

THE STATE OF THE NATIONAL PIPELINE INFRASTRUCTURE

Introduction

Over the past 70 plus years, a nationwide system of pipelines has been constructed to transport almost 100 percent of the natural gas and about 71 percent of the oil and refined petroleum products consumed in the United States. Three industry segments are involved in transporting these energy materials by pipelines: hazardous liquid pipeline operators, gas transmission pipeline operators and gas distribution utilities. The first two industry segments transport energy materials from producers, refiners, and processors to industrial and commercial end users, as well as to terminals and to local gas distribution utilities. Local gas utilities distribute natural gas to residential customers and smaller commercial users. The majority of the materials transported by the hazardous liquid and gas transportation operators are moved via large diameter steel pipelines from wells and refineries to where they are used or distributed further. Approximately 299,000 miles of onshore gas transmission pipelines and 171,000 miles of onshore hazardous liquid pipelines move natural gas, crude oil, and petroleum products throughout the U.S. every day.

Augmenting this network of cross-country pipelines is a gas distribution network used to deliver gas to local users. Gas distribution pipelines have delivered gas locally for almost 200 years. Distribution systems are made up of pipelines called “mains” that distribute gas within the system, and much smaller lines called “service lines” that distribute gas to individual customers. There are over 2.1 million miles of distribution pipelines in service today. Because the purpose of distribution pipelines is to deliver natural gas to end users – residential, commercial, industrial and institutional customers, distribution pipeline systems are present in restricted geographical areas that are predominantly urban and suburban. Distribution pipelines are generally smaller in diameter (as small as 1/2 inch) than transmission lines, operate at lower pressures, and are constructed of several kinds of materials including a significant percentage made from plastic.

Our nation’s pipelines are operated by many thousands of companies, large and small, ranging from giant multi-national corporations to small local municipal gas utilities.

Pipeline Risks

Risks to the public from hazardous liquid and gas transmission pipelines result from the potential for an unintentional release of a product transported through the pipelines. Releases of a product carried by these pipelines can impact surrounding populations, property, and the environment, and may result in injuries or fatalities as well as property and environmental damage.

These consequences may result from fires or explosions caused by ignition of the released product. Some hazardous liquid releases can cause environmental damage, impact wildlife, or contaminate drinking water supplies. Releases can have significant economic effects as well, such as business interruptions, damaged infrastructure, or interruption in the supplies of fuel such as natural gas, gasoline, home heating oil, and even jet fuel supply at airports. Interruption of natural gas service to homes and businesses during the winter heating season can be particularly disruptive.

The potential consequences of gas transmission pipeline releases vary primarily both as a result of the size and operating pressure of the pipeline and as a consequence of the number of people living near the pipeline. Gas transmission pipelines transport natural gas almost exclusively. The consequences of natural gas releases usually occur very shortly after the release. If an ignition source exists, a release of gas can result in an immediate fire near the point of the release. The potential for ignition, however, is reduced over a relatively short distance as the gas disperses. If the natural gas vapors accumulate inside a building, then the hazard may remain longer. Natural gas released from pipelines has been known to travel underground along migration pathways such as sewer lines, finding an ignition source some distance from the location of the release. Additionally, any release of natural gas, which is primarily methane - a potent greenhouse gas, contributes to the global "greenhouse effect".

Hazardous liquid pipelines transport a greater variety of products (including crude oil, petroleum products, natural gas liquids, anhydrous ammonia, and carbon dioxide), so the risks of hazardous liquid pipeline releases vary both according to the commodity being transported and the characteristics of the surrounding area. Releases of some commodities transported in hazardous liquid pipelines, such as propane, pose primarily a near-term hazard of fire or explosion, similar to natural gas. These commodities are transported in liquid form under pressure in a pipeline. However, if they are released from the pipeline, they will evaporate as they enter the atmosphere. Some of these commodities have densities greater than air, so they are more likely to remain near the ground than natural gas, which disperses more readily.

Releases of other hazardous liquids, such as gasoline and crude oil, have both near-term and longer-term potential consequences, as the released product can spread over land and water, flowing into valleys, ravines, and waterways. This can result in harmful consequences to people and to the environment, including human injuries or fatalities from fire or explosion, as well as potential ecological damage and contamination of drinking water supplies occurring some distance from the point of initial release.

Incident Causes

The causes of pipeline incident fall into several broad categories based on how PHMSA collects incident data from pipeline operators. Figures 1 and 2 below show the number and percentage of significant onshore hazardous liquid and gas transmission pipeline incidents attributable to different cause categories during 2006-2010. Only incidents involving line pipe are included (pipeline facilities such as pump or compressor stations or tank facilities are not included). For both hazardous liquid and gas

transmission pipelines, the predominant failure causes for line pipe are corrosion, material/weld failures, and excavation damage.

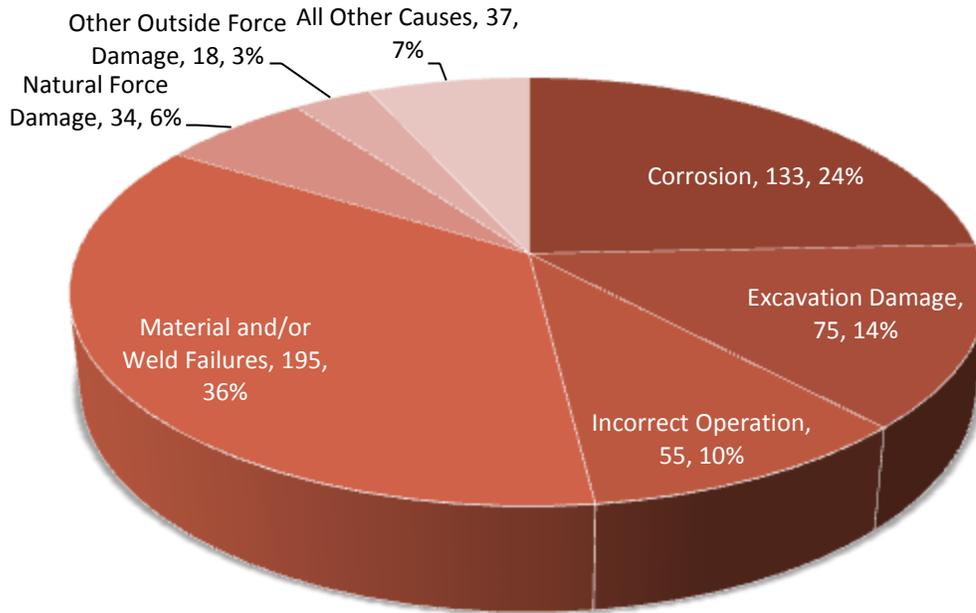


Figure 1 Causes of Significant Onshore Hazardous Liquid Pipeline Incidents

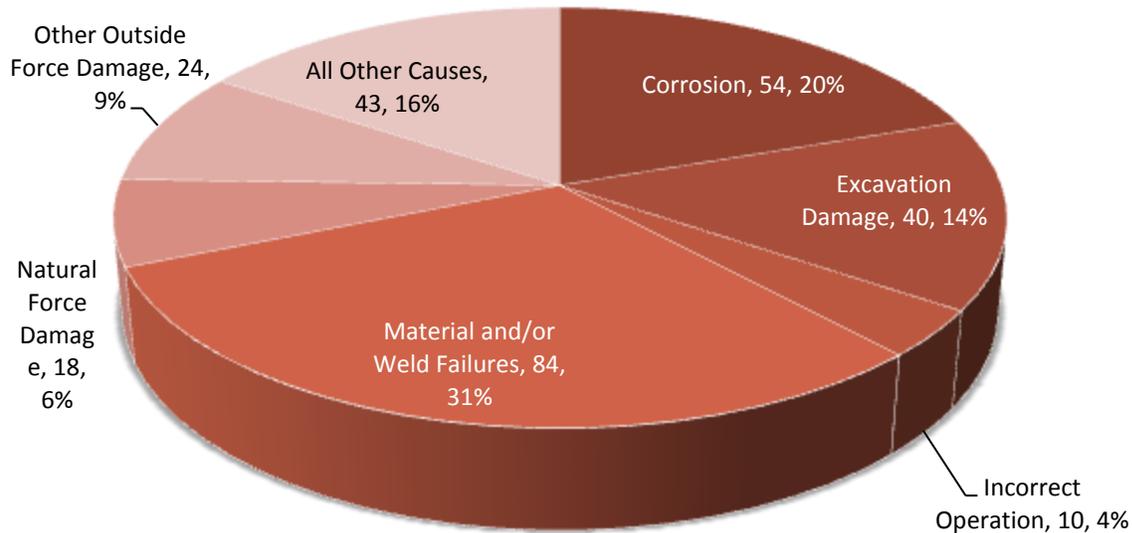


Figure 2 Causes of Gas Transmission Pipeline Significant Incidents

Gas Distribution Incidents

Figure 3 below shows that for U.S. distribution pipeline systems, the most significant individual cause categories for significant incidents are excavation damage, other outside force damage, and other unspecified causes. The major contributor to the other outside force damage is damage by a vehicle not engaged in excavation. The category “all other causes” represents a major fraction of significant incidents. This category is comprised of any cause that does not fit into another category, and includes incidents caused by deterioration of the pipe material.

Gas Distribution Leaks

Gas distribution systems have leaks. The approach distribution operators take to ensure these leaks do not lead to incidents is to conduct periodic leak surveys and remove or repair leaks that have the potential to result in damage. While different operators have different philosophies regarding whether all leaks are removed and exactly how removed leaks are reported, it is illustrative to consider the typical number of leaks removed from distribution systems annually. Reported data on leaks removed or repaired in 2009 indicate there were 0.12 leaks repaired per mile of mains (about one leak for every eight miles of main), and 0.47 per mile of service lines (about one leak for every two miles of service line).

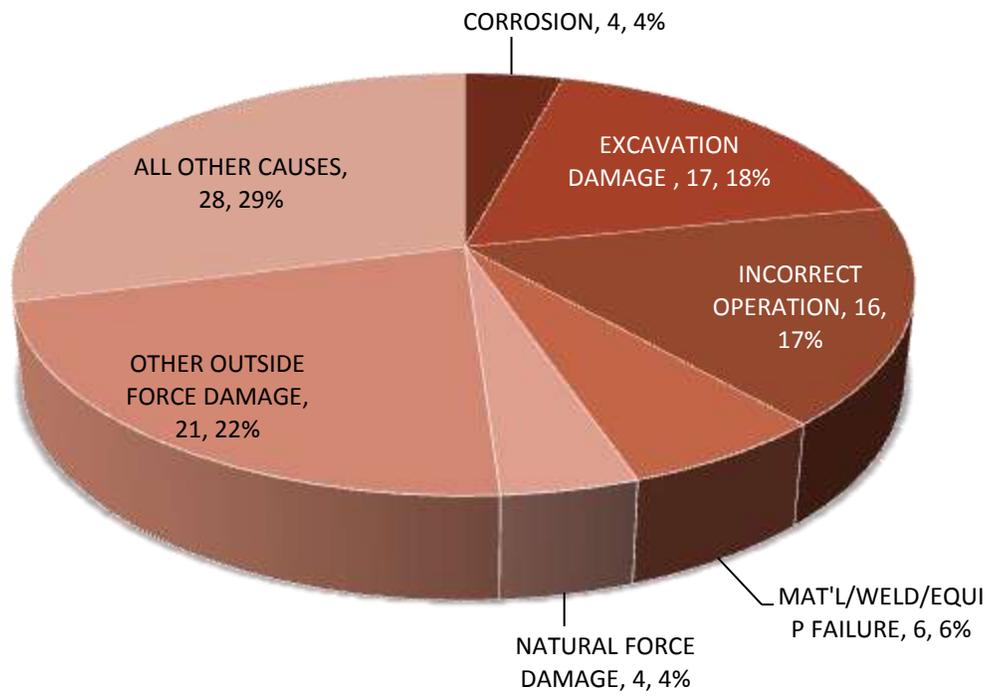


Figure 3 Significant Distribution System Incidents by Cause (2008-2010)

Pipeline Condition

By some measures, the overall trend in pipeline safety has shown steady improvement over the past two decades. Figure 4 shows pipeline incidents involving death or injury to people have dropped by more than half over the past 20 years.

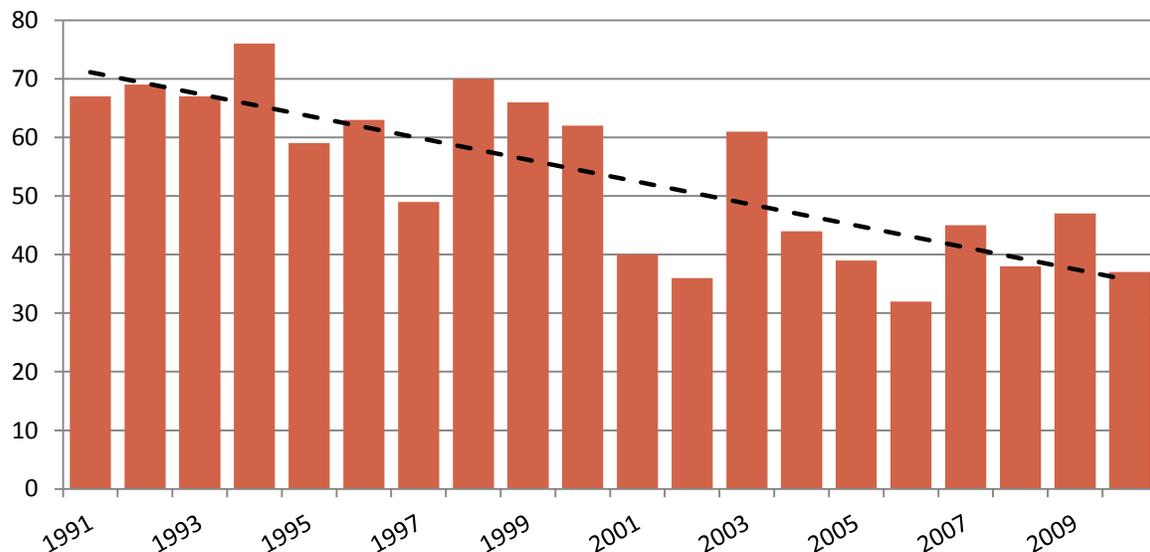


Figure 4 Trends in Pipeline Incidents Involving Death or Injury

In spite of its gradually improving safety performance, some pipe has been in the ground for a long time. Over 50% of the nation's pipelines were constructed in the 1950's and 1960's during the creation of the interstate pipeline network built in response to the huge demand for energy in the thriving post-World War II economy. Some pipelines were built even earlier. Approximately 3% of our gas distribution mains are made of cast or wrought iron and were built in the first half of the 20th century. Over 12% of the nation's cross-country gas transmission and hazardous liquid pipelines were built prior to the 1950's. Each of these types of pipelines has its own unique age (and even material) distribution. Figure 5 below depict the percentage of pipelines constructed by decade (50s = 1950's) for each of the three types of regulated pipelines.

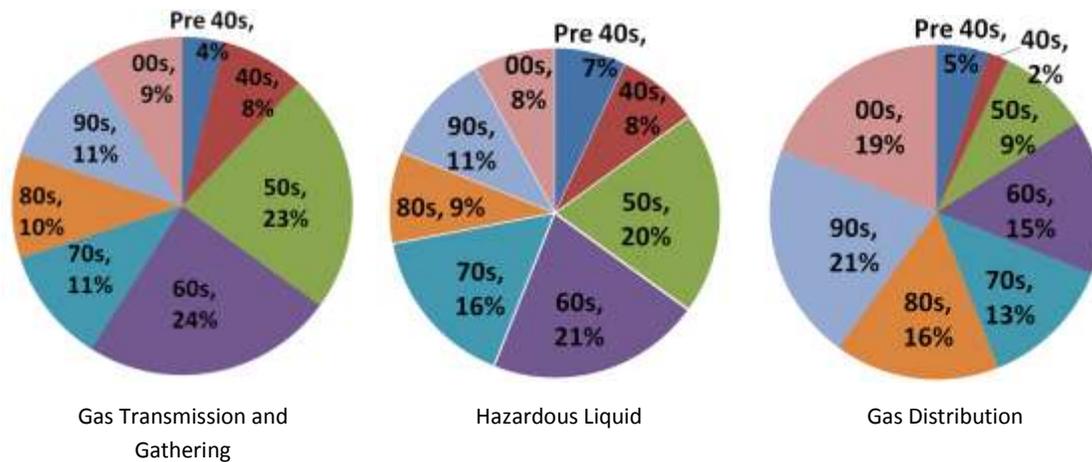


Figure 5 Age Distribution of U.S. Pipeline Infrastructure

The first federal pipeline safety regulations were put in place for gas pipelines in 1968 based on the standard that had been adopted by most states - the American Society of Mechanical Engineers standard ASME B31.8 - Gas Transmission & Distribution Piping Systems. Soon thereafter, similar regulations were added covering hazardous liquid pipelines, based on ASME B31.4 - Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids. Prior to these rules, operating companies generally used the accepted industry standards for pipe materials, manufacturing, construction, testing, and operation that were considered state-of-the-art at the time of installation. Pipeline materials, corrosion protection methods, and construction technologies and standards changed and by and large improved over time. For example, modern coating materials for steel pipe have greatly improved over those used decades ago. In the very early decades of pipeline construction, no coating was used at all. In addition, pipe welding, inspection and testing techniques have evolved. Many of the welding techniques used earlier have been phased out and replaced by newer, more reliable, and more effective techniques. That means that some of our current pipeline infrastructure was built using materials and welding techniques that – though considered acceptable and state-of-the-art at the time - are no longer used today.

Recent incidents in San Bruno, California and Allentown, Pennsylvania have raised questions in the public's mind about the safety of older pipelines. PHMSA is taking a hard look at the causes and characteristics of these failures to identify means to prevent future incidents. Individual states are also examining the need to accelerate the replacement of high risk pipe to ensure public safety and the reliability of our critical pipeline infrastructure into the future.

Where Should We Be Most Concerned?

There is no simple formula for determining which parts of our nation's pipeline infrastructure should be our greatest concern. Factors often associated with higher risk include pipeline age, materials of construction, and an operator's practices in managing the integrity of its pipeline system. Certainly each of these factors can contribute to a pipeline's risk, but effective integrity management can counterbalance the impact of ageing and construction materials.

Pipeline Age - Figure 4 shows that, in spite of the continued aging of our pipeline infrastructure, safety performance continues gradually to improve. An older pipeline does not necessarily have a higher likelihood of leaking or rupturing than a newer one. Even while materials, manufacturing techniques, joining methods, and design standards have evolved, techniques for managing the integrity of older pipelines have also improved. For example, technologies for evaluating the condition of pipelines using in-line inspection have improved significantly over the past twenty years. In addition, PHMSA has issued new regulations requiring operators to develop and apply programs to strengthen the management of integrity of pipelines whose failure would affect areas of high consequence. In addition, through ongoing collection and analysis of performance data, operators and their trade associations can identify the pipes most susceptible to failure and better manage their integrity.

Pipeline Material - Each material has advantages and disadvantages in terms of long-term serviceability. Hazardous liquid and gas transmission pipelines are typically constructed from steel, while gas distribution pipelines are constructed from a range of materials from cast iron to current generation plastics. Steel has great physical strength and is less susceptible to failure due to excavation damage than plastics, but corrodes. Plastic does not corrode but is more susceptible to excavation damage and requires the use of a tracer wire to locate thereby reducing the likelihood of excavation damage. Cast iron has excellent corrosion resistance but has low beam strength, and is subject to graphitization which makes it more brittle. Within each material category lie subsets of pipe with different levels of serviceability. They may be distinguished due to method of manufacturing, joining, welding, or ability to be maintained.

One material that continues to be the focus of concern is cast iron, which was used decades ago to build some distribution mains and service lines that deliver gas to homes. There are still about 36,000 miles of cast iron main gas distribution lines in the U.S. Most of this is concentrated in five states - New Jersey, New York, Massachusetts, Pennsylvania, and Michigan; 80% is concentrated in just ten states. Of these, the small diameter cast iron pipes have low beam strength and are particularly susceptible to stresses from underground disturbances, such as ground settlement, freeze-thaw cycles, soil erosion, undermining due to water main breaks, or nearby excavation activities. Most cast iron problems have been with small diameter, thin wall pipe. Larger, heavier pipe typically performs well, especially if not subject to graphitization (embrittlement often accompanying cast iron aging) and when they have limited exposure to excavation damage. Preliminary analyses indicate that Pennsylvania has the highest incident frequency involving cast iron, and the highest overall incident rate per mile for states that have any significant amount of cast iron pipe.

There is also some steel pipe that was constructed before the requirement to provide a protective coating to inhibit corrosion on the outside of the pipe. These "bare" steel pipelines are also of concern. We also know that some of the older techniques used to coat pipe have problems.

The National Transportation Safety Board (NTSB) has reported that plastic pipe installed in natural gas distribution systems from the 1960's through the early 1980's may be vulnerable to brittle-like cracking resulting in gas leakage and potential hazards to the public. Hundreds of thousands of miles of plastic

pipe have been installed, with a significant amount installed prior to the mid-1980's. Significant industry and regulatory effort that has been focused on characterizing which plastic pipes are of greatest concern is discussed below.

Construction Techniques - In addition to concerns related to the materials from which pipe was constructed, there are also concerns about pipelines that were built using older methods, including dated welding and joining techniques. Serious leak problems have been experienced with fittings and fitting construction techniques used in Texas and Ohio. PHMSA has issued multiple advisories to owners and operators of gas pipelines to consider the potential failure modes for mechanical fittings used for joining and pressure sealing two pipes together. Both Texas and Ohio have responded aggressively by requiring replacement of suspect fittings.

An older welding technique of concern is low frequency electric resistance welding (ERW). In 1970, this welding technique was generally discontinued in transportation pipelines. There are still over 50,000 miles of this type of pre-1970 ERW pipe in the ground.

Management of Pipeline Integrity - Not all pipe material has performed well over time. Effective management of pipeline integrity requires an operator to identify and differentiate among those that were made using either materials with a history of deteriorating or ineffective construction practices and those that were constructed with materials and techniques that have proven effective. Environmental factors such as soil conditions, exposure to natural forces, and degree of exposure to excavation damage must also be understood and their effects accounted for. Furthermore, an operator needs to identify and differentiate among those pipelines that have been adequately tested, monitored, surveyed, assessed, operated, and maintained, and those that have not. When suspect pipe is identified, an operator has choices in managing its integrity ranging from increased frequency of monitoring to replacing the suspect pipe. PHMSA and its state partners need to continue to oversee operator's efforts to manage the integrity of their pipeline systems to increase public assurance that operators are vigilant and effective in the corrective actions they take.

Integrity Management Program - IMP regulations have been in place for hazardous liquid pipelines since 2000 and for gas transmission pipelines since 2003. As of August 2011, integrity management programs are also required for gas distribution pipeline systems. The scope of these programs is somewhat different. Only pipe in high consequence areas (population-based areas for both gas and hazardous liquid pipelines, and - for hazardous liquid pipelines - an area of unusually sensitive ecology or drinking water supply or a commercially navigable waterway) are affected by the regulations for gas and hazardous liquid cross-country pipelines; while the entire system is covered for distribution pipeline systems.

Effective management of pipeline integrity requires first and foremost that an operator clearly understand the characteristics of the infrastructure it manages, the environment in which it operates, and the impact of these characteristics and environment on the risk of various parts of its system. A significant part of the current infrastructure was constructed before formal regulatory requirements existed to retain comprehensive information on pipe and coating characteristics. Therefore, developing

a comprehensive understanding of pipeline systems may represent a challenge to some operators. IMP regulations require operators to assemble and integrate this information as part of understanding the risk of their pipeline systems. Other major integrity management requirements for cross-country pipelines include periodically assessing the physical condition of the covered pipe, repairing defects that meet certain criteria, and evaluating the need for additional preventive and mitigative measures to better manage system risk.

Gas distribution pipeline systems are typically not designed to allow integrity assessment by the same technologies used for cross-country pipelines. Therefore integrity management requirements for distribution systems are different. In addition to requiring assembly and integration of data on factors potentially affecting pipeline integrity and use of that data to assess the risk, distribution operators are required to implement a prescribed leak management program and to use experience data to evaluate where additional and accelerated actions, such as more frequent leak surveys and replacement of higher risk pipe, are needed.

How Are We Improving Our Knowledge?

Requirements for pipeline operators to publicly report the types of materials in their pipelines and their history of incidents for different types of pipe materials have evolved considerably over the years. However reporting much of this data has been required only recently. Consequently, there are currently gaps in PHMSA's understanding of how "risky" some of this pipe really is. The recent distribution integrity management rule will require distribution operators to categorize by material the number of hazardous leaks either eliminated or repaired. Using this data, operators and regulators alike will be able to monitor the relative frequency of hazardous leaks on pipe made from various materials such as cast iron, bare steel, and various plastic materials. This data monitoring will, over time, help operators develop a much better picture of the aging infrastructure.

In addition to new reporting requirements, PHMSA and its state partners, as well as several industry trade associations, have worked to gather and analyze data to help develop a better understanding of the risks of the pipeline infrastructure. Several ongoing initiatives are described below.

Gathering and Understanding Performance Data - PHMSA has been working for the past several years toward becoming a data-driven organization. Toward this end, it has assigned organizational responsibility for data gathering, quality assurance, and evaluation. In addition to producing periodic reports on industry performance displayed on its stakeholder communication web site, PHMSA is currently using available data to improve its operator evaluation process to improve inspections.

Plastic Pipe Database Committee - The age of distribution pipe made of plastic is not the primary factor in their likelihood to leak. The Plastic Pipe Database Committee (PPDC) - a joint industry-regulatory working group - has worked since 1995 gathering data on the causes of excessive pipeline leakage. Their efforts have identified several plastic pipes and components that have demonstrated a significantly lower resistance to locally-imposed stresses (like rock impingement), resulting in higher rates of pipe failure. The data indicate that many of the early plastic piping products manufactured in the 1960s to

early 1980s are more susceptible to cracking from locally-imposed stresses than newer vintage materials. These more susceptible pipes are the focus of some PUC-approved pipe replacement programs.

Pipeline Performance Tracking System (PPTS) - Since 1999, many hazardous liquid industry companies have reported spill data to the industry's Pipeline Performance Tracking System (PPTS). The stated philosophy of PPTS is to measure, learn, manage and improve. Currently, operators of about 85% of all US hazardous liquids pipeline miles under PHMSA's jurisdiction are reporting to PPTS. These reports include spills from non-regulated pipeline mileage. These data are reported -according to the new PHMSA reporting requirements. The industry uses PHMSA and PPTS data to analyze and improve its performance. Through PPTS, the industry develops metrics for evaluating changes in pipeline performance, evaluates and sets leading performance measures for the pipeline industry, and identifies leading and lagging indicators that may predict future performance. The industry produces reports called advisories from the PPTS data that includes considerations for operators. Advisories may be viewed by the public. PPTS data helps provide actionable recommendations to the pipeline industry targeting continuous performance improvement and solutions addressing today's and tomorrow's challenges.

INGAA Data Committee (DATCOM) - The Interstate Natural Gas Association of America (INGAA) is focusing data evaluation on a newly established data committee (DATCOM) whose mission is to: "Develop, collect, analyze and communicate the results of INGAA-member company-provided data, including information on detection, remediation, prevention and mitigation actions undertaken related to pipeline safety activities; and to improve pipeline safety by utilizing this data to measure the efficacy of our action and increase transparency through stakeholder communications." The DATCOM represents a continuation of INGAA member efforts to evaluate performance data.

What Are We Doing Right Now to Protect Against These Problems?

Both Federal and State regulators have aggressive inspection and enforcement programs to identify pipeline risks and segments of pipe with elevated levels of concern, and to force industry to make the necessary repairs or replacements.

Many States have mandated pipeline replacement programs for some of these types of older pipes. Some states have incentivized operators to replace cast iron pipe by providing operators with rate relief to accelerate replacement. However, some of these replacement programs in the larger states are not scheduled for completion for many decades. Pennsylvania's cast iron replacement program is scheduled to be completed in about a century.

PHMSA has also taken a variety of actions to alert the industry to these problems and work toward solutions.

PHMSA has issued a series of Advisory Bulletins (<http://www.phmsa.dot.gov/pipeline/regs/advisory-bulletin>) to operators on various issues related to materials, fittings, manufacturing, welding, and joining, including:

- PHMSA–2011–0177 Pipeline Safety: Potential for Damage to Pipeline Facilities Caused by Flooding
- PHMSA-2010-0078 Pipeline Safety: Girth Weld Quality Issues Due to Improper Transitioning, Misalignment, and Welding Practices of Large Diameter Line Pipe
- PHMSA-2009-0158: Weldable Compression Coupling Installation
- PHMSA-2009-0148; Pipeline Safety: Potential Low and Variable Yield and Tensile Strength and Chemical Composition Properties in High Strength Line Pipe.
- ADB-08-02 - 73 FR 11695 Issues Related to Mechanical Couplings Used in Natural Gas Distribution Systems
- ADB-07-02 - 72 FR 51301 Updated Notification of the Susceptibility to Premature Brittle-like Cracking of Older Plastic Pipe
- ADB-02-07 - 67 FR 72027 Notification of the Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe; Notice; correction
- ADB-02-07 - 67 FR 70806 Notification of the Susceptibility to Premature Brittle-Like Cracking of Older Plastic Pipe
- ADB-99-02 Potential failures due to cracking of plastic pipe in natural gas systems
- ADB-99-01 Potential failures due to cracking of plastic pipe manufactured by Century Utility Products, Inc
- ALN-92-02 Addresses concerns arising from Allentown, P A, explosion
- ALN-91-02 NTSB recently issued recommendation P-91-12 related to the August 1990 explosion and fire in Allentown, PA, caused by a crack in a 4-inch cast iron gas main.
- ALN-89-02 Results of OPS-conducted investigation of the San Bernardino, CA, 05/12/89 train derailment; each gas/liquid operator should test check valves.
- ALN-88-01 Recent findings relative to factors contributing to operational failures of pipelines constructed with ERW prior to 1970
- ALN-87-01 Incident involving the fillet welding of a full encirclement repair sleeve on a 14" API 5LX-52 pipeline; King of Prussia, PA 10/07/86 pipeline failure
- ADB-86-02 Piping, Mechanical Coupling

PHMSA has also held a series of public workshops to improve our understanding of these problems and devise practical solutions, including:

- 07/21/2011 Improving Pipeline Risk Assessment and Record Keeping
- 07/20/2011 Managing Challenges with Pipeline Seam Welds
- 11/17/201- Control Room Management Implementation

- 06/30/2010 Public Awareness
- 04/28/2010 Workshop on Guidelines for Integrity Assessment of Cased Pipe
- 04/20/2010 Distribution Construction Workshop
- 04/23/2009 New Pipeline Construction Workshop
- 03/26/2009 Workshop on Internal Corrosion in Hazardous Liquid Pipelines
- 10/22/2008 Anomaly Assessment and Repair Workshop
- 07/15/2008 Cased Pipeline Integrity Assessment Workshop
- 11/04/2003 OPS/NACE/Industry Direct Assessment Workshop

Additionally, PHMSA's Training and Qualifications team participates in ongoing communications with operators about new regulations and pertinent industry issues such as advisory bulletins at Regulations and Code Compliance State Seminars.

PHMSA has approximately forty members on twenty-seven committees involved with the development and maintenance of various standards related to pipelines and pipeline safety. Active committee membership provides PHMSA a means to mitigate risks of undesirable changes to standards (requirements in conflict with the regulations or those not in the best interest of public safety) and to leverage committees to produce new, improved provisions in the standards.

The Secretary of the Department of Transportation is currently preparing a "Report to the Nation on Pipeline Safety", expected to be released in the fall of 2011. This report is expected to describe in greater detail the challenges related to managing the pipeline infrastructure, what is currently being done to address these challenges and candidate additional activities to further the cause of improving pipeline safety.

What Are the Challenges We Face?

In managing the pipeline infrastructure it is necessary to begin with what we have and to determine how to improve safety from that starting point. The practical problems associated with major infrastructure change are enormous. It's not possible, or even prudent, to simply dictate that all pipelines of a certain type or age be replaced by a certain date. Even if we ignore the cost of such an effort, there is the problem of supply disruption. Replacing, rehabilitating, repairing, or requalifying current pipelines requires that the existing system be at least partially shut down. This would require a carefully thought out plan and schedule that does not result in unacceptable or widespread disruptions of energy supply.

It is also not easy to replace pipe in heavily urbanized areas. Sometimes roads need to be dug up. There are also other utility lines like telephone, cable, or water that have to be worked around safely. The local permitting process must look at all these considerations before local officials can permit a pipe to be dug up and replaced. This process can require large lead times.

Other than the assessment and repair requirements in the hazardous liquid and gas transmission IMP regulations, PHMSA has not issued guidance or promulgated regulations covering the rehabilitation of pipelines. The process for major rehabilitation or replacement of distribution pipelines involves operators determining which pipe is highest risk, then developing and seeking approval from their Public Utility Commissions (or municipal governments in the case of municipal utilities) to replace suspect pipe on an established schedule. Once the rate regulator has agreed to the replacement schedule and approved the associated costs, the replacement can begin. The increased cost of transporting gas to the public and industry are passed through to the customers.

What Additional Actions are we Considering?

Pipeline safety has gradually improved for much of the past twenty years. Evaluation of recent performance suggests that the effectiveness of changes in improving pipeline safety may be diminishing. While much is being done to improve pipeline safety and some of the initiatives are still too early in their development or application for their full impact to have been realized, there remain numerous opportunities for continued pipeline safety improvement. The stakeholders in pipeline safety realize the need for continuing improvement, and are vigorously exploring means to eliminate pipeline incidents, especially those impacting the public and the environment. The Secretary's Report to America on pipeline Safety is expected to provide a context for the public to understand and evaluate the effectiveness of ongoing and future improvement efforts.