leaks as reported in Duke Energy's Annual Distribution Reports.

[2] Duke Ohio Annual Distribution DOT Reports

[3] Note that reported leak data, which comes from the DOT Annual reports is somewhat different from repaired leak data, which comes from Duke internal data bases.

Figure 4. Reported Leaks on Mains (2005-2012)

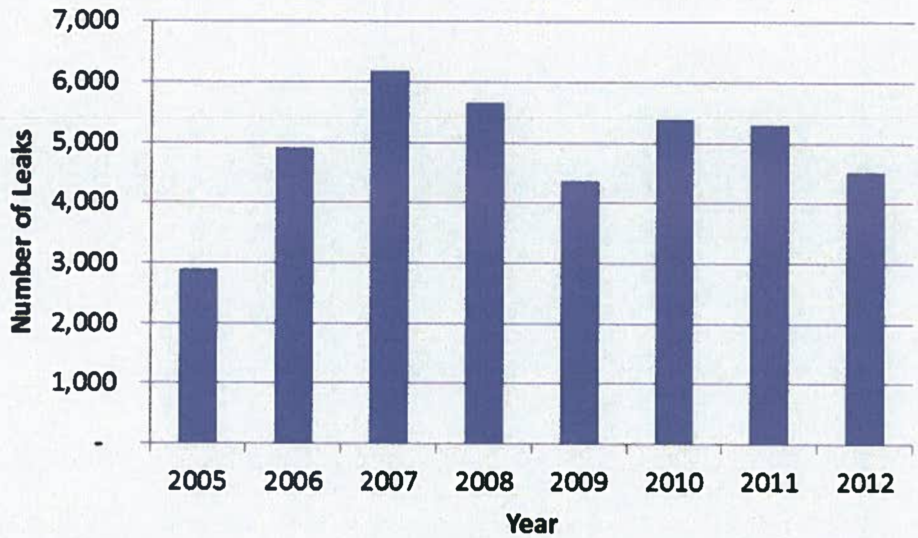


Data Source: Annual DOT Reports

3.4 Service Line Reported Leak History – Inclusive of Meter Set Leaks

Over the same period as shown above for the decline in leak rates on mains (year 2005 through year 2012), Duke Energy has **not** experienced similar declining leak rates on its service lines. Even though substantial numbers of service lines with typically high leak rates have been replaced under Duke Energy's AMRP program, high leak rates have continued. This result would not ordinarily be anticipated and is partly explained by the Department of Transportation (DOT) data. The DOT reported data identifies leaks that have occurred on regulator and meter assemblies, in addition to leaks specifically on the service pipe between the main and meter. (The latter types of leaks are reported further in Section 3.5, below.) Figure 5 identifies the number of Duke Energy reported service line leaks on its system for the years from 2005 to 2012.

Figure 5. Reported Leaks on Services (2005-2012)



Data Source: Annual DOT Reports

3.5 Leak History on Service Line Segments

Lummus Consultants also analyzed "repaired leaks", in addition to the "reported leaks" shown in the previous Section. In this manner leaks on specific segments of the service line, such as Main to Curb (M-C) and Curb to Meter (C-M) segments, were analyzed separately. Figure 6 shows the repaired service line leak history for years 2002 through 2013, including all leak types (Grade one and Grade two)[4].

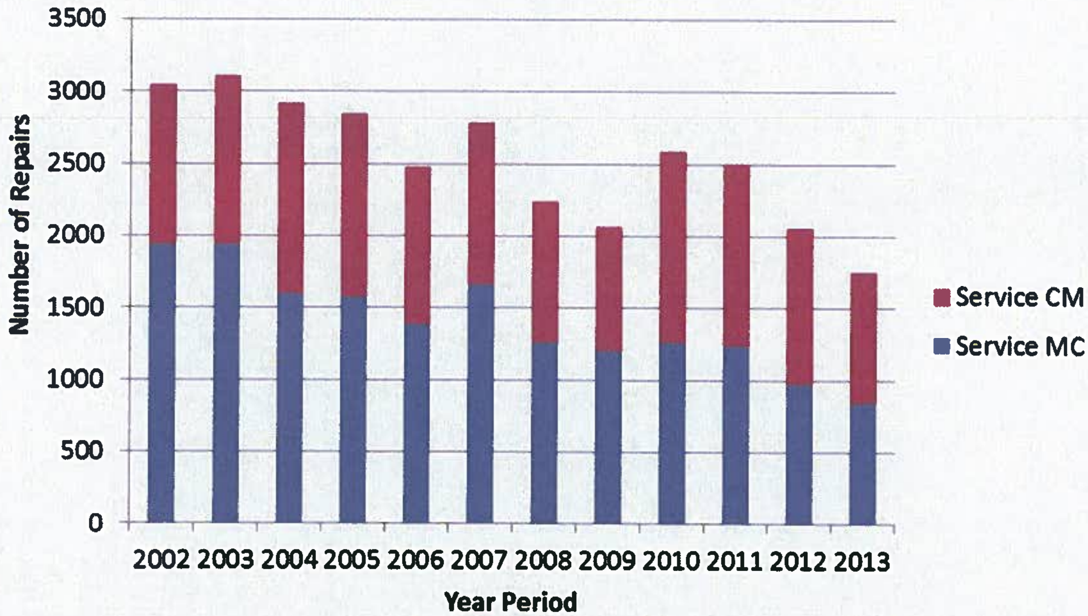
[4] (1) A Grade-one classification represents an indication of leakage presenting an existing or probable hazard to persons or property, and requires immediate repair or continuous action until the conditions are no longer hazardous.

(2) A Grade-two classification represents an indication of leakage recognized as being nonhazardous at the time of detection, but requires scheduled repair based upon the severity and/or location of the leak.

(3) A Grade-three classification represents an indication of leakage recognized as being nonhazardous at the time of detection and can be reasonably expected to remain nonhazardous.

Duke Energy takes a more conservative approach by including leaks that would have fallen into the Grade-three classification as a Grade-two classification.

Figure 6. Repaired Leaks on Services



Data Source: Duke Internal EGIS Leak Repaired Data

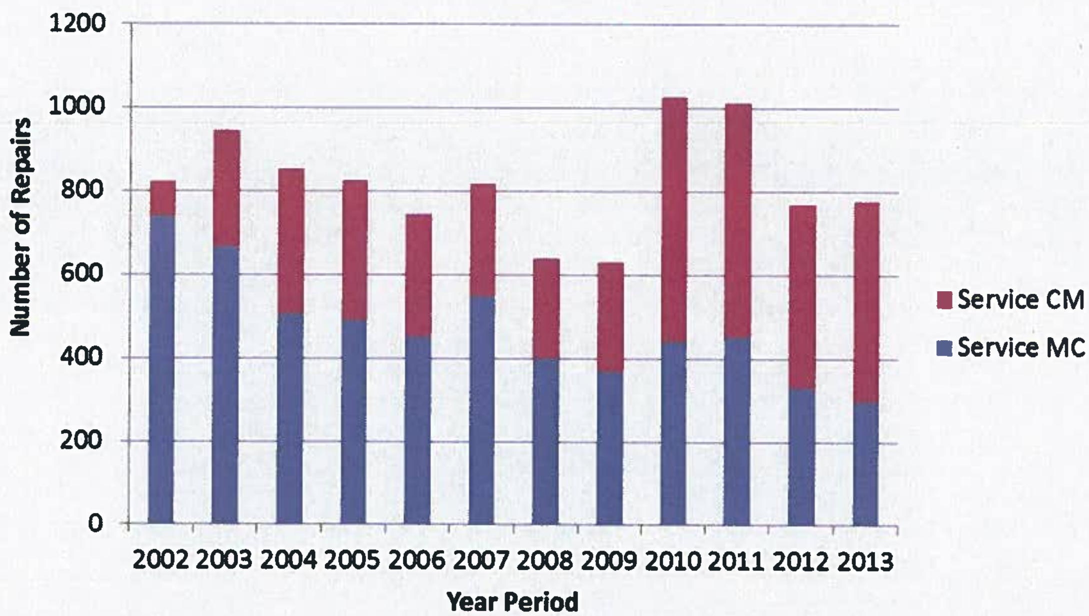
In the above chart, leaks on service line segments are seen to be declining overall, but possibly not quite as fast as one might anticipate, given the extensive AMRP program that has taken place.

3.6 Leak History on Service Lines by Cause

Lummus Consultants was able to identify and categorize the causes of the repaired service line leaks shown in the previous section. Leak trends were declining for most causes, however two of the causes actually indicated mostly flat or increasing trends during recent years. The causes that had increasing trends are corrosion, and material & welds. Figure 7 depicts the number of repaired service line leaks due to corrosion, Data Source: Duke Internal EGIS Leak Repaired Data

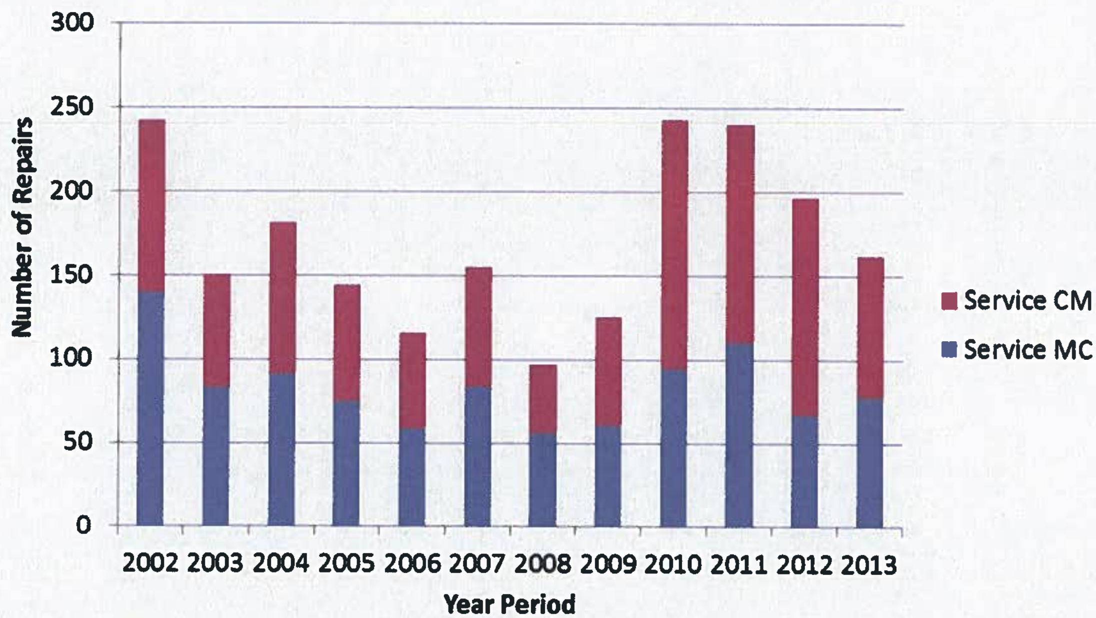
Figure 8 depicts the number of repaired service line leaks due to material & welds, and Figure 9 depicts the number of repaired service line leaks due to all other causes (including incorrect operations, natural forces, equipment malfunction, other outside force damage, and other causes; but excluding excavation damage). All three figures include all leak types (Grade 1 and Grade 2).

Figure 7. Repaired Leaks on Services due to Corrosion



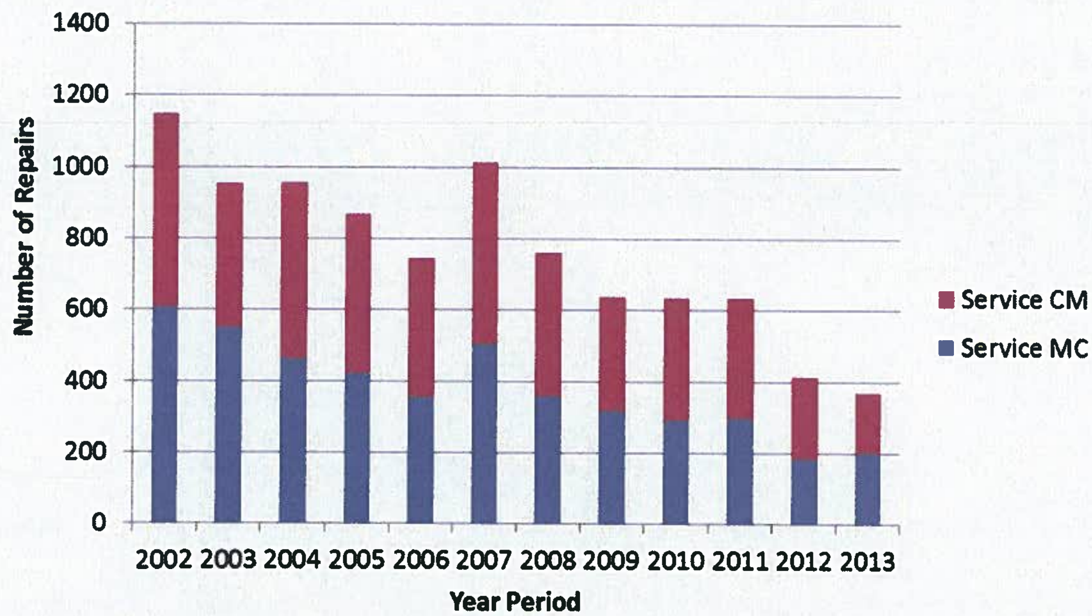
Data Source: Duke Internal EGIS Leak Repaired Data

Figure 8. Repaired Leaks on Services due to Material & Welds



Data Source: Duke Internal EGIS Leak Repaired Data

Figure 9. Repaired Leaks on Services due to All Other Causes (Except Excavation Damage)



Data Source: Duke Internal EGIS Leak Repaired Data

As shown in Figures 7 and 8, the trends in the cause of the leaks are unexpected and relate to continuing deterioration of primarily metallic service lines. It appears that although overall service line leaks are declining, leak trends caused by the two categories, corrosion and materials & welds, have remained elevated. This may indicate that even after Duke Energy's Ohio AMRP program is completed, service line leaks may continue to rise due to age, soil condition, stray-current, or other promoting continued deterioration of metallic services. In direct contrast to the trends shown in Figures 7 and 8, Figure 9 indicates all other leaks causes (not including Excavation Damage) have been declining.

4 Current Service Line Status

4.1 Main to Curb vs Curb to Meter

Duke Energy maintains records of service lines in their internal data files categorized as either M-C, or C-M. The M-C line extends from the supplying main as far as the property line, where a curb box valve is often located. The C-M service line is the portion extending from the property line, or curb box valve, as the case may be, to the meter. There are at least two reasons for the categorization of service lines. The first reason is historical – Ohio had traditionally split the ownership of service lines where the gas company owned and maintained the M-C portion, while the homeowner owned and maintained the C-M portion. This designation has been changing with new rules for ownership and maintenance. The gas company will continue to be responsible for the C-M portion and the appropriate M-C portion when the gas company performs maintenance (such as replacement of the line) on the C-M line.

The second reason for keeping track of both portions of the service lines relates to the electrical protection on metallic lines. The curb box valves are not electrically conductive, resulting in a potentially different degree of cathodic protection on the two portions of the service line. The continuity of ownership from main through to the meter is seen as an obvious and prudent arrangement, giving line integrity responsibility to the most capable party, the LDC. As such, the objective of maintaining safety of the service lines is enhanced.

Records supplied by Duke Energy indicate that as of November, 2013 there were 402,440 M-C service lines in the data files, and 378,503 C-M service lines.

4.2 Service Line Material Types

4.2.1 M-C Service Line Material Types

Table 2 identifies the number of M-C service line material types that are currently installed in Duke Energy's Ohio system.

Table 2. Duke Energy Number of M-C Services by Material Type	
Bare Steel	2,413
Cast Iron	20
Coated Copper	12
Coated Steel	17,041
Copper Tubing	105
Copper	45,121
Steel Tubing	927
Steel	1,617
(Subtotal Metallic)	*67,256*
Plastic	331,519
Unknown	3,665
Total	**402,440**

Data Source: Duke Internal EGIS Leak Repaired Data

4.2.2 C-M Service Line Material Types

Table 3 identifies the number of C-M service line material types that are currently installed in Duke Energy's Ohio system.

Table 3. Duke Ohio Number of C-M Services by Material Type	
Bare Steel	2,136
Cast Iron	3
Coated Copper	1,423
Coated Steel	7,492
Copper Tubing	2,031
Copper	14,603
Steel Tubing	643
Steel	2,065
(Subtotal Metallic)	*30,396*
Plastic	280,890
Unknown	67,217
Total	**378,503**

Data Source: Duke Internal EGIS Leak Repaired Data

4.3 Service Line Age Categories

4.3.1 M-C Service Line Age Categories

Table 4 identifies the number of service lines by installation date for M-C service lines currently installed in Duke Energy's Ohio system.

Table 4. Duke Ohio Number of M-C Services by Age Categories for Year Installed	
pre-1940	4,816
1940s	2,336
1950s	10,324
1960s	36,531
1970s	26,653
1980s	40,619
1990s	100,588
2000s	141,391
2010s	34,782
Unknown	4,400
Total	**402,440**

Data Source: Duke Internal EGIS Leak Repaired Data

4.3.2 C-M Service Line Age Categories

Table 5 identifies the number of service lines by installation date for C-M service lines currently installed in Duke Energy's Ohio system:

Table 5. Duke Ohio Number of C-M Services by Age Categories for Year Installed

pre-1940	3,160
1940s	35
1950s	125
1960s	536
1970s	715
1980s	28,027
1990s	83,131
2000s	128,718
2010s	33,827
Unknown	100,229
Total	**378,503**

Data Source: Duke Internal EGIS Leak Repaired Data

4.4 Service Line Pressure Categories

4.4.1 M-C Service Line Pressure Categories

Table 6 identifies the number of service lines at each maximum operating pressure level for M-C service lines currently installed in Duke Energy's Ohio system.

Table 6. Duke Ohio Number of M-C Services by MAOP Pressure Level

SP (7" - 10" W.C.)	59,159
MP (1 - 5 psig)	1,986
IP (5 - 35 psig)	236,140
HP (15 - 60 psig)	97,513
Feeder (60+ psig)	7,175
Transmission	428
Unknown	39
Total	**402,440**

Data Source: Duke Internal EGIS Leak Repaired Data

4.4.2 C-M Service Line Pressure Categories

Table 7 identifies the number of service lines at each maximum operating pressure level for C-M service lines currently installed in Duke Energy's Ohio system.

Table 7. Duke Ohio Number of C-M Services by MAOP Pressure Level	
SP (7" - 10" W.C.)	61,815
MP (1 - 5 psig)	1,923
IP (5 - 35 psig)	218,845
HP (15 - 60 psig)	88,326
Feeder (60+ psig)	6,206
Transmission	336
Unknown	1,052
Total	**378,503**

Data Source: Duke Internal EGIS Leak Repaired Data

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5 Accelerated Replacement Considerations

5.1 Accelerated Service Line Replacement Programs

Duke Energy, like most LDCs, annually replaces a small number of service lines based on their condition and judged level of obsolescence. These replacements are included in rate base proceedings for reimbursement of expenses.

In the last few years, another reimbursement procedure has been adopted in a number of states throughout the U.S. whereby expense trackers have been utilized to provide accelerated reimbursement for selected pipe replacement expenditures. This procedure has been encouraged by Federal pipeline safety authorities and State Commissions that have been concerned with the decaying pipeline infrastructure and a number of serious accidents that have occurred in recent years. By using this accelerated reimbursement procedure, LDCs are incentivized to replace a much larger number of pipes than historically observed.

Duke Energy has been permitted by the PUCO to utilize the accelerated replacement procedure for its mains, now nearing the end of its 15-year AMRP (see Section 2.2 above). Lummus Consultants has been engaged by Duke Energy to analyze the service line make up and leak history to assess the need for an ASRP (accelerated service line replacement program) to follow its AMRP project.

5.2 PHMSA Justification for Accelerated Replacement Programs

PHMSA has sent a Call to Action to all pipeline stakeholders, including the National Association of Regulatory Utility Commissioners (NARUC) and its members, and in it specifically called on Public Utility Commissions to establish cost recovery mechanisms that effectively address infrastructure replacement costs. A copy of key documents distributed by PHMSA can be found in: http://opsweb.phmsa.dot.gov/pipelineforum/docs/PHMSA%20111011-002%20NARUC.pdf and are provided in Attachment C of this report. Included is an overview of natural gas ratemaking, a discussion of the need to take prompt action to remediate high-risk pipeline infrastructure, and a description of the various State programs that are being used for that purpose.

In this document PHMSA states: "We believe that the timely repair, rehabilitation, and replacement of high-risk gas pipeline infrastructure are critical to ensuring public safety. A series of recent gas pipeline accidents, including the September 9, 2010 San Bruno, California accident, the January 19, 2011 Philadelphia, Pennsylvania accident, and the February 10, 2011 accident, show the terrible loss of life and property that can occur without adequate attention to the integrity of pipeline infrastructure. PHMSA believes that an effective program for ensuring the timely rehabilitation, repair, or replacement of high-risk gas pipelines might have helped prevent these accidents."

PHMSA often uses the term "high-risk" pipeline segments or infrastructure when describing its replacement targets. PHMSA also regularly cites the three incidents given above when making a case for public safety through the prevention of these types of incidents. Together, the three incidents resulted in fourteen fatalities, thirty-three injuries, thirty-eight homes destroyed, and over two million dollars in other property damage. It is critically important to define and understand the term "*high-risk*" to clarify the objectives that PHMSA and the public would want - and the PUCO would support - for the ASRP proposed by Duke Energy. PHMSA's definition of "high-risk" pipe follows from pages 4 and 5 of their document and is stated below:

"High-risk pipeline infrastructure is piping or equipment that is no longer fit for service. As discussed below, that lack of fitness can be the product of a variety of factors.

a. **Cast iron gas mains and service lines** can be prone to failure as a result of graphitization or brittleness. The installation of cast iron pipe dates to the 1830s, and remained prevalent until the post-World War II period. Many major urban areas, including Philadelphia, PA; Boston, MA; Baltimore, MD; Washington, DC; Detroit, MI; Chicago, IL; and San Francisco, CA, still have cast iron pipe in their natural gas distribution systems.

b. **Certain vintages of plastic pipe** are susceptible to premature failures as a result of brittle-like cracking. In April 1998, the National Transportation Safety Board (NTSB) released a Special Investigation Report on Brittle-Like Cracking in Plastic Pipe for Gas Service. NTSB found that the long-term strength and resistance of plastic pipe to brittle-like cracking may have been overrated for much of the plastic pipe manufactured and installed from the 1960s through the early 1980s. The NTSB also found that any potential public safety hazards from these failures are likely to be limited to locations where stress intensification exists. In response to the NTSB report and subsequent investigations, PHMSA issued four advisory bulletins on the susceptibility of certain kinds of older plastic pipe to brittle-like cracking.

c. **Mechanical coupling installations** are devices that are used for the joining and pressure sealing of two pieces of pipe. These devices are prone to failure under certain conditions. In March 2008, PHMSA issued an Advisory Bulletin (ADB) on the use of mechanical couplings in natural gas distribution systems. The ADB noted that these devices are more likely to fail when there is inadequate restraint for the potential stresses on the two pipes, when the couplings are incorrectly installed or supported, or when components experience age-related deterioration. The ADB also noted that inadequate leak surveys can fail to detect a coupling in need of repair and lead to more serious incidents.

d. **Pipelines lacking adequate construction records** or assessment results to verify their integrity. In January 2011, PHMSA issued an ADB on the need to use traceable, verifiable, and complete records in establishing the maximum allowable operating pressures and developing and implementing integrity management programs for natural gas pipelines. The ADB responded to an NTSB recommendation, which resulted from its investigation of the September 2010 intrastate natural gas transmission line rupture in San Bruno, California, which is discussed below.

e. **Other kinds of pipe installations**, including bare steel pipe without adequate corrosion control (i.e., cathodic protection or coating) and copper piping, are also more susceptible to failure.

f. **Age of pipe** should be considered in determining whether pipeline infrastructure is vulnerable to failure from time-dependent forces, like corrosion, stress corrosion cracking, settlement, embrittlement, or cyclic fatigue."

5.3 Analysis of PHMSA's Recommendations for Accelerated Service Line Replacement Program

Lummus Consultants investigated the data provided in the DOT Gas Distribution System Annual Reports for Duke Energy for 2012 and earlier years to assess the current inventory of pipe, segmented into the number of service lines, age, operating pressures, as well as size of pipe. This permitted an assessment of the need for a replacement plan for Duke Energy, since different pipe sizes and material types may require very different rates of replacement depending on current inventory, leak rate, and age. It also permits an assessment of the types or specific attributes of pipes that should be addressed in a replacement plan.

Lummus Consultants also compared the characteristics of the Duke Energy service lines – particularly Duke Energy's remaining metallic services - to those identified by PHMSA as being in "high-risk" categories. Lummus Consultants' analysis of Duke Energy's service line records indicates that these pipes include five of the six attributes that are included in PHMSA's list of "high-risk" pipeline infrastructure as defined above:

1) Cast iron gas mains and service lines
2) Mechanical coupling installations
3) Pipelines lacking adequate construction records
4) Other kinds of pipe installations, including bare steel pipe without adequate corrosion control (i.e., cathodic protection or coating) and copper piping
5) Age of pipe

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6 Recommendations

6.1 Considerations for Service Line Replacement Programs for LDCs

Lummus Consultants recognizes that the key consideration for service line pipe replacement programs is the safety of the general public and Duke Energy employees. Risk to public safety created by gas piping is typically the result of, and often the product of, three factors:

1. Integrity or condition of the pipe - That is, its propensity for leakage as a result of corrosion, coupling integrity, breakage, or other.
2. The likelihood that leaking gas may escape to occupied areas or buildings - Urban locations do not always have open areas for gas to dissipate should leaking gas travel from the pipe in the street or in the yard to buildings. Older service lines, which run directly to the customers' buildings, are examples of the importance of the second factor.
3. The potential for serious consequence - Larger diameter pipes and higher-pressure gas within the pipes raise the stakes considerably for potential serious consequences.

6.1.1 First Safety Factor – Integrity

Duke Energy's DIMP program focuses on pipe integrity. A key factor involved in the formation of leak holes is the age of the pipe, as age is often directly related to pipe deterioration, due to influences such as corrosion, differential settlement around joints, earlier technologies in use, etc.

6.1.2 Second Safety Factor - Access

Unlike mains, service lines connect directly to buildings. These include not only single-family residences, but also high-occupancy structures, such as apartment buildings, hospitals, nursing homes, restaurants, shopping malls, movie theatres, houses of worship, etc. For this reason, the second risk factor applies more to service lines than it does to mains, which are normally not installed next to buildings.

6.1.3 Third Safety Factor - Pressure

Similar to mains, service lines typically operate under the same pressure as the mains they are connected to. Pressure is not normally reduced in a service line until it reaches the building where a regulator reduces the pressure before entering the meter. For this reason the third risk factor applies equally to service lines as it does to mains.

Noting the factors above and risks they present to the general public, as well as Duke Energy's employees, the replacement of service lines is an appropriate measure, particularly as in a planned accelerated program.

6.2 Recommendations for Duke Energy's Service Line Replacements

Lummus Consultants has evaluated the leak patterns shown for service lines (Section 3.4) and for specific causes of service line leaks (Section 3.6). Since these patterns have not shown the degree of abatement in leaks (due to corrosion and materials & welds) that would be expected from replacement trends, we recommend that a program be developed for the replacement of additional service lines having the potential to corrode or dislodge from mechanical fittings (see Appendix B).

Lummus Consultants recommends that material types having the potential to corrode or dislodge from mechanical fittings be considered for inclusion in this program. Materials that fit this category include all types of metallic service lines:

- Cast iron
- Steel
- Copper

These service lines should be replaced with modern materials, as is practiced in the industry world-wide.

Duke Energy's records indicate that 67,256 (see Section 4.2.1) M-C metallic service lines remain in Duke Energy's Ohio service territory as of year-end 2012 as well as 3,665 service lines of unknown material. Replacement of the metallic service lines and the service lines of unknown material is recommended. (Please refer to Table 2 for specific number of services of each type). This would concurrently address the number of metallic C-M service lines, which are partly undefined due to a large number still remaining under ownership of the property owner.

6.3 Prioritization of Service Line Replacement by Age

Lummus Consultants recognizes that, in addition to quantitative considerations, there are many practical considerations involved in the prioritization of pipe replacements. It is usually preferable, for instance, to group replacements geographically, in order to realize lower costs by minimizing contractor equipment and resource mobilization. Lummus Consultants feels that Duke Energy's Operating and Engineering personnel are best positioned to group replacements, capitalizing on their familiarity with the system. These types of considerations should be factored into prioritizing replacements. Lummus Consultants additionally recommends quantitative prioritization based on certain broad measures of leak rates, material type, age and pressure, as discussed herein.

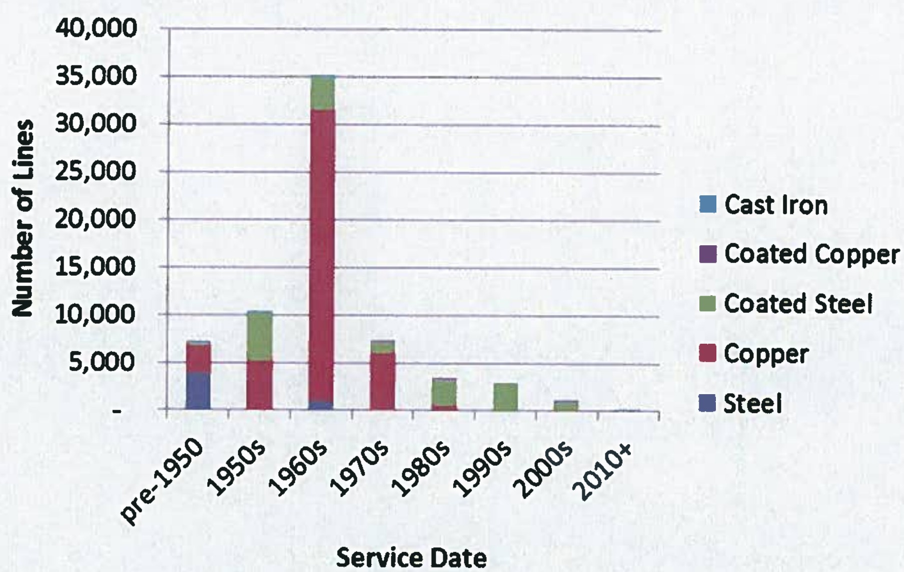
Lummus Consultants suggests that leak rates on the underground portion of the service lines (excluding riser assemblies, meters, and regulators) be used as the primary metric for prioritization of service line replacements. We have also illustrated two secondary factors for further prioritization for the replacement of Duke Energy's Ohio metallic service lines: first by age of installation, as shown in Table 8. This table arranges prioritization by age. We do not suggest that older service lines should be strictly prioritized, however the service lines having the earliest installation dates (i.e., those in the top rows of the table) should be considered for earlier replacement, when all other considerations are equal. We note that no information existed, either in the DOT data or in other data sources we analyzed, that would have permitted Lummus Consultants to analyze the possible correlation between age and leaks on Duke Energy's service lines. We have presented a table showing age versus material types in Table 8. Note that unknown service installation date category is not included in this table so the total is slightly less than the metallic subtotal in Table 2.

Table 8. Service Installation Date versus Material Type – M-C Ohio Metallic Services						
	Steel	Copper	Coated Steel	Coated Copper	Cast Iron	Total
pre-1950	3,861	2,894	371	-	4	7,130
1950s	73	5,057	5,153	1	6	10,290
1960s	939	30,643	3,448	2	9	35,041
1970s	2	5,945	1,228	1	-	7,176
1980s	1	457	2,855	6	-	3,319
1990s	3	66	2,847	-	-	2,916
2000s	35	60	895	2	-	992
2010+	14	11	149	-	1	175
Total	4,928	45,133	16,946	12	20	67,039

Data Source: Duke Internal EGIS Leak Repaired Data

Figure 10 pictorially represents the installation date and associated type of metallic material that was used on service lines.

Figure 10. Service Installation Date versus Material Type – M-C Ohio Metallic Services



Data Source: Duke Internal EGIS Leak Repaired Data

6.4 Prioritization of Service Line Replacement by Pressure

Lummus Consultants has prioritized Duke Energy's Ohio service lines also by operating pressure, as shown in Table 9. This table prioritizes services by pressure. Again, we do not suggest that higher pressure services should be strictly prioritized, however the service lines having the highest pressures (i.e., those in the top rows of the table) should be considered for early replacement, with all other considerations being equal. Note that the unknown pressure level category is not included in this table so the total is slightly less than the metallic subtotal in Table 2.

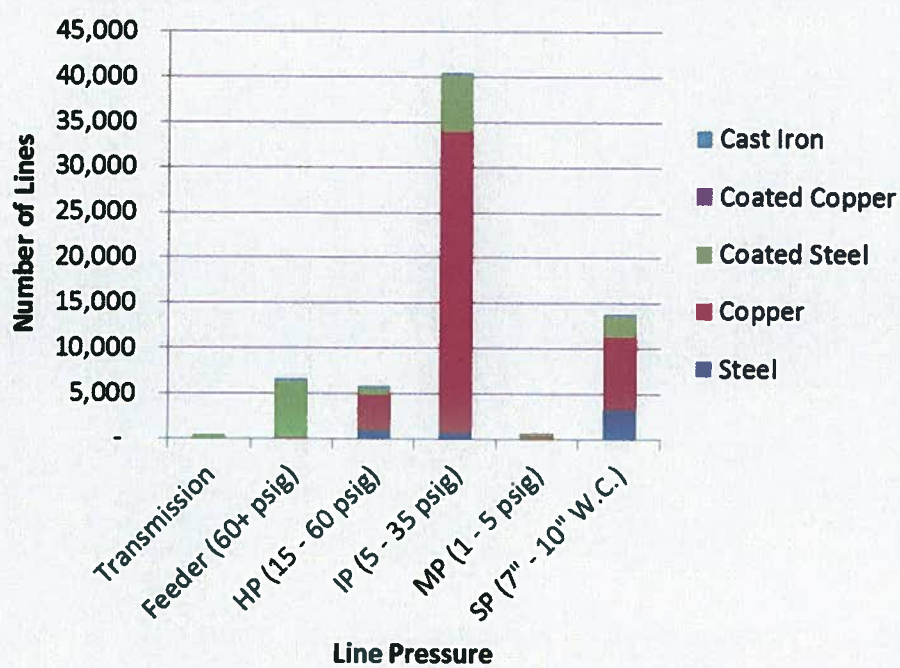
Table 9. Material Type versus Pressure Level – M-C Ohio Metallic Services

	Steel	Copper	Coated Steel	Coated Copper	Cast Iron	Total
Transmission	2	4	382	-	-	388
Feeder (60+ psig)	49	79	6,327	-	1	6,456
HP (15 - 60 psig)	956	3,799	932	2	1	5,690
IP (5 - 35 psig)	704	33,120	6,446	10	5	40,285
MP (1 - 5 psig)	13	257	433	-	-	703
SP (7" - 10" W.C.)	3,229	7,952	2,512	-	13	13,706
Total	4,953	45,211	17,032	12	20	67,228

Data Source: Duke Internal EGIS Leak Repaired Data

Figure 11 identifies the number of service lines with the indicated operating pressure regimes for the various types of metallic materials.

Figure 11. Material Type versus Pressure Level – M-C Ohio Metallic Services



Data Source: Duke Internal EGIS Leak Repaired Data

6.5 Prioritization of Service Line Replacement by Age and Pressure

Lummus Consultants has prioritized Duke Energy's Ohio service lines by both age and pressure, as shown in Table 10. The metallic service lines with the earliest installation dates, as well as the highest pressure (i.e., those nearest to the top left corner of the table) should be considered for early replacement, with all other considerations being equal. Note that unknown categories for service installation date and pressure level are not included in this table so the total is less than the previous tables.

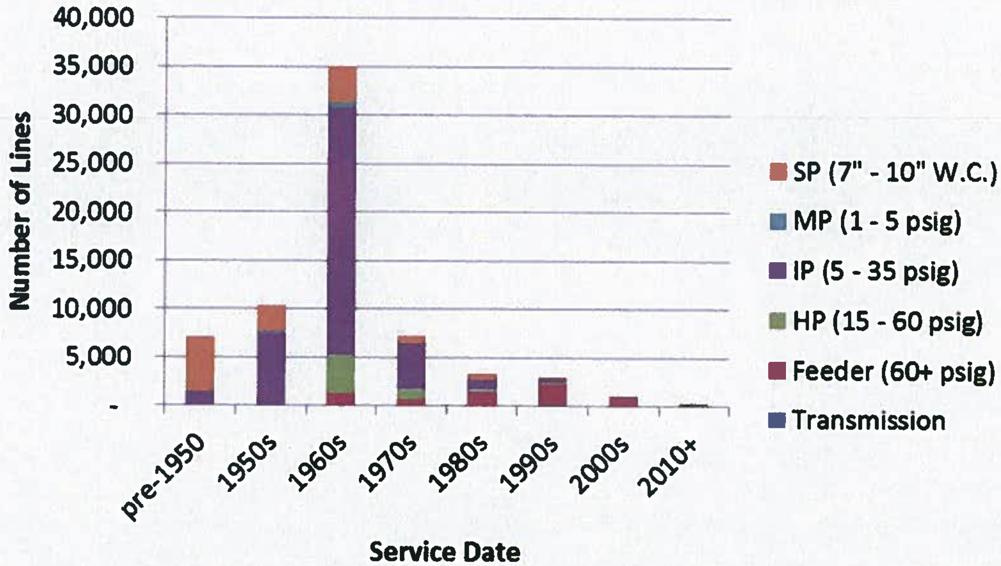
Table 10. Service Installation Date versus Pressure Level – M-C Ohio Metallic Services

	Transmission	Feeder (60+ psig)	HP (15 - 60 psig)	IP (5 - 35 psig)	MP (1 - 5 psig)	SP (7" - 10" W.C.)	Total
pre-1950	-	9	43	1,343	16	5,706	7,117
1950s	8	120	56	7,292	152	2,657	10,285
1960s	79	1,220	3,968	25,481	517	3,770	35,035
1970s	31	644	1,077	4,715	11	696	7,174
1980s	77	1,361	332	946	1	600	3,317
1990s	158	2,087	171	294	-	206	2,916
2000s	26	795	15	118	6	32	992
2010+	6	147	3	10	-	9	175
Total	385	6,383	5,665	40,199	703	13,676	67,011

Data Source: Duke Internal EGIS Leak Repaired Data

Figure 12 identifies the number of metallic service lines categorized by year of installation and pressure regime.

Figure 12. Service Installation Date versus Pressure Level – M-C Ohio Metallic Services



Data Source: Duke Internal EGIS Leak Repaired Data

6.6 Recommendation for an Accelerated Service Line Replacement Program

Lummus Consultants has reviewed the categories of pipes recommended for accelerated replacement programs by PHMSA (Section 5.3). Our analysis of Duke Energy's service line records indicates that these lines include five of the six pipe attributes that are included in PHMSA's list of "high-risk" pipeline infrastructure, as defined above:

1. Cast iron gas mains and service lines
2. Mechanical coupling installations
3. Pipelines lacking adequate construction records
4. Other kinds of pipe installations, including bare steel pipe without adequate corrosion control (i.e., cathodic protection or coating) and copper piping
5. Age of pipe

Based on our findings, we conclude that Duke Energy's service lines would qualify for accelerated replacement, in adherence to five out of six of PHMSA's priority categories. Accordingly, we recommend that Duke Energy Ohio petition the PUCO for permission to conduct an ASRP. Such a program should include all of Duke Energy's metallic services.

Appendix A List of Documents Reviewed

Section	File Name
Background/Historical Trends	Duke DIMP Plan [DIMP Plan.pdf]
	Ohio PUCO News Release [http://www.puco.ohio.gov/puco/index.cfm/media-room/media-releases/puco-ensuring-natural-gas-pipeline-safety-in-ohio/]
	Duke Ohio DOT 2012 Annual Report [DEO YE2012 Gas Dist Annual Report (SUPPLEMENTAL 6-14-13).pdf]
	Duke Kentucky DOT 2012 Annual Report [DEK YE2012 Gas Distribution Annual Report (SUPPLEMENTAL 6-14-13).pdf]
	DOT Data [PHMSA F 7100.1-1 Gas Distribution System Annual Report.xlsx]
	Duke Leak Repair Data [2012 Duke Energy Leak Repair Data 1996-2012.xlsx]
	Duke Threat Definitions [_THREAT_DEFINITIONS_(CAUSES).docx]
	Duke Repaired Leaks on Services Data [Repaired Leaks on Services with Specific Service Repaired.xlsx]
	Duke Leak Repair Data [EGIS Leak Repairs-Grade-State-Suburb-Collection.xlsx]
Accelerated Replacement Considerations	DOT State Pipeline Infrastructure Replacement Programs White Paper [PHMSA%20111011-002%20NARUC.pdf]
	Risk Analysis Charts [ICAM Risk Analysis 12-19-13.pdf]
Recommendations	Curb to Meter Duke Ohio Data [CM OhioService_w_zip_codes split 1 of 2.xlsx] [CM OhioService_w_zip_codes split 2 of 2.xlsx]
	Main to Curb Duke Ohio Data [MC OhioService_w_zip_codes split 1 of 4.xlsx] [MC OhioService_w_zip_codes split 2 of 4.xlsx] [MC OhioService_w_zip_codes split 3 of 4.xlsx] [MC OhioService_w_zip_codes split 4 of 4.xlsx]

Appendix B - Threat (Cause) Definitions

Excerpt from Duke Ohio's Classification Criteria for Causes of Leaks:

2.0 THREAT DEFINITIONS

2.1 Duke Energy has defined each threat category as it applies to its distribution system in order to maintain a consistent application of the threat identification procedure.

2.2 Corrosion - All metallic pipe and components in the distribution system are subject to one or more of the following types of corrosion.

2.2.1 External Corrosion. The threat of external corrosion will be identified where the pipeline is not cathodically protected, where trending shows insufficient cathodic protection or in areas where gas leakage has been identified in the past where the root cause was determined to be external corrosion.

2.2.2 Internal Corrosion. The threat of internal corrosion will be identified only where there is an expectation of liquid being present or liquid was previously found in the facility, or when an internal pipe inspection has shown corrosion to be present on the inside surface of the pipeline.

2.2.3 Atmospheric Corrosion. Atmospheric corrosion is a subset of external corrosion that will occur only on pipe and components that are exposed to the atmosphere. For exposed pipe in areas where only a light surface oxide forms that does not affect the safe operation of the facility (§192.479), the threat of atmospheric corrosion will not be identified.

2.2.4 Stray Current Corrosion. Induced AC current and fault AC current on the pipelines, due to close proximity to overhead high-voltage AC power lines or foreign line crossings, are threats that could lead to external corrosion. Ground Beds and Anode beds are installed at various locations to eliminate or reduce the effects of stray currents. Other stray currents (e.g., foreign DC current sources) could also be threats that could lead to external corrosion.

2.3 Natural Forces - Natural force threats are events which happen naturally, are unpredictable and can cause damage to distribution pipelines. Examples include:

- x Ice damage
- x Water damage (e.g., floods or heavy rain. associated erosion)
- x Earthquake
- x Tree roots
- x Lightning strikes
- x Wind damage (e.g., tornado, straight line)
- x Excessive high or low temperatures
- x Hill slides, road slides

2.4 **Excavation Damage** – Except as noted below, buried facilities in the Duke Energy distribution system face the threat of being damaged by excavation activities.

2.4.1 The excavation damage threat generally does not apply to piping within protective casings, inside underground structures such as basins or vaults, or within fenced Duke Energy-owned property.

2.4.2 Mechanical clean out of sewer laterals poses a threat to directionally drilled gas lines, requiring camera work to be performed prior to sewer lateral cleanout being performed. Clean outs or drainage pipes are tagged at the customer's premise with notice to contact Duke Energy prior to sewer work.

2.5 **Other Outside Force Damage** - Aboveground facilities including the following are considered of primary interest when determining if this threat is present.

2.5.1 Gas piping is close enough to vehicular traffic (e.g., automobiles, trucks, forklifts, construction equipment) where it may be reasonably expected that damage from vehicle movement could occur.

2.5.2 Locations known to be subject to vandalism, destruction, wreckage, sabotage, or other harm (e.g., unauthorized adjustment or valve movement) may be assigned a higher probability of this threat.

2.5.3 Gas facilities impacted by fire or explosion may be assigned a lower probability of this threat since this damage is a result of the fire or explosion, not a cause.

2.6 **Material or Welds** - This threat occurs due to potential or existing defects in pipe, fittings, components and joints that are introduced during the manufacturing or installation process.

2.6.1 Longitudinal pipe seams made by low-frequency ERW before 1970, electric flash welding, lap welding, hammer welding, or butt welding and fittings or components fabricated by welding may pose a weld-related threat.

2.6.2 Defects within fittings and components from the manufacturing process are material threats.

2.6.3 Certain vintage plastic piping materials in the Duke Energy distribution system such as, low-ductile inner wall DuPont Aldyl A PE pipe are subject to this threat.

2.6.4 Where it can be determined that pullout from a mechanical or compression fitting can be anticipated or a threaded connection is subject to vibration, the joint failure threat will be determined to apply.

2.7 Equipment malfunction - Items of equipment exhibiting possible systemic problems are considered vulnerable to the equipment malfunction threat. Such items may include:

2.7.1 Regulator or relief valves (e.g., failing to perform the intended task or operating outside of the manufacturer's specified tolerances),

2.7.2 Repeated history of:

- Failed flange gaskets.
- Failed O-rings.
- Broken pipe or stripped threads.

2.7.3 Equipment with a history of problems (e.g., a particular style or model of mechanical couplings).

2.8 Incorrect Operation - The threat of incorrect operation may be applicable to construction, operation (e.g., start up or shut down of a pipeline, purging) or maintenance activities (e.g., ignition of escaping gas). This threat is totally associated with personnel performance and does not include the designed operation of a device.

2.8.1 Poor workmanship or outdated methods during the construction or installation process (e.g., acetylene girth welds, wrinkle bends, cast iron joining or inadequate support) are considered within this threat category.

2.8.2 Knowledge of instances where personnel have not followed approved procedures could lead to identification of an inappropriate operation threat.

2.8.3 Human error is possible in performing every activity associated with a distribution pipeline system and is therefore always a threat.

2.9 Other - Duke Energy considers the following an "other" threat and will determine on a case-by-case basis when additional threats are present that are not covered in the above descriptions. "Other" threats will likely be attributable to special circumstances in specific locations on the system.

2.9.1 Incorrect installation (e.g. Horizontal Directional Drill (HDD) through a sewer lateral.)

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LUMMUS CONSULTANTS
INTERNATIONAL

Final

Supplement to the March 10, 2014 Accelerated Service Replacement Program Report

DUKE ENERGY®

Prepared for

Duke Energy

August 19, 2015

LUMMUS CONSULTANTS INTERNATIONAL

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1 Introduction

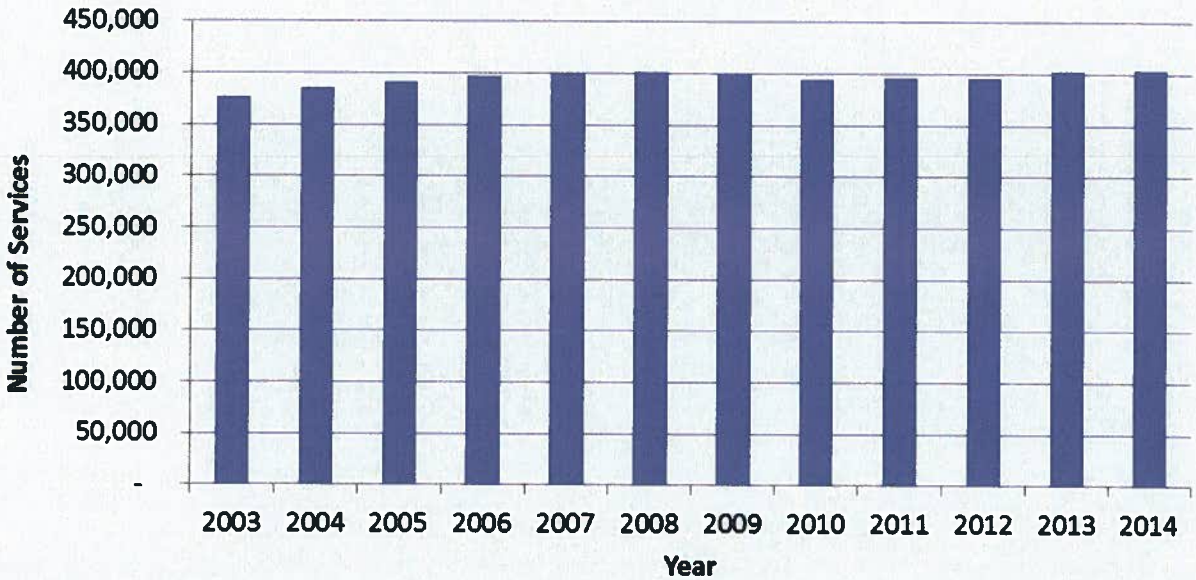
Lummus Consultants International, Inc. (Lummus Consultants) was retained by Duke Energy Corporation (Duke Energy) in 2013 to analyze the leak history on Duke Energy's service lines in its Ohio service territory. Lummus Consultants issued its report entitled "Accelerated Service Replacement Program" on March 10, 2014. That report was based on data through 2012, which was the latest complete set of data available during the course of the Lummus Consultants' study.

This current document entitled "Supplement to the March 10, 2014 Accelerated Service Replacement Program" is a supplement to the 2014 report and serves to update all Figures and Tables to include 2013 and 2014 data. Only the Figures and Tables (without explanatory text) are included in this supplement, so the 2014 Accelerated Service Replacement Program and the Supplement must be read in conjunction to fully understand the study.

The Supplement provides updates to all the Figures and Tables that were included in the 2014 Accelerated Service Replacement Program report, except Table 1, which does not contain service line data). The Figures and Tables are printed below in the same order and with the same numbering as they appeared in the earlier document for ease of reading the two documents together.

Figure 1

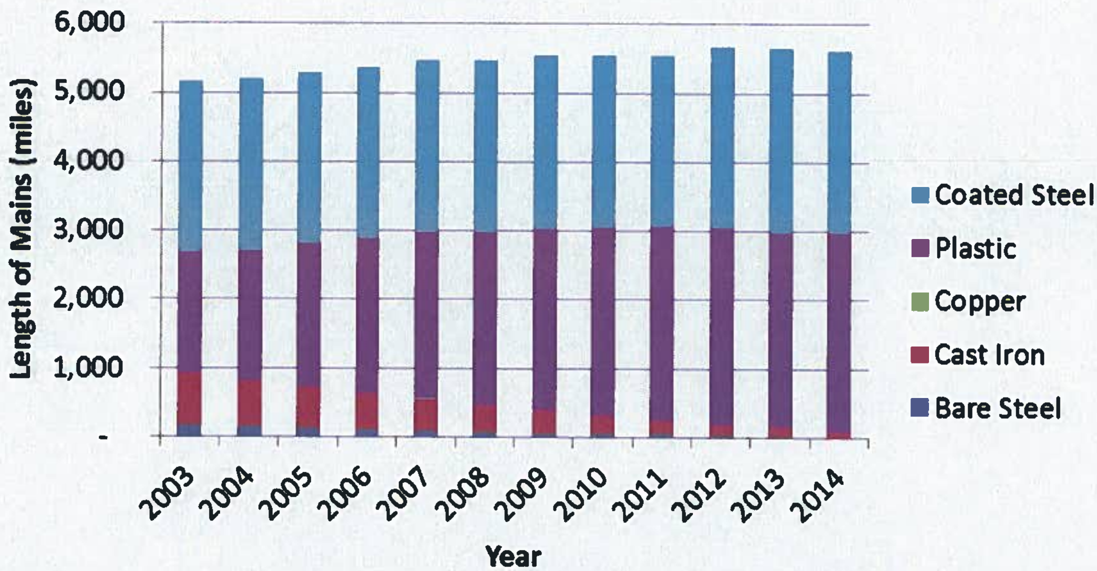
Figure 1. Total Number of Services (2003-2014)



Data Source: Annual DOT Reports

Figure 2

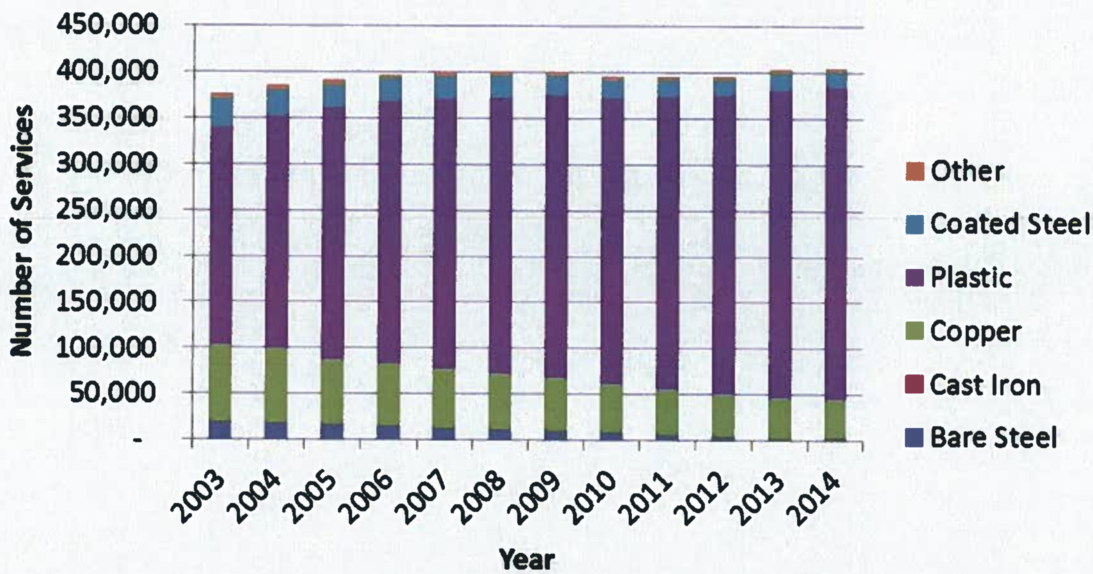
Figure 2. Length of Mains (2003-2014)



Data Source: Annual DOT Reports

Figure 3

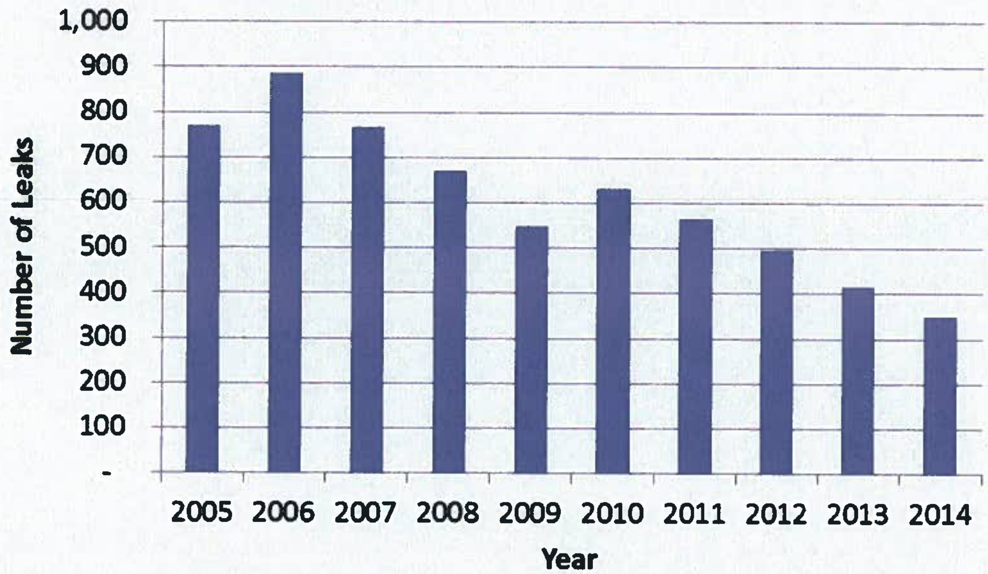
Figure 3. Number of Services (2003-2014)



Data Source: Annual DOT Reports

Figure 4

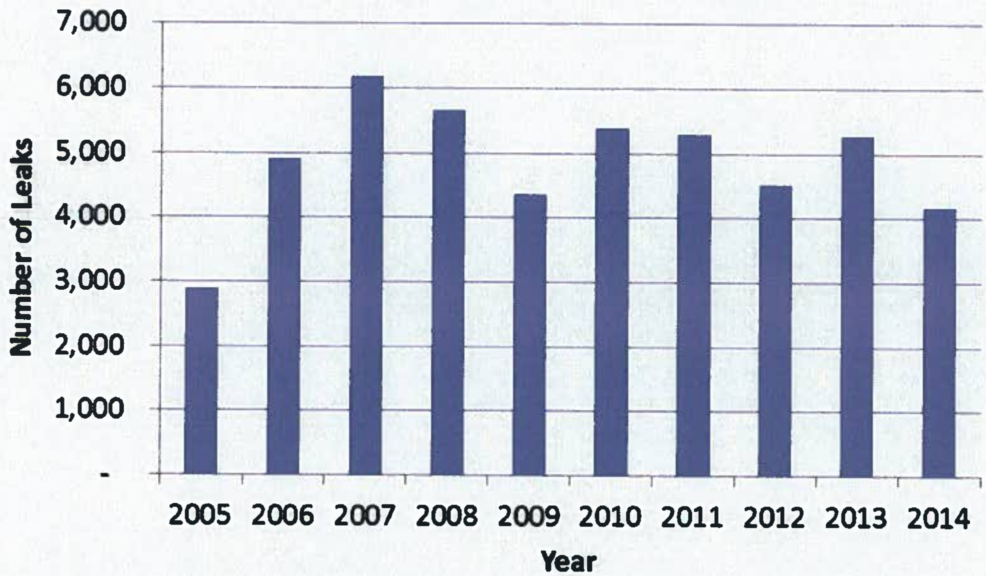
Figure 4. Reported Leaks on Mains (2005-2014)



Data Source: Annual DOT Reports

Figure 5

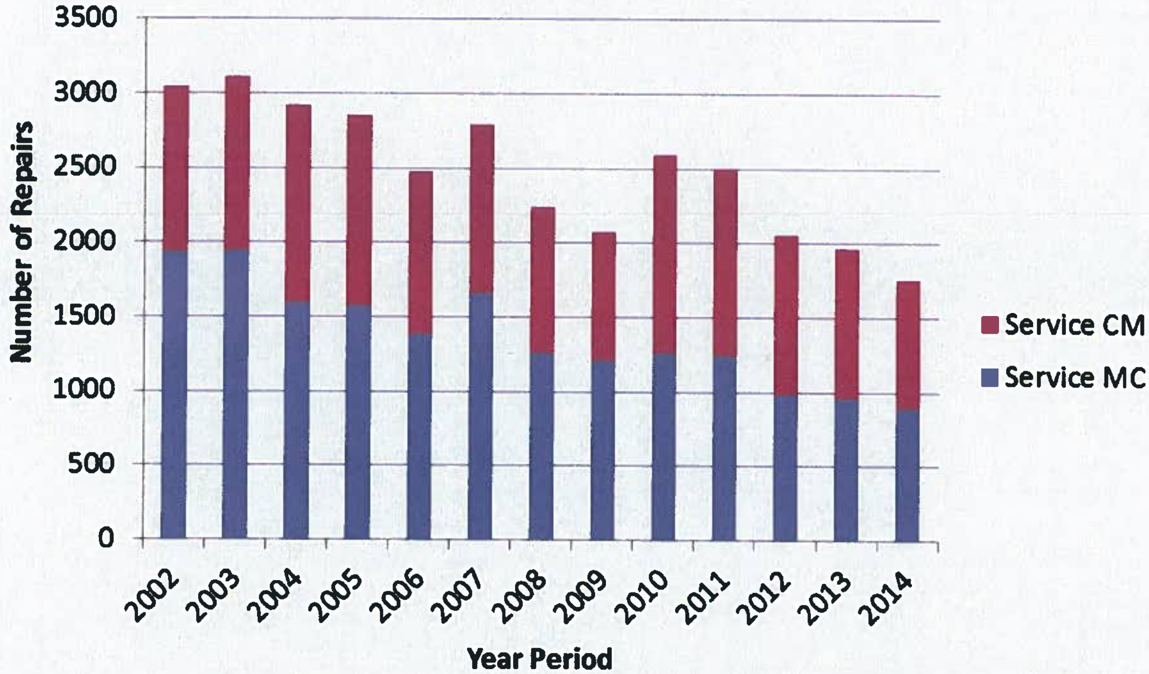
Figure 5. Reported Leaks on Services (2005-2014)



Data Source: Annual DOT Reports

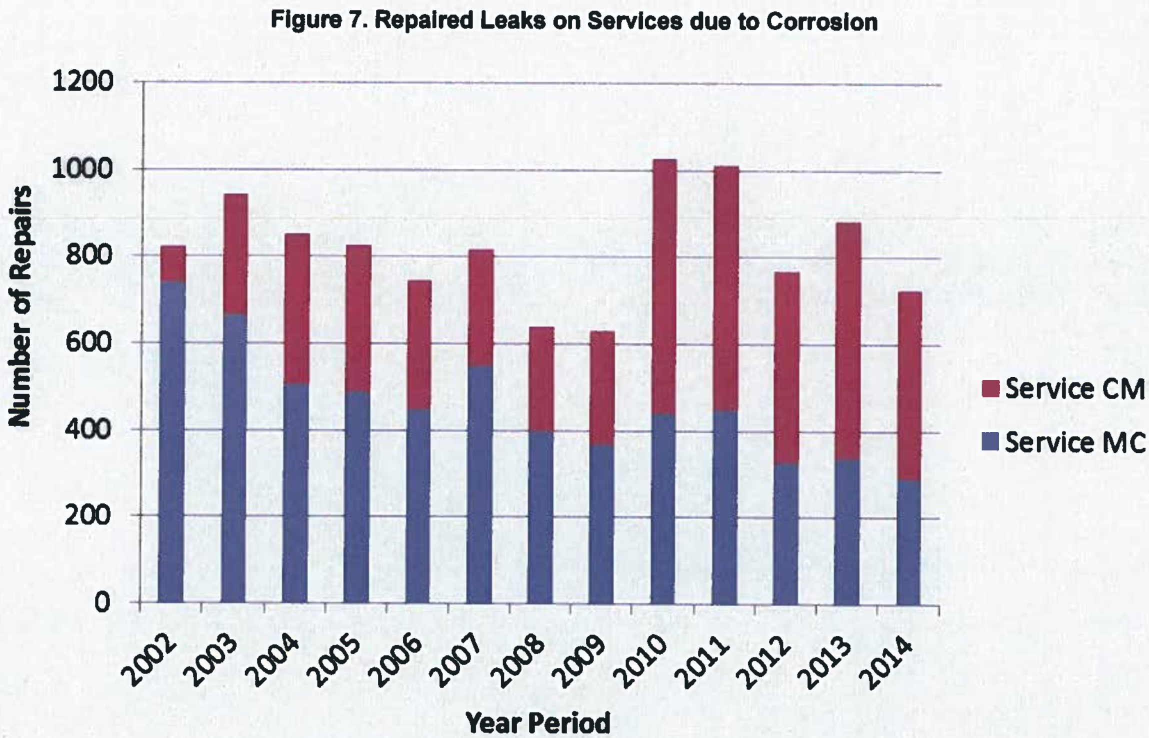
Figure 6

Figure 6. Repaired Leaks on Services



Data Source: Duke Internal EGIS Leak Repaired Data

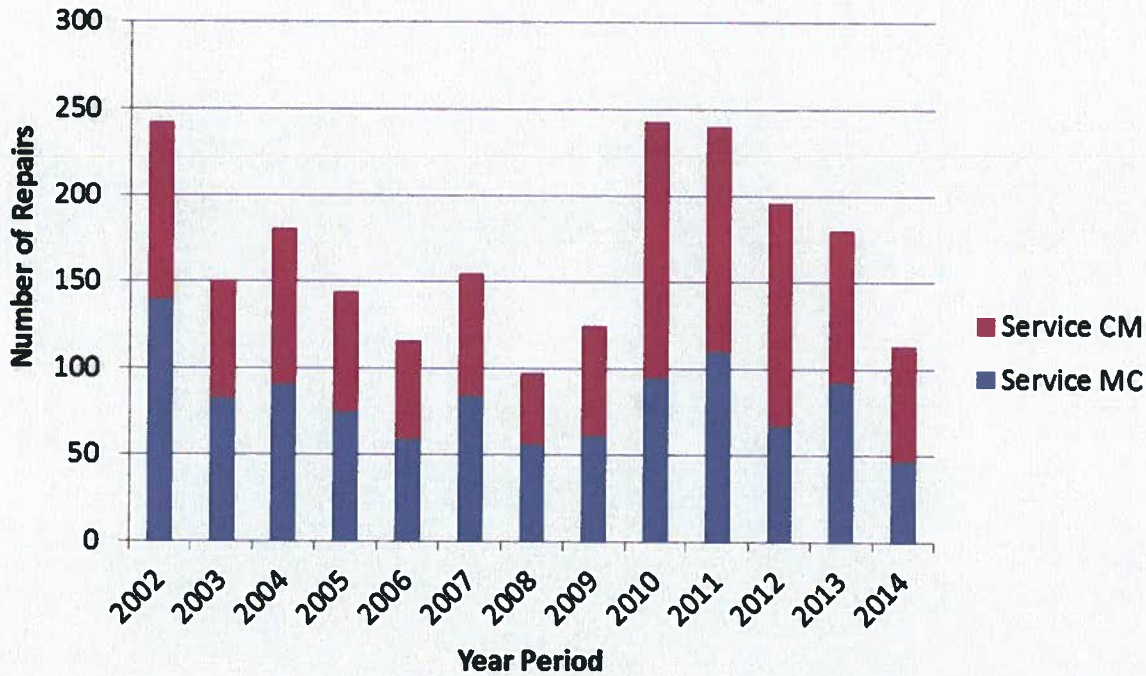
Figure 7



Data Source: Duke Internal EGIS Leak Repaired Data

Figure 8

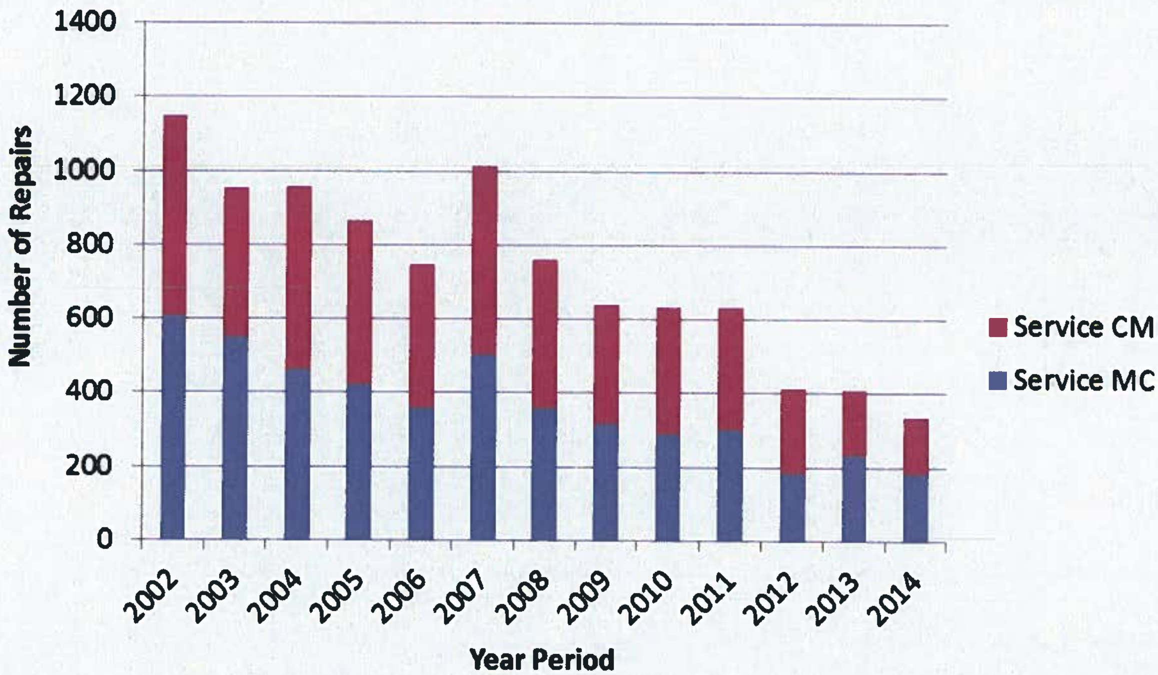
Figure 8. Repaired Leaks on Services due to Material & Welds



Data Source: Duke Internal EGIS Leak Repaired Data

Figure 9

Figure 9. Repaired Leaks on Services due to All Other Causes (Except Excavation Damage)



Data Source: Duke Internal EGIS Leak Repaired Data

Table 2. Duke Energy Number of M-C[1] Services by Material Type	
Bare Steel	881
Cast Iron	10
Coated Copper	12
Coated Steel	15,875
Copper Tubing	122
Copper	39,377
Steel Tubing	881
Steel	647
(Subtotal Metallic)	*57,805*
Plastic	343,979
Unknown	2,978
Total	**404,762**

[1]Main to Curb

Data Source: Duke Internal EGIS Leak Repaired Data

Table 3. Duke Ohio Number of C-M[1] Services by Material Type	
Bare Steel	1,712
Cast Iron	1
Coated Copper	1,384
Coated Steel	6,749
Copper Tubing	1,928
Copper	13,984
Steel Tubing	612
Steel	1,749
(Subtotal Metallic)	*28,119*
Plastic	295,923
Unknown	80,720
Total	**404,762**

[1]Curb to Meter

Data Source: Duke Internal EGIS Leak Repaired Data

Tables 4 & 5

Table 4. Duke Ohio Number of M-C Services by Age Categories for Year Installed	
pre-1940	2,220
1940s	1,021
1950s	8,439
1960s	33,165
1970s	24,634
1980s	38,880
1990s	98,817
2000s	144,085
2010s	53,447
Unknown	54
Total	**404,762**

Data Source: Duke Internal EGIS Leak Repaired Data

Table 5. Duke Ohio Number of C-M Services by Age Categories for Year Installed	
pre-1940	2,902
1940s	32
1950s	110
1960s	505
1970s	683
1980s	27,523
1990s	82,143
2000s	152,837
2010s	50,814
Unknown	87,213
Total	**404,762**

Data Source: Duke Internal EGIS Leak Repaired Data

Table 6. Duke Ohio Number of M-C Services by MAOP Pressure Level	
SP (7" - 10" W.C.)	45,601
MP (1 - 5 psig)	637
IP (5 - 35 psig)	251,346
HP (15 - 60 psig)	99,674
Feeder (60+ psig)	7,066
Transmission	416
Unknown	22
Total	**404,762**

Data Source: Duke Internal EGIS Leak Repaired Data

Table 7. Duke Ohio Number of C-M Services by MAOP Pressure Level	
SP (7" - 10" W.C.)	45,601
MP (1 - 5 psig)	637
IP (5 - 35 psig)	251,346
HP (15 - 60 psig)	99,674
Feeder (60+ psig)	7,066
Transmission	416
Unknown	22
Total	**404,762**

Data Source: Duke Internal EGIS Leak Repaired Data

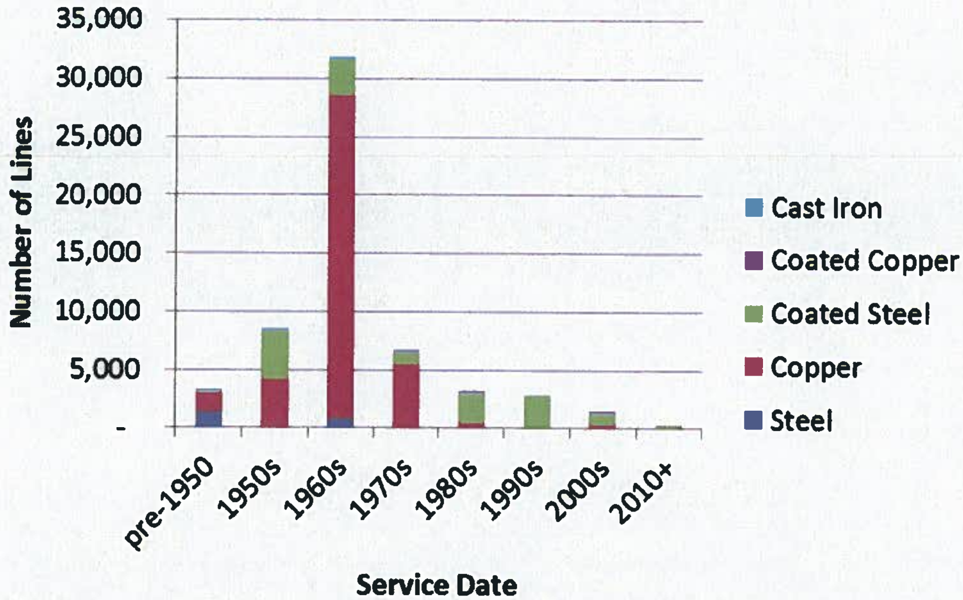
Table 8

Table 8. Service Installation Date versus Material Type – M-C Ohio Metallic Services						
	Steel	Copper	Coated Steel	Coated Copper	Cast Iron	Total
pre-1950	1,397	1,626	190	-	3	3,216
1950s	50	4,074	4,276	1	3	8,404
1960s	896	27,646	3,257	2	4	31,805
1970s	1	5,469	1,158	1	-	6,629
1980s	1	374	2,727	6	-	3,108
1990s	2	53	2,829	-	-	2,884
2000s	54	239	1,145	2	-	1,440
2010+	8	15	288	-	-	311
Total	2,409	39,496	15,870	12	10	57,797

Data Source: Duke Internal EGIS Leak Repaired Data

Figure 10

Figure 10. Service Installation Date versus Material Type – M-C Ohio Metallic Services



Data Source: Duke Internal EGIS Leak Repaired Data

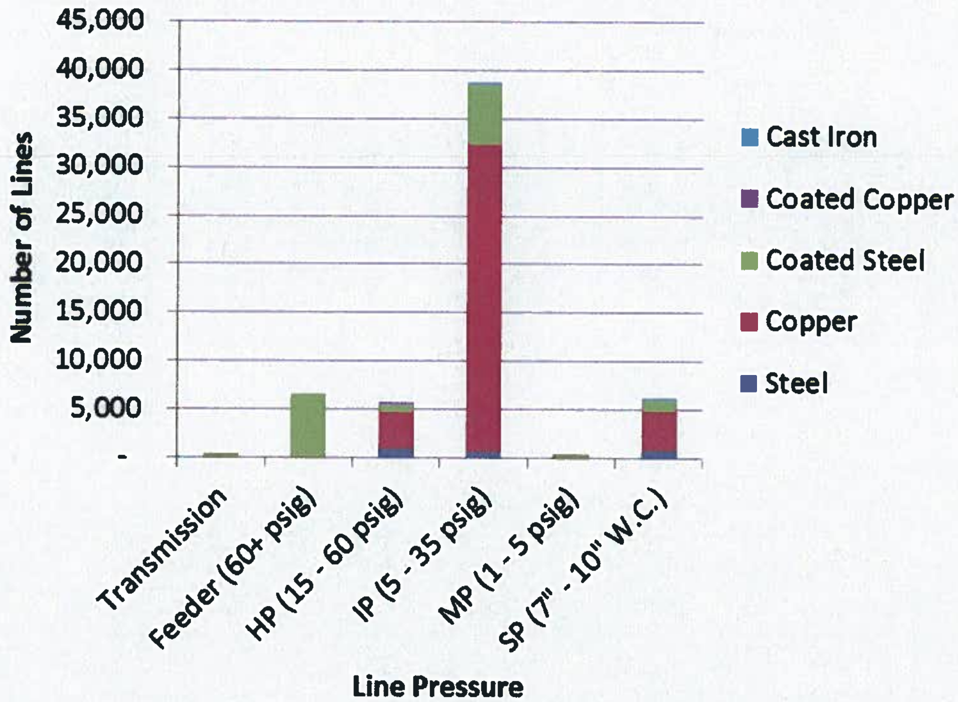
Table 9

Table 9. Material Type versus Pressure Level – M-C Ohio Metallic Services						
	Steel	Copper	Coated Steel	Coated Copper	Cast Iron	Total
Transmission	1	3	394	-	-	398
Feeder (60+ psig)	22	43	6,593	-	-	6,658
HP (15 - 60 psig)	915	3,702	939	2	-	5,558
IP (5 - 35 psig)	651	31,702	6,283	10	3	38,649
MP (1 - 5 psig)	3	61	334	-	-	398
SP (7" - 10" W.C.)	815	3,982	1,329	-	7	6,133
Total	2,407	39,493	15,872	12	10	57,794

Data Source: Duke Internal EGIS Leak Repaired Data

Figure 11

Figure 11. Material Type versus Pressure Level – M-C Ohio Metallic Services



Data Source: Duke Internal EGIS Leak Repaired Data

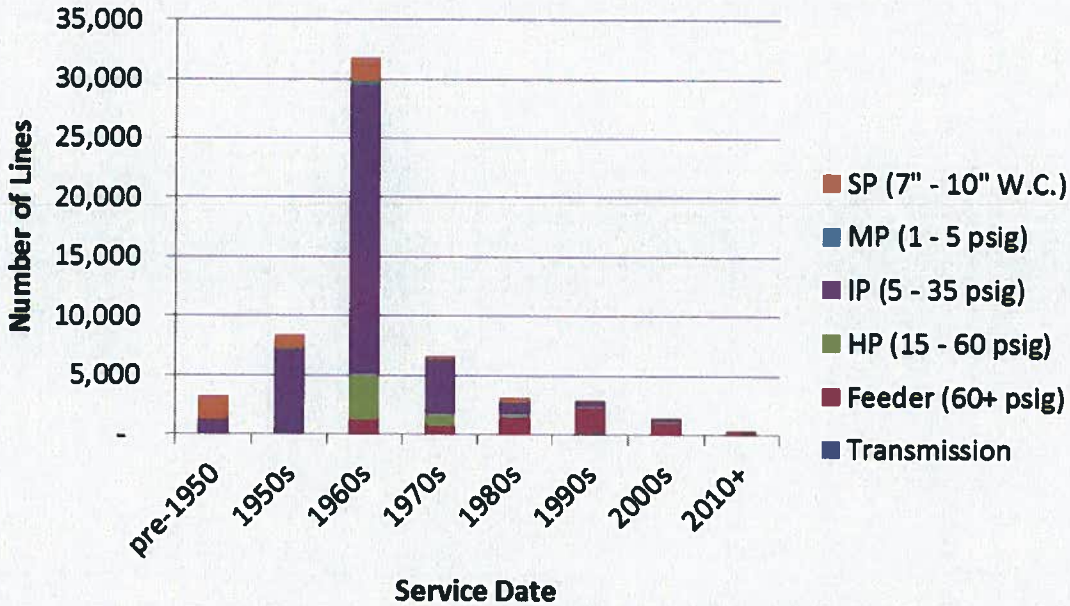
Table 10

Table 10. Service Installation Date versus Pressure Level – M-C Ohio Metallic Services							
	Transmission	Feeder (60+ psig)	HP (15 - 60 psig)	IP (5 - 35 psig)	MP (1 - 5 psig)	SP (7" - 10" W.C.)	Total
pre-1950	-	7	40	1,232	2	1,929	3,210
1950s	8	116	51	6,993	57	1,177	8,402
1960s	79	1,182	3,839	24,395	326	1,982	31,803
1970s	31	634	1,054	4,521	6	382	6,628
1980s	78	1,351	326	913	1	439	3,108
1990s	160	2,110	168	286	-	160	2,884
2000s	32	987	74	292	5	50	1,440
2010+	9	268	4	16	1	13	311
Total	397	6,655	5,556	38,648	398	6,132	57,786

Data Source: Duke Internal EGIS Leak Repaired Data

Figure 12

Figure 12. Service Installation Date versus Pressure Level – M-C Ohio Metallic Services



Data Source: Duke Internal EGIS Leak Repaired Data

2 Oberservations and Conclusions

This supplement to Lummus Consultants' earlier report entitled "Accelerated Service Replacement Program Report" provides updated figures and tables. The earlier report, dated March 10, 2014 encompassed complete operating data through the end of 2012 (with partial data through October 2013, as explained below), whereas this supplement includes complete operating data through the end of 2014.

A comparison of the two reports indicates there are no changes to the principal trends in the data and accordingly no changes to the Findings, Conclusions, or Recommendations expressed by Lummus Consultants in the earlier report. There are two minor differences in presentation that occur throughout this supplement, neither of which affects any Findings, Conclusions, nor Recommendations. Both arise from reconciliation between the main to curb (M-C) and curb to meter (C-M) portions of each service line. The set of data used for this supplement includes explicit ties between the two different portions of the service. This permitted the following improvement in the presentations:

1) Tables 3, 5, and 7 contained incomplete numbers for C-M services in the earlier report (about 378,000 versus 402,000 in Tables 2, 4, and 6). This arose from the past policy where Duke Energy did not always assume responsibility from the homeowner for this portion of the service. The current supplement includes complete numbers of C-M services (about 405,000) with updated counts for services that have been replaced during the past two years, as well as increased numbers for the "unknown" category – representing still missing information for C-M services where Duke Energy does not have complete records.

2) Table 7 has been updated in two ways. The first update is explained above. The second update is that all pressure-category counts now are identical to those shown in Table 6 for the M-C portion of the services. This again was made possible by tying together the two portions through information in the data file. This is correct in an engineering sense because pressures are identical in both portions of the same service since they are connected only by an open valve, which does not affect pressure levels between sections.

An additional minor difference in data occurs in Figures 6, 7, 8, and 9. These four figures contained data for the year 2013 in the earlier report. The information was obtained in early 2014; however, because of a time lag some of the repaired leaks on services towards the end of the year were not yet in the database. This supplement contains complete information for the entire years 2013 and 2014. Thus the information shown in this supplement supersedes information shown for 2013 in the earlier report. Again, no Findings, Conclusions, or Recommendations were affected by this change.

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