

BIOGRAPHICAL INFORMATION

William J. Meehan, P.E,
Director, Utility Solutions
ESRI

Specific Responsibilities

Bill Meehan joined ESRI in 2002. He has extensive background in utility operations, management, including the integration of IT and GIS. Bill manages the worldwide electric and gas utility practice for ESRI. His specific responsibilities include strategic industry planning, business development, support of sales and project consulting.

Past Experience

Bill was formerly the Vice President of the Electric Operations, Vice President of Supply Chain and Manager of Engineering for NSTAR. He was the champion of Boston Edison's GIS project. Bill managed the NSTAR merger process of Boston Edison and Commonwealth Energy Systems and led the effort to comply with the Massachusetts Utility Restructuring (deregulation) Law.

Education

B.S in Electrical Engineering, Northeastern University, Boston MA
M.S in Electric Power Engineering, Rensselaer Polytechnic Institute, Troy, NY

Professional Memberships and Affiliations

Registered Professional Engineering in the Commonwealth of Massachusetts
GITA
IEEE, Power Engineering Society

Awards

Multiple GITA speaker award winner

Publications and Presentations

Author of a numerous papers, articles, and the textbook, Power System Analysis by Digital Computer, he has lectured extensively and taught courses at Northeastern University and the University of Massachusetts. Bill has made a number of presentations and keynote addresses at host of industry and business functions.

BIOGRAPHICAL INFORMATION

David M. Frye
Senior Consultant/Project Manager &
Petroleum/Pipeline Services Manager
ESRI

Specific Responsibilities

Dave joined ESRI in 1995. He is a Senior Consultant/Project Manager in the Energy and Utility Group within ESRI Professional Services. He is responsible for consulting, program and project management on large enterprise GIS projects within the petroleum, pipeline, electric and gas industries. He has worked on projects for Pennsylvania Power and Light, Centerpoint Energy, Consumers Energy, DOT/OPS, Saudi Aramco, Kuwait Oil Company and BP, plus many other projects.

Past Experience

Prior to joining ESRI, he was the CADD/EDMS/GIS Supervisor at ARCO Transportation Company

Education

David attended Fullerton College, in Fullerton, California, and earned an Associates Degree in Drafting and certificates in Engineering and Computer Aided Design.

GIS – A MUST FOR ASSESSING NEW PIPELINE SAFETY RULES

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ABSTRACT

The Department of Transportation's Research and Special Programs Administration (RSPA), Office of Pipeline Safety (OPS) has issued new regulations on "Pipeline Integrity Management in High Consequence Areas". Integrity management is a new regulatory method for assessing pipeline safety, determining risk and prioritizing natural gas transmission pipeline inspection, repair, prevention and mitigation for pipelines that traverse high consequence areas (HCA). HCA's require higher protection because the impact of a failure would do substantial harm. This paper presents an overview of the new rules, how a geographic information system (GIS) can help operators with initial assessment and ongoing reassessment requirements and the benefits of expanding the GIS to the enterprise information technology environment.

BACKGROUND

Early in the morning of August 19, 2000, twelve people from an extended family slept at their campsite under a concrete-decked steel bridge along the Pecos River near Carlsbad, New Mexico. Their three pickup trucks were parked nearby. The bridge supported Natural Gas Transmission Line 1100. At 5:25AM pipeline SCADA operators noted that the pressure of Line 1100 dropped from 673 psig to 377 psig. The maximum allowable operating pressure (MAOP) was 837 psig. They immediately knew something was very wrong. At about 5:30AM, the 30-inch diameter, natural gas transmission line ruptured and ignited, severely burning all twelve campers. Their vehicles were destroyed. The fire lasted nearly an hour.

None of the victims survived.

The rupture and subsequent explosion left a crater near the Pecos River that was more than 80 feet long, nearly 50 feet wide and 20 feet deep. Flames were seen for miles. A 20-foot section of pipe was found nearly 300 feet away. Another section crashed into the bridge causing serious damage. Approximately 60 feet of transmission line was destroyed.

The impact of this accident was that twelve people lost their lives, a million dollars of damage was done to the pipeline, and gas supply was curtailed into California at an estimated (by the DOT) nearly eighteen million dollars loss per day to the California economy.

The National Transportation Safety Board (NTSB) determined that the probable cause of the rupture and fire was internal corrosion of the pipe to the extent that approximately 50 percent of the pipe wall had disintegrated prior to the rupture. The NTSB, in the report, "Pipeline

Accident Report: Natural Gas Pipeline Rupture and Fire near Carlsbad, New Mexico, August 19, 2000” PB2003-916501, states

“The major safety issues identified in this investigation are as follows:

- The design and construction of the pipeline
- The adequacy of the operator’s internal corrosion control program
- The adequacy of Federal safety regulations for natural gas pipelines, and
- The adequacy of Federal oversight of the pipeline operator.”

Sadly, this pipeline accident was not an isolated event.

The Department of Transportation (DOT) in its incident summary of natural gas pipelines reported on December 12, 2003 that since 1986, there have been nearly 300 fatalities and nearly 2400 injuries, with a property damage of almost 300 million dollars as a result of natural gas pipeline accidents. See Appendix B for complete details.

The Carlsbad accident, other serious accidents, and environmental accidents from liquid pipeline accidents, lead Congress to pass the Pipeline Improvement Act of 2002, which provides the level of Federal oversight to pipeline design, construction, and on-going inspection and risk mitigation. Among its requirements, the law prescribes that pipeline operators execute a pipeline integrity management program. Under Title 49 of the Code of Federal Regulations (CFR), the Department of Transportation’s Research and Special Programs Administration (RSPA), Office of Pipeline Safety (OPS) was charged with enacting rules that detail the implementation requirements of the law. Part 192 (Transportation of natural and other gas by pipeline: minimum federal safety standards) has been enhanced to describe the specific implementation details.

Key Concepts of the New Regulations

The new regulations require natural gas pipeline operators to meet these mandates:

- a. Develop and implement a comprehensive *integrity management program* for pipeline segments where a failure would have the greatest impact on the public or property
- b. Identify and characterize applicable *threats* to pipeline segments that could impact a high consequence area
- c. Conduct a *baseline assessment* and *periodic reassessments* of these pipeline segments
- d. *Mitigate* significant defects discovered from the assessment
- e. *Continuously monitor* the effectiveness of its integrity program and *modify* the program as needed to improve its effectiveness

A new key definition within the regulations is the high consequence area (HCA). This area surrounds the natural gas pipeline, which, in the event of a rupture and subsequent ignition, would cause serious injury and possibly death to anyone in that area. Pipeline operators must initially establish and document these HCAs. The exact detail of how these HCAs are calculated is beyond the scope of this paper. In effect they:

- Depend on the Department of Transportation Class Definition
- Depend the nature of the line and its potential impact (e.g. its pressure, size and wall thickness for example)

- Depend on the buildings (and other places where people congregate) and the use of the buildings that lie within close proximity to the pipeline, particularly those places where large numbers of people congregate and may have difficulty in evacuation
- Are determined by a complex spatial calculation along the pipeline.

See Appendix A for a description of the details of DOT class, HCA and identified site as cited from the regulation for reference.

GIS ROLE IN PIPELINE INTEGRITY

The DOT correctly recognized that safety consists of three essential components:

- Outstanding, accurate and coordinated information
- Consistent, methodical discovery and reporting of threats and risks to an oversight agency
- Timely mitigation and remediation of risks.

Data Management

Natural gas pipeline companies and utilities have been collecting enormous amounts of information about their facilities for years. Often, though, the information has been captured in a fragmented way. The critical data useful for basing decisions, such as inspection reports, pigging (inline inspection) databases, photography and general facilities data have not always been well coordinated.

Prior to computer technology, pipeline operators captured data in manually prepared drawings of line segments called alignment sheets. Each alignment sheet displayed a segment of pipe over a section of area. Each sheet had to be matched to the adjacent sheet. These thousands of sheets collectively was a bible for the engineers and technicians who managed the pipelines. The pipelines were delineated with stationing along the length of the pipe. Events, accidents, repairs and inspections were all referenced to the station along the pipe (as opposed to the geographic location). Keeping this data-bible up to date took considerable effort and in some cases the updating effort would fall woefully behind.

In the 1980s, many pipeline operators converted their existing alignment sheets to computer aided design (CAD) systems. While this improved the productivity of the updating process, it did not improve the fundamental flaw that the data was uncoordinated and fragmented.

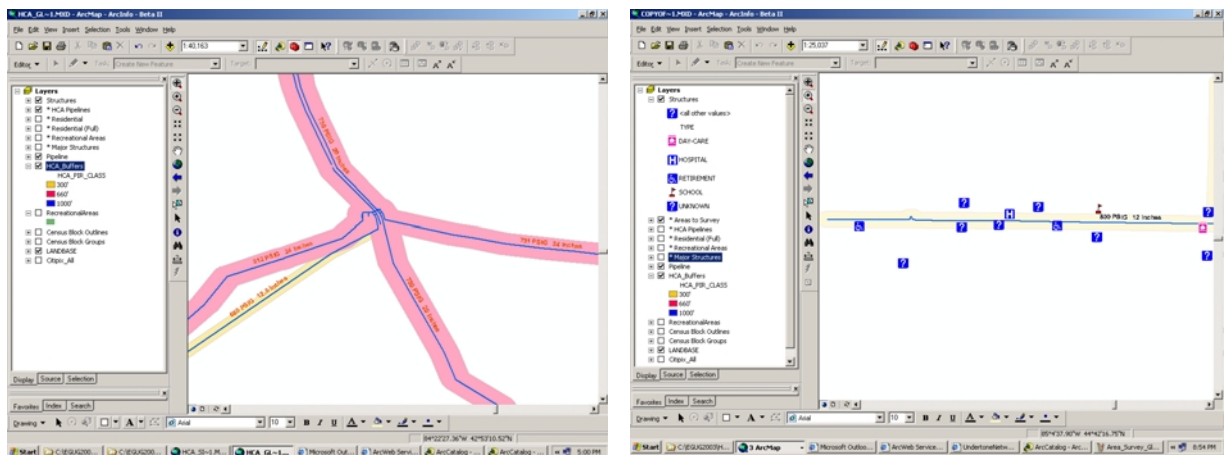
Although CAD is an excellent tool to design facilities, including basic maps and detailed facility construction drawings, CAD is not a capable information repository, nor can it perform spatial analysis. GIS, on the other hand, can generate, store, edit, analyze, distribute and present large amounts of geographically referenced data. Many comparisons between GIS and CAD technology have been conducted over the years. A comprehensive comparison between CAD and GIS is not the point of this paper, but there are a couple points worth emphasizing.

First, the more advanced GIS technologies take full advantage of the standard enterprise IT and the relational databases that are in use at most pipeline companies today. Second, GIS

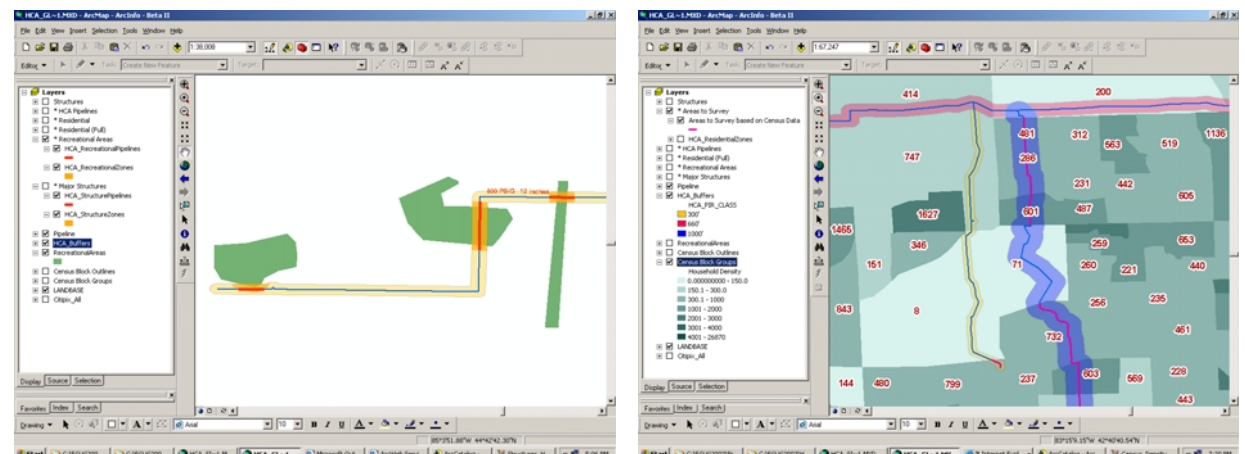
data on the more sophisticated GIS platforms is continuous. This means that there are no drawings to manage or tiles to deal with. Recall with alignment sheets, each sheet is standalone; offers match lines for each adjacent segment. With CAD converted alignment sheets, this is still true. Last, there is a wealth of third party applications available that can be added on as an extension to the GIS technology, which can address everything from probabilistic risk, HCA analysis and MAOP calculations to hydraulic modeling.

GIS generates alignment sheets on the fly, on demand and custom configured based on current data in the GIS database. Further, since GIS is geographic based, no longer is data linked strictly to the linear stationing method. GIS that has linear referencing capability can provide the operator with two views of the data: by pipeline station (critical for historic data of events) and by geographic coordinate (critical for modern inspection using GPS).

Section 192.911 of the regulations defines the elements of a comprehensive integrity management program. Many of the requirements are data related. One of the key elements is the creation and documentation of HCA. From the discussion above about HCA, it is clear that in order to comply, operators need geographic and attribute data about the pipeline and geographic and attribute data for the surrounding region. Further, given that data, operators need a way to perform a dynamic spatial analysis to determine HCAs.



GIS Captures the Impact Radius (left) and the Structure Data (right)



GIS Identifies Camp Grounds and Playgrounds (left) and Performs HCA Analysis (right)

With a GIS enabled natural gas pipeline system in place, the problem of data management becomes significantly less burdensome. By creating a GIS model for the pipeline system, operators can manage their pipeline assets (they need to do this anyway), have the infrastructure to perform HCA analysis, and perform a host of other analysis. GIS provides operators with an easy method of determining DOT class.

Discovering and Reporting Threats

Current GIS technology allows operators to manage, coordinate, and identify discovered threats in a standard form and report them to the DOT. By capturing and coordinating data in GIS, associating scanned documents (such as historic manual inspection reports), operators will be able to comply with the new regulations in a cost effective way.

New Web service technology could automatically notify operators of a potential change to a class location or of an identified site. Automated notification could be generated. For example, a Web service could be established that notifies the pipeline operator whenever a building permit is issued near a pipeline. The GIS could then analyze the structure to see if it impacts the class or the HCA.

GIS helps manage threat data, facilitates reporting both internally and to the regulators, and provides visualization of the set of threats on a macro level.

Managing Mitigation and Remediation of Risks

GIS provides a platform to help operators prioritize risk in the most cost effective way. By coordinating and effectively organizing all the relevant data relating to integrity management, operators may find that their mitigation activities can be optimized. For example, if an operator is not sure if a pipe segment is class 2 or 3, the operator may choose to take a conservative approach and assume that it is class 3. If that pipe segment cannot be inspected using in-line inspection methods, assessment may have to be direct. Direct assessment involves expensive and dangerous excavation. Conversely, if the operator assumes that the pipe is class 2, based upon inaccurate or uncoordinated data and it really is class 3 and an event occurs, the consequences for the operator will be severe.

Thus, the GIS can help to manage the mitigation activities. With solid processes and procedures in place, a GIS platform can give operators the best opportunity to make the proper decisions about mitigation and remediation, being neither too conservative (which may be expensive) nor too optimistic (which may be risky).

Financial Advantages

In today's business environment, pipeline companies do not have the luxury of maintaining a large staff of people to build, maintain, analyze and deploy geographic data. Consequently, the implementation of a GIS enables the pipeline operator to meet all of the geographically related application requirements with a minimum staff. In fact, recent GIS design has created a platform for accomplishing a greater quantity and variety of spatial work than that of engineering drafting staff 10 times the size 30 years ago.

GIS is the most accurate and cost effective way to build an environment to meet the new OPS regulations. A pipeline company could utilize a variety of commercially available GIS data sources as its foundation/landbase that would provide it with the structure count and population density data needed for HCA and risk analysis. It could then move ahead and implement GIS based applications for HCA analysis. The end result would be a system that allows the operator to integrate pipeline data (from all sources, such as Smart Pig, existing internal databases, etc.) and efficiently complete the HCA. Even if commercially available data is not available in a given operator's area or the population/urban growth in the area is rapid, requiring the acquisition of new aerial imagery, GIS technology is still the most effective way to integrate all of the required data, meet the requirements of new regulations, and build the most accurate representation of pipeline for regulatory and general business purposes.

GIS has the ability to integrate and deal with volumes of data of all types, formats, and provide diverse functionality. It enables pipeline operators to spend more time analyzing data instead of merely collecting and building the database in a manual fashion or by using CAD.

In order to take full financial advantage of the effort required to build a pipeline GIS, the next logical step is to expand the GIS beyond its use as a regulatory compliance tool and integrate it with the enterprise IT environment.

ENTERPRISE IMPLICATIONS

GIS is considered enterprise if, by design, it is part of the overall IT architecture of the company. This implies that GIS is integrated with the standard corporate systems, such as asset management, supply chain, engineering, analysis and SCADA. The new regulations require that pipeline operators change their fundamental business processes. GIS is a key tool for compliance and has a variety of applications for, at a minimum, complying with regulations and at most providing core IT technology for the enterprise. Every physical asset a pipeline company owns has a spatial component. GIS can eliminate decentralized islands of data and applications to improve management and workflow. GIS, integrated with financial, supply chain, human resources and environmental areas provide powerful business intelligence. Enterprise GIS facilitates the compliance process aides in the design, field inspection, asset management and pipeline siting processes.

Implementation of mobile devices linked to a single database gives field inspectors access to latest available data and the ability to feedback errors immediately. Field data then becomes available to everyone within the company. Adding a Web services component can alert operators to new risks outside of their control. Work management and risk assessment becomes proactive. Integrating or embedding GIS technology within the enterprise maximizes the value of corporate systems and increases the accuracy of data and the confidence level of the pipeline operators.

SUMMARY

Natural gas pipeline safety is a major concern. The accident at Carlsbad, New Mexico was a dramatic example of the consequences of a pipeline rupture. The Pipeline Safety

Improvement Act of 2002 started a long process of stringent compliance requirements. Fortunately for pipeline operators, tools and data are available to help. GIS is one of them.

New regulations have placed additional financial burdens onto pipeline operators. Moreover the financial and human consequences of a rupture are equally daunting. New rulings mandated by the DOT leave pipeline operators no choice but to comply. Pipeline operators should view this as an opportunity to adopt the best technology and methodologies for pipeline integrity management and HCA compliance. The key is having reliable, accurate, coordinated and integrated information in a form that is easily communicated both internally and externally, and will help in the overall operations of the company.

Implementing an enterprise GIS solves the immediate problems of regulatory compliance. This is a unique and exciting time for the engineering, regulatory and information technology departments within pipeline companies. Available for many years, GIS technology has now reached a level of sophistication that offers ease of integration and unprecedented application functionality. The various staff responsible for regulatory compliance and information technology administration within the pipeline operating companies should recognize that this new regulatory environment, combined with the current state of the art GIS technology, has created a positive environment for enterprise pipeline information technology implementation.

APPENDIX A

DOT Class

The DOT defines pipeline class in section 192.5 of the existing regulations. The term class location unit refers to an onshore area that extends 220 yards on either side of the centerline of a continuous 1 mile length of pipe.

Class 1: a) An offshore area or b) Any class location area that has 10 or few buildings intended for human occupancy

Class 2: Any class location area that has more than 10 but fewer than 46 buildings intended for human occupancy.

Class 3: a) Any class location area that has 46 or more buildings or b) An area where the pipeline lies within 100 yards of either a building or a small, well defined outside area (such as a playground, recreational area, outside theater or other place of public assembly) that is occupied by 20 or more persons on at least 5 days per week for 10 weeks in any 12-month period. (the days and weeks need not be consecutive).

Class 4: a) Any class location unit where buildings with four or more stories above ground are prevalent

The length of Class locations 2, 3 and 4 may be adjusted as follows: a) A class location 4 ends 220 yards from the nearest building with four or more stories above ground b) If a cluster of buildings intended for human occupancy requires a class 2 or 3 location, and the class location ends 220 yards from the nearest building in the cluster

HCA Methods

Two methods are used to calculate HCA's in the regulations (citing from the regulations section 192.903):

- a) The area defined as
 - 1) Current class 3 locations
 - 2) Current class 4 locations
 - 3) Any area outside a class 3 or 4 location where the potential impact radius is greater than 660 feet and the area within a Potential Impact Circle contains 20 or more buildings intended for human occupancy.
 - 4) The area within a potential impact circle containing an identified site
- b) The area within a Potential Impact Circle containing
 - 1) 20 or more buildings intended for human occupancy, (unless the exception described above in method a applies):or
 - 2) An identified site

Identified Site

An identified site (as defined in the regulations) is:

- a) An outside area or open structure that is occupied by 20 or more persons on an least 50 days in any 12 month period (the days need not be consecutive). Examples include beaches, playgrounds, recreational facilities, camping grounds, outdoor theaters, stadiums, recreational areas near a body of water, or areas outside a rural building such as a religious facility.
- b) A building that is occupied by 20 or more persons on at least 5 days a week for 10 weeks in ant 12 month period (the days and weeks need not be consecutive). Examples included in the definition are religious facilities, office buildings, community centers, general stores, 4-H facilities, and roller rinks
- c) A facility occupied by persons who are confided, are of impaired mobility or would be difficult to evacuate. Examples included in the definition are hospitals, prisons, schools, day-care facilities, retirement facilities and assisting living facilities.

The new pipeline safety law went into effect on December 17, 2002, and is applicable to both high-pressure distribution and transmission systems. This is also the start date for baseline assessment intervals. Operators will have either seven or ten years to complete baseline assessments depending on the type of assessment used. But regardless of the type of assessment, operators must determine the portion of their pipelines that traversed High Consequence areas and must address integrity issues with either an immediate repair, 180-day remediation or longer than 180-day remediation.

APPENDIX B

**Department of Transportation
Incident Summary Statistics by Year
1/11986 – 10/31/2003**

Year	No of Incidents	Fatalities	Injuries	Property Damage
1986	142	29	104	\$11,078,800
1987	163	11	115	\$11,736,125
1988	201	23	114	\$12,131,436
1989	177	20	91	\$8,675,816
1990	109	6	52	\$7,594,040
1991	162	14	77	\$7,765,748
1992	103	7	65	\$6,777,500
1993	121	16	84	\$15,346,655
1994	141	21	91	\$53,260,166
1995	97	16	43	\$10,950,673
1996	110	47	109	\$16,252,842
1997	102	9	67	\$12,493,163
1998	137	18	64	\$19,055,118
1999	118	16	80	\$25,913,658
2000	154	22	59	\$23,398,834
2001	124	5	46	\$14,071,486
2002	102	9	45	\$23,744,202
2003	123	8	48	\$16,962,716
Totals	2386	297	1354	\$297,208,978