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REGULATION AND NATURAL GAS DESIGN

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Abstract

This document serves as a resource for engineers in the engineering design space to foster discussion for how federal and municipal regulations affect natural gas design. The white paper covers four sections including natural gas regulations and historical events, critical factors that affect natural gas design, impacts of variations in regulation, and current solutions. The whitepaper provides specific examples of how various natural gas operators are affected by federal and municipal regulations, and the strategies that both operators and design engineers have employed to adapt to the current industry.

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Executive Summary

The natural gas industry is in a state of flux, with evolving industry regulations facilitated by lessons learned from previous catastrophes. CFR Part 192 is critical to maintain the minimum safety standards for the transportation of natural and other gas by pipeline. Natural Gas design engineers play a key role in setting the stage for safe construction. Factors such as population density, utility conflicts, and accuracy of information play a critical role in determining a safe and reliable design for natural gas pipelines. While current technology has generally improved the accuracy shown on designs, discrepancies in the accuracy and reliability of existing information still persist. Each of those factors in conjunction with federal and municipal regulation need to be carefully understood. Current solutions have improved the accuracy of information shown on natural gas design drawings. GIS has emerged as a powerful tool in the industry as newer federal regulations have been proven to push operators in a direction that can force modernization of records. As the natural gas industry evolves, operators and design engineers continue to provide a unique perspective of the industry to provide more constructible, reliable, and safer designs.

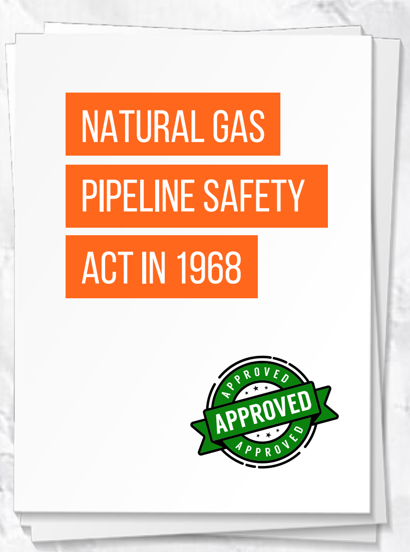
Natural Gas Regulations and Historical Events

Engineering design serves as a fundamental pillar of the lifecycle of an engineering project. The fundamentals of engineering design involve using industry standards combined with federal, state, and municipal codes to produce a construction ready engineering package. Regulation plays a key role in determining the accuracy and reliability of the information provided on design drawings. For the natural gas industry, modern day regulation was founded as a response to a catastrophe.

On April 6th, 1968 in the town of Richmond Indiana, **an existing cast iron natural gas main exploded** near a sporting goods store, causing a secondary explosion from the gunpowder that was located inside the store. Both explosions killed 41 individuals and injured over 150. The cause of the explosion was later identified as a corroding transmission pipe owned by the Richmond Gas Corporation. (1968)

In response to the explosion, the US Government passed the Natural Gas Pipeline Safety Act in 1968, which later went into effect in 1970. As a response, the Office of Pipeline Safety (OPS) and the Office of Hazardous Materials Safety (OHMS) were created, which were eventually combined in 2004 into the Pipeline and Hazardous Materials Safety Administration (PHMSA).

Source: USA Today



For Natural Gas operators in the United States, PHMSA enforces federal regulations including the Code of Federal Regulations (CFR) part 192 titled "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards". (2022) Over 305,000 miles of interstate and intrastate transmission pipelines are regulated using CFR Part 192. (U.S. Energy Information Administration, 2008)

While PHMSA provides regulations for all natural gas operators, many municipalities have relied on their own past experiences within their jurisdiction to create regulations. For example, the City of Chicago, historically let contractors install natural gas utilities in the roadway via a trenchless method called directional boring. When utilities are installed via directional boring there is less visual confirmation of the location of underground utilities causing an increased risk of a cross bore.

CROSS BORE
Intersection of an existing underground utility or underground structure by a second utility installed using trenchless technology

This results in an intersection of the utilities, compromising the integrity of either or both utilities or underground structure. (PHMSA/NAPSR Plastic Pipe Ad Hoc Committee, 2014) Over time, the City of Chicago saw an increase in the amount of cross bores, and as a response, they required all underground utilities to be placed in the roadway to be installed via open cut instead of directional bore. (City of Chicago, 2022)

Regulations continue to evolve and as shown by the examples above are heavily influenced by historical events.

Critical Factors that Affect Natural Gas Design

Population Density

While federal codes provide the framework for minimum safety standards, state and municipal codes use specific geography and population density to establish safety standards for installing natural gas pipelines underground within their jurisdiction. Population density specifically helps determine the balance between natural gas distribution and transmission piping. Using the state of Illinois as an example, **there are three major natural gas operators:**

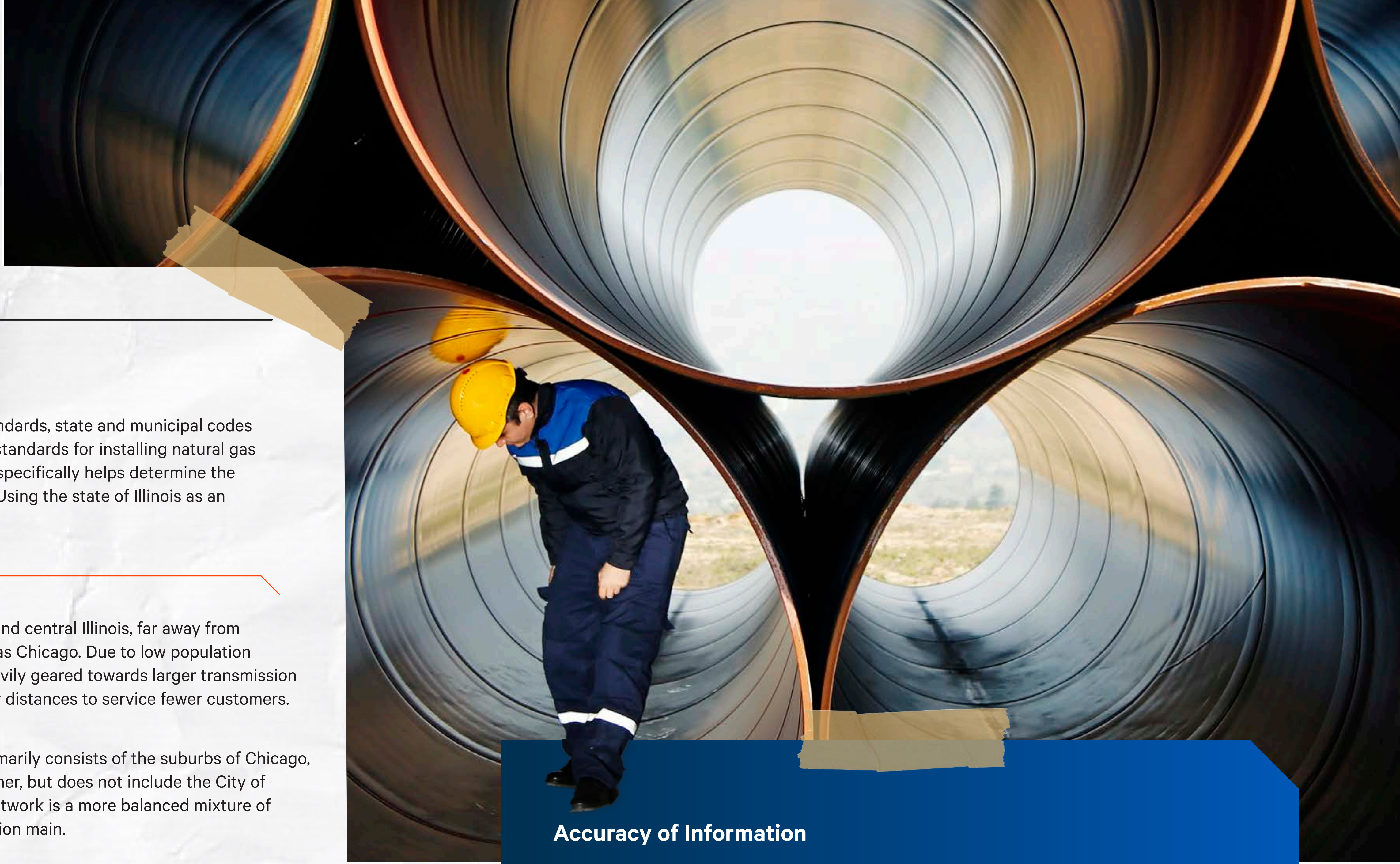
Smallest — Population Density — Largest

Ameren ILLINOIS: Ameren is located in southern and central Illinois, far away from major population centers such as Chicago. Due to low population density, Ameren's system is heavily geared towards larger transmission mains that have to travel longer distances to service fewer customers.

Nicor Gas: Nicor Gas's service territory primarily consists of the suburbs of Chicago, where population density is higher, but does not include the City of Chicago. Nicor Gas's pipeline network is a more balanced mixture of distribution main and transmission main.

PEOPLES GAS NATURAL GAS DELIVERY: Peoples Gas, the natural gas operator for the City of Chicago, has a pipeline network that consists of almost solely distribution main, with transmission trunk lines interspersed within their territory.

Natural gas operators also have to take into account how population density affects the density of other utility infrastructure in the area. In additional to natural gas, common utilities across the United States include: water, storm sewer, sanitary sewer, electrical power, and telecom/fiber. All of these utilities have overlapping networks of above and below ground infrastructure that all must be maintained and improved upon in order to provide reliable and safe infrastructure all across the United States.



Accuracy of Information

Before the 1980's, installing underground facilities relied on contractors to make decisions in the field to avoid utility conflicts. The only method available at the time was simply digging to expose an existing utility. However, due to an abundance of inaccurate records, many utilities were attempted to be excavated only to find that they were not in the aforementioned location. As time went on, regulators determined that this caused too many utility conflicts, relocations, and project delays. In the late 1980's, the Virginia Department of Transportation adopted SUE (Subsurface Utility Engineering) standards, originally known as "digging and locating" for all underground work located in their territory.

In the 1990's SUE began to spread, with the Federal Highway Administration (FHWA) actively promoting the SUE concept as well as introducing SUE quality levels we see today. SUE levels are broken out from A-D depending on the quality of information provided.

Per FHWA, SUE levels are defined as below:

Quality Level D

QL-D is the most basic level of information for utility locations. It comes solely from existing utility records or verbal recollections, both typically unreliable sources. It may provide an overall "feel" for the congestion of utilities, but is often highly limited in terms of comprehensiveness and accuracy. QL-D is useful primarily for project planning and route selection activities.

Quality Level C

QL-C is probably the most commonly used level of information. It involves surveying visible utility facilities (e.g., manholes, valve boxes, etc.) and correlating this information with existing utility records (QL-D information). When using this information, it is not unusual to find that many underground utilities have been either omitted or erroneously plotted. Its usefulness, therefore, is primarily on rural projects where utilities are not prevalent, or are not too expensive to repair or relocate.

Quality Level B

QL-B involves the application of appropriate surface geophysical methods to determine the existence and horizontal position of virtually all utilities within the project limits. This activity is called "designating". The information obtained in this manner is surveyed to project control. It addresses problems caused by inaccurate utility records, abandoned or unrecorded facilities, and lost references. The proper selection and application of surface geophysical techniques for achieving QL-B data is critical. Information provided by QL-B can enable the accomplishment of preliminary engineering goals. Decisions regarding location of storm drainage systems, footers, foundations and other design features can be made to successfully avoid conflicts with existing utilities. Slight adjustments in design can produce substantial cost savings by eliminating utility relocations.

Quality Level A

QL-A, also known as "locating", is the highest level of accuracy presently available and involves the full use of the subsurface utility engineering services. It provides information for the precise plan and profile mapping of underground utilities through the nondestructive exposure of underground utilities, and also provides the type, size, condition, material and other characteristics of underground features.

Figure 1: Description of SUE Levels

As SUE levels **INCREASE** from D to A,

the cost of providing each level of information **INCREASES.**

Utility density also plays a role in determining SUE levels for a project. For example, municipalities located in rural areas may rely more on SUE Level D as a more cost-effective option compared to other SUE levels. A major city, such as the City of Chicago, can require a SUE level C or higher due to a higher congestion of utilities. There are many different variables when determining SUE levels and as such each project should be considered on a case-by-case basis. (U.S. Department of Transportation Federal Highway Administration, 2018)

Even before SUE levels were established, obtaining and maintaining records of locations of existing natural gas facilities has been a crucial factor to avoid conflicts. For natural gas operators, per the Code of Federal Regulations (CFR) Part 192.1015, all natural gas operators must have and maintain a Distribution Integrity Management Program (DIMP). (2022)

While Natural Gas operators have DIMP programs that provide reliable information, there are many less regulated utilities for which records can vary in quality, reliability, and accuracy. Nicor Gas's territory contains approximately 640 different municipalities. (Nicor Gas, 2022) Depending on the location of the project, the level of information provided can vary depending on the municipality. Even within a single jurisdiction such as the City of Chicago, the level of detail and accuracy of information can vary depending on the type of utility.

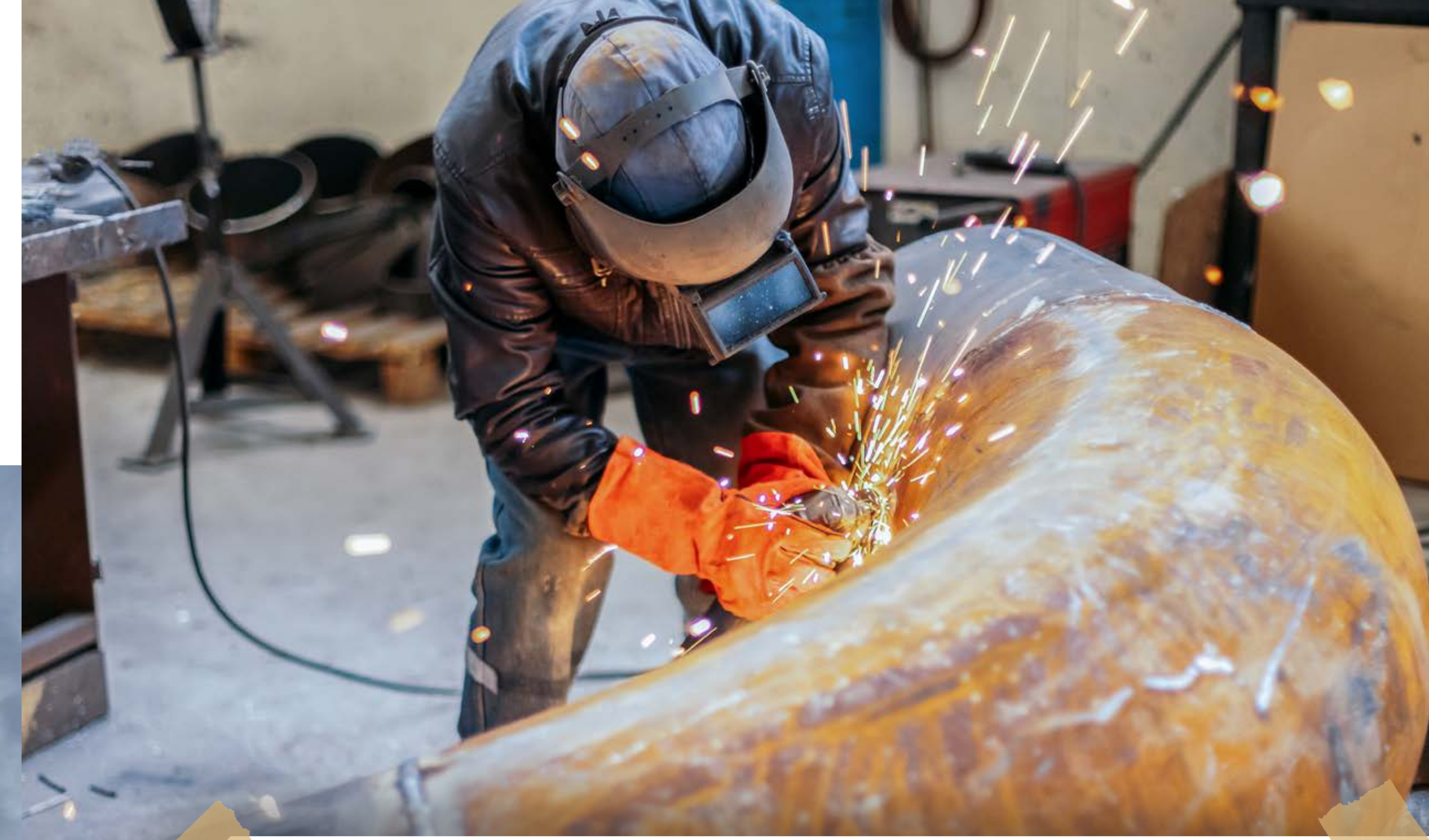
Utility Conflicts

According to PHMSA, excavation damage during construction activities is among the primary causes of pipeline damage. Only corrosion and equipment failure account for more incidents.

[**85,896** leaks at gas utilities led to excavation damage in 2016.]

While PHMSA has the ability to evaluate the effectiveness of states in enforcing their damage prevention laws, the specific requirements and the level of enforcement of those laws can vary considerably from state to state. (2021)

Continuous maintenance and improvement of utility networks require an immense amount of coordination. In high population areas, a critical factor of utility design is providing sufficient clearance from other existing utilities in order to mitigate risk of excavation damage. Most municipalities will require minimum horizontal and vertical separation requirements for each utility.



MINIMUM CLEARANCE REQUIREMENTS

AGENCY	SIZE OF FACILITY	HORIZONTAL	VERTICAL
WATER	FEEDER MAIN (16" OR LARGER)	5 FT (edge to edge)	1.5 FT
	GRID MAINS (LESS THAN 16")	3 FT (edge to edge)	1.5 FT
	WATER HYDRANTS	3 FT	
MCI WORLDCOM	PIPES	1 FT	0.5 FT
	POWER OR OTHER CONDUIT UNDERGROUND	3" (CONCRETE) 4" (MASONARY) 12" (EARTH)	
AT&T BROADBAND	ALL CONDUIT	2 FT	1 FT
SBC / AMERITECH	ALL CONDUIT	2 FT	2 FT
SEWER	ALL SEWER	OUTSIDE DIAMETER (O.D.) + 4 FT	1.5 FT
ELECTRICITY (DOE)	ALL CONDUITS & POLES	2.0 FT	1.5 FT
FORESTRY	See attachment		
C.T.A. FACILITIES	ALL	3 FT	
PARK DISTRICT	NOT RECEIVED		
M.W.R.D.	ALL CONDUITS		
RCN/COMCAST	ALL CONDUITS	2 FT	1.5 FT
COMED	ALL	3 FT	1.5 FT
PEOPLES GAS	16" OR LESS	3 FT	1.5 FT
	18" OR LARGER	5 FT	2.0 FT

Figure 2: City of Chicago Minimum Clearance Requirements

As shown in Figure 2, the City of Chicago has specific standards for horizontal and vertical clearance requirements for all utility installations. All projects that require below grade excavation are required to retrieve existing utility information from the City of Chicago. Once the existing utility information has been obtained, a survey of the project area is completed to conform to SUE Level C. Design Engineers then combine the survey and existing information on drawings so conflict analysis can occur and the running line of the proposed gas main be designed.

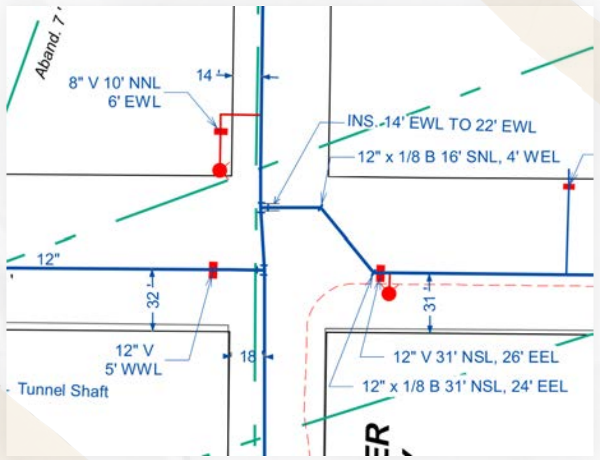


Figure 3: City of Chicago Water Main Record

Figure 4: City of Chicago Telecom Record

As shown in Figures 3 and 4, the level of information provided can vary drastically. Figure 3 shows a water main atlas page, with specific Right of Way (ROW) dimensions and fittings such as valves, tees, elbows, and hydrants. Figure 4 gives a general idea and scope of the location of the telecom utility but does not contain any dimensions or scale that ties the underground asset to a specific location in the field.

Using utility records provided in Figure 3 and 4 in combination with an above ground survey would qualify as SUE Level C even though both records provide drastically different levels of information. It is important to understand that SUE Level C is only as accurate as the information provided on the records.

The City of Chicago may be unique in the sense that there is one governing entity that manages utility coordination. Utility coordination in the surrounding suburbs follows a different path. The amount and age of existing utility information available is dependent on each municipality, ranging from older physical records to modern GIS systems. As a result, the detail and amount of existing information shown on natural gas design plans can vary widely, which can put additional risk on operators and contractors during construction to properly locate and avoid utility conflicts.

Impacts of Variation in Regulations

While there is little debate that regulations play a critical role in ensuring the safety of all natural gas pipeline operations, municipal regulations can directly affect the cost of projects and programs. As referenced in the "Natural Gas Regulations" section, the City of Chicago requires all natural gas pipe to be installed within its jurisdiction to be installed via the open cut method due to an increased risk of cross bores. Per the 2019 Rules and Regulations for Construction in the Public Way, all openings in the public way must also be restored per CDOT standards. (Chicago Department of Transportation, 2019) Figure 5 shows an example of the limits of restoration based off of various opening within a sample roadway.

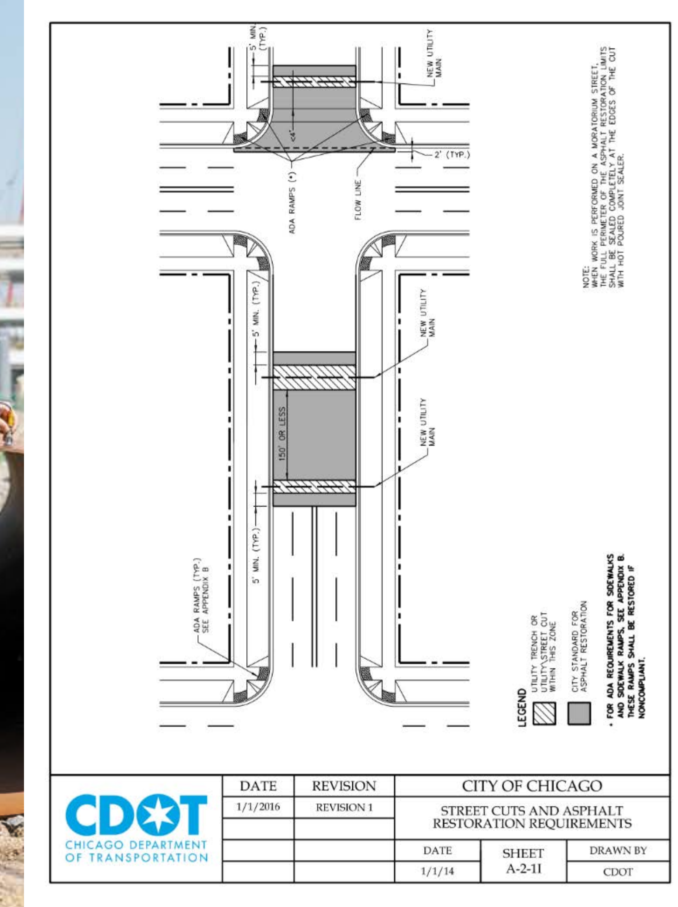


Figure 5: CDOT Detail A-2-11 Street Cuts and Asphalt Restoration Requirements

Figure 5 shows typical examples of how a simple street crossing with a natural gas pipe can impact restoration limits. First, if two openings are located within 150' of each other, the area between those openings must be restored. Second, if a new utility is being installed within 5' of an intersection, the intersection must be restored up to the flow line of the adjacent street. Since natural gas pipes are required to be open cut in the roadway, these restoration standards must be followed. Experienced engineers working on natural gas designs in the City of Chicago understand these requirements, and in turn use judgement to minimize restoration impacts. In many cases, proposed gas mains within 150' of each other will be moved farther apart in order to save on restoration costs as long as it can be designed in a safe manner.

In contrast to the City of Chicago, Will County, IL has different regulations that also considerably impact the cost of natural gas design and construction. Per the Will County Utility Permit Guidelines dated 2-22-19, Will County does not allow roadway impacts for any newly installed facility without the written permission from Will County DOT. (Will County Department of Transportation, 2022) Natural Gas facilities are required to be directionally bored across the roadway to minimize impacts to traffic and street restoration. Will County also does not allow the abandonment of underground facilities, requiring contractors to remove abandoned natural gas piping once retired. The cost of the removal falls on the owner of the facility. (2022)

Current Solutions

In order for engineering designs to be effective, information shown on design drawings needs to be reliable, accurate, and easily accessible.

For the City of Chicago, the Office of Underground Coordination is responsible for the protection of the surface and subsurface infrastructure from damage due to planned and programmed construction, installation, and maintenance projects. Any proposed projects for new construction and installation work within the City must be processed through the OUC. The OUC is made up of 27 reviewing utility members, consisting of both city agencies and private entities who review existing utility information and proposed projects to determine the effect that specific requests will have on their facilities. (Chicago Department of Transportation, 2022) The OUC acts as a centralized hub that disseminates existing utility information and provides coordination between all of its members to minimize conflicts in the field during construction.

[**The OUC process can be separated into two different stages:** Information Retrieval (IR) and Existing Facility Protection (EFP).]

During the IR process, each representative from the participating companies have 30 calendar days to respond to the proposed underground work. Each reviewing utility members, consisting of but not limited to water, sewer, telecom, electric, and natural gas utilities provide information for the requested project area straight from their records. Combined with the City of Chicago's requirement to survey all projects areas, this ensures that all submitted projects to the City adhere to SUE Level C standards. (U.S. Department of Transportation Federal Highway Administration, 2018)

During the EFP process, each of the utility representatives will review the submitted project and based off of the proposed design and existing information shown will authorize the permit, reject the plans due to a conflict, or mark that their facilities are not located in the project area. Each utility reviewer will provide comments that need to be addressed until a permit can be authorized. These comments can help to address any concerns or questions that arise due to older or less accurate records. Only once all participating members authorize the permit, then a project can be approved and issued for construction. Accurate and reliable information allows engineers to provide conflict analysis to mitigate risk of damage during construction.

While this whitepaper mainly focuses on design, it is worth mentioning that design plans often require contractors to utilize their local 811 number before they dig to electronically locate any utilities in the project area. Electronic locates (SUE Level B) completed just before construction compiled with accurate information on the design drawings has shown to lower the risk of change orders and damage to other facilities.

Recent federal regulation has also been a driver for improved accuracy and reliability of information. CFR Part 192.607 reads: "Records established under this section documenting physical pipeline characteristics and attributes, including diameter, wall thickness, seam type, and grade (e.g., yield strength, ultimate tensile strength, or pressure rating for valves and flanges, etc.), must be maintained for the life of the pipeline and be traceable, verifiable, and complete. (2022) While this regulation applies specifically to steel transmission natural gas pipeline, the key words are traceable, verifiable, and complete. As technology continues to evolve, natural gas operators have already turned to GIS systems to help adapt to CFR 192.607. Natural gas operators will have 14 years starting on July 1st, 2020, to become compliant with CFR 192.607. While it remains to be seen how GIS systems will evolve in 14 years, PHMSA's goal is clear; provide regulation to improve the accuracy, reliability and availability of pipeline information.

Closing Statement

In closing, natural gas has become an integral part of everyday life in society. Federal and municipal regulations strive to provide safer more reliable systems to minimize risk of a catastrophic event. Design engineers play a critical role in providing safe designs to minimize risk of cross bores and field changes. It is critical for natural gas design engineers to understand where their information comes from and how it can be affected by current regulation. Engineering judgement is required to determine when existing information needs to be supplemented with advanced locating techniques. An understanding of federal and municipal regulations is crucial to maintain a balance between a cost-effective design and a safe design.

How MILHOUSE Can Help

Milhouse has a unique position of being a natural gas design engineering consultant for many different natural gas operators across the United States. Regulations have left room for operators to choose different paths on how to address and meet current industry standards. Milhouse continues to observe the current state of industry regulation, learn different processes and procedures from each operator (client), and work with each unique municipality within our client's territory. Milhouse's unique perspective on the natural gas industry helps us to provide proactive recommendations, oversight, and guidance to operators across the country.

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