Voluntary Information-Sharing System Working Group
Federal Advisory Committee

April 26, 2019

The Honorable Elaine Chao
Secretary of Transportation
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

Dear Secretary Chao:

As Chair of the Voluntary Information-Sharing System Working Group (VIS WG), it is my pleasure and privilege to submit the final Pipeline Safety Voluntary Information-Sharing System Recommendation Report (Report) for your consideration on behalf of the VIS WG. The VIS WG is a federal advisory committee established under Section 10 of the Protecting Our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (Public Law 114-183). In December 2016, the United States Department of Transportation (U.S. DOT) formed the VIS WG in accordance with the provisions of the Federal Advisory Committee Act, as amended (5 U.S.C. App. 2) to provide recommendations to you, the U.S. DOT Secretary, on the development of a voluntary information-sharing system (VIS). The purpose of the recommendations is to improve gas transmission, gas distribution, and hazardous liquid pipeline integrity risk analysis with the intent of reducing or eliminating pipeline safety risk.

The VIS WG members consist of a diverse group of pipeline safety stakeholders, including Federal and state regulators, operators of pipeline facilities, inspection technology experts, coating and cathodic protection service providers, pipeline inspection organizations, safety advocacy groups, research institutions, labor representatives, and other entities.

The Report represents the collaborative work of the VIS WG members. Since December 2016 when the VIS WG first formally met, its members have worked diligently to better understand information sharing systems by collaborating with the numerous stakeholders in the pipeline industry, as well as other energy and transportation sectors. As a result of this collaborative engagement, the VIS WG members were able to provide balanced recommendations that appropriately protect the voluntarily reported information while also ensuring that the recommended regulatory/legislative framework does not provide a means for pipeline operators to purposefully avoid regulatory obligations via participation in the VIS.

The Report provides three primary recommendations for consideration, accompanied by a set of supporting recommendations. Importantly, the VIS WG determined that, since information sharing is an essential element of an effective pipeline safety program, it is imperative to develop a VIS, and the Report provides a framework for establishing a viable and sustainable pipeline VIS program. The VIS WG concludes that a VIS framework aligns well with Pipeline Safety Management System principles, and if established, would be a ground-breaking initiative to advance safety in the pipeline industry. The safety, integrity and reliability of our pipeline system is paramount. As a state energy regulator chairing the VIS WG, I recognize how critical it is to direct our collaborative work at serving the public interest. Each and every one of us serving on the VIS WG was dedicated to working together to find ways to improve and enhance pipeline safety. To that end, we challenged each to ensure that we were addressing all of the necessary elements prior to making recommendations for the creation of a viable, sustainable and effective VIS program. In sum, these recommendations are the result of a collaborative effort to find ways to improve and enhance pipeline safety, and are focused on ultimately achieving the goal of zero incidents.

This Report does not signify the termination of the discussion. In fact, until pipeline accidents and incidents are reduced to zero, such a claim would fall short of the ultimate vision for a VIS. As chair of the VIS WG, my objective, from the outset, was to conduct and encourage clear and thoughtful research, engagement and dialogue, and to provide sound and balanced recommendations to you, the Secretary of the U.S. DOT. We are confident that the recommendations in the Report fulfil our Congressional mandate to determine the feasibility of a VIS, and identify how a VIS program can be implemented in a workable way that leads to more sustained and improved pipeline safety.

Implementing the VIS WG's primary and supporting recommendations will help advance pipeline safety and will lead to opportunities for reducing pipeline accidents and incidents to achieve the goal of zero incidents. Implementing these recommendations will take careful planning and consideration. With our collective efforts, we can close the gap between the aspirational goal of zero incidents and actual zero incidents in my regulatory life time. Accordingly, VIS WG developed this Report and hereby submits it as so directed for your consideration.

Sincerely yours in dedicated public service,

Diane Burman

Diane X. Burman, Esq.
Chair, PHMSA Federal Advisory Committee
Voluntary Information-Sharing System Working Group

Attachment:
Voluntary Information-Sharing System Recommendation Report

Pipeline Safety

Voluntary Information-Sharing System Recommendation Report

Submitted by the:

Voluntary Information-Sharing System

Working Group

April 2019

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Foreword

As the chair of the Voluntary Information-Sharing System Working Group (VIS WG), it is my pleasure and privilege to submit the final Pipeline Safety Voluntary Information-Sharing System Recommendation Report for consideration (Report) on behalf of the VIS WG. The VIS WG is a federal advisory committee that was established under Section 10 of the Protecting Our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (Public Law 114-183). In December 2016, the United States Department of Transportation (U.S. DOT) formed the VIS WG in accordance with the provisions of the Federal Advisory Committee Act (FACA), as amended (5 U.S.C. App. 2) to provide recommendations to the U.S. DOT Secretary on the development of a voluntary information-sharing system (VIS). The purpose of these recommendations is to improve gas transmission, gas distribution, and hazardous liquid pipeline integrity risk analysis with the intent of reducing or eliminating pipeline safety risk.

The VIS WG members consist of a diverse group of pipeline safety stakeholders, including Federal and state regulators, operators of pipeline facilities, inspection technology experts, coating and cathodic protection service providers, pipeline inspection organizations, safety advocacy groups, research institutions, labor representatives, and other entities.

This Report represents the collaborative work of the VIS WG members. Since December 2016 when the VIS WG first formally met, its members have worked diligently to better understand information sharing systems by collaborating with the numerous stakeholders in the pipeline industry, as well as other energy and transportation sectors. As a result of this collaborative engagement, the VIS WG members were able to provide balanced recommendations that appropriately protect the voluntarily reported information while also ensuring the recommended regulatory/legislative framework does not provide a means for pipeline operators to purposefully avoid regulatory obligations via participation in the VIS.

The Report provides three primary recommendations for consideration, accompanied by a set of supporting recommendations. Importantly, the VIS WG determined that, since information sharing is an essential element of an effective pipeline safety program, it is imperative to develop a VIS, and the Report provides a framework for establishing a viable and sustainable pipeline VIS. The VIS WG concluded that a VIS framework aligns well with Pipeline Safety Management System principles and, if established, would be a ground-breaking initiative to advance safety in the pipeline industry.

The safety, integrity, and reliability of our pipeline system is paramount. As a state energy regulator chairing the VIS WG, I recognize how critical it is to direct our collaborative work at serving the public interest. Each and every one of us serving on the VIS WG was dedicated to working together to find ways to improve and enhance pipeline safety. To that end, we challenged each other to ensure that we were addressing all of the necessary elements prior to making recommendations for the creation of a viable, sustainable, and effective VIS. In sum, these recommendations are the result of a collaborative effort to find ways to improve and enhance pipeline safety, and are focused on ultimately achieving the goal of zero incidents.

This Report does not signify the termination of the discussion. In fact, until pipeline accidents and incidents are reduced to zero, such a claim would fall short of the ultimate vision for a VIS. As chair of the VIS WG, my objective, from the outset, was to conduct and encourage clear and thoughtful research, engagement, and dialogue, and to provide sound and balanced recommendations to the Secretary of the U.S. DOT. We are confident that the recommendations fulfill our Congressional mandate to determine the feasibility of a VIS and identify how a VIS program can be implemented in a workable way that leads to more sustained and improved pipeline safety.

Implementing the VIS WG's primary and supporting recommendations will help advance pipeline safety and will lead to opportunities for reducing pipeline accidents and incidents to achieve the goal of zero incidents. Implementing these recommendations will take careful planning and consideration. With our collective efforts, we can close the gap between the aspirational goal of zero incidents and actual zero incidents in my regulatory lifetime. Accordingly, the VIS WG developed this Report and hereby submits it as so directed.

Sincerely yours in dedicated public service,

Diane X. Burman, Esq.

Chair, PHMSA Federal Advisory Committee
Voluntary Information-Sharing System Working Group

Disclaimer

This Report represents the collaborative and collective work and the final recommendations of the Voluntary Information-Sharing System Working Group (VIS WG). The views expressed in this Report are a product of the independent advice, recommendations, guidance, and considerations of the VIS WG members. The VIS WG is a federal advisory committee under the Federal Advisory Committee Act (FACA) (5 U.S.C. App 2), established under Section 10 of the Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (Public Law 114-183). The views expressed herein should not be construed as potential future policies or practices of the VIS WG members' respective entities, state administrations, nor interpreted that the VIS WG members have individually or collectively made a determination with respect to the outcome of a matter or otherwise prejudged an issue without considering all positions that may come before such VIS WG members in other matters or proceedings.

Readers of this Report should not take the language and perspectives in this Report out of context. In fact, it is important when analyzing and interpreting any single aspect of the Report that it is understood as one element of a larger framework with the full narrative Report. This document is issued exclusively as a recommendation report and is not indicative of current Pipeline and Hazardous Materials Safety Administration (PHMSA) policies and regulations. This document is the property of the U.S. Department of Transportation (U.S. DOT) and is to be used in conjunction with official U.S. DOT and PHMSA responsibilities.

FACA helps ensure the independent nature of the advisory committee and requires that the U.S. DOT not exercise influence over the advice and recommendations contained in the report. Consistent with this provision, neither this report, nor the final recommendations, have been formally cleared or approved by the U.S. DOT or PHMSA.

Acknowledgments

First, we thank Congress itself for recognizing the need for increased focus on pipeline safety when it established this VIS WG in Section 10 of the Protecting Our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (Public Law 114-183).

The VIS WG is grateful to the many individuals and organizations that provided expertise, knowledge, and important insights on the need for a voluntary information-sharing system (VIS) in the pipeline industry. The VIS WG would like to thank the numerous technical experts, organizations, and other individuals who presented and shared valuable information at the VIS WG meetings. These presentations were vital to our work and informed this final Recommendation Report. The VIS WG also appreciates the individuals and organizations that provided public comment.

We sincerely appreciate the support of the Honorable Elaine L. Chao, Secretary to the U.S. DOT, and PHMSA leadership including Administrator Howard 'Skip' Elliott, Deputy Administrator Drue Pearce, Chief Counsel Paul Roberti, Associate Administrator for Pipeline Safety Alan Mayberry, Deputy Associate Administrator for Policy and Programs Massoud Tahamtani, and Dr. Christie Murray, VIS WG Designated Federal Official. The VIS WG is equally grateful for the support of the seven VIS WG subcommittee members, including the individual experts formally invited by the VIS WG to join various subcommittees as external members, all of whom contributed significantly to the work of the subcommittees.

Finally, we extend a special thank you to the PHMSA staff for providing outstanding assistance and expertise that significantly contributed to the success of the VIS WG: Tewabe Asebe, Ahuva Battams, Dr. Sherry Borener, Amal Deria, Michelle Freeman, Max Kieba, Karen Lynch, Janice Morgan, Paul Mounkhaty, Amy Nelson, Hung Nguyen, Chris McLaren, Amy Slovacek, Cheryl Whetsel, Dr. Douglas White, and Nancy White. Their professionalism and technical support helped the VIS WG achieve its desired outcomes.

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1. Executive Summary

Congress recognized the need for increased focus on pipeline safety in Section 10 of the "Protecting Our Infrastructure of Pipelines and Enhancing Safety Act" of 2016 (Public Law 114-183 – PIPES Act 2016). Congress required the Pipeline and Hazardous Materials Safety Administration (PHMSA) to establish a federal advisory committee, in accordance with the provisions of the Federal Advisory Committee Act (FACA) as amended (5 U.S.C. App 2), referred to as the Voluntary Information-sharing System Working Group (VIS WG), to provide recommendations to the United States Department of Transportation Secretary (the "Secretary") on the development of a voluntary information-Sharing system (VIS). The VIS encourages collaborative efforts to improve inspection information feedback and information sharing with the purpose of improving gas transmission and hazardous liquid pipeline facility integrity risk management. To address the Congressional mandate and to improve pipeline safety, the VIS WG identified two needs with mutually beneficial improvement opportunities:

> *1. The need for the pipeline industry to implement an overarching and rigorous pipeline safety management system (SMS) process to evaluate, prioritize, and create comprehensive risk reduction programs that lead to a continuous improvement model for pipeline safety. The VIS WG acknowledges that individual pipeline operators are establishing and implementing SMS programs within their organizations and there is substantial collaboration among pipeline operators and trade organizations to do so. However, greater safety value may be realized if the pipeline industry as a whole embraced and applied the tenants of an SMS and the continuous improvement cycle.*
>
> *2. The need to continuously improve system knowledge and pipeline-specific data to analyze and mitigate pipeline safety risks. The industry lacks a comprehensive, systematic, and integrated way to gather, evaluate, quantify, and share critical pipeline safety data and recommended remediation measures or lessons learned of all types to operators across the various industry segments (hazardous liquid transmission, gas transmission, gas distribution) in an efficient and confidential manner.*

The VIS WG acknowledges the American Petroleum Institute's Recommended Practice 1173 (API RP 1173) as a foundational industry best practice that complements the goals and objectives of the VIS. API RP 1173 provides an excellent framework for gathering, evaluating, prioritizing, remediating, and measuring the results of programmatic pipeline safety improvement solutions. As more operators commit to implementing the elements of API RP 1173, the many positive consequences for pipeline safety will continue to accrue. Understanding and enthusiasm for SMS grows as the industry, PHMSA, and other regulators increasingly commit to a common value: that SMS is a journey, not a destination, and that continuous improvement is the principle by which operators conduct their daily work. The benefits of API RP 1173 will be enhanced by the information shared and lessons learned by the VIS as recommended by the VIS WG.

The VIS WG examined and discussed the role of voluntary information sharing within the context of a pipeline SMS, and specifically how voluntary information sharing relates to meeting the requirements of the API RP 1173, "Pipeline Safety Management Systems." The most obvious and one of the primary objectives of the Congressional mandate is the value that voluntary information sharing provides in stakeholder engagement. It would formalize the information sharing processes for the following contexts: amongst operators; service providers; and between operators and service providers on a global basis with deliberate intention to improve how technology is deployed, how it performs, and how the pace of innovation and improvement can be accelerated. Equally important is that voluntary information sharing improves transparency and creates the opportunity for dialogue among operators, regulators, public representatives, tribal leaders and universities.

Voluntary information sharing also provides pipeline operators with increased information and knowledge to manage risk, an element of API RP 1173. Improving risk analysis was another objective of the legislation. Improved data gathering and risk evaluation complemented with improving assessment technology should reduce risk and improve pipeline safety performance.

The VIS WG spent considerable time studying how other industries leveraged voluntary information sharing and incorporated it as an integral part of their SMS. One of the key aspects of SMS is a strong lessons learned process, which is an element of API RP 1173, Incident Analyses and Lessons Learned. The VIS WG reviewed examples from Commercial Aviation SMS established under the FAA, Process Industries including Chemical and Petroleum Refining within Process Safety Management under the Occupational Safety and Health Administration (OSHA), and the Offshore Exploration and Production Industry under the Center for Offshore Safety, among others. Each of these had well-established processes for learning from incidents, including near misses, and systematically sharing the information throughout an operator's organization. The VIS WG also observed examples of how lessons learned were used to evaluate the way in which risks were considered and ultimately managed, with the focus on improving risk management.

The VIS WG determined that information sharing is an essential element of an effective pipeline safety management program. An information sharing system could result in a breakthrough in pipeline safety risk reduction and provide the industry with the tools and systems to enable its evolution into an industry that continuously learns and measurably improves its safety performance. The VIS WG recognizes the need for a secure system that protects proprietary data, develops advanced pipeline assessment methods and enhanced risk analysis, and protects safety and security-sensitive information.

In the process of responding to the Congressional mandate that the VIS WG consider and provide recommendations to the Secretary on existing regulatory, funding, and legal barriers to voluntary information-sharing, the VIS WG quickly turned to examine the most prominent and successful voluntary information-sharing developments in American history: the Federal Aviation Administration (FAA)/Commercial Aviation programs. The VIS WG learned much about how FAA and Commercial Aviation identified and overcame many barriers to voluntary information-sharing in the aviation industry. Over a period of nearly 30 years, the FAA and Commercial Aviation collaborated to institute credible approaches to address barriers to participation in VIS, including concerns related to enforcement, litigation, and fear of reprisal against employees and companies.

The VIS WG members provided balanced recommendations that appropriately protect the voluntarily reported information, while also ensuring the recommended regulatory/legislative framework does not provide a means for pipeline operators to purposefully avoid regulatory obligations via participation in the VIS. These safeguards are vital. Such protections ensure the integrity of the VIS and will help to increase participation in the VIS. If such protections are absent, and enforcement actions are initiated based on data that is voluntarily shared into the VIS, it would discourage pipeline operator participation and minimize the effectiveness of a VIS.

The VIS is intended to allow PHMSA, pipeline operators, technology providers, and pipeline stakeholders to collaborate on anonymous, de-identified safety information that is otherwise only shared, if at all, and analyzed in a very controlled manner such as between operators and technology providers or amongst operators in various private agreements.

Therefore, in its first and very significant response to the Congressional mandate, the VIS WG unanimously agreed on December 19, 2016, to recommend to the Secretary that a VIS should be established. Also, in addition to the inherent value of the VIS itself, the VIS WG recognized that a VIS would complement the already existing voluntary SMS approach, API RP 1173, thereby creating additional benefits. In fact, a careful review of API RP 1173 program framework led the VIS WG to agree that an industry-wide VIS program could leverage and accelerate the overall safety value generated by industry's on-going SMS adoption.

Benefits

There are numerous benefits to establishing a VIS including:

- Serve as a trusted repository of high-volume, high-quality data and information that would advance pipeline safety and lead to opportunities for reducing pipeline accidents and incidents[1] to achieve the goal of "zero."
- Increase public safety and decrease environmental risk.
- Improve operators' awareness of potential threats and risks to their facilities that they might not have previously encountered.
- Improve responses to new threats.
- Improve understanding of existing and emerging technologies and potentially accelerate development and demonstration of new technology.
- Improve effectiveness of technologies to identify specific threats and to enhance an operator's decision-making.
- Provide technical support for service providers' technology investments to improve technology performance.
- Determine gaps in pipeline information to drive continuous improvement.
- Improve communication between the industry, the public, and pipeline safety stakeholders through greater transparency and relationships built on trust.
- Provide a greater understanding among operators on applying rate-payers' funds to reduce risk.

[1] Hereafter, the use of "incidents" is intended to cover both incidents (gas – 49 CFR 191.3) and accidents (hazardous liquids – 49 CFR 195.50).

Barriers

While there are numerous benefits to establishing a VIS, there are also existing regulatory, funding, and legal barriers that may prevent the pipeline industry from establishing an information sharing system on its own, necessitating Congressional and U.S. DOT involvement to remove or reduce the impact of the barriers. Some of those barriers include:

- Legal barriers.
    - Risk of potential enforcement or punitive regulatory action against operators who voluntarily submit data.
    - The challenge of providing necessary protections that encourage pipeline operator participation in a VIS, while at the same time ensuring that those protections are not used to purposely avoid regulatory obligations.
- Organizational and governance barriers.
- Relationship/trust barriers between pipeline operators, regulators, and pipeline safety advocates and stakeholders.
- Funding and cost barriers. Lack of a funding model to develop and sustain an effective VIS.

VIS WG Recommendations

To meet the voluntary information sharing needs and address the barriers described above, the VIS WG developed "primary" and "supporting" recommendations for the Secretary. The VIS WG did not decide at the outset to create two different sets of recommendations. To the contrary, all members and subcommittees worked hard for two years to consider the elements of the Congressional mandate, intending to deliver one set of recommendations to the Secretary. However, as the VIS WG neared the end of the two-year period, three key elements came into focus as absolutely essential, in the opinion of the VIS WG, to delivering the best recommendations possible to the Secretary – those were named Primary Recommendations. All other recommendations that had been developed were termed Supporting Recommendations, based on the belief of the VIS WG that unless the three Primary Recommendations could be achieved, all other recommendations supporting the Primary Recommendations could become moot. However, the Secondary Recommendations are in fact very valuable products and represent the overwhelming volume of work by the VIS WG.

Primary Recommendation 1: Congress should authorize a VIS and direct PHMSA to establish the VIS, including a governance structure and technology platform, to include participation by pipeline operators, PHMSA, and other pipeline safety stakeholders, as more fully described in this Report.

Primary Recommendation 2: Congress should enact legislation to provide confidentiality, non-punitive, and other legal protections to pipeline operators and other pipeline safety stakeholders that participate in the VIS, as more fully described in this Report.

Primary Recommendation 3: Information sharing should include gas distribution system data in the VIS program to significantly reduce industry incidents nationwide, across all three key industry segments: natural gas transmission, natural gas distribution, and hazardous liquids transportation.

The Primary Recommendations are critical to effectively establishing a VIS and essential to delivering the benefits of improved pipeline safety and SMS. While the Congressional mandate expressly focused on VIS between pipeline operators and their in-line inspection (ILI) service providers, the implicit Congressional intent hinged on a desire for the VIS WG to truly consider the viability of opportunities to responsibly improve pipeline safety. The VIS WG carefully considered all of the facts to determine what best aligns with the Congressional mandate. Out of the nation's 2.7 million miles for the pipeline transportation system, approximately 2.5 million miles are dedicated to the gas distribution system. The gas distribution facilitities have a larger percentage (approxinmately 80%) of serious federally reportable incidents occurring. The VIS WG believes broadening the scope to include gas distribution systems is in line with the implicit safety focus of the Congressional mandate. Doing so can help fulfill the goal of maximizing the safe operation of the nation's 2.7- million mile pipeline transportation system as we collectively strive towards a goal of zero incidents. Thus, the VIS WG carefully considered all of the facts and determined this best aligns with the implicit intent of the Congressuional mandate.

The VIS WG believes that if the three Primary Recommendations are coupled with robust SMS programs and are accepted and implemented, the nation will reap the benefits of improved pipeline safety and pipeline SMS. If these three primary recommendations are not fully embraced and addressed, the VIS effort will not be successful or sustainable.

Supporting Recommendations - The Foundation to the VIS Report

The VIS WG developed Supporting Recommendations to ensure that the VIS provides a comprehensive and practical approach to sharing information. These recommendations are organized in this Report by subject matter type:

- Best Practices
- Regulatory, Funding, and Legal
- Governance
- Competency, Awareness, and Training
- Process for Sharing Information
- Technology and Research & Development (including IT Architecture Considerations)

The Supporting Recommendations are designed to provide the level of detail necessary to support full VIS implementation. Greater detail is provided in Section 6.

Recommendation No.	Supporting Recommendation
Best Practices	
Supporting Recommendation Best Practice-1	Include All Elements of the Integrity Management Process
Supporting Recommendation Best Practice-2	Leverage Existing Information Sharing
Supporting Recommendation Best Practice-3	Provide a Framework for Best Practices
Supporting Recommendation Best Practice-4	Provide Transparency and Communication

Regulatory, Funding, and Legal	
Supporting Recommendation Regulatory, Funding, Legal -1	Authorize and Establish Legislation for a VIS Governance Structure
Supporting Recommendation Regulatory, Funding, Legal -2	Disclosure of VIS Information
Supporting Recommendation Regulatory, Funding, Legal -3	Exempt VIS Information from FOIA Release
Supporting Recommendation Regulatory, Funding, Legal -4	Protection of Voluntarily Shared Information
Supporting Recommendation Regulatory, Funding, Legal -5	Prohibit the Use of VIS Information in Litigation
Supporting Recommendation Regulatory, Funding, Legal -6	Provide Adequate and Sustainable Funding for the VIS
Governance	
Supporting Recommendation Governance-1	Establish VIS Executive Board
Supporting Recommendation Governance-2	Establish Program Management
Supporting Recommendation Governance-3	Secure Third-Party Data Manager
Supporting Recommendation Goveranance-4	Appoint Issue Analysis Teams
Supporting Recommendation Governance-5	Authorize and Appropriate Funding for VIS
Competency, Awareness, and Training	
Supporting Recommendation Competency-1	Author Job Descriptions
Supporting Recommendation Competency-2	Develop a Collaborative Process with Meaningful Metrics
Supporting Recommendation Competency-3	Develop a Training and Evaluation Process
Supporting Recommendation Competency-4	Develop Educational Materials
Supporting Recommendation Competency-5	Develop Initial Training for VIS Development and Implementation
Supporting Recommendation Competency-6	Develop Participant Training Modules for Workflow Processes
Supporting Recommendation Competency-7	Develop Participant Training Modules for Quantitative and Qualitative Data
Process for Sharing Information	
Supporting Recommendation Process Sharing-1	Define the types and what information to be shared to enhance integrity management including pipeline integrity assessments and risk management.

Supporting Recommendation Process Sharing-2	Develop a plan for an information sharing center, hereafter referred to as a voluntary information sharing Hub (VIS Hub).
Supporting Recommendation Process Sharing-3	Encourage adoption of API RP 1163 as a starting framework for information sharing between operators and ILI service providers within the VIS Hub and foster its broader use.
Supporting Recommendation Process Sharing-4	Develop a process for pipeline operators to share lessons learned from integrity assessments.
Supporting Recommendation Process Sharing-5	Define the processes to be used in a VIS Hub to facilitate the sharing discrete data from integrity assessments.
Supporting Recommendation Process Sharing-6	Consider existing information sharing systems already in use for energy pipelines to accelerate development and maturity.
Supporting Recommendation Process Sharing-7	Develop a process for pipeline integrity assessment service providers to share lessons learned from integrity assessments.
Supporting Recommendation Process Sharing-8	Develop a process for non-destructive evaluation (NDE) service providers to share lessons learned from integrity assessment excavations.
Supporting Recommendation Process Sharing-9	Define a process for disseminating lessons learned.
Supporting Recommendation Process Sharing-10	Consider development and periodic update of a Pipeline Integrity Management Compendium
Supporting Recommendation Process Sharing-11	Consider conformance to industry Recommended Practices and Standards to standardize the Sharing of Qualitative and Quantitative Data
Technology/R&D	
Supporting Recommendation Technology-1	Consider design and implementation requirements for input validation that support system quality and consistency.
Supporting Recommendation Technology-2	Consider the qualitative and quantitative inputs needed to support meaningful analysis.
Supporting Recommendation Technology-3	Standards Developing Organization (SDO) create the minimum requirements for the collection of field verification data
Supporting Recommendation Technology-4	SDO establish a protocol for comparing pipeline integrity assessment results with ITD/NDE field measurements.
Supporting Recommendation Technology-5	Provide analyses and outputs that serve to encourage adoption of best practices across the industry and stimulate continuous improvement in technology and analyses.

Supporting Recommendation Technology-6	Development, implementation, and operation of a technology platform (the VIS Hub) to advance pipeline safety.

Authorization, Initiation, and Deployment of a Voluntary Information Sharing System

The VIS WG developed an example timeline to depict how a VIS might be authorized and carried out (Figure 1). The timeline is not to be an exact predictor of what might happen but to provide a roadmap of the VIS WG's concept, vision, and deliberation on what would be involved for the path forward.

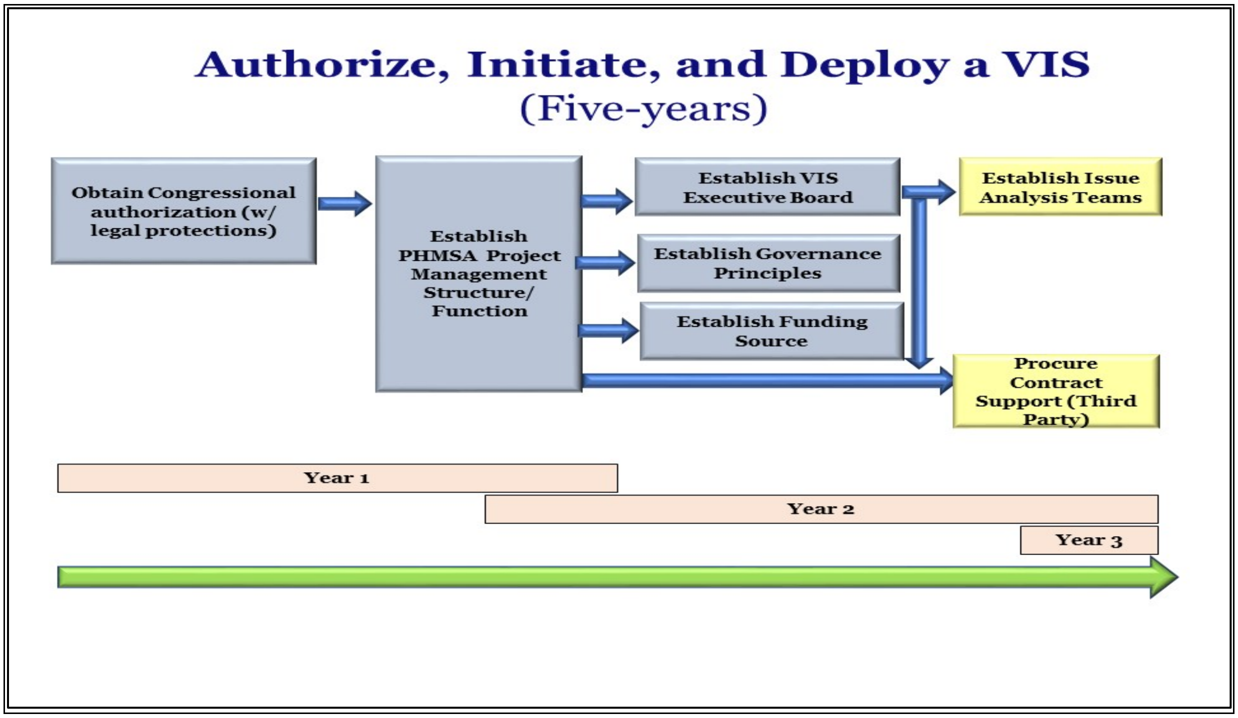
Establishing a VIS begins with authorization of VIS in statute, as described in the recommendations, and to provide the legal and funding framework to achieve similar success as in the case of the FAA/Commercial Aviation programs. The presumption was that Congress would authorize the VIS program in 2019 or soon after. The steps that follow are those related to establishing the required administrative, governance and contract support. Developmental work is depicted in "green" while implementation is depicted in "tan." The timeline reflects five years of effort to establish and deploy a VIS. This is consistent with the experience of other Federal and private efforts. The work will continue to be a journey of continuous improvement in the years beyond.

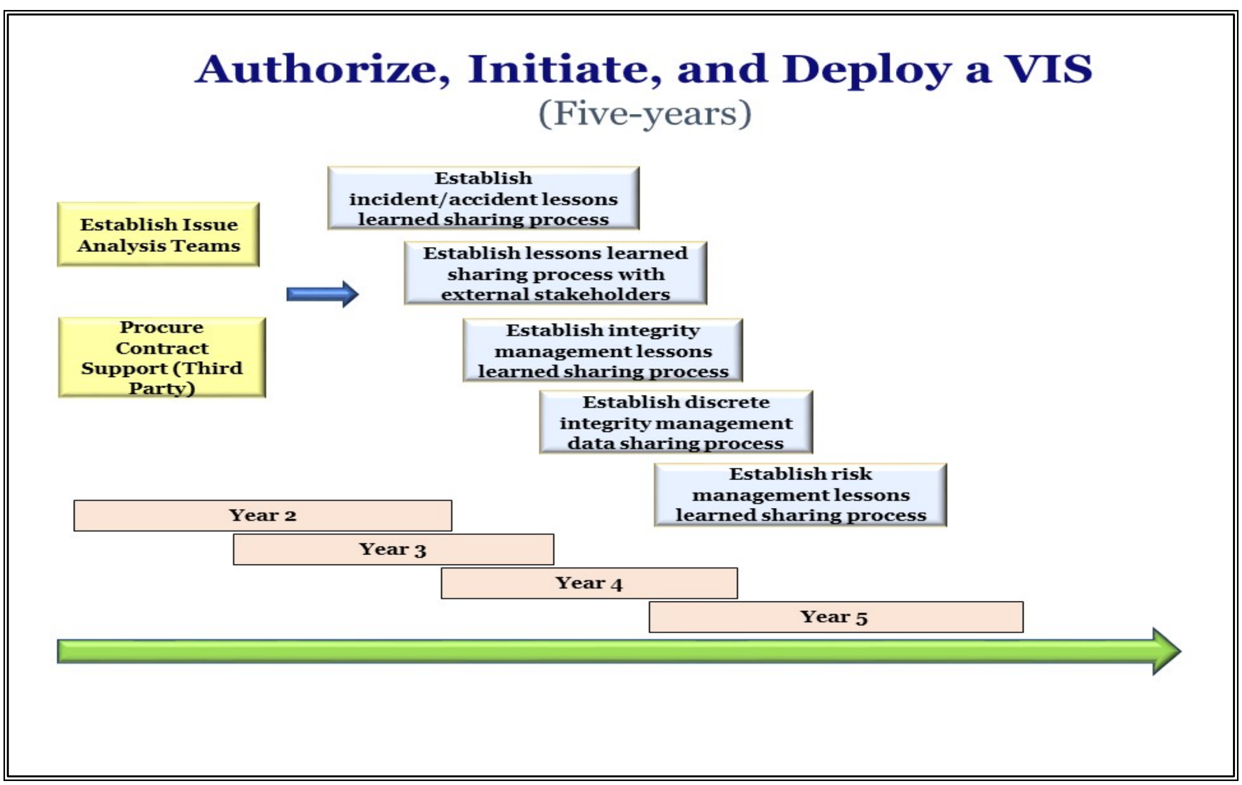
After standing up the administrative, governance and contract support, the VIS WG set up a timeline that addresses the major categories of information sharing. The VIS WG recognized the importance of prioritization and that everything cannot be done at once. The first effort envisioned was to build upon the current sharing practices, finding ways to support and unify the individual sharing practices described below, while strengthening PHMSA's existing methods. Establishing and formalizing information sharing with the broad group of stakeholders was envisioned as an important next step. This is not only consistent with the intent of a Pipeline SMS but ensures that public stakeholders become an integral part of the sharing processes.

The Congressional mandate directed the Secretary of Transportation to focus on sharing information regarding the use of in-line inspection data. In the two years that the VIS WG examined ways to most effectively share ILI information and even more broadly pipeline integrity assessment information, two discrete steps emerged. The first step is to share information and lessons learned at a high level through planning, execution, and evaluation of pipeline integrity assessments. This is reflected in the example timeline in Figure 1. A more detailed example of the timeline is included in Appendix XX.

Recognizing success in establishing a high-level process for sharing pipeline integrity assessment lessons would then provide the foundation for establishing a process for sharing discrete pipeline integrity assessment information, improving use of existing technology, and fostering more rapid advances in technology. The second step is the VIS WG believed that the statute also recognized the importance of sharing and learning about risks on pipeline systems and that is reflected as the last aspect of the work in implementing a VIS. This effort could be prioritized higher and begun earlier but the VIS WG believed that development of other processes would facilitate development of this one.

Figure 1 – Example Timeline for Authorization, Initiation, and Deployment of a Voluntary Information Sharing System





Conclusion

The VIS WG determined that a robust information sharing process providing the ability to rapidly share pipeline safety data across the pipeline industry, coupled with a rigorous risk identification and evaluation process, is likely to improve pipeline safety outcomes.

Information sharing within the pipeline industry will allow all pipeline operators to learn from each other's experiences by bridging data and information gaps. Information sharing can allow pipeline operators with smaller systems, budgets, and resources to leverage the knowledge and learnings of the larger pipeline operators. It is equally important for the proactive identification of safety issues, risk analysis, and communication of risk within and outside of the pipeline industry. While there is evidence of some information sharing in the pipeline industry taking place already, the process by which such information is shared tends to be inconsistent and limited due to legal and cultural restrictions.

There is no existing industry-wide culture of consistent data sharing and trust. Additionally, safety advocate, environmental, and labor stakeholders have been concerned by instances of what they perceive as a lack of transparency and honesty with regards to pipeline safety information. Establishing a reliable VIS that is managed using secure protocols and a state-of-the-art information technology process would allow for the collection, de-identification, analysis, archiving, and dissemination of risk information based on historic, real-time, or near real-time factors for assessing pipeline integrity. Such a system and process would greatly improve the quality of information shared and likelihood of its collection. Analysis of anonymized data would likewise improve risk trend identification and communication about trends and risk mitigation, benefiting public safety. Establishing and sustaining a reliable, credible VIS would create trust between pipeline operators, regulators, and the public. While the trust may initially be small, it would grow as the VIS produces increasing knowledge and tools to improve pipeline safety, and as the number of incidents continues to reduce toward zero. As the FAA and Commercial Aviators will testify, creating and maintaining that trust is the key to continuing success with voluntary information systems and safety management systems.

The VIS WG was inspired by how other DOT industries benefited from information sharing programs, particularly the commercial aviation information sharing program. The commercial aviation information sharing program, established more than 20 years ago, ultimately contributed to a ten-year, accident-free U.S. safety record. If the voluntary information-sharing system primary and supporting recommendations are embraced, the VIS WG envisions significant improvements in pipeline safety that will lead to opportunities for reducing and avoiding pipeline incidents to achieve the goal of "zero incidents."

2. Introduction

The VIS WG developed recommendations and advice for the establishment of a voluntary information-sharing system and process that will allow efficient risk management useful for minimizing near misses, pipeline malfunction, incidents, and accidents of varying levels of seriousness.

2a. Congressional Mandate

Congress recognized the need for increased focus on pipeline safety in Section 10 of the "Protecting Our Infrastructure of Pipelines and Enhancing Safety Act" of 2016 (Public Law 114-183 – PIPES Act 2016), which required the Pipeline and Hazardous Materials Safety Administration (PHMSA) to establish a federal advisory committee in accordance with the provisions of the Federal Advisory Committee Act (FACA) as amended (5 U.S.C. App 2). This committee, referred to as the Voluntary Information-sharing System Working Group (VIS WG), was to provide recommendations to the United States Department of Transportation Secretary (the "Secretary") on the development of a voluntary information-sharing system (VIS) to encourage collaborative efforts to improve inspection information feedback and information sharing with the purpose of improving gas transmission and hazardous liquid pipeline facility integrity risk management.

The U.S. Department of Transportation (U.S. DOT) established the VIS WG in December 2016 in accordance with the Charter and Bylaws in Appendices II and III, respectively. The VIS WG is comprised of members appointed by the Secretary of Transportation for a term of 3 years, and includes *"the Pipeline and Hazardous Materials Safety Administration; industry stakeholders, including operators of pipeline facilities, inspection technology, coating, and cathodic protection service providers, pipeline inspection organizations; safety advocacy groups; research institutions; state public utility commissions or state officials responsible for pipeline safety oversight; state pipeline safety inspectors; labor representatives; and other entities, as determined appropriate by the Secretary."* Over the course of two years, the VIS WG conducted numerous public meetings and subcommittee meetings to consider and provide recommendations to the Secretary on the following:

a) The need for, and the identification of, a system to ensure that dig verification data are shared with in-line inspection (ILI) operators to the extent consistent with the need to maintain proprietary and security-sensitive data in a confidential manner to improve pipeline safety and inspection technology;
b) Ways to encourage the exchange of pipeline inspection information and the development of advanced pipeline inspection technologies and enhanced risk analysis;
c) Opportunities to share data, including dig verification data, between operators of pipeline facilities and in-line inspector service providers to expand knowledge of the advantages and disadvantages of the different types of ILI technology and methodologies;
d) Options to create a secure system that protects proprietary data while encouraging the exchange of pipeline inspection information and the development of advanced pipeline assessment methods and enhanced risk analysis;

e) Means and best practices for the protection of safety and security-sensitive information and proprietary information; and
f) Regulatory, funding, and legal barriers to sharing the information described in paragraphs (a) through (e).

2b. Scope

2b.1 Scope and Audience

The scope of these recommendations is governed by PHMSA's jurisdictional framework and only specific to gas transmission, gas distribution, and hazardous liquids pipelines that are in operation within the United States. This Report does not address gathering pipelines or the siting, permitting, and inspection of new gas or hazardous liquids pipelines. While the Congressional mandate expressly focused on VIS between pipeline operators and their in-line inspection (ILI) service providers, the implicit Congressional intent hinged on a desire for the VIS WG to truly consider the viability of opportunities to responsibly improve pipeline safety. The VIS WG carefully considered all of the facts to determine what best aligns with the Congressional mandate. Out of the nation's 2.7 million miles for the pipeline transportation system, approximately 2.5 million miles are dedicated to the gas distribution system. The gas distribution facilitities have a larger percentage (approxinmately 80%) of serious federally reportable incidents occurring. The VIS WG believes broadening the scope to include gas distribution systems is in line with the implicit safety focus of the Congressional mandate. Doing so can help fulfill the goal of maximizing the safe operation of the nation's 2.7- million mile pipeline transportation system as we collectively strive towards a goal of zero incidents. Thus, the VIS WG carefully considered all of the facts and determined this best aligns with the implicit intent of the Congressuional mandate.

Any reference in this Report to "pipelines" or "pipeline operators" includes distribution pipelines and distribution operators. The audience for the Report is primarily the Secretary, as that was the directive of Congress, but the VIS WG was mindful that a diverse group of stakeholders would likely be interested in these recommendations. Therefore, the VIS WG was mindful to keep in mind other readers of this Report such as Congress; other interested pipeline safety stakeholders including Federal and State regulators; operators of pipeline facilities; inspection technology experts; coating and cathodic protection service providers; pipeline inspection organizations; safety advocacy groups; research institutions; labor representatives; and other entities.

2b.2 Strategic Mission Statement

The VIS WG formally developed the following strategic mission statement to guide its efforts:

> *"To provide the Secretary of Transportation with independent advice and recommendations on the development of a secure, voluntary information-sharing system(s) that encourages collection and analysis of integrity inspection and risk assessment information and other appropriate data to improve pipeline safety for gas transmission, gas distribution and hazardous liquid pipelines in a measurable way. The intent of the system(s) is to provide a collaborative environment that is proactive in nature, facilitate technological advancements and lead industry to actionable outcomes*."

2b.3 Guiding Principles

The strategic mission statement set the foundation to establish guiding principles to frame the recommendations and potential future VIS implementation efforts. These principles are:

1. Submission of safety sensitive data to the VIS is always voluntary;
2. Transparency and open, honest communication is paramount in how data are managed and used;
3. Analysis and issues addressed are approved by a governing multi-stakeholder VIS Executive Board;
4. Procedures and policies of VIS are based on a collaborative governance model to be finalized by the VIS Executive Board;
5. Collect only data intended to improve safety performance;
6. Pipeline operator and service provider data are synthesized and de-identified;
7. Synthesized data and analyses are used solely for advancement of safety;
8. The VIS Hub is scalable to accommodate growth; and,
9. Existing best practices, standards, and recommended practices are leveraged, as appropriate.

2c. Methodology

To complete the write-up of the Report, the VIS WG developed an outline and milestone plan and formed seven subcommittees to consider different aspects of the tasks within the jurisdiction of the VIS WG. The seven short-term subcommittees were:

- Best Practices
- Regulatory, Funding, and Legal
- Mission and Objectives (Governance)
- Competency, Awareness, and Training (formerly Training and Qualifications)
- Process for Sharing Information
- Technology and R&D
- Reporting

The subcommittee members are listed in Appendix IV. The VIS WG approved task statements for each subcommittee to guide the subcommittees' efforts. Subcommittee tasks are listed in Appendix V. The subcommittees focused on a wide variety of issues: evaluation of existing safety procedures, the best and most effective ways of sharing data and information through active participation of stakeholders, building secured system(s) architecture that contribute to continuous improvement of technologies and methodologies, and identification and validity of information that is subject to sharing among various stakeholders. The subcommittees were created and operated in accordance with 41 C.F.R. §§ 102–3.35, 102–3.145, and reported to the VIS WG, not to PHMSA or DOT. All tasks were deliberated within the subcommittees, and such deliberations were reported out of the subcommittees by the respective subcommittee chairs or their designees and discussed extensively during the VIS WG regular meetings. Subcommittee members invited subject matter experts to present and share information relative to the subcommittee's task.

To identify recommendations for the development of a voluntary information-sharing system, the VIS WG examined current pipeline safety regulations; analyzed data on pipelines regulated by PHMSA to understand the types of pipeline data currently collected; compared and analyzed accident, injury, fatality, and other trends; met with industry experts on current voluntary information-sharing systems outside of and within the pipeline industry; and analyzed safety practices. The evidence obtained provides a reasonable basis for the VIS WG's recommendations.

The VIS WG and subcommittees gathered information, performed research, and collaborated with pipeline and technical experts. The VIS WG spent considerable time studying how other industries leveraged voluntary information sharing and incorporated it as an integral part of their SMS. One of the key aspects of SMS is a strong lessons learned process, which is an element of API RP 1173, Incident Analyses and Lessons Learned. The VIS WG reviewed examples from Commercial Aviation SMS established under the FAA, Process Industries including Chemical and Petroleum Refining within Process Safety Management under the Occupational Safety and Health Administration (OSHA), and the Offshore Exploration and Production Industry under the Center for Offshore Safety, among others. Each of these had well-established processes for learning from incidents, including near misses, and systematically sharing the information throughout an operator's organization. The VIS WG also observed examples of how lessons learned were used to evaluate the way in which risks were considered and ultimately managed, with the focus on improving risk management.

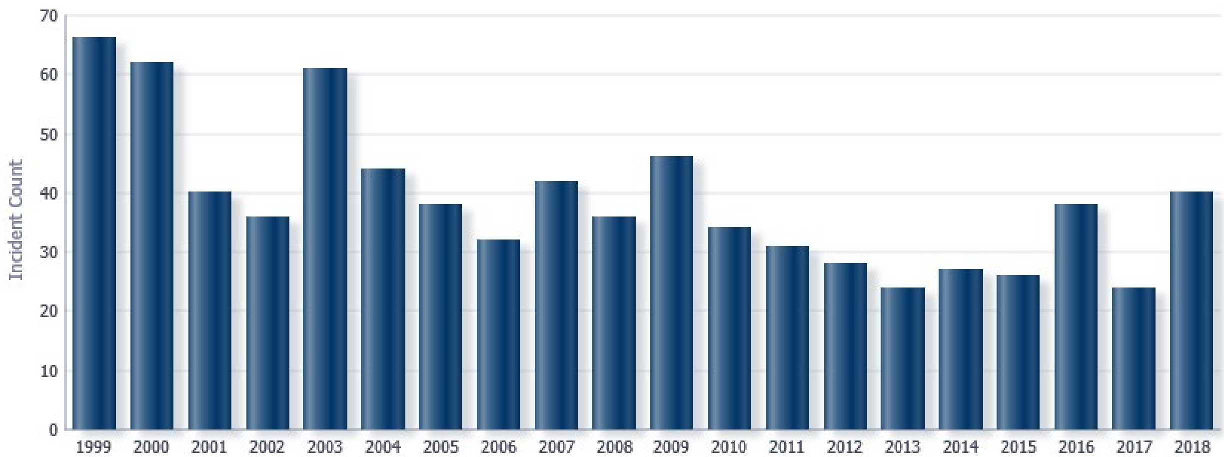
In the process of responding to the Congressional mandate that the VIS WG consider and provide recommendations to the Secretary on existing regulatory, funding, and legal barriers to voluntary information-sharing, the VIS WG quickly turned to examine the most prominent and successful voluntary information-sharing developments in American history: the Federal Aviation Administration (FAA)/Commercial Aviation programs. The VIS WG learned much about how FAA and Commercial Aviation identified and overcame many barriers to voluntary information-sharing in the aviation industry. Over a period of nearly 30 years, the FAA and Commercial Aviation collaborated to institute credible approaches to address barriers to participation in VIS, including concerns related to enforcement, litigation, and fear of reprisal against employees and companies.

Three key elements came into focus as absolutely essential, in the opinion of the VIS WG, to delivering the best recommendations possible to the Secretary – those were named Primary Recommendations. All other recommendations that had been developed were termed Supporting Recommendations, based on the belief of the VIS WG that unless the three Primary Recommendations could be achieved, all other recommendations supporting the Primary Recommendations could become moot. However, the Secondary Recommendations are in fact very valuable products and represent the overwhelming volume of work by the VIS WG. The VIS WG deliberated and achieved a general consensus on the set of primary recommendations and the set of supporting recommendations and specific considerations that are provided in this Report and hereby submitted to the Secretary for consideration.

2d. Achieving Continuous Pipeline Performance Improvement

Pipelines transport a significant amount of our domestic energy supplies through approximately 2.8 million miles of pipeline throughout the United States. While the annual rate of pipeline incidents remains relatively low compared to other modes of transportation, the safety performance as shown in Figure 2 has plateaued and falls short of the goal of zero incidents.

Figure 2 - PHMSA Pipeline Incidents: Count (1999-2018)*
Incident Type: Serious System Type: (All) State: (All)



Note: Serious Incidents are those including a fatality or injury requiring in-patient hospitalization, but Fire First incidents are excluded.

To achieve better pipeline industry safety performance, in line with the Congressional mandate, the pipeline industry must embrace continuous improvement. This continuous improvement process would manifest itself by a robust information sharing process that provides the ability to rapidly share pipeline safety data across the pipeline industry, coupled with a rigorous risk identification and an evaluation process.

2e. The Need for an Information Sharing System

To achieve better pipeline industry safety performance, the VIS WG determined that a robust information sharing process that provides the ability to rapidly share pipeline safety data across the pipeline industry, coupled with a rigorous risk identification and evaluation process, is likely to improve pipeline safety outcomes.

Information sharing within the pipeline industry will allow all pipeline operators to learn from each others' experiences by bridging data and information gaps. Information sharing can allow pipeline operators with smaller systems, budgets, and resources to leverage the knowledge and learnings of the larger pipeline operators. It is equally important for the proactive identification of safety issues, risk analysis, and communication of risk within and outside of the pipeline industry. While there is evidence of some information sharing in the pipeline industry taking place already, the process by which such information is shared tends to be inconsistent and limited due to legal and cultural restrictions.

There is no existing industry-wide culture of consistent data sharing and trust. Additionally, safety advocate, environmental, and labor stakeholders have been concerned by instances of what they perceive as a lack of transparency and honesty with regards to pipeline safety information. Establishing a reliable VIS that is managed using secure protocols and a state-of-the-art information technology process would allow for the collection, de-identification, analysis, archiving, and dissemination of risk information based on historic, real-time, or near real-time factors for assessing pipeline integrity. Such a system and process would greatly improve the quality of information shared and likelihood of its collection. Analysis of anonymized data would likewise improve risk trend identification and communication about trends and responses.

On December 19, 2016, the VIS WG voted unanimously that the need existed for the establishment of a voluntary information-sharing system.

The VIS WG reached the conclusion recognizing that an effective information sharing system is critical to ensure the integrity, reliability, and safety of our pipeline infrastructure and to bridge data and information gaps across the industry to advance pipeline safety. It is equally important for the proactive identification of safety issues, risk analysis, communication of risk within and outside of the pipeline industry, and approaching safety in a business-like manner. Such an information-rich source in an SMS environment will contribute to finding ways to detect problems before they become accidents or incidents. Shared information can produce actionable items and offer opportunities for continual learning and improvements.

2f. VIS Alignment with Pipeline SMS

An SMS is a comprehensive management system designed to manage safety elements in a workplace. It includes policy, objectives, plans, procedures, organization, responsibilities, and other measures that encourage information sharing and promote better safety practices across the industry to achieve the best possible safety outcomes. SMS is used widely in industries that manage significant safety risks, including aviation, petroleum, chemical, electricity generation, nuclear, and others, including the pipeline industry.

The VIS WG viewed a VIS alignment with the pipeline SMS concept to be an integral part of how to create an effective VIS. Specifically, the VIS WG agreed that an effective and successful pipeline VIS should meet the following five minimum criteria:

1. Exchange relevant pipeline safety information
2. Share lessons learned
3. Leverage best practices
4. Engage with stakeholders
5. Foster continuous improvement

SMS also includes a comprehensive look at everything that an operator does and ties every action to a process that is connected to a safety outcome. The essential components for a successful SMS system are data analysis and sharing, and VIS is a key tool in having the necessary industry data to share. Such an information-rich source in an SMS environment will contribute to finding ways to detect problems before they become accidents or incidents. Shared information can produce actionable items and offer opportunities for continual learning and improvements.

SMS is useful for investing in predictive analysis capabilities, improving integrity verification procedures, and using data to stay ahead of developments that could pose new and unforeseen threats to pipeline safety. This approach is in alignment with how the VIS WG developed the recommendations laid out in this Report. A commitment to SMS will assist pipeline operators in managing the multiple facets of pipeline safety, fundamentally changing the day-to-day operations by incorporating a focus on safety into all aspects of a pipeline management system.

2g. Public Engagement

In accordance with FACA, 41 C.F.R. Parts 101-6 and 102-3, and DOT policies, the VIS WG Chair actively encouraged the public, at regular intervals throughout public meetings, to provide their invaluable feedback, thoughts, and perspectives to the VIS WG. Members of the public also had the opportunity to submit written comments to the meeting docket (Docket No. PHMSA-2016-0128) on all of the public meetings. Even after the public meetings concluded, the VIS WG Chair ensured that an initial scoping draft of this Report was posted by PHMSA to the docket at: www.regulations.gov (Docket No. PHMSA-2016-0128), so that the public could have another avenue to further comment.

3. Background and History of Information Sharing

To develop a comprehensive recommendation, the VIS WG invited experts on voluntary reporting from outside and inside the pipeline industry to share their policies, practices, and results. This information illuminated the successes and challenges that others experienced with voluntary reporting systems, and provided material aid to the VIS in shaping this recommendation.

3a. Outside the Pipeline Industry

The VIS WG invited safety management experts from outside the pipeline industry to present information and case studies about the why, what, who, and how of information sharing as an established best practice of SMS in their industries. The experts were asked what they would do differently if they were starting the information-sharing system today, including things they would do more of, as well as less of. The invited experts included:

- Federal Aviation Administration (FAA) – Aviation Safety Information Analysis and Sharing (ASIAS), Warren Randolph, Director, Aviation Safety Analytical Services
- Aviation Safety Action Program (ASAP) and Safety Management Systems – John DeLeeuw, American Airlines (AA) and Vickie Toman, SMS Manager (AA)
- Information Collection Presentation – Dr. Rolf Schmitt, Bureau of Transportation Statistics, Deputy Director
- Confidential Close Call Reporting System (C3RS) – Brian Reilly, Federal Railroad Administration (FRA) Human Performance Program Specialist
- Center for Offshore Safety (COS) – Charlie Williams, Executive Director, COS and Julia FitzGerald, Senior Associate
- National Transportation Safety Board (NTSB) – Robert Hall, Director, Office of Railroad, Pipeline and Hazardous Materials Investigations

Please refer to Appendix XI: Examples of Information Sharing Outside the Pipeline Industry for more details.

3b. Within the Pipeline Industry

To get an idea of the current context of safety information sharing within the pipeline industry, the VIS WG invited safety management experts from integrity management and voluntary safety information sharing initiatives within the pipeline industry to present information and case studies. The VIS WG used the information to understand what these experts had learned in the pipeline industry context and how to leverage existing practices, processes, and types of data currently being used. After spending time understanding the history of successes and lessons learned in other industries, it became apparent that there were some established voluntary information-sharing system practices within the pipeline industry to draw upon. An example of a specific accepted practice for safety information sharing for gas and hazardous liquids transmission pipelines is API RP 1163, In-Line Inspection System Qualification Standards, which was evaluated by the VIS WG and the Best Practices, Process Sharing, and Technology and R&D subcommittees.

The invited pipeline industry experts included:

- Drew Hevle, Kinder Morgan (*Provided briefing on API RP 1163, ILI Systems*)
- Erika Lee, VP, Programs & Administration, Common Ground Alliance (CGA) (*Provided briefing on CGA Voluntary Reporting - Damage Information Reporting Tool*)
- Cliff Johnson, President, Pipeline Research Council International and Walter Kresic, Vice President, Asset Integrity, Enbridge Liquid Pipelines (*Provided briefing on Pipeline Research Council International*)
- Toby Fore, Kinder Morgan (*Provided briefing on Pipeline Operator Data Sharing*)
- David Nemeth, Energy Transfer (*Provided briefing on Data Integration*)
- Michael Stackhouse, Phillips 66 (*Provided briefing on Operator Assessment Tool and GIS Implementation*)
- Nick Homan, Marathon Pipe Line (*Provided briefing on Integration of ILI and GIS to Advance Pipeline Integrity*)

Please refer to Appendix XII: Examples of Information Sharing Inside the Pipeline Industry for more details.

4. Benefits and Barriers of a Voluntary Information Sharing System

4a. Benefits - Aviation VIS Eliminates Commercial Airline Crashes for Ten Years?

The VIS WG recognized that there are significant pipeline safety benefits and technology improvements that could be realized from applying the same FAA/Commercial Aviation voluntary information sharing principles to our nation's pipelines. The commercial aviation VIS accomplished the goal of zero crashes in the United States in ten years.

There are numerous benefits to establishing a VIS including:

- Serve as a trusted repository of high-volume, high-quality data and information that would advance pipeline safety and lead to opportunities for reducing pipeline accidents and incidents[2] to achieve the goal of "zero."
- Increase public safety and decrease environmental risk.
- Improve operators' awareness of potential threats and risks to their facilities that they might not have previously encountered.
- Improve responses to new threats.
- Improve understanding of existing and emerging technologies and potentially accelerate development and demonstration of new technology.
- Improve effectiveness of technologies to identify specific threats and to enhance an operator's decision-making.
- Provide technical support for service providers' technology investments to improve technology performance.
- Determine gaps in pipeline information to drive continuous improvement.
- Improve communication between the industry, the public, and pipeline safety stakeholders through greater transparency and relationships built on trust.
- Provide a greater understanding among operators on applying rate-payers' funds to reduce risk.

Through pipeline operator and stakeholder participation, the VIS could be designed and managed to embrace information from a variety of pipeline integrity efforts currently undertaken by pipeline operators. A VIS could also be a robust mechanism to identify pipeline safety risks among various industry segments.

The incorporation of the following types of data would encourage participation and maximize the benefit and use by key pipeline stakeholders:

1. Data from the use of all pipeline integrity assessment technologies (ILI, DA, HT, and other technologies) and in-the-ditch anomaly measurements and characterizations.
2. Data from preventative and mitigative efforts, such as line locates and leak surveys, and risk identification and evaluation processes.

[2] Hereafter, the use of "incidents" is intended to cover both incidents (gas – 49 CFR 191.3) and accidents (hazardous liquids – 49 CFR 195.50).

3. Data relevant to process improvement, including lessons learned, and pipeline operator and service provider best practices.

Focusing on these types of data in the VIS would enhance pipeline safety by augmenting process and information sharing among pipeline integrity stakeholders and by motivating continuous improvement efforts. These changes would be of great benefit in supporting the pipeline industry's efforts to prevent the next incident and reach the goal of zero incidents.

Types of Sharing

Process and information sharing efforts currently exist among some stakeholders in pipeline integrity. As the VIS is developed, consideration for how to ensure actionable, definitive, or measurable outcomes from the processes and information shared will enhance confidence in the benefits gained. The types of sharing that occur can be described in three ways:

1. High Value Sharing involves an increase in knowledge, process improvement, or best practice at a company or entity level. To this end, the sharing should target the right side of the value chain when considering (data → information → knowledge → understanding → wisdom). To this end, information sharing should move beyond sharing data to improve knowledge and ultimately wisdom. This type of sharing involves experiential or knowledge transfer and/or collaboration on common problems or issues to reach a desirable end state sooner and more efficiently than an individual company might otherwise accomplish on their own.

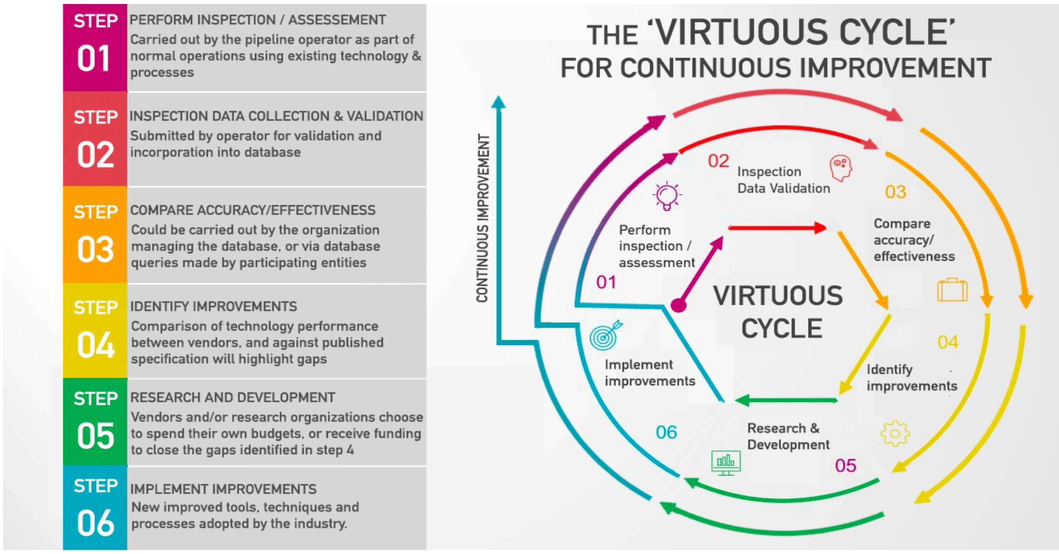
2. Deliberate and Actionable Sharing involves at least one party is learning/gaining knowledge or wisdom from another, or they are deliberately engaged in process improvement and seek to take action to change processes or practices within that entity (industry or service providers).

3. Measurable Sharing occurs when sharing process, as well as the results of the improvements/actions, are measurable up to and including measurable safety improvement.

Sharing information through the VIS in any of these ways generates action by one or more users of the system and in the best case will create better outcomes and safety improvements to processes and/or practices within and across the pipeline industry.

In addition to enhancing information sharing, the ability to access and analyze the suggested sources of pipeline integrity data is expected to inform varied stakeholders and identify needed technology improvements or gaps. This awareness is expected to motivate pipeline operators to practice a "Virtuous Cycle" where the stakeholders' priorities reinforce a cycle of continuously improving technology, threat identification, and pipeline integrity assessment (Refer to Figure 3). A VIS that shares information with pipeline safety stakeholders about the relative performance of the various pipeline integrity assessment technologies and processes could fuel a continuous improvement cycle for the pipeline integrity stakeholders.

Figure 3: Virtuous Cycle of Continuous Improvement



Currently, the public has little visibility into pipeline integrity efforts or effectiveness and is increasingly concerned about the safety and environmental impacts of existing and proposed pipelines. A VIS could raise awareness of the field verifications being performed and the effectiveness of these pipeline integrity assessments. Continuous improvement to pipeline integrity assessments and risk management would result in increasing public safety and decreasing environmental risk. The improved sharing of these efforts with the public and increased public understanding could reduce public concerns about pipeline operations and indicate where to use/develop new technology, enhance processes/procedures, or modify/enhance regulations.

Universities and research institutions are working to identify potential opportunities to apply the insights from their research endeavors or to support applications for research funding. An effective VIS should enhance awareness of the limitations associated with current pipeline integrity assessments so that universities and research institutions could leverage these limitations to promote current research endeavors or justify research funding. The resulting improvements could lead to continuous improvement of pipeline integrity assessment technologies to the extent of additional needed research and development (R&D).

Service providers would make their investments with greater confidence concerning the gaps they were trying to fill and would be further motivated by the awareness of their performance as compared to other technologies or other de-identified service providers. This awareness would be a strong motivation for quality improvements and/or technological investments.

Operators assessing the integrity of their pipelines are faced with a wide array of integrity threats, and a variety of potential tools/technologies from multiple service providers to choose from in evaluating and addressing those threats. There are some standards and/or best practices that exist on risk assessment technologies, as well as guidance material for selecting and validating available tools/technologies and their applicable service providers. However, none of these standards, practices, or guidance materials exist in a broad, far reaching, and systematic way across all three considered pipeline industry segments. The process of tool/technology testing and service provider validation can be significantly enhanced by having the applicable data shared and available in a VIS. A VIS with metrics on the effectiveness of technologies for identifying specific threats will enhance an operator's decision-making when it comes to tool/technology selection as well as helping to establish confidence in an associated service provider.

In addition, a VIS would allow operators to be more aware of threats identified during other operators' pipeline integrity assessments, and to assess the frequency of their actionable anomalies as compared to the frequency of other de-identified operators. This information would help them to better assess the effectiveness of their integrity management programs and their service provider, and to better understand the operating/environmental conditions that may be affecting their performance. Once identified, operators would be motivated to seek technological or performance improvements that addressed the gaps identified, resulting in improved identification of integrity threats.

Finally, regulators could see benefit in their efforts to determine the appropriate response to new threats, emerging technologies, and unique operator needs in response to special permit applications and changing operating conditions. The technical analysis required to evaluate new threats, special permit applications, and state waivers can be time consuming, costly, and of limited applicability. A VIS should provide the data warehouse for this analysis.

The gathering and sharing of data on tool/technology performance in real-world environments (e.g. 'live' pipeline operations) can thus be used to power a virtuous cycle that harnesses and focuses the existing dynamics around the pipeline industry to boost the process of technology improvement and adoption, as depicted in Figure 3.

Given the high likelihood that an effective VIS could provide impetus for continuous improvement, consideration should be given to development of strategies to emphasize the value of data that indicates opportunities for technology improvement or helps identify technologies in need of additional development.

This virtuous cycle would be initiated for many different pipeline integrity assessment tools/technologies and processes standards and/or best practices.

Some of the anticipated areas of continuous improvement include:

1. Industry consistent/best in class application and deployment of existing technology, whether it be ILI tools, Direct Assessment (DA), hydro testing, leak survey, line locating, or others.
2. Operator/Industry gap analyses that improve existing technology capabilities, such as unique morphologies or interacting threats.
3. Development of new and/or improved technology(ies) (sensors, analytical techniques) via Operator/Industry gap analysis.
4. Identification of unique (low probability, high consequence) integrity threats and approaches to assess susceptibility and threats (Operator transparency relative to emerging/found threats, e.g., "I was not expecting to find this but we did, you might consider that").

Future refinement and maturity of the pipeline VIS could lead to additional benefits, including:

1. Offering enhancement and improvement of PHMSA data for analysis, evaluation, inspection prioritization, and the National Pipeline Mapping System (NPMS).
2. Enhancing PHMSA's ability to share lessons learned from accidents/incidents and operator responses.
3. Improving consistency in pipeline safety enforcement.
4. Improving quality and consistency of safety data among and across states.
5. Creating opportunities for industry collaborations to increase cooperation and share engineering standards, specifications, operating procedures, and integrity management practices including welding procedures, coating procedures, and line pipe specifications, among others.
6. Creating industry segment-specific risk repositories to capture and house the variety of different risks that individual pipeline operators have identified through their Transmission Integrity Management Programs (TIMP) and Distribution Integrity Management Programs (DIMP). This would enable individual operators to identify risks that could occur in their systems, but may not yet have happened, to factor into ongoing risk evaluation and remediation efforts.

A more detailed discussion of how the virtuous continuous improvement cycle could work in practice is provided in Appendix VI and with specific case studies in Appendices VII - XIV.

4b. Barriers - Existing Regulatory, Funding, and Legal Barriers to Establishing a VIS

While information sharing is a positive and desirable practice, barriers must be overcome to effectively establish an information sharing system. Barriers can exist because of perceptions of an uncertain or unknown outcome, lack of trust, or fear of reprisal in sharing information. The VIS WG learned from the experience of the FAA that the foundation to overcome any such barriers are rooted in a sound governance model, statutory protections, secure data management, and the willingness and dedication of participants to work cooperatively with one another. In response to the Congressional mandate, the VIS WG identified the following barriers to establishing a successful VIS:

1. Legal Barriers
   a. Fear of regulator enforcement. Potential legal issues may arise during identification of potential safety issues through information sharing with DOT that could lead to enforcement or punitive actions.
   b. Fear of civil or criminal litigation and/or liability exposure for industry participants.
   c. Legal repercussions may arise out of information sharing as they relate to antitrust rules.
   d. Lack of sufficiently strong legal protections for personal, confidential, proprietary, and other sensitive information that is part of or related to the voluntary submission of information to a VIS.
   e. Absence of existing PHMSA authority for a VIS. It is not clear that PHMSA currently has the authority to establish and maintain a VIS. Nor is it clear that PHMSA has the authority to enter into MOUs and other contractual arrangements that will provide the regulatory protections to pipeline operators that are necessary to establish and operate a successful VIS.

f. Lack of a clear governance structure for a VIS, with clear rules for participation and related protections, is a real concern for pipeline operators. In addition, pipeline operators fear that any "voluntary" program might be transformed later into a "mandatory" program.
g. The ability of any party to obtain voluntarily submitted information through the Freedom of Information Act (FOIA). It is a reality today that pipeline operators have a reasonable fear of potential FOIA release of any voluntarily submitted information, which could lead to compromised anonymity, loss of confidential and proprietary information, litigation, reputational damage, and other potential negative consequences. The fear by pipeline operators of such disclosure is a strong barrier to participation in any VIS.
h. Lack of focus on broader range of pipeline threats. The original legislation enabling VIS focused on the information sharing environment as a tool to be used to benchmark in-line inspection technologies and their validation processes. This is very different from the type of information sharing system that the VIS WG envisions, which would address a broad range of threats and remediation/prevention information across all three pipeline industry segments (hazardous liquid transmission, gas transmission, and gas distribution pipelines).

2. Organizational and Governance Barriers
   a. Lack of clarity on how the VIS would be organized and governed, if the VIS is operated by the government. The role of operators, service providers, public representatives, and universities would need to be further clarified.
   b. Lack of clarity on how the VIS would be funded, stood up, and managed, if operated by a private entity.
   c. Complexities with technology platforms. An effective VIS will require a complex technology platform (such as the one used by the FAA for ASIAS), and absent a VIS as recommended by the VIS WG, it is very unlikely that any private voluntary group would be able to fund or execute a program with the scope and scale that the VIS WG recommends. A VIS would require a complex data management and IT system (such as the one used by the FAA for ASIAS) and it is not clear which one would be used or how that would be decided.
   d. Uncertainty about how to gain commitment and participation to use the information sharing environment to benchmark pipeline integrity assessment service providers.
   e. As technology develops at a much faster pace, it is unclear how the proper information technology may be employed effectively and efficiently.
   f. Optimal VIS organization and governance may need to reflect resolutions to relationship/trust issues (highlighted below).
   g. Analysis expertise. Management of VIS will demand significant expertise in data protection, aggregation, and analytics.
   h. Scale and funding required for an effective VIS is significant, and precludes establishment by voluntary, private groups.
   i. Lack of a clear IT system development strategy. As new technologies continue to develop, it is important that the VIS approach IT system development (both software and hardware) with a clear strategy to address all three industry segment needs with a system that can operate effectively and efficiently.

3. Relationship/Trust Barriers
   a. Trust among operators and competition between industry service providers.
   b. Trust among pipeline operators. The organizational environment needs to be constructed in such way that allows for the members to share information.
   c. Trust between operators and regulators. Fear of enforcement resulting from sharing data and information.
   d. Trust between operators and public. The public wants industry to be held to highest safety standards and accountable for incidents and accidents. The public wants honest communication with industry, meaningful education, and direct involvement. Industry wants to collaborate with the public in good faith discussions on pipeline infrastructure safety needs and improvements, and maintain open communications regarding pipeline safety.

4. Funding and Cost Barriers
   a. Lack of clarity on how to fund the development and sustainment of a VIS (information sharing hub, management of data, and distribution of results). To support a pipeline VIS, funding is essential, but does not yet exist. Adequate funding is essential to stand up and sustain a VIS program to ensure its success in delivering the intended benefits. Collective pipeline safety stakeholders will reap the many benefits of a properly funded, robust VIS, especially improved pipeline safety and fewer incidents.
   b. Lack of alignment between available funding and implementation phases may limit execution capabilities. Phased or stepped funding may allow for gradual implementation of VIS, but will initially limit scope and impact.
   c. Lack of clear understanding of how a nongovernmental entity could manage and sustain a VIS.

5. Types of Data and Information Shared

Early in the VIS WG's efforts, it was apparent that a VIS for the pipeline industry could provide greater safety and improvement benefits if the system was not limited to pipeline ILI and the resulting direct examination data. As evident in other industry voluntary information sharing systems, capturing and sharing a wide range of data using appropriate standards and formats is an important component to support continuous improvement in pipeline integrity methods that will result in safer, more reliable pipeline systems. The VIS WG proposes to expand the VIS scope to include data and information that would support the enhancement of integrity management processes (IMP) in general for gas transmission, gas distribution, and hazardous liquid transmission pipelines. The VIS WG identified the following types of data and information that should be considered when implementing a pipeline VIS:

5a. Data from Pipeline Integrity Assessments

The variety of threats and challenges caused by pipeline operating conditions, configurations, and age, have necessitated the use of many different assessment methodologies, technologies, techniques, et cetera, to assess a pipeline's integrity. Data might include, and are not limited to:

- Pipeline Integrity Assessment
    - In-line inspection
        - Deformation/Geometry inspection
            - Caliper
            - Eddy Current
        - Metal Loss inspection
            - Ultrasonic wall measurement
            - Magnetic Flux Leakage
                - Axial field
                - Circumferential field
            - Eddy Current
        - Crack inspection
            - Ultrasonic shear wave
            - Electro-Magnetic Acoustic Transducer (EMAT)
    - Direct assessment
        - External Corrosion Direct Assessment (ECDA)
        - Internal Corrosion Direct Assessment (ICDA)
        - Stress Corrosion Cracking Direct Assessment (SCCDA)
    - Hydro test
    - Other (e.g., guided wave, etc.)

- NDE Verification Data
    - Magnetic Particle Inspection
    - Depth Micrometer
    - Ultrasonic transducer (UT) probe
    - Laserscan

    - Structured Light
    - Phased Array Ultrasonics (PAUT)

- Above-ground Surveys
    - Close Interval Survey (CIS)
    - Direct Current Voltage Gradient (DCVG)
    - Alternating Current Voltage Gradient (ACVG)
    - Pipeline Current Mapper (PCM)

- Soil Resistivity

- Pipeline Threat Based
    - Metal loss
        - Corrosion (external and internal): minimum depth, length, width, and orientation
        - Gouges: minimum depth, length, width, geometry and orientation
    - Cracking anomalies (pipe body or weld). Minimum depth, length, width (opening), orientation, and proximity to other cracks, anomalies, or pipeline components
    - Deformation
        - Dents: minimum depth, or reduction in cross-section, or reduction in diameter and orientation
        - Pipe ovality: minimum ovality
        - Wrinkles or 'ripples': minimum height and spacing & orientation
        - Buckles: minimum depth or reduction in cross-section or diameter & orientation
        - Expansion
    - Blisters and mid wall delaminations
    - Metallurgical
        - Cold work: presence of and severity
        - Hard spots: minimum diameter of hard spot and difference in hardness between the hard spot and the base material
    - Manufacturing anomalies (such as slugs, scabs, and slivers): minimum dimensions and position
    - External coating faults: minimum dimensions
    - External coating transitions
    - Girth welds, seam welds
    - Other anomalies, conditions, or pipeline components as required, dependent on industry standards or practices
    - Spatially coincident features (e.g. crack in corrosion)
    - Applicable components, features and characteristics

- Performance-based
    - Detection thresholds
    - Probability of detection (POD)
    - Probability of identification (POI)
    - Sizing accuracy

  - Sizing capability
  - Uncertainties and confidence
  - Associated limitations

The quantity and variations in data types and formats will be a key challenge for the implementation of a VIS. During the VIS WG efforts, the Subject Matter Experts (SMEs) recognized that consistent data fields and formats for collecting and sharing the data is essential to perform meaningful analysis. Further discussion on this is offered in Appendix XIII, XIV, and XV.

5b. Data from Preventative and Mitigative Efforts

A large source of data that could provide significant safety benefits is the variety of preventative and mitigative efforts implemented by pipeline operators. These efforts include but are not limited to:

- Locate and mark: Including the root causes of excavator damage (e.g. failure to call, delayed response, excavator failure to hand dig, locator error, inadequate/incorrect records).
- Leak detection and repair by leak type: Corrosion, natural force, other outside force, material or weld defect by type, equipment failure type and cause, incorrect operations by type and cause, or other concerns that may affect the integrity of the pipeline.
- Geohazard identification and notification.
- Repair methods.
- Near miss events that had the potential to impact the integrity of a pipeline.

Discussion of these efforts and suggested data analyses is contained in Appendix XVI.

5c. Data Relative to Process Improvement

There are currently many different venues in which the public, regulators, operators, and service providers discuss learnings leading to process improvement. These include various public and regulatory websites, regulatory notifications, and industry associations' websites and meetings. By incorporating these data types into the VIS, these valuable learnings could be compiled and accessible in one location. Consideration could be made to include, but not limited to, the following data:

- Sharing of enhanced processes and practices (i.e. solutions to known problems including experience with new data/information technology to improve detection and characterization).
- Operator lessons learned from:
  - Reportable incidents
  - Near misses
  - Unexpected situations and solutions
  - Routine assessments
  - Descriptive rule-based take-aways
  - Specific risks
  - Information sharing and learnings with public stakeholders

- ILI service provider lessons learned.
- NDE service provider lessons learned (all including best practices, as applicable).
- Identification of current gaps in technology and/or analytics that need to be closed.
- R&D Projects in progress to address gaps: lessons learned with respect to execution of the various integrity management and O&M processes, individual contributor (SME) observations, improved analytics, unexpected outcomes/observations.
- Near miss data and information operator actions to prevent reoccurrence.
- Operator and service provider best practices/procedures.
- Post incident related Root Cause Failure Analysis (RCFA) and subsequent company/regulator learning.

6. Foundation for the VIS WG's Recommendations and Considerations

6a. Primary Recommendations

The VIS WG recommends the establishment of a pipeline VIS and a VIS Hub to serve as a trusted repository and a source of pipeline integrity information that individual operators can consistently use to proactively eliminate pipeline risks towards zero incidents and accidents. The VIS WG recognizes that the success of a VIS will be contingent on pipeline operators' voluntary participation.

The VIS WG developed three primary recommendations and a set of supporting recommendations to the Secretary. The primary recommendations are critical to effectively establishing a VIS and essential to delivering the benefits of improved pipeline safety and SMS. The VIS WG believes that if the three primary recommendations are coupled with robust SMS programs and are accepted and implemented, the nation will reap the benefits of improved pipeline safety and pipeline SMS. If these three primary recommendations are not fully embraced and addressed, the VIS effort will not be successful.

Primary Recommendation 1: Congress should authorize a VIS, and direct PHMSA to establish the VIS, including a governance structure and technology platform, to include participation by pipeline operators, PHMSA, and other pipeline safety stakeholders, as more fully described in this Report.

Primary Recommendation 2: Congress should enact legislation to provide confidentiality, non-punitive, and other legal protections to pipeline operators that participate in the VIS, as more fully described in this Report.

Primary Recommendation 3: Information sharing should include gas distribution system data in the VIS program to significantly reduce industry incidents nationwide, across all three key industry segments – natural gas transmission, natural gas distribution, and hazardous liquids transportation.

The supporting recommendations are designed to provide the level of detail necessary to support full VIS implementation and are organized by subject matter:

- Best Practices
- Regulatory, Funding, and Legal
- Governance
- Competency, Awareness, and Training
- Process for Sharing Information
- Technology and Research & Development (including IT Architecture Considerations)

6b. Supporting Recommendations

The VIS WG developed supporting recommendations to ensure that the VIS provides a comprehensive and practical approach to sharing information.

Recommendation No.	Supporting Recommendation
Best Practices	
Supporting Recommendation Best Practice-1	**Include All Elements of the Integrity Management Process.** A VIS for the regulated pipeline industry (i.e. gas transmission, gas distribution, and hazardous liquid pipelines) should not be limited specifically to pipeline in-line inspection (ILI) data. Considerable value and safety improvement is possible if the sharing is expanded to include all of the elements of an integrity management process including data, information, and knowledge relative to the process steps, as well as lessons learned and near misses, from incidents or process improvements, technology deployment practices, and solutions to common problems.
Supporting Recommendation Best Practice-2	**Leverage Existing Information Sharing.** A VIS for the regulated pipeline industry should complement, build upon, and/or leverage existing information sharing that currently occurs at the operator or regulator level, within industry associations, or between operators and service providers. The VIS should provide a means to share information, knowledge, and solutions relative to high value learning events from existing industry efforts and programs for the benefit of all operators (regardless of affiliation or not with specific associations or interest groups) and broader audiences or stakeholders.
Supporting Recommendation Best Practice-3	**Provide a Framework for Best Practices.** A VIS for the regulated pipeline industry should provide a framework for best practices that includes fundamental elements found in various other businesses or entities including but not limited to: • Governance, policies, procedures, and recommended practices. • Quality Assurance/Quality Control of data, information, and knowledge. • Security of Data and Information including methods to de-identify data and provide anonymity. • Recognition of potential barriers to participation and methods to mitigate those barriers. • Communication of results and performance measures.

Supporting Recommendation Best Practice-4	**Provide Transparency and Communication.** A VIS for the pipeline industry should provide for transparency and communication of industry capabilities, processes, procedures, technologies, improvements, and safety results.
Regulatory, Funding, and Legal	
Supporting Recommendation Regulatory, Funding, Legal-1	**Authorize and Establish Legislation for a VIS Governance Structure.** Congress should enact legislation during the PHMSA reauthorization process in 2019 authorizing PHMSA to establish a secure, confidential Voluntary Information-Sharing System (VIS). The VIS should be designed to encourage the voluntary sharing of pipeline safety information among operators of gas transmission, gas distribution, and hazardous liquid pipelines (collectively referred to as pipeline operators), employees, labor unions, contractors, ILI service providers, non-destructive evaluation experts, PHMSA, representatives of state pipeline safety agencies, tribal agencies, pipeline safety advocacy groups, and other pipeline stakeholders. The overall purpose of the VIS is to improve pipeline safety for gas transmission, gas distribution, and hazardous liquid pipelines. The proposed legislation should state clearly the intent of Congress with respect to the following: • The VIS is intended to be an entirely new paradigm for analyzing pipeline safety issues that is separate and apart from, but complementary and additive to, existing PHMSA pipeline safety programs, in particular SMS. • The VIS should be established and implemented to the maximum extent possible under existing PHMSA authority, with the goal of avoiding unnecessary and time-consuming rulemaking. • Other than with respect to the VIS protections described below, the VIS is not intended to change current PHMSA enforcement, regulatory programs, or other PHMSA initiatives. • The VIS is intended to develop its own governance structure and to create as many VIS programs (issues for analysis) as it deems necessary to address various areas of pipeline safety. • The VIS is intended to allow PHMSA, pipeline operators, and pipeline stakeholders to draw upon anonymous, de-identified safety information that is currently kept confidential and used by individual pipeline operators to improve pipeline safety.

	• The VIS is intended to enable all industry participants to share the rich source of safety information often held only by an individual pipeline operator, which will enhance SMS across the industry. • The VIS analysis of de-identified, voluntarily shared information is intended to deliver tangible, measurable safety benefits to industry participants, PHMSA, and other pipeline safety stakeholders. • The VIS's collaborative approach to collecting and analyzing safety information is intended to enhance pipeline SMS, delivering benefits to the public including a reduction in pipeline releases, personal injuries, and damage to the environment. • The VIS is intended to be based solely on voluntary participation. The VIS shall not be transformed into a mandatory program, in whole or in part. *Note 1: The VIS is intended to encourage the widest possible participation by industry. Such participation will only be achieved by providing VIS information protections described below. It is the intent of Congress to encourage and present opportunities to securely share voluntary safety information, which requires that information protections be established. Without such protections, pipeline operators will not voluntarily share information, thereby depriving the nation of associated improvements in pipeline safety and SMS.* *Note 2: The VIS WG recognizes that legislation needs to address and incorporate appropriate legal protections for not only PHMSA staff but also for the VIS Executive Board and others who operate under the VIS Hub structure.*
Supporting Recommendation Regulatory, Funding, Legal -2	**Disclose VIS Information.** Congress should enact legislation providing for the protection of information provided to the VIS, to encourage and allow voluntary safety information sharing by pipeline operators. The proposed legislation should clearly state the intent of Congress with respect to the following: • It is intended that neither PHMSA, nor any federal, state, local, or tribal agency, nor any person having or obtaining access to the information voluntarily submitted to the VIS, shall release or communicate that information to any person outside the VIS governing body, with the sole exception being the publication of reports by the VIS or PHMSA based on analysis of de-identified information and safety findings that the VIS

	governing body in its sole discretion determines to publish or authorize PHMSA to publish. • The intent of Congress is to encourage wide-scale industry participation in the VIS by entities and individuals to further the goal of improving pipeline safety in the United States, and that goal can only be accomplished by creating strong protections for information voluntarily submitted by those entities and individuals to the VIS.
Supporting Recommendation Regulatory, Funding, Legal -3	**Exempt VIS Information from FOIA Release.** Congress should enact legislation providing that PHMSA shall be exempt from releasing, under the provisions of the Freedom of Information Act (FOIA), any information that was voluntarily disclosed to the VIS by any company, organization, or person. *Note: The VIS Executive Board is given the authority, as necessary, to determine what information is made public. See below in this section for more context.*
Supporting Recommendation Regulatory, Funding, Legal -4	**Protect Voluntarily Shared Information.** To encourage the voluntary submission of information to the VIS, Congress should enact legislation providing that neither PHMSA nor any other federal, state, local or tribal agency, nor any entity or person shall initiate enforcement action, punitive action, or civil/criminal litigation, nor seek a fine or civil penalty against a pipeline operator or its employees, contractors, or related entities based on any information that has been voluntarily provided to the VIS, including, but not limited to: ILI, NDE, and Dig Confirmation data and information; Near Misses/Close Calls; Non-reportable Releases; and Non-reportable Unusual Events or Conditions, with the exception of information already required to be reported. The protections described above are not intended to replace PHMSA's existing authorities and should not limit PHMSA or other parties from pursuing the above described actions based on facts established independent and separate from the VIS process. *Note: This edit on the legal position came about after careful reflection and thought by the VIS WG to clarify this recommendation. The VIS WG has made clear its intent to create a program that encourages participation with safe-guards to prohibit the use of submitted data in a punitive*

	manner, while not affecting current regulatory enforcement authorities. Pipeline operators and their contractors are prohibited from taking any retaliatory action against any employee who voluntarily reports information to the Pipeline operator or to the VIS, unless: • The employee intentionally violated a law, regulation, or written company procedure. • The employee engaged in criminal conduct. • The employee was under the influence of illegal drugs or alcohol at the time of the event. Nothing in this section is intended to prevent a pipeline operator or its contractors from requiring further training of the employee, temporarily limiting the types of work the employee is allowed to perform, or taking other remedial steps to mitigate the risk that an employee will repeat the conduct at issue.
Supporting Recommendation Regulatory, Funding, Legal -5	**Prohibit the Use of VIS Information in Litigation.** Congress should enact legislation providing that any information voluntarily submitted to the VIS shall not be subject to discovery or admitted into evidence in any federal, state, local, tribal, or private litigation or other proceedings. This prohibition does not limit discovery or admissibility in any regulatory, civil, or criminal proceedings of evidence developed independent and separate from the VIS process.
Supporting Recommendation Regulatory, Funding, Legal -6	**Provide Adequate and Sustainable Funding for the VIS.** PHMSA should provide initial seed and sustaining funding. The Secretary in consultation with the VIS Executive Board should explore sustainable funding sources including public-private partnerships.
Governance	
Supporting Recommendation Governance-1	**Establish a VIS Executive Board.** There should be a VIS Executive Board (Board) that has ultimate authority over VIS decisions. Decisions will be made by consensus of the Board and its Co-Chairs. One Co-Chair will be from industry and one Co-Chair from PHMSA. The Board will ultimately decide what consensus means. The Board will have the authority to develop its Governance documents and should oversee the enforcement of the Governance and supporting documents. The Board should have decision-making authority over what issues are addressed and what information is disseminated to industry

	and the public safety advocacy representatives. Third-Party Data Providers, Issue Analysis Teams (refer to Governance-3, 4, and 5), and outside experts may identify issues for consideration by the Board. The Board should appoint members to the Issue Analysis Teams based on the content to be addressed. Board representation should be made up of the following stakeholder groups: PHMSA, pipeline operators, service providers, NAPSR representatives, trade associations, public safety and environmental advocates, tribal agencies, labor unions, and universities. The PHMSA Administrator should appoint VIS Executive Board members after consulting with the stakeholder groups. The Board should be involved in the final decision on the selection of the third-party provider in accordance with the Federal Acquisition Regulations. *Note 1: The VIS Executive Board is not intended to be a federal advisory committee.* *Note 2: The VIS Executive Board membership should be flexible and nimble to effectively function and execute.*
Supporting Recommendation Governance-2	**Establish Program Management.** The governance model should provide PHMSA with day-to-day program management over the VIS. This day-to-day management function should include program management oversight over the Third-Party Data Manager.
Supporting Recommendation Governance-3	**Secure a Third-Party Data Manager.** A third-party data manager should be retained by the VIS to provide data management and data oversight functions. Further, the third-party data manager should work with the Issue Analysis Teams to analyze data submitted, aggregate data as necessary, and submit recommendations to the VIS Board.
Supporting Recommendation Governance-4	**Appoint Issue Analysis Teams.** The Board should appoint Issue Analysis Teams and populate them with technical and subject matter experts in the areas addressed.
Supporting Recommendation Governance-5	**Authorize and Appropriate Funding for VIS.** The Board should, in collaboration with the Secretary of Transportation, be charged with developing a long-term funding strategy to sustain VIS. Contributions from participants and other stakeholders should be encouraged, but not required.

	Note: The VIS WG assumes that Congress will provide the necessary and additional authorities to PHMSA to execute the VIS, as recommended.
Competency, Awareness, and Training	
Supporting Recommendation Competency-1	**Author Job Descriptions.** The Board should author job descriptions that define the education, knowledge, skills, abilities, and experience necessary for those working with confidential data and information. This will foster hiring criteria for a third-party data administrator.
Supporting Recommendation Competency-2	**Develop a Collaborative Process.** The Board should establish a process whereby VIS analytical staff will collaborate with pipeline operators and other industry subject matter experts (SMEs), including in-line inspection (ILI) companies, in-the-ditch (ITD) assessment companies, and companies deploying other pipeline integrity assessment methods including those used for Distribution Integrity Management Programs (DIMP) methods. The collaboration is intended to ensure those analyzing the data understand industry terminology, regulations, operating procedures, best practices, and be willing and capable of discussing meaningful data. An objective of establishing this work environment for this community of practice is to create meaningful reports and metrics such that stakeholders can expand their knowledge and learn the advantages and disadvantages of various types of in-line inspection technologies, direct assessment, and other assessment methodologies.
Supporting Recommendation Competency-3	**Develop a Training and Evaluation Process.** The Board should develop a training and evaluation process for employees working within the VIS Hub to ensure they will: • Protect data security, and • Preserve member anonymity and confidentiality. The Board and the third-party data administrator will mutually agree upon and authorize the evaluation process.
Supporting Recommendation Competency-4	**Develop Educational Materials.** The Board should develop educational materials based on tenants of trust and leadership to market the VIS with the intent to motivate stakeholders to join and stay involved. A primary objective is to find ways to encourage the exchange of pipeline inspection information, which will lead to the development of advanced pipeline inspection technologies and enhance risk analysis and other assessment methodologies.

Supporting Recommendation Competency-5	**Develop Initial Training for VIS Development and Implementation.**
	The Board should create initial training that will enable the development and implementation of VIS.
	
	Distinct audiences to be trained:
	• Those who input data and information (e.g. employees from ILI companies, ITD assessment companies, pipeline operators, public advocacy groups, federal and state community liaisons)
	• Those who work within the system or the VIS Hub and are exposed to identified data
	• Those who receive VIS output. It is the participants in these communities of practice that will expand their knowledge of the advantages and disadvantage of the different types of in-line inspection technology and methodologies.
	    o Data Rich (ILI as-found versus as-called feature dimensions and feature signature calibration)
	    o Information Rich (info sharing re: unwanted events and continuous improvement)
	    o Regulatory Agencies (federal, state, local)
	    o Portal for appropriate data available to the public
	
	Types of Training:
	• In-Person/Hands-On
	• Computer Based Training Modules
	• Train the Trainer
	• Recurring training that promotes the awareness of VIS and data security.

Supporting Recommendation Competency-6	**Develop Participant Training Modules for Workflow Processes.** The Board should develop training modules that instruct participants in the workflow processes and protocols as recommended by the Process Sharing Subcommittee. These modules will likely be phased in as the VIS structure and workflow processes will take time to develop. • Trainers could consist of SMEs from across the industry and regulatory agencies • Training should cover participants' methodology for data submission to include types of input, how to input, format, et cetera. If a form for data and information submittal is created, train to the form. • Training should cover confidentiality requirements as recommended by the Governance Subcommittee.

	o Robust rules with degrees of separation to preserve anonymity. Training modules shall be successfully completed before working with information within the VIS Hub.
Supporting Recommendation Competency-7	**Develop Participant Training Modules for Quantitative and Qualitative Data.** The Board should develop training modules that are tailored for the participants, specifically for those working with quantitative data and those working with qualitative information.
Process for Sharing Information	
Supporting Recommendation Process Sharing-1	**Define the types and what information is to be shared to enhance integrity management including pipeline integrity assessments and risk management.**
Supporting Recommendation Process Sharing-2	**Develop a plan (design) for an information sharing center, hereafter referred to as a voluntary information sharing hub.**
Supporting Recommendation Process Sharing-3	**Encourage adoption of API RP 1163 as a starting framework for information sharing between operators and ILI service providers within the VIS Hub and foster its broader use.** • Operators should formalize their use of API RP 1163 with each of their service providers ensuring that learnings can be recognized, documented and shared. o API RP 1163 provides a framework for operators and ILI service providers to work together to ensure that assessment results are valid and improvements in the use of ILI are identified. The Process Sharing Subcommittee found in discussions with operators and ILI service providers that RP 1163 is being used, but there are opportunities to formalize and institutionalize its use within organizations and use it more broadly among organizations. The desired future state is one that reflects the integration among stakeholders creating the environment that fosters information sharing. o The process can be improved, evolved, and matured over time to present the learnings in a manner that data is searchable and can be analyzed using technology identified by the Technology and Research and Development Subcommittee. • An operator's use of API RP 1163 should be evaluated and audited periodically in conformance with their

	implementation of requirements of API RP 1173, Section 10, Safety Assurance. o Integrate the lessons learned process established therein into the management review process.
Supporting Recommendation Process Sharing-4	**Develop a process for pipeline operators to share lessons learned from the planning, execution, and evaluation of pipeline integrity assessments.** The process may start with operators providing case studies (use cases) of their findings from use of API RP 1163 for ILI, or more generally, other assessment technologies in managing risk and pipeline integrity. The process should produce information on pipe and material properties, coatings, the environment around the pipe, why the assessment was conducted including which threats were being addressed, and consequential benefits of the work as applicable. Information to be considered for sharing is defined in Section 5.
Supporting Recommendation Process Sharing-5	**Define the processes to be used in a VIS Hub to facilitate the sharing discrete data from pipeline integrity assessments using information management and sharing technology defined in Supporting Recommendation Technology-6.**
Supporting Recommendation Process Sharing-6	**Consider the evaluation of existing information sharing systems already in use for energy pipelines and select ones to adopt within the VIS Hub to accelerate development and maturity.** For example, consider the system developed by PRCI as a possible foundation for information sharing of ILI information among operators and service providers.
Supporting Recommendation Process Sharing-7	**Develop a process for pipeline integrity assessment service providers to share lessons learned from the planning, execution, and evaluation of pipeline integrity assessments, including in-line inspection, direct assessment, pressure testing, and applications of other technology.** The process may start with pipeline integrity assessment service providers providing case studies of their findings. The process can be improved, evolved, and matured over time to present the learnings in a manner that data is searchable and can be analyzed using technology identified in Supporting Recommendation Technology-6. The process should produce information on pipe and material properties, coatings, the environment around the pipe, why the assessment was conducted including which threats were being addressed, and consequential benefits of the

	work as applicable. Information to be considered for sharing is defined in Section 5.
Supporting Recommendation Process Sharing-8	**Develop a process for non-destructive evaluation (NDE) service providers to share lessons learned from the planning, execution, and evaluation of pipeline integrity assessment excavations.** The process should produce information on pipe and material properties, why the assessment was conducted including which threats were being addressed, the NDE methods used including reference to specific published methods, and consequential benefits of the work as applicable. The process can be improved, evolved, and matured over time to present the learnings in a manner that data is searchable and can be analyzed using technology identified by the Technology and Research and Development Subcommittee.
Supporting Recommendation Process Sharing-9	**Define a process for disseminating lessons learned.** Different stakeholder groups will need different processes. • For operators and operator organizations to receive the lessons learned, including AGA, AOPL, APGA, API, INGAA, as well as PRCI, GTI, and NYSEARCH. • For government stakeholders and agencies to receive the lessons learned, including PHMSA, state and local pipeline safety regulatory authorities, and interested Federal, state, tribal, and local officials. • For public stakeholder organizations to receive the lessons learned, including organized such as public safety and environmental advocates (the Pipeline Safety Trust and the Pipeline Safety Coalition), labor unions, and universities.
Supporting Recommendation Process Sharing-10	**Consider the development and periodic update of a Pipeline Integrity Assessment [Management] Compendium.** Share the state of the art information with regard to pipeline integrity assessment technology, risk assessment, including data integration, and NDE technology.
Supporting Recommendation Process Sharing-11	**Consider conformance to industry Recommended Practices and Standards to standardize the Sharing of Qualitative and Quantitative Data.** In design and development of the VIS, the Board should consider conformance to industry recommended practices/standards for standardizing the sharing of qualitative pipeline data (such as lessons learned) and quantitative data (such as in-line inspection results

	compared to in the ditch findings). Industry recommended practices and standards already represent best practice consensus among the industry stakeholders and include common and consistent terms, definitions, nomenclatures, data types, data formats, procedures, and process flows.
Technology/R&D	
Supporting Recommendation Technology-1	**Consider design and implementation requirements for input validation that support system quality and consistency.** Implementation of a VIS should consider the mechanisms and associated requirements for input validation, to ensure quality and consistency for input into the VIS Hub. This includes data validation that ensures the appropriate quality needed for meaningful analysis. This is necessary for the analyses to produce trustworthy lessons learned and trends that lead to continuous improvements and research and development. As data validation will ensure quality and overall trust in the input(s) delivered, it could also enable a tiered approach to quantify the quality/trust of the input associated with the lessons learned and/or continuous improvement recommendations. Input validation could be performed in a few different ways, including conformance to industry recommended practices/standards, having a dedicated resource (personnel) to vet the information prior to input into the system, and automated routines of the architecture/IT for ingress into the VIS Hub.
Supporting Recommendation Technology-2	**Consider the qualitative and quantitative inputs needed to support meaningful analysis.** • The VIS Hub should be able to ingest and connect to data from disparate and potentially diverse sources having varying degrees of structure. • Various modern techniques and tools (including machine learning) should be leveraged to ingest, relate or conflate, store, and analyze data. • The VIS Hub's data management solution should be designed with big data and analytics at the forefront. This modern enterprise architecture entails dedicated data management tools for running complex analysis on data. • Qualitative or free-form data should be included to support analysis of lessons learned, near misses, incident reports, and other information that could be beneficial for continuous improvements. • The qualitative data should be qualified with domain validated values and ingested via modern techniques and tools.

	• The quantitative data (discrete, numerical) to support analysis should include assessment results (e.g. ILI, DA), verification results (e.g. ITD/NDE results), and other specific data associated with measurable numeric values. • For quantitative data, the input definition should specify the categorical data type, attribute names, codes, acronyms, data formats, data types, measurement units, measurement process, and the resolution of the data captured for profiles and volumetric parameters. • The quantitative data sets should be normalized using automated routines before ingress into a data warehouse. Different models exist to meet the specific needs and requirements of the problem to be solved. • Like most common types of databases, the VIS should incorporate structured and unstructured data. • Unstructured data should include text files (with abbreviated words), excel spreadsheets, videos, or photos. The VIS Hub should consider a data warehouse containing relational (structured) and non-relational (unstructured) data with multiple data marts for data integration and case-driven analysis. • The data input should be, as necessary, specified with essential elements/variables and the required minimum data set needed for meaningful analysis, which will vary by analysis type (reported outputs).
Supporting Recommendation Technology-3	**Engage the appropriate SDO to create the consensus minimum requirements for the collection of field verification data to be ingested into the VIS Hub.** This should include: • A consensus recommendation for the ITD/NDE tools/technologies to employ for a given threat type. • A consensus procedure for each ITD/NDE tools/technology and threat type. An example is the guideline from the Pipeline Operator Forum (POF), 'Guidance on Field Verification Procedures for In-Line Inspection' (December 2012). • A consensus procedure to record measurements that ensures comparisons between measurement technologies are valid (e.g. one-to-one or one-to-many, 'apples to apples'). • A consensus definition of competency for ITD/NDE personnel. • The American Society of Non-Destructive Testing (ASNT) has developed similar formats (e.g. SNT-TC-

	1A) training, education, and experience requirements per technology (e.g. UT, MPI). This needs to be enhanced to cover pipeline safety and integrity needs. Currently, there are efforts underway with ASNT and API to develop programs to address this issue. ILI has ASNT-ILI-PQ; ITD NDE needs something similar.
Supporting Recommendation Technology-4	**Engage the appropriate Consensus SDOs to establish a consensus protocol for comparing pipeline integrity assessment results with corresponding ITD/NDE field measurements.** For example, a protocol should allow for consideration of the specific measurement techniques and uncertainties associated with each tool/technology. The appropriate subject matter experts should be engaged on the use and resulting analysis of these data. A protocol should also avoid inappropriate comparisons between ITD/NDE field measurements and tool results.
Supporting Recommendation Technology-5	**Provide analyses and outputs that serve to encourage adoption of best practices across the industry and stimulate continuous improvement in technology, while ensuring anonymity is maintained.** Some options for achieving this anonymity may include: • A searchable database of lessons learned, from which operators can benefit from the experiences shared by their peers. • A periodic "state of the art" analysis of key pipeline integrity assessment tools/technologies that describes their real-world capability to find, discriminate, and size critical pipeline anomalies. • Comparison within an assessment tool/technology peer group of the top quartile, lower quartile, and average performance. • Comparison of effectiveness of tools/technologies to the direct examination results for specific anomaly types (e.g. deformations, metal loss, cracking).
Supporting Recommendation Technology-6	**Develop, implement, and operate a technology platform (the VIS Hub) that is secure, ensures anonymity, and fosters collaborative information sharing, analysis, and reporting to advance pipeline safety**. The VIS Hub requires a robust system architecture that possesses scalability, elasticity, and resiliency. The VIS Hub should store and process data from disparate and potentially diverse sources with varying degrees of structure, having the ability to visualize and deliver informative results for all stakeholders. Details of the

	Architectural IT components are further described later in this section.

6c. Context for the Recommendations

6c.1 Best Practices

The VIS WG invited safety management experts from outside the pipeline industry to present information and case studies about the why, what, who, and how of information sharing became an established best practice of SMS in their industries. The experts were asked what they would do differently if they were starting the information-sharing system today, including things they would do more of, as well as less of.

The Best Practices, Process Sharing, and Technology/R&D subcommittees used the information presented to understand what these experts learned in setting up an information-sharing system in their specific industry's context and how to leverage existing practices, processes, procedures, and governance models currently being used in other industries. Especially of interest were existing and ongoing processes that focus on data and information sharing for improving safety performance. In some cases, the level of sophistication and overall systems used are quite elaborate and have evolved over time.

The VIS WG recognizes how ASIAS manages data from two distinct information systems that allows for a cycle of continuous aviation safety improvement. For example:

1. Aviation Safety Action Program (ASAP) – The objective of the ASAP is to encourage air carrier and repair station employees to voluntarily report safety information that may be critical to identifying potential precursors to accidents. Under ASAP, safety issues are not resolved through punishment or discipline. The ASAP information is a blend of alpha-numeric, numeric data, and text.

2. Flight Operations Quality Assurance (FOQA) – The objective of FOQA is to use flight data to reveal operational situations in which risk is increased to enable early corrective action before that risk results in an incident or accident. A FOQA program is part of the operator's overall operational risk assessment and prevention program (as described in part 119, section 119.65, and FAA guidance materials), which in turn are a part of the airline operator's SMS. Data are collected from the aircraft by using special acquisition devices such as a Quick Access Recorder or Flight Data Recorder. The FOQA information is also a blend of alpha-numeric and numeric data.

The complete ASIAS InfoShare Case Study is provided in Appendix XIV. Compared to the airline industry, there are inconsistencies and gaps in information sharing across the pipeline industry that need to be filled. The VIS WG recommends establishing a pipeline safety VIS and fostering industry-wide involvement to fill these gaps. The VIS WG recommends that implementation of a VIS for the pipeline industry should provide for a framework of best practices and fundamental information sharing elements found in other information sharing contexts or in other industries including, but not limited to:

- Governance, policies, procedures, and recommended practice;
- Quality Assurance/Quality Control of data, information, and knowledge;

- Security of Data and Information, including methods to de-identify data and provide anonymity;
- Recognition of potential barriers to participation and methods to mitigate these barriers; and
- Communication of results and performance measures.

There is also safety information sharing within the pipeline industry today. To get an idea of the current context of this, the VIS WG invited safety management experts from integrity management and voluntary safety information sharing initiatives within the pipeline industry to present information and case studies about the why, what, who, and how of these current initiatives.

The Best Practices, Process Sharing, and Technology/R&D subcommittees used the information presented to understand what these experts learned in the pipeline industry context and how to leverage existing practices, processes, and types of data currently being used. After spending time understanding the history of successes and lessons learned in other industries, it became apparent that there were also established voluntary information-sharing system practices within the pipeline industry to draw upon. An example of a specific accepted practice for safety information sharing for gas and hazardous liquids transmission pipelines is API RP 1163, In-Line Inspection System Qualification Standard, which was evaluated by the Best Practices, Process Sharing, and Technology/R&D subcommittees, and the VIS WG as a whole.

As a result of their in-depth evaluations, the VIS WG recommends that pipeline industry engagement and sharing of data and information be encouraged by creating a pipeline safety VIS that in its initial stages builds off of existing and already accepted pipeline industry best practices and standards through collaboration with Pipeline Research Council International (PRCI) and specific efforts by pipeline industry trade associations such as the American Petroleum Institute (API), Common Ground Alliance (CGA) and Interstate Natural Gas Association of America (INGAA).

Guidance documents and workflow available from the various associations (API, AOPL, PRCI, INGAA, SGA, AGA, APGA, CGA others) describing their specific initiatives, processes, best practices, protections, performance measures, et cetera should be used in the design and initial implementation of the VIS. An industry-wide pipeline safety VIS would enable a broader context for information sharing and allow greater sharing between pipeline operators of:

- Lessons learned from failures (including near misses);
- Lessons from unique or unexpected situations and solutions; and
- Lessons learned from routine assessments.

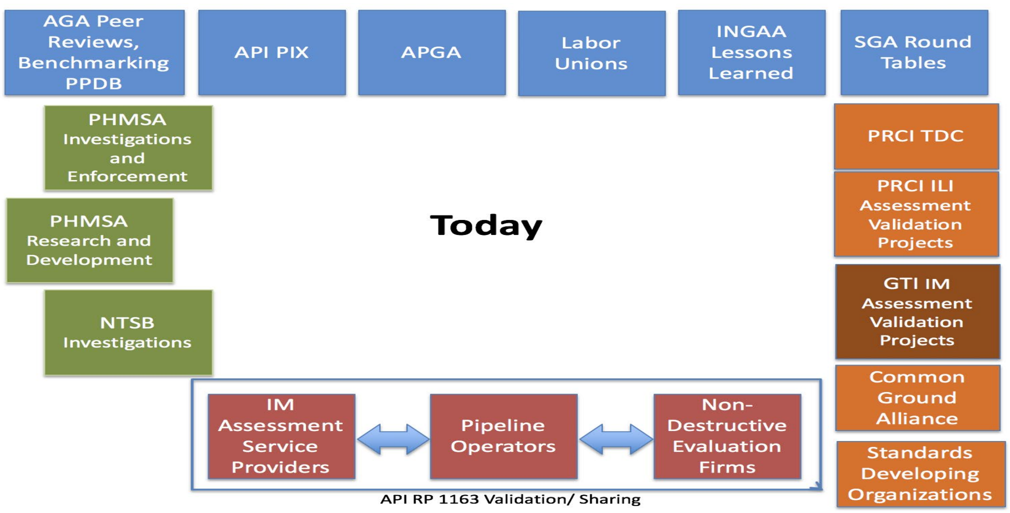
Because of this evaluation, the VIS WG recommends that the development and implementation of a pipeline safety VIS be considered and implemented by first refining, expanding on, and increasing use of the current practices, processes, and types of data shared based on API RP 1163, specific corrective action programs already created by specific utility companies and operators, and other existing and already accepted industry best practices and standards.

Opportunities for Pipeline Safety Information Sharing Across the Industry

API RP 1163 provides a consistent means of assessing, using, and verifying in-line inspection (ILI) equipment and the results of inspections across the industry. The standard covers equipment as it relates to data quality, consistency, accuracy, and reporting.

As another important part of Best Practices, the VIS WG recommends that the participation in and implementation of a VIS for the pipeline industry should complement, build upon, and/or leverage existing information sharing that currently occurs at the operator level, within industry associations, or between operators and service providers. The VIS should provide a means to share information, knowledge, and solutions relative to high value learning events from existing industry efforts and programs for the benefit of all operators (regardless of affiliation or not with specific associations or interest groups) and broader audiences or stakeholders. A recommended framework of the various information sharing processes currently in place is included in Figure 4.

Figure 4: Current - Multi-Stakeholder and Design of a VIS Hub



The framework introduces the concept that the specific organizations identified should have an active role in a VIS and/or at a minimum be a consumer of the available information and ongoing efforts and result of the process. The framework also illustrates that there are various information sharing processes and activities within specific stakeholder groups, as well as across common stakeholders and to some extent across different types of stakeholder groups. As an example, there is active and ongoing interaction and information sharing and collaboration on safety issues amongst operators, service providers, AOPL, PHMSA, GTI, and PRCI relative to industry research and development to improve technology and ILI technology. In the context of VIS, this sharing activity and the results of such sharing should be more transparent across the stakeholder groups and move beyond just industry stakeholders to all stakeholders and open pathways for those not currently aware of or participating in such information sharing to participate. The pipeline safety VIS framework should include the means, processes, and systems for sharing data, information, and knowledge among all industry and public stakeholders.

6c.2 Regulatory, Funding, and Legal (RFL)

Regulatory Structure

A VIS must encourage the exchange of pipeline safety information and enhances risk analysis as a critical element of SMS that are now being implemented by pipeline operators and also must protect safety-related, security-related, proprietary, and other sensitive information to encourage and allow pipeline operators, employees and service providers to share this information with the industry, regulators, and others.

The RFL Subcommittee researched and analyzed potential solutions for overcoming the barriers and industry fears to participation in a VIS. Building upon lessons learned from voluntary information-sharing systems established in the aviation and other industries, the RFL subcommittee believed that protecting voluntarily shared information about pipeline safety from public disclosure and from use in regulatory enforcement actions, litigation, and employee disciplinary actions is a prerequisite to operator participation in a successful VIS program. The RFL subcommittee also believed that such protections are consistent with a SMS philosophy and with PHMSA's pipeline safety responsibilities. There are similar protections in place for aviation-related information sharing.

The RFL subcommittee also believed that those fundamental protections for voluntarily shared information are best secured through self-executing statutes expressing the clear intent of Congress to protect that information for the ultimate purpose of improving pipeline safety in the U.S. Such self-executing statutory protections would be binding on all persons and entities as the law of the land, with no further action, such as lengthy rulemaking proceedings, required.

Sustainable Funding

A sustainable funding strategy is essential to the development of a VIS and is necessary to accomplish program goals. While sustainable funding can be a challenging and complex process, being open to new ideas and planning for the long-term future of the VIS is vital. The VIS WG recommended that PHMSA should provide initial seed and sustaining funding. The Secretary in consultation with stakeholders should explore sustainable funding sources, including public-private partnerships.

Legislation Required to Encourage Participation

The RFL Subcommittee recognized the following facts underlying the supporting recommendations for legislation creating a VIS:

1. Industry, regulators, and other pipeline safety stakeholders express widespread agreement that a VIS should be established for the exchange of pipeline safety information that will lead to enhanced risk analysis, improved pipeline safety, and continual improvement of pipeline SMS.

2. The effectiveness of a VIS will be directly proportional to the percentage of participation by pipeline operators nationwide. A higher participation level produces more representative information and more reliable analysis, while a low level of participation will quickly lead to failure of the VIS.

3. Building upon lessons learned from VIS established in the aviation industry, pipeline operators and their employees will refuse to participate in a VIS at any level unless they are provided with strong protections to ensure anonymity, confidentiality, and a safe harbor from punitive enforcement actions, retaliation, and litigation.

4. The fundamental and essential protections required to encourage VIS participation are best secured through self-executing statutes expressing the intent of Congress to provide those protections for the ultimate purpose of improving pipeline safety in the U.S.

6c.3 Governance

A sound governance model is instrumental in implementing a VIS that is effective, provides transparency, and ensures proper oversight. Such a model will enable the executive leadership to organize the structure of the VIS body and the mechanisms by which governance is implemented. By the same token, a governance model may support a solid governance structure and consistent processes that could lead to a successful VIS. To promote and encourage participation from across the pipeline industry, a VIS should provide for transparency and open, honest communication of industry capabilities, processes, procedures, technologies, improvements, and safety results relative to the value that the sharing process generates.

A VIS for the pipeline industry can standardize how and what information is reported and shared. Information can be used to improve industry risk identification, assessment, and remediation standards in each segment of the industry, and prevent a potential pipeline accident or incident. There is a need to establish a VIS that encourages the exchange of pipeline safety information and enhances risk analysis as a critical element of SMS. These systems are currently being voluntarily implemented by individual pipeline operators in silos, where a VIS for the industry will benefit all pipeline safety stakeholders. A governance model for a VIS will protect safety-related, security-related, proprietary, and other sensitive information to encourage and allow pipeline operators, employees, and service providers to share this information with the industry, regulators, and others.

The VIS WG agreed upon a governance model that includes a VIS Executive Board, Program Manager, Third-Party Information Manager, and Issues Analysis Team.

- **The VIS Executive Board**
  - Provide strategic oversight and governance to the VIS.
  - Develop governance documents necessary to oversee and operate the VIS.
  - Decide what issues are analyzed in detail by the VIS and what information is disseminated to industry and the public safety advocacy representatives.
  - Appoint members to the Issue Analysis Teams based on the content to be addressed.
  - Along with PHMSA Sr. Leadership, be involved in the final decision on the selection of the third-party provider in accordance with the Federal Acquisition Regulations.

- **The Program Manager (PHMSA)**
  - Provide day to day program management over the VIS. This day to day management function should include program management oversight over the Third-Party.

- **The Third-Party Data Manager**
  - Provide data management and data oversight functions.
  - Work with the Issue Analysis Teams to analyze data submitted, aggregate data as necessary, and submit recommendations to the VIS Executive Board.

- **Issue Analysis Teams** (Appointed by the VIS Executive Board and populated with technical and subject matter experts)
  - Work with the third party data manager to analyze data submitted, aggregate data as necessary, and submit recommendations to the VIS Executive Board.

The governance model should provide PHMSA with day to day management over the VIS, provide statutory protections on the data and information within the system, and support non-punitive reporting. Non-disclosure agreements and other tools should be used to bind individual and groups. Other examples of governance models are available in Appendix XVIV.

The intent of the supporting recommendations is to provide guidance to create an innovative information sharing system that improves industry standards, standardizes how information is shared, and makes reporting simpler and less obstructive. The goal is to encourage industry wide participation in the VIS that will lead to industry innovation and safety improvement. While information sharing platforms currently exist within the pipeline industry, these systems generally consist of closed groups and provide limited access to others. By standardizing how information is reported and disseminated, a VIS can broaden the scope of the information shared beyond partnered ILI service providers or pipeline operators, and make it available to operators, distributors, and service providers on a global scale. A VIS can also serve a diverse audience representing the many aspects of the pipeline industry. The most practical way to recruit the participation of industry operators is to place emphasis on legislative protections and ensure that the reporting of errors, flaws or mistakes fall under the protections of the VIS, as long as it's reported.

6c.4 Competency, Awareness, and Training

People who work within a VIS need to have an appropriate level of competence in terms of education, training, knowledge, and experience. In July 2015, API issued API RP 1173, which includes Section 13, titled "Competence, Awareness, and Training." While the narrative within Section 13 is rather limited compared to other API RP 1173 sections, the content directly relates to the processes envisioned by the VIS WG.

Job descriptions should be authored to define the necessary knowledge, skills, and abilities for key positions within the VIS organization. This would include members of any Boards or SME Teams, as well as employees working with a third-party data administrator. Comprehensive job descriptions will define hiring criteria for employees as well as selection criteria for positions that are appointed. Once roles have been filled, an ongoing evaluation process should be established to ensure that data remains secure and that confidentiality is preserved. To sustain voluntary participation, operators and service providers need the assurance that those working with identified data will not compromise the non-punitive nature of the VIS.

As employees are hired and stakeholder representatives are appointed to boards and teams, they will need to be properly brought on-board the system. Initial training programs should be developed to enable the implementation of issue analysis teams, employees of third party data administrator(s), and for member companies who will input data. Training will need to be developed in a manner that fits the audience and the type of information. There will be both "data-rich," and quantitative sharing and "information-rich," or qualitative sharing. The VIS Executive Board will confirm what information will be shared and the mechanics of how the information will be collected, combined, and consumed.[3] Once these processes and templates have been developed, the training modules should be created to meet the information exchange expectations.

The exchange of data and information is a key element of the PIPES Act of 2016 mandate. A primary objective is to expand stakeholder knowledge on the advantages and disadvantages of various ILI technology and methodologies. There are many constituents that make up this community of practice, including ITD and NDE service providers, ILI tool companies, operators, and regulatory agencies. A process should be established to pair VIS analytical staff with pipeline operators and other industry SMEs, including ILI companies and ITD assessment companies. The efficient exchange of data and information will require a prescriptive workflow whereby all participants understand their role and their expectations. Once this workflow has been developed, people should be trained accordingly. This will better assure that processes established to preserve data and information security will not be jeopardized.

There are many stakeholders beyond those directly involved with pipeline safety tasks. Members of the public and media are expecting transparent output from the VIS. As the VIS develops meaningful metrics and authors reports, it is likely that the public will need further education about pipeline maintenance activities to fully understand the metrics and reports. Training material should be developed to foster this.

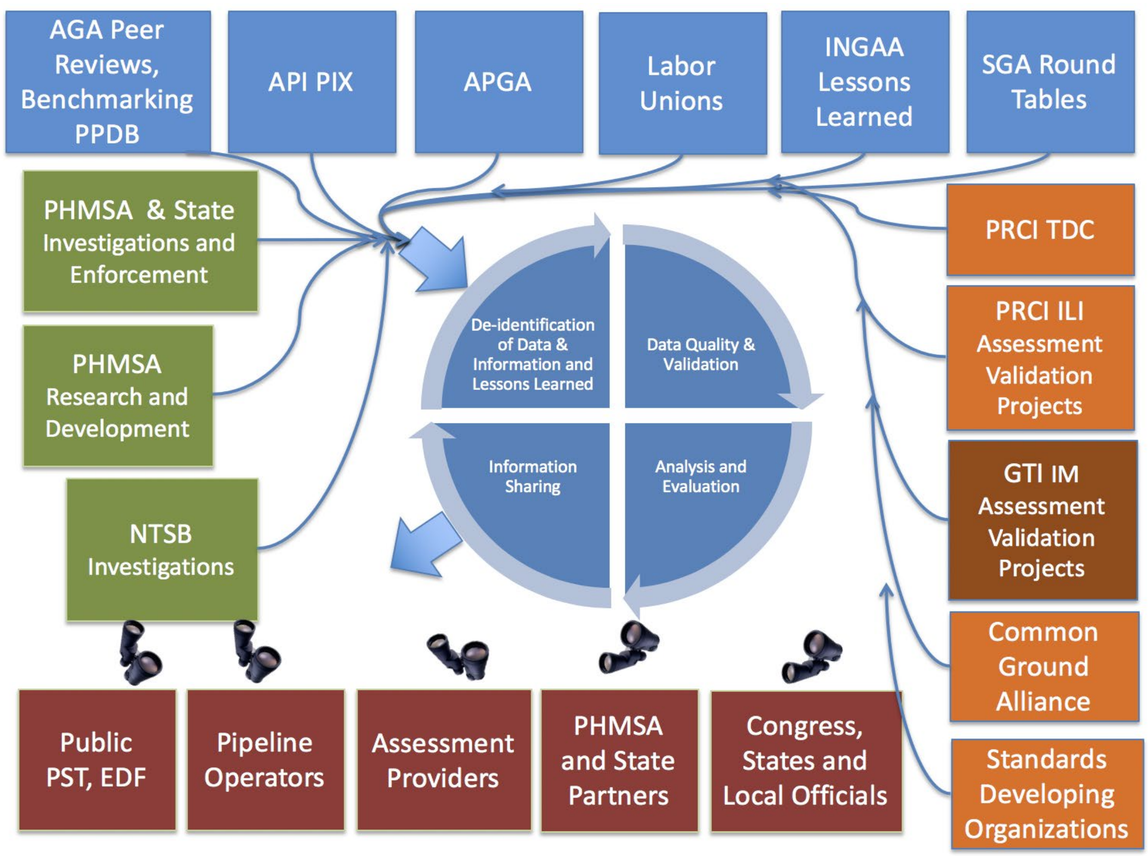
[3] Three other subcommittees have discussed the latter.

While initial training is a key aspect to ensure that the VIS is effectively established, there will be a need for ongoing training and evaluation. Employee turnover and member participation will evolve. The VIS will also evolve and mature with time. Training modules should be developed as necessary to facilitate effective workflow and VIS output.

6c.5 Process for Sharing Information

The Process Sharing subcommittee was tasked with understanding: (1) the need for an information sharing system, (2), the types of information and data to be shared, (3) the key issues to be resolved surrounding the data sharing itself, and (4) the data sharing possibilities and how the different stakeholders could benefit, as depicted in Figure 5.

Figure 5: Future - Multi-Stakeholder and Design of a VIS Hub



The Process Sharing subcommittee defined a set of requirements for the sharing of information including the following elements:

- Centralized security - access control to align with governance
- Continuous validation and verification - to address data quality issues, inconsistent data feeds and new algorithms with limited verification
- Data management - with computing environment (in situ/in cloud)

- Data analytics software and tool integration - practices that can handle the volume, velocity and diversity of data

Types of Information to Be Shared and Design of a VIS Hub

The subcommittee defined the types of information to be shared drawing upon earlier work done by the VIS WG. These include:

1. Learnings from reportable incidents and accidents, and near misses
2. Learnings from routine use of pipeline integrity assessment technology (ILI, DA, HT, Other Technology)
   a. Lessons Learned – descriptive of rule-based take-aways
   b. Discrete Pipeline Integrity Assessment and Excavation Data
3. Learnings about specific risks
4. Sharing Information and Learnings with our public stakeholders

Leveraging Industry Standards

In design and development of the VIS, consideration should be made to conformance to industry recommended practices/standards for standardizing the sharing of qualitative pipeline data (such as lessons learned) and quantitative data (such as in-line inspection results compared to in the ditch findings). Industry recommended practices and standards already represent best practice consensus among the industry stakeholders and include common and consistent terms, definitions, nomenclatures, data types, data formats, procedures, and process flows.

As a basis, the VIS WG recommends the adoption of API RP 1163 as a starting framework for information sharing between operators and ILI service providers within the VIS Hub, and for broader use. Operators should formalize their use of API RP 1163 with each of their service providers, ensuring that learnings can be recognized, documented, and shared. API RP 1163 provides a framework for operators and ILI service providers to work together to ensure that assessment results are valid and improvements in the use of ILI are identified. Operators and ILI service providers indicated that RP 1163 is being used, but there are opportunities to formalize, institutionalize, and broaden its use within organizations. The desired future state is one that reflects the integration among stakeholders creating the environment that fosters information sharing. The process can be improved, evolved, and matured over time to present the learnings in a manner that data is searchable and can be analyzed using technology identified by the Technology and Research and Development Subcommittee.

An operator's use of API RP 1163 should be evaluated and audited periodically in conformance with their implementation of requirements of API RP 1173, Section 10, Safety Assurance.

Examples of such practices/standards include, but are not limited to:

- For In-Line Inspection (ILI), the most relevant recommended practices/standards include (see Appendices VII and VIII):
  - API Standard 1163 'ILI Systems Qualification Standard,'
  - NACE SP0102 'Recommended Practice: ILI of Pipelines,' and

- ASNT ILI-PQ ‘Personnel Qualification Standard’ in their current versions (supports PS-9, PS-10).

- Other pipeline recommended practices/standards that would help standardize VIS data inputs include:
  - NACE SP0502 ECDA,
  - NACE SP0206 ICDA,
  - NACE SP0204 SCCDA,
  - API 1176 Recommended Practice for Assessment and Management of Cracking in Pipelines,’ and,
  - API 1178 Integrity Data Management and Integration Guideline.

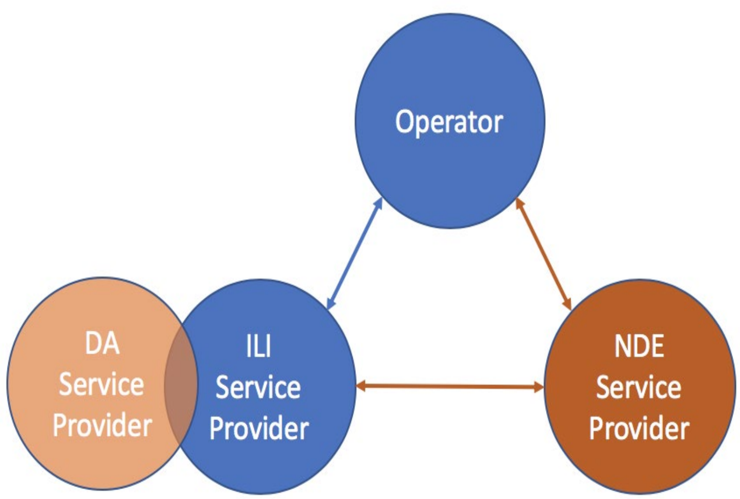
Sharing Discrete Data

To effectively implement a VIS, the VIS WG recommends that processes be defined to facilitate the sharing of discrete data from pipeline integrity assessments using information management and sharing technology defined in the Information Technology System Architecture and Best Practices section below. Today, the typical data that are being shared consist of assessment results and the associated validation measurements taken in the field. The use of the existing industry standards will help in understanding what and how such data are shared.

Sharing Lessons Learned

Pipeline Operators to Share Pipeline Integrity Assessment Lessons Learned
The VIS WG recommends that for a pipeline safety VIS to be effectively implemented, a process should be developed for pipeline operators to share lessons learned from the planning, execution and evaluation of integrity assessments. Figure 6 depicts how a VIS might evolve.

Figure 6: Evolve to Improve and Integrate



The process may start with operators providing case studies (use cases) of their findings from use of API RP 1163 for ILI, or more generally, other assessment technologies in managing risk and pipeline integrity. The process should produce information on pipe and material properties, coatings, the environment around the pipe, why the assessment was conducted including which threats were being addressed, and consequential benefits of the work as applicable.

The opportunity in establishing a formalized VIS is to build on the strength of the bilateral sharing under API RP 1163, and evolve to including the NDE service providers, and concomitantly or subsequently add in other integrity assessment processes.

The objective is to develop an integrated operator/IM assessor/NDE sharing process building on the requirements of API RP 1163 and integrate into a common validation process to build a database with great depth. The sharing of discrete data will enable assessment providers to accelerate learning and advancement of technology and process development.

Pipeline Integrity Assessment Service Providers to Share Lessons Learned

The VIS WG recommends development of a process whereby pipeline integrity assessment service providers can share lessons learned from the planning, execution and evaluation of pipeline integrity assessments; including in-line inspection, direct assessment, pressure testing and applications of other technology.

The process may start with pipeline integrity assessment service providers providing case studies of their findings. The process can be improved, evolved, and matured over time to present the learnings in a manner that data is searchable and can be analyzed using technology identified by the Technology and Research and Development Subcommittee. The process should produce information on pipe and material properties, coatings, the environment around the pipe, why the assessment was conducted including which threats were being addressed, and consequential benefits of the work as applicable.

NDE Service Providers to Share Lessons Learned

The VIS WG recommends the development of a process whereby NDE service providers can share lessons learned from the planning, execution, and evaluation of pipeline integrity assessment excavations. The process should produce information on pipe and material properties, why the assessment was conducted including which threats were being addressed, the NDE methods used including reference to specific published methods, and consequential benefits of the work as applicable.

These sharing processes can be improved, evolved, and matured over time to present the learnings in a manner that data is searchable and can be analyzed using the Information Technology System Architecture identified by the Technology and R&D subcommittee.

Existing Data-Sharing Systems

The subcommittee invited in experts from other applications where information sharing is an established practice. These included:

- Federal Aviation Administration – Aviation Safety Information Analysis and Sharing (ASIAS), Federal Aviation Administration, Warren Randolph, Director, Aviation Safety Analytical Services
- Aviation Safety Action Program (ASAP) and Safety Management Systems, John DeLeeuw, American Airlines and Vickie Toman, SMS Manager (AA)
- API RP 1163, In-line Inspection Systems, Drew Hevle, Kinder Morgan
- Information Collection Presentation, Dr. Rolf Schmitt Bureau of Transportation Statistics Deputy Director
- Confidential Close Call Reporting System (C3RS), Brian Reilly Federal Railroad Administration, Human Performance Program Specialist
- Common Ground Alliance Voluntary Reporting (DIRT) Erika Lee, VP, Programs & Administration
- National Transportation Safety Board Presentation, Robert Hall, Director, Office of Railroad, Pipeline and Hazardous Materials Investigations
- Pipeline Research Council International Presentation, Cliff Johnson, President and Walter Kresic, Vice President, Asset Integrity, Enbridge Liquid Pipelines

Subcommittee members wanted to understand what these experts learned while establishing an information sharing system. Experts also shared what they would do differently, do more of, or less of, if they were establishing an information sharing system today.

The FAA launched a similar voluntary information system (ASIAS) to reduce airline accidents. The ASIAS implementation faced similar challenges with trust and participation. However, through demonstrated confidentiality and ensuring ASIAS reports do not result in disciplinary actions by the FAA on the operators or the operators on employees, the program now has wide participation that has been effective in reducing accidents and fatalities. ASIAS was implemented within the FAA in 2007. ASIAS is governed by six key principles, described above, including:

1. Voluntary submission of safety-sensitive data.
2. Transparency for how data are managed and used.
3. Analyses approved by an ASIAS Executive Board.
4. Data used solely for advancement of safety.
5. Operator/OEM/MRO data are de-identified.
6. Procedures & policies based on collaborative governance.

Define and Develop a Community of Practice

To ensure that broad participation from the industry and other stakeholders is encouraged and continues, the VIS WG recommends defining and developing a community of practice that fosters the voluntary sharing and exchange of information related to pipeline integrity assessments and risk management. The term “community of practice” was selected to convey the importance of creating an environment where the stakeholders recognize the importance of information sharing, and their interdependency. Each stakeholder group brings value that will improve the overall effectiveness of pipeline integrity assessments, managing risk, and improving pipeline safety performance. Stakeholders should include operators, service providers, regulators, universities and research organizations, organized labor, and public safety advocates.

It is likely that stakeholders will be initially reluctant to participate in VIS and it will take time to develop the trust and awareness of value before a significant number of stakeholders participate. However, as the experience of Pipeline Research Council International (PRCI) with their recent Crack Study (NDE-4E) has shown, and as the FAA has demonstrated with ASIAS, it may be sufficient to start with a coalition of the willing, and as others see the benefits and the anonymity of the information, they subsequently become motivated to join.

The PRCI experience with NDE-4E demonstrated that keeping the data sharing process voluntary and protecting the anonymity of contributors and their data is essential to encourage participation. The process could be further strengthened by ensuring that access to the detailed data is limited to only those operators and service providers who participate, and that individual operators and service providers are able to identify their own performance and some key metrics like "average" and "top quartile." No one should be able to identify the performance or data from a specific service provider or operator other than their own.

The development of trust will be critical for the success of a VIS. Trust will grow as the VIS stays focused on the safety learnings from the data collected and the benefits provided to individual companies who can assess their own performance as compared to average or top quartile performance. Protections need to be established to ensure the data is not directed to other uses that will discourage participation. The protections will need to address operator concerns that the data shared could be used punitively by regulators. For technology service providers, these protections need to ensure that data on real-world performance will not be used by their peers to put them at a disadvantage.

As the benefits are realized and communicated, the community will grow, and the value of a pipeline integrity VIS will continue to increase.

To build participation and strengthen trust, high level metrics should be established to communicate the growth of the community of practice and the value gained from the VIS. Some possible metrics include:

- Quantitative statistics relative to data and information available
- Number of inspections submitted
- Number and variety of operators and technology service providers participating
- Size of operators participating
- Metrics that operators and service providers can use to assess their own performance as compared to the average or top quartile
- Documentation on any new threats or technologies improvements that were advanced because of the VIS

Confidentiality and Security: Motivating Participation

To promote and encourage participation from across the pipeline industry a VIS should provide for transparency and open, honest communication of industry capabilities, processes, procedures, technologies, improvements, and safety results. This should include defining what data, information, and specific messaging should be included in industry and public communications. Such communications should describe the state of the state not just in terms of what industry is capable of, but in how well the pipeline industry does or does not deploy that capability.

To protect confidentiality and ensure security of all data, all data types should be categorized using an established industry framework such as FIPS 199, Standards for Security Categorization of Federal Information and Information Systems, to ensure confidentiality, integrity, and availability. The VIS Hub should be protected following an established industry standard such as NIST 800-53 (Rev. 4), Recommended Security Controls for Federal Information Systems and Organizations. This baseline should be implemented according to the established industry standards. Implementation of such standards would include many normal information security practices, such as system patching, vulnerability assessments, incident response planning, encryption, and many other industry best practices.

Data Quality Control and Quality Assurance: Foundational Requirements for Success

Foundational to the success of such an information sharing effort is the quality of the data gathered. If stakeholders cannot trust the data, the anticipated benefits are unlikely to follow. Therefore, issues such as the development of data quality assurance processes (QA), standards to define data formats (QC), and training to ensure consistent measurement practices will need to be resolved.

6c.6 Technology and Research & Development

The VIS should consider the qualitative and quantitative inputs needed to support meaningful analysis.

- The VIS Hub should ingest and connect to data from disparate and potentially diverse sources having varying degrees of structure.
- Various modern techniques and tools (including machine learning) should be leveraged to ingest, relate or conflate, store, and analyze data.
- The VIS Hub's data management solution should be designed with big data and analytics at the forefront. This modern enterprise architecture entails dedicated data management tools for running complex analysis on data.
- Qualitative or free-form data to support analysis includes lessons learned, near misses, incident reports and other information that could be beneficial for continuous improvements.
- The qualitative data is qualified with domain validated values and ingested via modern techniques and tools.
- Quantitative data (discrete, numerical) to support analysis includes assessment results (e.g. ILI, DA, etc.), verification results (e.g. ITD/NDE results, etc.), and other specific data associated with measurable numeric values.
- For quantitative data, the input definition will specify the categorical data type, attribute names, codes, acronyms, data formats, data types, measurement units, measurement process and the resolution of the data captured for profiles and volumetric parameters.
- The quantitative data sets are normalized using automated routines before ingress into a data warehouse. Different models exist to meet the specific needs and requirements of the problem to be solved.
- Currently, the most common types of databases address structured and unstructured data.
- Unstructured data may include text files (with abbreviated words), spreadsheets, videos, or photos. The VIS Hub should consider a data warehouse containing relational (structured) and non-relational (unstructured) data with multiple data marts for data integration and case-driven analysis.

The data input should be, as necessary, specified with essential elements/variables, including the required minimum data set needed for meaningful analysis, which will vary by analysis type (reported outputs).

In developing the VIS, the VIS WG recommends engaging with the appropriate SDO to establish a consensus protocol for comparing tool assessment results with corresponding ITD/NDE field measurements. For example, protocols should be developed that consider the specific measurement techniques and uncertainties associated with each tool/technology. The appropriate subject matter experts should be engaged on the use and resulting analysis of these data. A protocol should also avoid inappropriate comparisons between ITD/NDE field measurements and tool results.

For example, with ILI these comparisons should consider:

- For metal loss, the anomaly size that an ILI tool detects and measures is limited by the detection threshold and is usually smaller than the field measurements, which usually include the area of metal loss that is less than the detection threshold.
- Establishing rigorous feature-matching processes between measurement technologies to ensure proper one-to-one (apples to apples) overlay comparison, e.g. 'box matching' with consideration for interaction and measurement error.
- For crack lengths, the ILI tool has a threshold depth, above which a crack is not measured or reported with consistency. Shallow portions along the axial length of the crack are not reported by the ILI tool. In contrast, the field technique used to measure cracks involves magnetic particle penetration of the crack. The surface breaking length is measured and reported in the field NDE report. As a result, the correlation between the field and the ILI tool reported lengths can differ significantly, even when both measurements are accurate. To address this difference, some operators are comparing ILI crack length to the NDE measured length at the threshold depth.

The VIS should also use the appropriate SDO to create the consensus requirements for the field verification data to be included in the system. This should include, but not be limited to:

- A consensus recommendation for the ITD/NDE tools/technologies to employ for a given threat type.
- A consensus procedure for each ITD/NDE tools/technology and threat type. An example is the guideline from the Pipeline Operator Forum (POF), "Guidance on Field Verification Procedures for In-Line Inspection" (December 2012).
- A consensus procedure to record measurements that ensures comparisons between measurement technologies is valid. (e.g. one-to-one or one-to-many, 'apples to apples').
- A consensus definition of competency for ITD/NDE personnel.
- American Society of Non-Destructive Testing (ASNT) has developed similar formats (e.g. SNT-TC-1A) training, education, and experience requirements per technology (e.g. UT, MPI). This needs to be enhanced to cover pipeline safety and integrity needs. Currently, there are efforts underway with ASNT and API to develop programs to address this issue. It is generally known that API is working together with ASNT to fulfill this. ILI has ASNT-ILI-PQ, ITD NDE needs something similar.

Importantly, the VIS should provide analyses and outputs that serve to encourage adoption of best practices across the industry and stimulate continuous improvement in technology and the analyses and outputs should ensure anonymity is maintained. Some options for achieving this anonymity may include:

- A searchable database of lessons learned, from which operators can benefit from the experiences shared by their peers.
- A periodic "state of the art" analysis of key pipeline integrity assessment tools/technologies that describes their real-world capability to find, discriminate, and size critical pipeline anomalies.
- Comparison within an assessment tool/technology peer group of the top quartile, lower quartile, and average performance.
- Tools/technologies effectiveness compared to the direct examination results for specific anomaly types, e.g. deformations, metal loss, cracking.

To gain the most value from the data ingested and these analyses, development of a VIS should consider the mechanisms and input validation necessary to ensure the quality and consistency of the data ingested into the system. This is necessary for the analyses to produce trustworthy lessons learned and trends that lead to continuous improvements and motivate research and development. Data validation will ensure quality and overall trust in the input(s) delivered, and may also enable a tiered approach to quantify the quality/trust of the input associated with the lessons learned and/or continuous improvement recommendations. Input validation could be performed in a few different ways, including conformance to industry recommended practices/standards, having a dedicated resource (personnel) to vet the information prior to ingress into the system, and automated routines of the architecture/IT for ingress into the system.

With both qualitative and quantitative data incorporated, standards organizations engaged to develop consensus protocols, strong QA/QC implemented and defined metrics in place, the public, regulators, operators, and service providers should be able to implement improvements and clearly identify the benefit of the VIS and its impact on pipeline safety.

6d. Architecture Considerations and Examples

The VIS WG recommends the development, implementation, and operation of a technology platform (the VIS Hub) that is secure, ensures anonymity, and fosters collaborative information sharing, analysis, and reporting to advance pipeline safety.

The VIS Hub requires a robust system architecture that possesses scalability, elasticity, and resiliency. The VIS hub should store & process data from disparate and potentially diverse sources with varying degrees of structure, having the ability to visualize and deliver informative results for all stakeholders.

The implementation of a VIS Hub will require a robust system architecture that allows for growth, maintains strong security and privacy, and provides capabilities for analyzing disparate data sets. The following technology architecture considerations provide guidance for how a big-data analytics system, like the VIS Hub, could be constructed to support the requirements described by the VIS WG. The Technology and R&D Subcommittee developed these considerations to provide a short-term, early-win, system that can grow as the industry evolves the requirements and advances towards increased data-driven practices.

The following graphic depicts a mind-map based on the feedback received by the Technology and R&D Subcommittee and used as guidance for the requirements of the proposed system. Each box informs the design approach for each step in the roadmap of the VIS Hub, outlined in Figure 7.

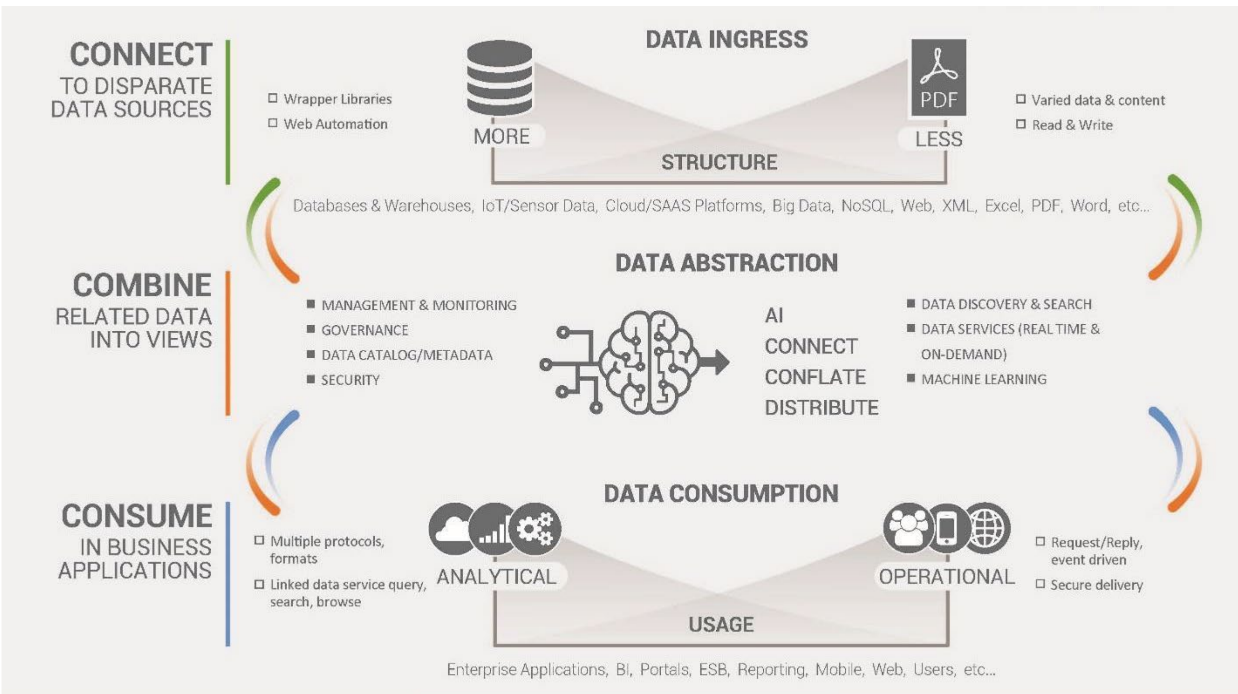
Figure 7: Roadmap of a VIS Hub

Using this roadmap, the subcommittee determined the VIS Hub will require infrastructure that allows for self-service, resource pooling, and delivery of on-demand computing resources, and that possesses scalability, elasticity, and resiliency. Scalability exists at the application layer, implying a system, network, or process that can handle a growing amount of work, or its potential to be enlarged to accommodate that growth. Elasticity in infrastructure involves enabling the virtual machine monitor (or hypervisor) to create virtual machines or containers to meet the real-time demand. Resiliency refers to the system being operable and able to provide and maintain an acceptable level of service.

Consideration 1: The VIS Hub should consider implementation on a cloud-based platform to satisfy infrastructure requirements for self-service, resource pooling and delivery of on-demand computing resources, scalability, elasticity and resiliency.

The proposed cloud computing and big data architecture addresses all aspects of the following components: infrastructure, analytics, data structures and models, and security. It is the whole complex of components to store, process, visualize, and deliver results for consumption in targeted business applications. The complete system involves three (3) distinct layers for consideration: the connect, combine, and consume layers as outlined below.

Figure 8: Data Ingress, Abstraction, and Consumption



Connect
The data ingress layer connects to data from disparate and potentially diverse sources with varying degrees of structure. Various techniques and tools for data connection may be required such as API (Application Programming Interface) libraries, web services, web map services, or other web automation.

In data management, the time scale of the data determines how it is processed and stored. Data is fixed, it is updated, or it is continuous. Consideration for how data is processed and stored must be addressed by the architecture. Each of the following data types would be consumed and stored in different ways as described in Appendices XVII and XVIII.

- Static (or persistent)
    - Infrequently accessed and not likely to be modified. This data is a snap shot of data in time and space.

    - An inspection such as an ILI run.
- Dynamic (or transactional)
    - Information that is periodically updated, meaning it changes asynchronously over time as new information becomes available. This data is created, updated, changes, is tracked historically, and is retired.
    - An asset such as a pipeline.
- Streaming
    - Is a constant flow of information adding to the repository. This data is a set of snapshots en masse.
    - A stream of constant data such as pressure/temperature readings, video, ILI Raw data, internet of things (iOt).

Consideration 2: The VIS Hub should consider integration componentry to connect to data from disparate and potentially diverse sources with varying degrees of structure. Various modern techniques and tools for data connection may be required (such as Application Programming Interface (API) libraries, web services, web map services or other web automation). Various modern techniques and tools (including machine learning) for data conflation should be considered to store, analyze and distribute data.

Consideration 3: The VIS Hub should also consider the approach of a data management solution designed with big data and analytics at the forefront. This modern enterprise architecture entails dedicated data management tools for running complex analysis on data from disparate and potentially diverse sources. The qualitative data is qualified with domain validated values and ingested via modern techniques and tools (such as a standard web portal or through JavaScript Object Notation (JSON) or Extensible Markup Language (XML) formatted document submissions. The quantitative data sets are normalized using automated routines before ingress into a data warehouse.

Combine

The data abstraction layer combines related data into views. Various techniques and tools for data conflation may be required to store, analyze and distribute data including machine learning.

Data storage models are optimized for solving particular types of problems. Different models exist to meet the specific needs and requirements of the problem to be solved. Steps to data storage technology selection include clearly defining the problem, identifying the solution to the problem, identifying the type of database that is optimized for that type of solution, and lastly identifying the data storage model of that type that best meets particular needs. There are many ways to store information and not all are applicable – it depends on data state.

- Standard Relational Database Models (transactional) have been the de facto data management solution for many years. Relational databases require a schema before data can be inserted. Relational databases organize data according to relations/tables.
- Document Databases (non-transactional) store structured documents that are organized to a standard (e.g. JavaScript Object Notation – JSON, XML). Document databases tend to be schema-less, meaning they do require specification of the structure of the data to be stored.

- Network or Graph or Hierarchical Databases (non-transactional) store objects and their relationships to one another, vertices, and edges respectively. Graph databases tend to be optimized for graph-based traversal algorithms.
- Block Storage (documents) (non-transactional) are raw volumes of storage created so that each block can be controlled as an individual hard drive. These Blocks are controlled by server based operating systems and each block can be individually formatted with the required file system.
- Block-Chain Storage (quasi-transactional) is a decentralizing model of data storage, whereby data no longer exists on a server, but rather across a network of shared ledgers, each containing the same encrypted data. This presents advantages to security and resiliency, however, when large volumes of data in the storage chain must traverse and sync each node in the network, the process can be slow – thus scaling presents a potential current limitation.

Consideration 4: Data storage models are optimized for solving particular types of problems. Different models exist to meet the specific needs and requirements of the problem to be solved. Currently, the most common types of databases are relational databases and non-relational databases. The VIS Hub should consider a data warehouse containing relational and non-relational data with multiple data marts for data integration and case-driven analysis.

Consume

The data consumption layer facilitates visualization and delivery of results to targeted business applications. Various techniques and tools for data consumption may be required for secured delivery of event driven results that vary from analytical to operational usage.

A common approach to the consumption layer is called Business Intelligence dashboard. Business intelligence (BI) can be described as a set of techniques and tools for the acquisition and transformation of raw data into meaningful and useful information for business analysis purposes. Known as decision support technologies, their primary purpose is allowing businesses to collect data more quickly and concisely, thus enabling crucial decision-making to take place.

Goals of BI:

- Descriptive (Hindsight)
  - What happened?
  - Static, moving toward real-time
- Diagnostic (Insight)
  - Why did it happen?
- Predictive (Foresight)
  - What will happen?
  - Probabilistic in nature
- Prescriptive (Optimization)
  - How can we make it happen?
  - Providing the optimal answer

Consideration 5: The VIS Hub should consider establishing the conditions for group and role-based access. Each principal user would require the ability to input data within the context of their *role and the ability to report on data they have input into the system, including the termination of their data via an opt-out capability. The system would provide public or role-based reports that require de-identification. Methods for de-identification include removal or shuffling of IDs or other identifiable information when reported, removing all personally identifiable information for persons when the data enters the system, and abstraction of geographic context of pipeline assets when reporting publicly.*

Architecture and Technology Selection

A disciplined technology selection methodology involves technology and licensor comparisons from economic, technical, operability and reliability, and commercial standpoints.

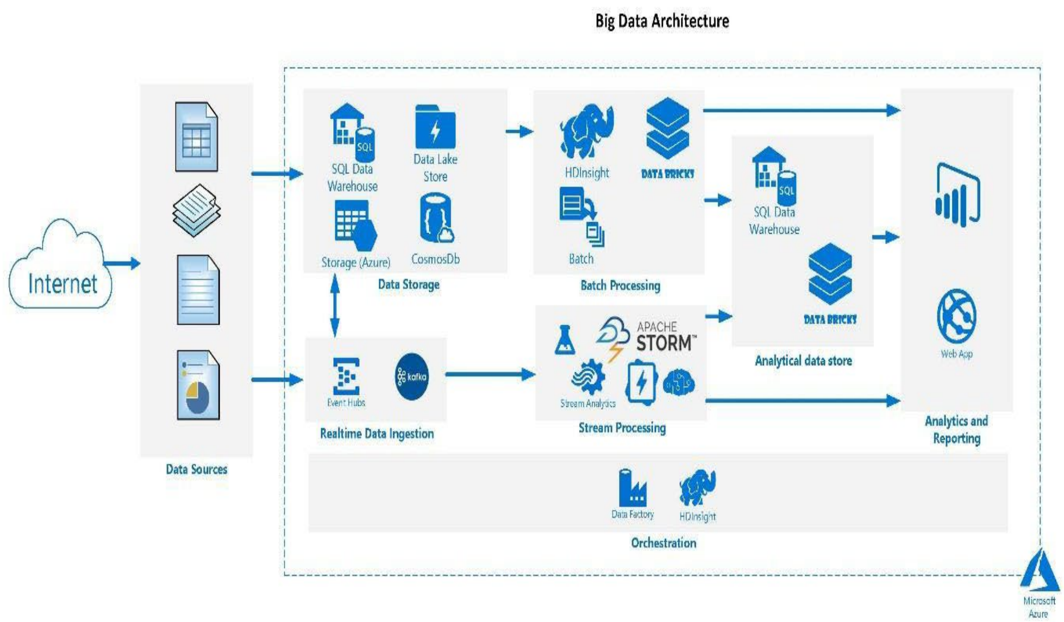
The evaluation criteria are usually listed in three main categories: economics, technology, and commercial, with a corresponding weighting for each category. Each of these categories is identified below, in turn.

- Economics, to consider for example:
  - Cost (Capital and/or Operating expenditure)
  - Total operating cost including maintenance & manpower
  - Economics – ROI, NPV etc.
- Technology, to consider for example:
  - Scale
  - Performance
  - Integration
- Commercial, to consider for example:
  - License agreements
  - Government cloud computing
  - Intellectual property landscape

IT Architecture Diagram – PHMSA VIS Cloud Computing and Big Data

As described previously, implementing a robust cloud computing big data system requires careful consideration of economics, technology and commercial aspects in addition to schedule. Increased complexity and scale yields corresponding cost and schedule. The VIS Hub should strive to achieve a state-of-the-art implementation as depicted here, and further detailed in Appendices XVII and XVIII.

Figure 9: Big Data Architecture



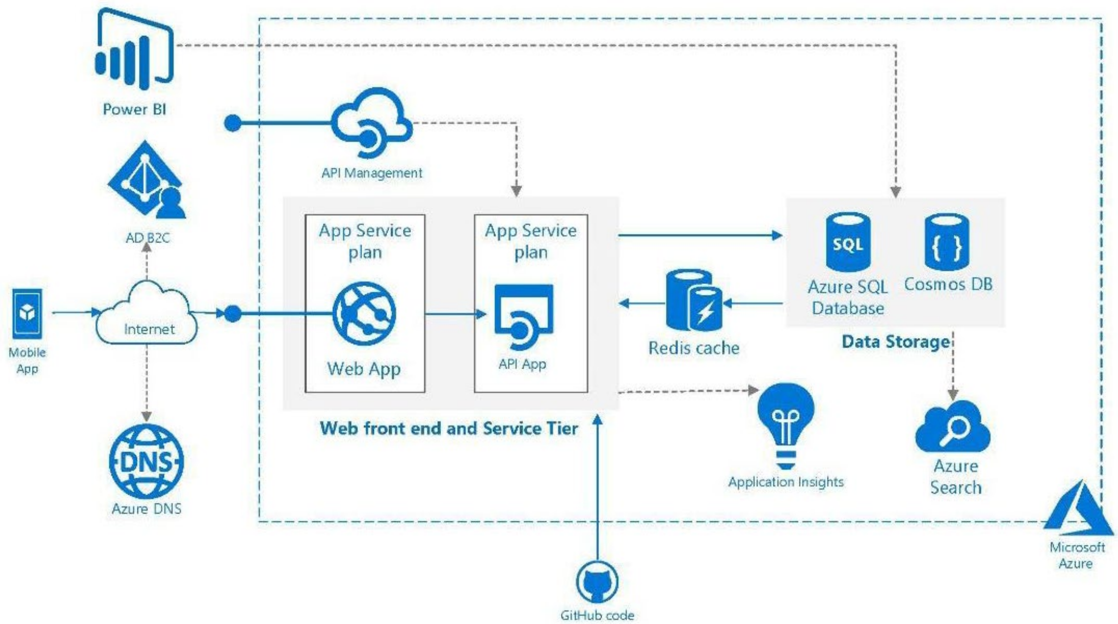
IT Architecture – PHMSA VIS Phased Approach

While a robust system could be in the future VIS Hub, the VIS WG advises starting small and gaining traction rather than an all-in approach. As such a Pipeline Safety Data system, depicted below, is proposed as the first of a phased approach, consisting of structured, qualified form-based safety information captured via a simple application and storage resident in the VIS Hub. The purpose of the app is to prevent incidents by encouraging employees of participants to voluntarily report safety issues and events. The VIS Hub will provide access to the data via a set of clearly defined methods of communication between various software components. These defined methods will support a set of subroutine definitions, protocols, and tools for analysis and reporting purposes.

Consideration 6: The VIS Hub should consider starting with a lower cost, quick-win, qualitative system for capturing and sharing safety related incidents around the industry. This system could be first of a phased approach, consisting of structured, qualified form-based safety information captured via a simple application with storage resident in the VIS Hub. The VIS Hub would provide access to the data and support tools for analysis and reporting purposes.

The VIS WG proposes a Pipeline Safety Data system, depicted in Figure 10, as the first of a phased approach, consisting of structured, qualified form-based safety information captured via a simple application and storage resident in the VIS Hub. The purpose of the app is to prevent incidents by encouraging employees of participants to voluntarily report safety issues and events. The VIS Hub will provide access to the data via a set of clearly defined methods of communication between various software components. These defined methods will support a set of subroutine definitions, protocols, and tools for analysis and reporting purposes.

Figure 10: Cloud Infrastructure for Cross-Platform Support



Cyber Security Considerations and Examples

Cyber security is concerned with three primary domains: confidentiality, integrity, and availability. Confidentiality refers to only those entities that require having access to information being able to access it. Integrity refers to only those entities that should modify information being able to. Availability refers to the system being up and able to respond to a request when required. These definitions and recommendations in this text are based on the NIST 800 standard, a set of basic standards for Information Security practices used in government agencies and public firms alike. Frameworks like NIST 800 provide a comprehensive foundation to understand and manage the cyber risk of an information system, and the VIS Hub should consider cyber security protections that follow a well-known standard like NIST 800-53.

The recommended VIS Hub would contain sensitive information and require strong cyber security practices to be implemented, protecting the data and systems from an unexpected breach. Further, the system will need to de-identify some information when aggregating and presenting reports to users of the system. Protecting the confidentiality of the pipeline operator, inspection service providers and any others who input data into the system.

Consideration 7: The VIS Hub should consider cyber security protections that follow a well-known standard like NIST 800-53. Cyber security is concerned with three primary domains, confidentiality, integrity, and availability. Confidentiality refers to only those entities that require having access to information being able to access it. Integrity refers to only those entities that should modify information being able too. Availability refers to the system being up and able to respond to a request when it's required. The NIST 800 standard is a set of basic standards for Information Security practices used in government agencies and public firms alike. Frameworks, *like NIST 800 provide a comprehensive foundation to understand and manage the cyber risk of an information system.*

Cybersecurity Standards and Operations

The VIS Hub would contain information that would have a serious adverse effect on the organization and industry if data were to be breached or interfered with. As such we would rate the security category, as defined in FIPS 199, as {(confidentiality, MODERATE), (integrity, MODERATE), (availability, LOW)}.

Considertion 8: The VIS Hub should consider that all data types be categorized using a framework like FIPS 199 to ensure confidentiality, integrity and availability. Following data categorization, a standard like NIST 800-53 could be used to protect the environment. It is proposed that this baseline be implemented according to a standard. Implementation of a standard would include many normal InfoSec practices, like system patching, vulnerability assessments, incident response planning, encryption and many other industry best practices.

The NIST 800-53 outlines many control families and with the aforementioned security categorization, the standard outlines security controls tailored to the FIPS 199 level. As required by NIST 800-53, a security operations team would need to be put in place. This team would be responsible for responding to cyber security incidents and performing audits of the environment to ensure expected outcomes. The security operations team would likely be in a shared services capacity within the organization housing the VIS environment.

Consideration 9: The VIS Hub should consider auditing and monitoring controls to be implemented as part of an overall framework and strategy. This framework includes assurance practices such as management review, risk assessments and audits of the cyber security controls. The audit program should be based on a common and well-known cybersecurity framework and cover sub-processes such as asset management, awareness training, data security, resource planning, recover planning, and communications. This includes consideration for use of automated systems/tools to capture and regularly audit system logs looking for suspicious or unexpected behavior. A strategy to continuously monitor the environment for compliance through audits, self-assessments, and a third-party cybersecurity assessment should also be considered.

Roles Based Authentication

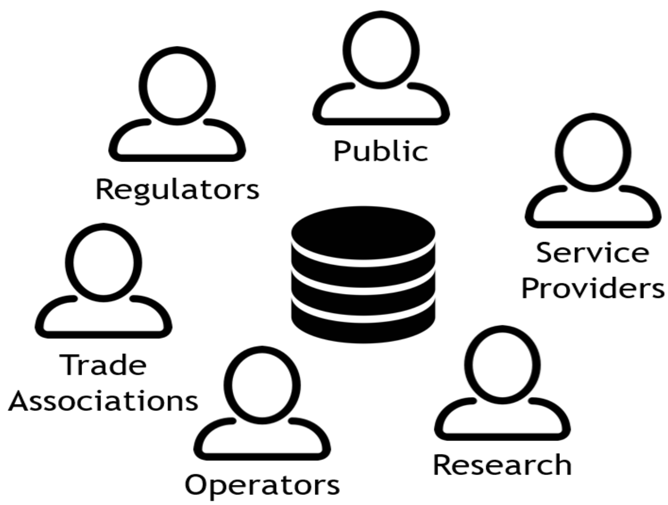
The NIST 800-53 standard calls for specific account management activities as part of the AC-2 control. The VIS Hub should consider the use of a role-based access control mechanism to control dissemination from data marts. These roles and their appropriate permissions need to be built into the system:

- Regulators
- Public
- Service Providers
- Researchers
- Asset Operators

- Trade Associations

Each principal user would require the ability to input data within the context of their role. Each principal user would require the ability to report on data they have input into the system, including the termination of their data via an opt-out capability. The 3rd party data manager would have full access to the data warehouse. The governance committee will be the sole responsible party to define the authorized access of data in the data mart.

Figure 11: Examples of Role-Based Access



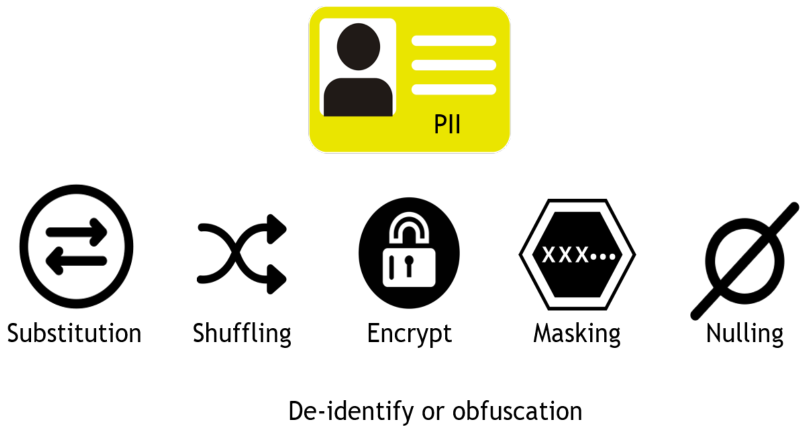
Consideration 10: The VIS Hub should consider the use of a role-based access control mechanism to control dissemination from data marts. These roles and their appropriate permissions need to be built into the system including, but not limited to: Regulators, Public, Service Providers, Researchers, Asset Operators, and Trade Associations. The 3rd party data manager would have full access to the data warehouse. The governance committee will be the sole responsible party to define the authorized access of data in the data mart.

Information Privacy

Privacy of an organizations data is a critical success factor to the VIS. While it is believed a research organization should maintain full access to the raw data in the data warehouse, the system will inevitably provide public or role-based reports that require de-identification. The following recommendations provide guidance for the implementation of privacy concerns:

- Remove of IDs or other identifiable information when reported.
- Remove all personally identifiable information for persons when the data enters the system.
- Abstract geographic context of pipeline assets when reporting publicly.

Figure 12: De-identify or Obfuscation Techniques



IT Governance Requisite

It will be essential to set up a governance body to ensure the practices listed above are being executed and updated as the VIS matures. The VIS WG recommends the establishment of a governance body that meets quarterly to drive the functionality, security, and privacy of the environment.

7. Conclusion

While the annual rate of pipeline incidents remains relatively low compared to other modes of transportation, significant incidents still occur and fall short of the industry's goal of zero incidents and accidents. The VIS WG determined that information sharing is an essential element of an effective pipeline safety management program and that there is a need for a voluntary information-sharing system. The creation of a viable, sustainable VIS would mark a historical breakthrough in pipeline safety and provide industry and regulators with continuous improvement in SMS and risk reduction in the U.S.

The VIS WG met with information sharing experts in various industries. The VIS WG analyzed how voluntary information sharing by pipeline safety stakeholders, might lead to opportunities for reducing pipeline incidents to zero. Implementing the VIS WG's primary and supporting recommendations will help advance pipeline safety. These recommendations will take careful planning and consideration. The Executive Summary offers an example of how to address the authorization, implementation, and deployment of these recommendations.

The VIS WG recommends that the Secretary and Congress take advantage of all the VIS WG has learned from the improvements in aviation safety due to voluntary information sharing systems established by the FAA and aviation participants. By establishing a pipeline safety VIS, supported by self-implementing statutes that are designed and informed by over 20 years of aviation industry evolution, Congress can create the conditions for the rapid build out of a VIS that will offer verifiable near term and long term improvements in pipeline safety.

8. Appendices

Appendix I: Key Terms, Acronyms, and Definitions

AA: American Airlines
American Airlines, Inc. is a major U.S. airline headquartered in Fort Worth, Texas, within the Dallas-Fort Worth metroplex. It is the world's largest airline when measured by fleet size, revenue, scheduled passengers carried, scheduled passenger-kilometers flown, and number of destinations served.

AEB: ASIAS Executive Board
The Executive Board that governs the Aviation Safety Information Analysis and Sharing System (ASIAS) procedures, operations and analysis activities.

AGA: American Gas Association
Represents companies delivering natural gas safely, reliably, and in an environmentally responsible way to help improve the quality of life for their customers every day. AGA's mission is to provide clear value to its membership and serve as the indispensable, leading voice and facilitator on its behalf in promoting the safe, reliable, and efficient delivery of natural gas to homes and businesses across the nation.

API: American Petroleum Institute
The largest U.S. trade association for the oil and gas industry and the only national trade association representing all facets of the oil and gas industry. Membership includes large integrated companies, as well as exploration and production, refining, marketing, pipeline, and marine businesses, and service and supply firms. API's mission is to promote safety across the industry globally and to influence public policy in support of a strong, viable U.S. oil and = gas industry.

API RP: API Recommended Practice
API documents that communicate recognized industry practices that may include both mandatory and non-mandatory requirements.

API RP 1173: API Recommended Practice 1173, Pipeline Safety Management Systems
The recommended practice that establishes a comprehensive pipeline safety management framework for pipeline operators to voluntarily identify and address safety for a pipeline's life cycle. A free, downloadable copy can be found at: https://pipelinesms.org/rp-1173/.

AQP: Advanced Qualification Program
A voluntary departure from traditional Federal Aviation Administration (FAA) Part 121 and 135 pilot training methods. Under an approved AQP a pilot need only demonstrate one type of non-precision approaches. AQPs place heavy emphasis on Crew Resource Management.

ASAP: Agency Safety Action Plan
ASAP, together with organizational review, is how the Pipeline and Hazardous Materials Safety Administration (PHMSA) leads by example. It constitutes a model for the entire pipeline sector to

take a close look at where safety improvements can be made and to take concrete steps to drive toward enhanced safety in a methodical and comprehensive way.

ASAP: Aviation Safety Action Program
The objective of the ASAP is to encourage air carrier and repair station employees to voluntarily report safety information that may be critical to identifying potential precursors to accidents.

ASIAS: Aviation Safety Information Analysis and Sharing System
Developed by the Federal Aviation Administration (FAA), ASIAS enables users to perform integrated queries across multiple databases, search an extensive warehouse of safety data, and display pertinent elements in an array of useful formats. A phased approach continues to be followed in the construction of this system. Additional data sources and capabilities will be available as the system evolves in response both to expanded access to shared data and to technological innovation.

ASME: American Society of Mechanical Engineers
A not-for-profit membership organization that enables collaboration, knowledge sharing, career enrichment, and skills development across all engineering disciplines, toward a goal of helping the global engineering community develop solutions to benefit lives and livelihoods. Founded in 1880, ASME has grown through the decades to include more than 130,000 members in 151 countries. 32,000 of these members are students.

ASNT: American Society of Nondestructive Testing
A nonprofit organization and technical society for nondestructive testing (NDT) professionals. ASNT publishes and maintains an important standard, SNT-TC-1A, which, with the addition of Codes of Practice ANSI/ASNT CP-189 and ANSI/ASNT CP-105, covers all aspects of qualification and certification of NDT personnel.

ATC: Air Traffic Control
A service provided by ground-based air traffic controllers who direct aircraft on the ground and through controlled airspace, and can provide advisory services to aircraft in non-controlled airspace.

CAST: Commercial Aviation Safety Team
Founded in 1997, CAST has developed an integrated, data-driven strategy to reduce the commercial aviation fatality risk in the United States and promote new Government and industry safety initiatives throughout the world.

CGA: Common Ground Alliance
A nonprofit organization dedicated to promoting shared responsibility in damage prevention. Representing individuals from 15 stakeholder groups and over 150 member organizations, the CGA works cooperatively with all interested stakeholders to identify and implement effective measures to protect the underground infrastructure during excavation activity.

COS: Center for Offshore Safety
An industry-sponsored group focused exclusively on offshore safety on the U.S. Outer Continental Shelf (OCS) that is responsible for developing of good practices for the offshore industry in SMS, industry continuous improvement, outreach and facilitation with government and external stakeholders.

DA: Direct Assessment
Direct Assessment is one of the PHMSA approved pipeline integrity assessments for external corrosion, internal corrosion or stress corrosion cracking on a pipeline.

Dig Verification Data
Validation measurement, as defined in API Recommended Practice 1163, which is the collection of information "in the ditch" (ITD) during a dig, or an above-ground anomaly from an anomaly identified for investigation and compared to the results of an ILI result.

DIRT: Damage Information Reporting Tool
A secure online database that allows damage prevention stakeholders to anonymously submit information about underground damages and near-miss incidents. DIRT then determines root causes, promotes underground damage prevention education and training efforts, and creates an industry-wide picture of opportunities to improve safety.

ECDA: External Corrosion Direct Assessment
A structured process that is intended to improve safety by assessing and reducing the impact of external corrosion on pipeline integrity. This standard is intended for use by pipeline operators and others who must manage pipeline integrity.

EDGAR: Electronic Data Gathering, Analysis, and Retrieval
A system of filings by corporations, funds, and individuals. It is intended to benefit electronic filers, enhance the speed and efficiency of Securities and Exchange Commission (SEC) processing, and make corporate and financial information available to investors, the financial community and others in a matter of minutes.

FAA: Federal Aviation Administration
The FAA mission is to provide the safest, most efficient aerospace system in the world; striving to reach the next level of safety, efficiency, environmental responsibility and global leadership.

FACA: Federal Advisory Committee Act
An act that ensures that all advice given by the various advisory committees formed over the years is objective and accessible to the public. It provides a process for establishing, operating, overseeing and terminating these advisory bodies.

FAF: Financial Accounting Foundation
An independent, private-sector, nonprofit organization responsible for the oversight, administration, financing and appointment of the Financial Accounting Standards Board (FASB) and the Governmental Accounting Standards Board (GASB).

FASB: Financial Accounting Standards Board
A private, nonprofit organization standard-setting body whose primary purpose is to establish and improve financial accounting and reporting standards, to include the U.S. Generally Accepted Accounting Principles (GAAP).

FERC: Federal Energy Regulatory Commission
The U.S. federal agency that regulates the transmission and wholesale sale of electricity and natural gas in interstate commerce and regulates the transportation of oil by pipeline in interstate commerce.

FIPS 199: Federal Information Processing Standard 199
Standards for Security Categorization of Federal Information and Information Systems, is an important component of a suite of standards and guidelines that National Institute of Standards and Technology (NIST) has developed to improve the security in federal information systems, including those systems that are part of the nation's critical infrastructure.

FOQA: Flight Operations Quality Assurance
FOQA uses digital flight data from normal line operations to provide insight into the safety of flight operations. It allows for objective comparison of an aircraft's performance against a company's own Standard Operating Procedures. This safety-critical insight highlights any occurrence where safety may have been compromised and gives a company an opportunity to implement corrective actions. As such, it forms a key element of a company's SMS.

Form 8-K: Current Report Pursuant to Section 13 OR 15(d) of the Securities Exchange Act of 1934
A report of unscheduled material events or corporate changes at a company that could be of importance to the shareholders or the Securities and Exchange Commission (SEC). It also notifies the public of events reported, including acquisition, bankruptcy, resignation of directors or a change in the fiscal year.

Form 10-Q: U.S. Securities and Exchange Commission Form 10-Q
A SEC form that serves as comprehensive report of a company's performance that must be submitted quarterly by all public companies to the SEC.

FR: Federal Register
The official journal of the U.S. Federal Government that contains rules, proposed rules, and public notices of Federal agencies and organizations, as well as executive orders and other presidential documents.

FRA: Federal Railroad Administration
Created by the Department of Transportation (DOT) Act of 1966, the FRA is one of ten agencies within DOT concerned with intermodal transportation, safety, and efficient movement of people and goods.

GAAP: Generally Accepted Accounting Principles
A collection of commonly-followed accounting rules and standards for financial reporting, set to ensure that financial reporting is transparent and consistent from one organization to another.

GAJSC: General Aviation Joint Steering Committee
A public-private partnership working to improve general aviation safety. The GAJSC uses a data-driven, consensus-based approach to analyze aviation safety data and develop risk reduction efforts.

GASB: Governmental Accounting Standards Board
A private, non-governmental organization that is the source of generally accepted accounting principles (GAAP) used by state and local governments in the United States. Its mission is to establish and improve standards of state and local governmental accounting and financial reporting that will result in useful information for users of financial reports and guide and educate the public, including issuers, auditors, and users of those financial report. The GASB is subject to oversight by the Financial Accounting Foundation (FAF).

GIS: Geographic Information System
A system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data. GIS applications are tools that allow users to create interactive queries, analyze spatial information, edit data in maps, and present the results of all these operations.

GTI: Gas Technology Institute
GTI works to solve important energy challenges, turning raw technology into practical solutions that create exceptional value for our customers in the global marketplace. It is driven by its main objectives being expansion and promotion natural gas and clean energy resources, ensuring reliable delivery infrastructure, and reduction of carbon emissions to the environment.

HT: Hyper-Threading Technology
Intel's simultaneous multi-threading design that allows a single processor to manage data as if it were two processors by handling data instructions in parallel rather than one at a time. HT is designed to improve system performance and efficiency.

HUB: A group of people or community of practice who are authorized to work with "identified" data submitted by VIS participants.

ICDA: Internal Corrosion Direct Assessment
A process that can be used to assess pipeline integrity, based on identifying areas along the pipeline where internal corrosion is most likely to exist.

ILI: In-Line Inspection
Typically refers to the tool but can also refer to the process of in-line assessment.

IMP: Integrity Management Programs
Pipeline safety regulations include requirements for pipeline operators of hazardous liquid and natural and other gas transmission and distribution pipelines to develop and implement

comprehensive integrity management programs. These integrity management regulations are codified in Title 49 of the Code of Federal Regulations (CFR) Part 195, § 195.452 for hazardous liquid pipelines, Part 192, Subpart O for gas transmission pipelines, and Part 192, Subpart P for gas distribution pipelines.

INGAA: Interstate Natural Gas Association of America
A trade organization that advocates regulatory and legislative positions of importance to the natural gas pipeline industry in North America. INGAA is comprised of 27 members, representing a large majority of the interstate natural gas transmission pipeline companies in the U.S. and Canada. INGAA members operate almost 200,000 miles of pipeline. PHMSA oversees the industry's safety efforts, while the Federal Energy Regulatory Commission (FERC) is responsible for the economic regulation of pipelines.

IOT: Internet of Things
The interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.

ITD: In the Ditch
Methods used by technical personnel to examine anomalies on pipe.

KPI: Key Performance Indicator
A metric that demonstrates how effectively key objectives are being met. KPIs for the VIS would demonstrate the amount of voluntary participation and data available for the analyses that would drive technological and safety improvements.

MD&A: Management Discussion and Analysis
The section of a company's annual report in which management provides an overview of the previous year's operations and how the company performed financially.

MRO: Maintenance, repair and overhaul
An essential requirement to ensure that commercial aircraft are maintained in pre-determined conditions of airworthiness to safely transport passengers and cargo.

NAPSR: National Association of Pipeline Safety Representatives
A nonprofit organization of state pipeline safety regulatory personnel who serve to promote pipeline safety in the United States and its territories. NAPSR members support the safe delivery of pipeline products by conducting inspections of pipeline operators to determine compliance with applicable state and federal pipeline safety requirements under a certification agreement.

NDE: Nondestructive Examination
Inspection techniques used to evaluate and measure anomalies or damage to a pipe. Common techniques include magnetic particle inspection, ultrasonic inspection and X-ray.

NIST: National Institute of Standards and Technology
NIST is a U.S. government non-regulatory agency that promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

NPMS: National Pipeline Mapping Systems
A dataset containing locations of and information about gas transmission and hazardous liquid pipelines and Liquefied Natural Gas plants which are under the jurisdiction of the PHMSA. The NPMS also contain voluntarily submitted breakout data, which is used by PHMSA for emergency response, pipeline inspections, regulatory management and compliance, and analysis purposes. It is used by government officials, pipeline operators and the general public for variety of tasks, including emergency response, smart growth planning, critical infrastructure protection and environmental protection.

NTSB: National Transportation Safety Board
An independent U.S. government investigative agency responsible for civil transportation accident investigation. In this role, the NTSB investigates and reports on aviation incidents, certain types of highway crashes, ship and marine accidents, pipeline incidents, and railroad accidents. The NTSB is also in charge of investigating cases of hazardous materials releases that occur during transportation.

OCS: U.S. Outer Continental Shelf
The OCS consists of the submerged lands, subsoil, and seabed in a specified zone up to 200 nautical miles or more from the U.S. coastline. It is regulated by the U.S. Federal government through the Outer Continental Shelf Lands Act. The OCS refers to 1.7 billion acres of Federal submerged lands, subsoil, and seabed generally beginning 3 nautical miles off the coastline (for most states) and extending for at least 200 nautical miles to the edge of the Exclusive Economic Zone, or even farther if the continental shelf extends beyond 200 nautical miles. The OCS has been divided into four regions: Atlantic, Gulf of Mexico, Pacific, and Alaska.

PCAOB: Public Company Accounting Oversight Board
A private-sector, nonprofit corporation established by Congress to oversee the audits of public companies to protect investors and the public interest by promoting informative, accurate, and independent audit reports. It also oversees the audits of brokers and dealers, including compliance reports filed pursuant to federal securities laws, to promote investor protection.

PHMSA: Pipeline and Hazardous Materials Safety Administration
A Federal agency under the U.S. Department of Transportation. It oversees the nation's pipeline infrastructure and develops and enforces regulations for the safe, reliable, and environmentally sound operation of pipeline transportation. It is responsible for daily shipments of hazardous materials by land, sea, and air.

PIPES Act: Pipelines and Enhancing Safety Act of 2016
Congressional mandate that strengthens PHMSA's safety authority and includes many provisions that will help PHMSA fulfill its mission of protecting people and the environment by advancing the safe transportation of energy and other hazardous materials.

Pipeline Operators:
Any owner or operator of a pipeline or facility under PHMSA's jurisdiction or regulatory authority including: (1) gas transmission, (2) gas distribution, and (3) hazardous liquid transmission.

Pipeline Safety Stakeholders:
A person, group, or organization that has interest or concern with pipeline safety. Stakeholders can affect or be affected by pipeline safety related activities, regulations, policy, mandates and/or laws. Some examples of stakeholders include: Congress, federal and state regulators, public officials, tribal governments, pipeline safety and environmental advocates, the public, environmentalists, non-government organizations, pipeline operators and owners, industry trade associations, research institutions, service providers, material suppliers, excavators, and labor representatives.

POD: Probability of Detection
The probability of a feature being detected by an ILI tool.

POF: Probability of False Call
The probability of a non-existing feature being reported as a feature.

POI: Probability of Identification
The probability that the type of an anomaly or other feature, once detected, will be classified correctly (e.g. a metal loss, dent, etc.)

PQ: Personnel Qualification Standard
A written list of knowledge and skills a person must have to qualify for specific types of jobs or roles.

PRCI: Pipeline Research Council International
PRCI was established in 1952 as the Pipeline Research Committee of the American Gas Association (AGA) and became an independent not-for-profit corporation in 2000. PRCI's initial charter was to confront the problem of long-running brittle fracture in natural gas transmission pipelines. Although initially an organization focused solely on pipelines in North America, PRCI began to broaden its membership and technical perspectives beginning in 1980 with many members from outside of North America.

R&D: Research and Development
A series of investigative activities to improve existing products and procedures or to lead to the development of new products and procedures.

RCFA: Root Cause Failure Analysis
The process of identifying the most basic reason for a failure which, if eliminated or corrected, would have prevented it from existing or occurring. That "basic reason" is generally referred to as the root cause. There can be and often are multiple causes involved when a failure occurs.

SCCDA: Stress Corrosion Cracking Direct Assessment
A procedure that can identify areas where either near-neutral-pH or high-pH stress corrosion cracking can occur on external pipe surfaces.

SEC: Securities and Exchange Commission

A group that protects investors, maintains fair, orderly and efficient markets, and facilitates capital formation, to promote a market environment that is worthy of the public's trust.

Section 10 of Public Law 114-183 (Information-sharing System)
Not later than 180 days after the date of the enactment of this Act, the Secretary of Transportation shall convene a working group to consider the development of a voluntary information-sharing system to encourage collaborative efforts to improve inspection information feedback and information sharing with the purpose of improving gas transmission and hazardous liquid pipeline facility integrity risk analysis. The Secretary shall publish the recommendations provided under subsection (c) on a publicly available Website of the DOT.

Securities Exchange Act of 1934
With this Act, Congress created the Securities and Exchange Commission (SEC). It empowers the SEC with broad authority over all aspects of the securities industry.

SGA: Southern Gas Association
The SGA mission is to grow individuals and advance the industry by linking people, ideas and information. SGA supports member company volunteers and industry leaders who work to actively engage the industry for a sustainable tomorrow.

Smart Pig
An inspection device that is sent down a pipeline and propelled by the pressure of the product flow in the pipeline itself. A smart pig records information about the internal conditions of a pipeline.

SME: Subject Matter Expert
A subject-matter expert is a person who is an authority in a particular area or topic.

SMS: Safety Management System(s)
A formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of safety risk controls. It includes systematic procedures, practices, and policies for the management of safety risk.

SPI: Safety Performance Indicators
The process of measuring and monitoring safety-related outcomes associated with a given operational system or organization.

U.S. DOT: U.S. Department of Transportation
A federal cabinet department under the U.S. Government responsible for matters of transportation and governed by the U.S. Secretary of Transportation.

VIS: Voluntary Information-sharing System
A system where pipeline operators and other stakeholders can voluntarily share information and data. The system is designed to encourage collaborative efforts to improve inspection information feedback and sharing. The purpose of this effort is to improve gas transmission, gas distribution, and hazardous liquid transmission pipeline facility integrity risk analysis.

VIS Hub: Voluntary Information-sharing System Hub
The technology platform that encourages collaborative efforts to improve inspection information feedback and information sharing with the purpose of improving gas transmission, gas distribution, and hazardous liquid pipeline integrity risk analysis. It will be a robust system architecture that is secure and will ensure anonymity. It will possess scalability, elasticity and resiliency. It will store and process data from disparate and potentially diverse sources with varying degrees of structure, and have the ability to visualize & deliver informative results for all pipeline safety stakeholders.

VIS WG: Voluntary Information-sharing System Working Group
A federal advisory committee, established in December 2016, in accordance with the Federal Advisory Committee Act, to fulfill Section 10 of the "Protecting our Infrastructure of Pipelines and Enhancing Safety (PIPES) Act" of 2016. The VIS WG will provide the Secretary of Transportation with independent recommendations on the development of a VIS.

XBRL: eXtensible Business Reporting Language
An XML (eXtensible Markup Language) standard for tagging business and financial reports to increase the transparency and accessibility of business information by using a uniform format.

Appendix II: VIS WG Charter

CHARTER

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Voluntary Information-Sharing System Working Group

1. Committee's Official Designation: The committee will be known as the Voluntary Information-Sharing System Working Group (the Group).

2. Authority: The Group is established pursuant to section 10 of the Protecting our Infrastructure of Pipelines and Enhancing Safety (PIPES) Act of 2016 (Public Law 114-183), and in accordance with the Federal Advisory Committee Act (FACA), as amended, (5 U.S.C. App. 2).

3. Objectives and Scope of Activities: The Group shall provide the Secretary of Transportation (the Secretary) with independent advice and recommendations on the development of a voluntary information-sharing system designed to encourage collaborative efforts to improve inspection information feedback and sharing. The purpose of this effort is to improve gas transmission and hazardous liquid pipeline facility integrity risk analysis.

4. Description of Duties: In accordance with section 10 of Public Law 114-183, the Group shall consider and provide recommendations to the Secretary on:
   a. The need for, and the identification of, a system to ensure that dig verification data are shared with in-line inspection operators to the extent consistent with the need to maintain proprietary and security-sensitive data in a confidential manner to improve pipeline safety and inspection technology;
   b. Ways to encourage the exchange of pipeline inspection information and the development of advanced pipeline inspection technologies and enhanced risk analysis;
   c. Opportunities to share data, including dig verification data between operators of pipeline facilities and in-line inspector vendors to expand knowledge of the advantages and disadvantages of the different types of in-line inspection technology and methodologies;
   d. Options to create a secure system that protects proprietary data while encouraging the exchange of pipeline inspection information and the development of advanced pipeline inspection technologies and enhanced risk analysis;
   e. Means and best practices for the protection of safety and security-sensitive information and proprietary information; and
   f. Regulatory, funding, and legal barriers to sharing the information described in paragraphs (a) through (d).

   The Secretary shall publish the Group's recommendations on a publicly available Department of Transportation website.

5. Agency or Official to Whom the Committee Reports: The Group reports to the Secretary of Transportation.

6. Support: The Pipeline and Hazardous Materials Safety Administration (PHMSA) will provide support as the Group's sponsor.

7. Estimated Annual Operating Costs and Staff Years: The estimated annual operating cost is approximately $150,000, including 0.5 full-time equivalent in staff support.

8. Designated Federal Officer: The Group's Designated Federal Officer (DFO) must be a full-time or permanent part-time employee appointed in accordance with agency procedures. PHMSA's Deputy Associate Administrator for Pipeline Policy and Programs—or that individual's designee—will serve as the DFO. Alternate DFOs may be appointed. The DFO will approve or call all advisory committee and subcommittee meetings, prepare and approve all meeting agendas, attend all committee and subcommittee meetings, adjourn any meeting when the DFO determines adjournment to be in the public interest, and chair meetings when directed to do so by the Secretary.

9. Estimated Number and Frequency of Meetings: The Group will meet on an as needed basis.

10. Duration: Continuing. The Group's purpose, however, will be fulfilled once its recommendations are published online.

11. Termination: This Charter will terminate one year after its effective date unless:
    a. Renewed in accordance with FACA and other applicable requirements; or
    b. The Group is terminated earlier because it has fulfilled the purpose for which it was established.

12. Membership and Designation: The Group will consist of no more than 25 members appointed by the Secretary for a term of three years, including representatives from:
    a. PHMSA;
    b. Industry stakeholders, including pipeline inspection organizations and operators of pipeline facilities, inspection technology, coating, and cathodic protection vendors;
    c. Safety advocacy groups;
    d. Research institutions;
    e. State public utility commissions or State officials responsible for pipeline safety oversight;
    f. State pipeline safety inspectors;
    g. Labor representatives;
    h. Other entities, as determined appropriate by the Secretary.

    All members serve at the pleasure of the Secretary and may be reappointed for additional terms. To the maximum extent practicable, the Secretary will ensure the membership is fairly balanced regarding points of view of the affected interests.

A member chosen for his or her individual views or advice must be appointed as a Special Government Employee (SGE). Other members will serve as Representatives or Regular Government Employees (RGEs).

If a member misses two or more regularly scheduled meetings of the Group each calendar year, without good cause, their membership may be terminated at the discretion of the Secretary. If a membership is terminated in this manner, the vacancy may be filled for the unexpired portion of the term.

13. Subcommittees: PHMSA has the authority to create subcommittees. Subcommittees must report back to the parent committee, and must not provide advice or work products directly to PHMSA or the Secretary.

14. Recordkeeping: Records of the Committee, formally and informally established subcommittees, or other subgroups of the committee will be handled in accordance with General Records Schedule 6.2 or other approved agency records disposition schedules. These records will be available for public inspection and copying, subject to the Freedom of Information Act, 5 U.S.C. 552.

15. Filing Date: The effective date of this charter is November 2, 2018, and will expire one year from that date on November 2, 2019, unless renewed.

6. Support: The Pipeline and Hazardous Materials Safety Administration (PHMSA) will provide support as the Group's sponsor.

7. Estimated Annual Operating Costs and Staff Years: The estimated annual operating cost is approximately $250,000 for travel, meeting space, and recording proceedings, plus one-half of a full-time equivalent in staff support. This amount also covers limited conference management support for meetings provided by a contractor.

8. Designated Federal Officer: The Group's Designated Federal Officer (DFO) must be a full-time or permanent part-time employee appointed in accordance with agency procedures. PHMSA's Deputy Associate Administrator for Pipeline Policy and Programs—or that individual's designee—will serve as the DFO. The DFO will approve or call all advisory committee and subcommittee meetings, prepare and approve all meeting agendas, attend all committee and subcommittee meetings, adjourn any meeting when the DFO determines adjournment to be in the public interest, and chair meetings when directed to do so by the Secretary.

9. Estimated Number and Frequency of Meetings: The Group will meet approximately four times per year.

10. Duration: Continuing; however, the Group's purpose will be fulfilled once its recommendations are published online.

11. Termination: This charter will terminate 2 years after its effective date unless:
    a. Renewed in accordance with FACA and other applicable requirements or
    b. The Group is terminated earlier because it has fulfilled the purpose for which it was established.

12. Membership and Designation: The Group will consist of no more than 30 members appointed by the Secretary for a term of 3 years, including representatives from:
    a. PHMSA;
    b. Industry stakeholders, including operators of pipeline facilities, inspection technology, coating, and cathodic protection vendors, and pipeline inspection organizations;
    c. Safety advocacy groups;
    d. Research institutions;
    e. State public utility commissions or State officials responsible for pipeline safety oversight;
    f. State pipeline safety inspectors;
    g. Labor representatives; and
    h. Other entities, as determined appropriate by the Secretary.

Appendix III: VIS WG Bylaws

BYLAWS

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Voluntary Information-Sharing System Working Group

Section I: Purpose

The purpose of the Voluntary Information-Sharing System (VIS) Working Group is to consider the development of a voluntary information-sharing system to encourage collaborative efforts to improve inspection information feedback and information sharing with the purpose of improving gas transmission and hazardous liquid pipeline facility integrity risk analysis.

The VIS Working Group is a Department of Transportation (DOT) advisory committee. As the VIS Working Group's sponsor, the Pipeline and Hazardous Materials Safety Administration (PHMSA) provides support to the working group.

Section II: Authority

The VIS Working Group is established in accordance with section 10 of the Protecting Our Infrastructure of Pipelines and Enhancing Safety (PIPES) Act of 2016 (Public Law 114-183), the Federal Advisory Committee Act (FACA) of 1972 (5 U.S.C., App. 2, as amended), and 41 C.F.R. § 102-3.50(a).

Section III: Membership Selection and Appointment

The committee membership size will be in accordance with the VIS Working Group charter and will be large enough to promote deliberations, but will include only the number necessary to achieve the breadth and balance of expertise required to accomplish its mission. Appointments are personal to the member and are not transferrable to another individual. Members may not designate someone to attend in their stead, participate in discussions, or vote.

The advisory committee should have a fairly balanced membership that will be defined by several factors, including: the advisory committee's mission; the geographic, ethnic, social, economic, or scientific impact of the advisory committee's recommendations; the types of specific perspectives required; the need to obtain divergent points of view on the issues before the committee; and the relevance of state, local, or tribal governments to the development of the advisory committee's recommendations.

Membership is voluntary; however, members are expected to attend and participate in meetings, including those held via teleconference or through another electronic medium. Additionally, members may be required to provide written input for reports and recommendations.

The Secretary of Transportation (Secretary) appoints all members for terms of three years. The Secretary may reappoint serving members for additional terms, if warranted. If a vacancy occurs, PHMSA will take action to fill the vacancy. When the VIS Working Group terminates, all appointments to the VIS Working Group will terminate.

Section IV: Meeting Procedures

A. Agenda
   - Committee staff will develop the committee meeting agenda with input from the chairperson.
   - The Designated Federal Officer (DFO) will approve the agenda for all committee meetings. PHMSA will distribute the draft agenda to committee members prior to each meeting and will publish a summary of the agenda in the Federal Register meeting notice. Non-members, including members of the public, may suggest agenda items.

B. Minutes and Records
   - The DFO is responsible for ensuring that minutes of each meeting are taken and copies are distributed to each committee member. If transcription services are used for a meeting, an individual still must take minutes for the meeting. The chairperson must certify the accuracy of the minutes for each meeting. The DFO must ensure that minutes are certified within 90 calendar days of the meeting to which they relate.
   - The meeting minutes must include:
     - The time, date, and place of the advisory committee meeting;
     - A list of the people present at the meeting, including advisory committee members and staff, agency employees, and members of the public who presented oral or written statements;
     - An accurate description of each matter discussed and the resolution, if any, made by the advisory committee regarding such matters; and
     - Copies of each report or other documents received, issued, or approved by the advisory committee at the meeting.
   - Reports, transcripts, minutes, agendas, handouts, and other documents made available to, prepared for or prepared by the advisory committee for open meetings will be posted on the public docket and on the PHMSA website.

C. Open Meetings
   - Unless otherwise determined in advance, all meetings will be open to the public and announced in a notice published in the Federal Register at least 15 calendar days before the meeting. All committee meetings will be held at a reasonable time and in a manner or place reasonably accessible to the public.
   - Members of the public may attend any meeting or portion of a meeting that is not closed to the public and, at the determination of the chairperson and DFO, may offer oral comment at such meeting. Meetings will include a period for oral comments unless it is impracticable to do so. The chairperson may decide in advance to exclude oral public comment during a meeting, in which case the meeting announcement published in the Federal Register will note that oral comments from the public are excluded and will invite written comments as an alternative. Members of the public may submit written statements at any time.

D. Closed Meetings
   - All or parts of the committee meeting may be closed in limited circumstances and in accordance with applicable law. No meeting may be partially or fully closed unless the request for the closed meeting is approved by DOT's Office of General Counsel

(OGC) 30 calendar days before publication of the Federal Register meeting notice. The meeting notice must cite the specific exemption or exemptions of the Government in the Sunshine Act (GISA), 5 U.S.C. § 552b(c), that justify the closure.
- Detailed minutes for closed or partially closed meetings must also be kept. Minutes from closed meetings will not be posted on the public docket or on the PHMSA website.

Section V: Voting

When a decision or recommendation of the VIS Working Group is required, the chairperson will request a motion for a vote. Any member, including the chairperson, may make a motion for a vote. A quorum is required for a vote. In other words, a majority of the current members of the VIS Working Group must be present – whether attending in person, by teleconference, or through another electronic medium – at a meeting to perform the committee's statutory duties. The DFO will assure there is adequate representation of members to ensure a fair and comprehensive vote.

Section VI: Roles

A. Chairperson
- Designated by the DFO, is an appointed committee member, and is the presiding officer of the committee who guides efforts to complete assigned tasks.
- May establish subcommittees subject to the DFO's approval.
- Works with the DFO to establish priorities, identify issues that must be addressed, and determine the level and types of staff and financial support required.

B. DFO
- Serves as the government's agent for all matters related to the committee's activities.
- Must approve or call the committee meeting; approves meeting agendas; attends all meetings; adjourns the meetings when adjournment is in the public interest; serves as chairperson when directed by the committee's sponsor, PHMSA; and monitors the committee's meetings and progress.
- Ensures there is office space, equipment, supplies, adequate staff support for the committee, and that the following functions are performed: (1) members are notified of the time and place for each meeting; (2) records are maintained for all meetings, including those of subcommittees; (3) the roll is maintained; (4) the minutes are prepared, including those for subcommittees; (5) official correspondence is addressed; (6) official committee records are maintained and papers and submissions are filed and prepared for or by the committee, including those items generated by subcommittees; (7) vouchers for pre-approved expenditures are collected validated and paid; and (8) reports are prepared, including those required under 41 C.F.R. § 102-3.175.

C. Advisory Committee Manager
- Serves as the communication link between the pipeline safety office and the committee members.
- Manages committee meetings and the maintenance of committee records.
- Provides support services for the operation of the committee.

- Responsible for organizational and logistical issues.

D. Committee Member
  - An appointed individual to the committee who attends and participates in committee meetings.
  - Gathers information as necessary to discuss issues presented.
  - Deliberates and provides verbal or written consensus advice to the Secretary.

E. Committee Staff
  - Any Federal employee, private individual, or other party (whether under contract or not) who is not a committee member, and who supports the committee and/or any subcommittees that may be established.

Section VII: Compensation and Expense Reimbursement

Committee members are not compensated for their services. In compliance with FACA, members, while engaged in the performance of their duties away from their home or regular places of business, may be allowed travel expenses, including per diem.

Section VIII: Creating Subcommittees

As deemed necessary, the chairperson may establish subcommittees with PHMSA's approval. It is recommended that all subcommittee members be members of the parent committee. If this is not feasible, at least some members, including the chairperson must be members of the parent committee. Subcommittees of a continuing nature must be listed in the VIS Working Group charter and updated at renewal time. Subcommittee reports must be submitted to the parent committee for review and approval.

Subcommittees may not provide advice or work products or report directly to PHMSA or the Secretary or otherwise act independently of the VIS Working Group.

Appendix IV: VIS WG Subcommittee Members

VIS WG Subcommittee Members							
Role	**Mission and Objectives**	**Process Sharing**	**Best Practices**	**Technology/R&D**	**Competence, Awareness, and Training**	**Regulatory, Funding, Legal**	**Reporting**
PHMSA Alternate Designated Federal Officials (ADFO)	Nancy White	Dr. Sherry Borener	Max Kieba	Chris McLaren	Dr. Douglas White	Michelle Freeman	Karen Lynch
PHMSA Support Staff				Amy Nelson	Hung Nguyen	Amal Deria	Cheryl Whetsel
				Paul Mountkhaty		Tewabe Asebe	
						Paul Mountkhaty	
Committee Members	**Dan Cote (Chair)**	**Mark Hereth**	**Eric Amundsen**	**Bryce Brown**	**Leif Jensen**	**Randy Parker**	**Dr. Simona Perry**
	Holly Pearen	Dan Cote	Leif Jensen	Chris Warner	Bob Buchanan	Leif Jensen	Kate Blystone
	Walter Jones	Mike LaMont	Mark Hereth	Bob Buchanan	Dr. Yiming Deng	Holly Pearen	Holly Pearen
	Randy Parker	Joe Subsits	Mike LaMont	Mark Zuniga	John MacNeill	Eric Amundsen	Walter Jones
	Leif Jensen	Alicia Farag	Joe Subsits	Yiming Deng	Michael Keller		Randy Parker
	Joe Subsits	Kate Blystone	John MacNeill	Jason Cradit	Michelle Thebert		
		Leif Jensen	Kate Blystone	Michael Keller			
		Eric Amundsen	Bryce Brown	Alicia Farag			
		Bryce Brown	Walter Jones	Holly Pearen			
		Walter Jones	Randy Parker	Eric Amundsen			
		Michelle Thebert		Michael Bellamy			
		Randy Parker					
		Chris Warner					
External Members		Warren Randolph	Cliff Johnson	Cliff Johnson	Jason Montoya	Dane Jaques	
		Drew Helve		Jason Skow		Cynthia Dominik	
		Jim Crowley					

Appendix V: Subcommittee Tasks

Mission and Objectives (Governance) Subcommittee

Establish recommendations to support the mission and objectives of the VIS. Also, recommend governance considerations. The intent is to provide guidance to create an innovative information sharing system that improves industry standards, standardizes how information is shared, and makes reporting error simpler and less obstructive. Identify ways to encourage industry wide participation in the VIS that will lead to industry innovation and safety improvement. While information sharing platforms currently exist within the pipeline industry, these systems are generally closed groups that provide limited access.

Process Sharing Subcommittee

Produce recommendations for identification and improvement of the types of information and data shared among key stakeholders. This was accomplished through subcommittee deliberation, coordination with other subcommittees, consultations with outside experts, and synthesis of information collected during the subcommittee deliberation period.

Competency, Awareness, and Training Subcommittee

Provide recommendations on the appropriate level of competence in terms of education, training, knowledge and experience. When the program for voluntarily sharing pipeline safety information is established, considerations for implementation should include the following aspects.

- The necessary knowledge, skills, and abilities for key positions within the VIS organization. This would include members of any within VIS "Boards" or "SME (Subject Matter Expert) Teams," as well as employees working with a third-party data administrator;
- Hiring criteria for employees as well as selection criteria for positions that are appointed. Once roles have been filled, an on-going evaluation process should be established to ensure that data remains secure and that confidentiality is preserved.
- The assurance that those working with identified data will not compromise the non-punitive nature of the VIS.

Technology/R&D Subcommittee

Recommend secure system(s) architecture and make recommendations required for continuous improvement and/or needed development of technologies and methodologies.

The Technology addressed the identification of necessary components of a collaborative system (enterprise technology, information, and infrastructure) that can maintain proprietary and highly sensitive data and facilitate the seamless exchange and analysis of relevant pipeline inspection information (quantitative) across the industry from various assessment technologies/methods for improved pipeline safety, improved comprehension (capabilities/limitations), continuous improvement (need, functionality), further research and development, and threat/risk analysis purposes.

Best Practice Subcommittee

Evaluate existing processes (including other industry VIS models and practices) and make recommendations to the VIS WG on best practices that will promote the sharing of data and information in order to accomplish:

- Active participation of all stakeholders; compelled by the value proposition
- Integrity management process and technology improvements
    - Identification of current industry VIS processes and systems (PRCI, API, INGAA, SGA, Service Providers) and assessment of active participation by stakeholders
    - Identification of current gaps in data, technology and/or analytics that need to be closed
        - Sharing occurs between technology providers and pipeline operators
    - Sharing of enhanced processes and practices i.e. solutions to known problems including experience with new data/information technology
    - Training and education of lessons learned with respect to execution of the various integrity management processes
        - Improved analytics
        - Near misses
- Post incident related RCFA's and subsequent company/regulator learning
    - Systemic or acute process improvements
    - Cultural improvements
    - Technology/Technology deployment improvements
- Communication to and with stakeholders including regulators, public safety advocates, and the public.

Regulatory, Funding, Legal Subcommittee

To identify and make recommendations to the VIS WG to address regulatory, funding and legal barriers to a system designed to improve pipeline safety by encouraging the sharing of relevant pipeline safety information and inspection technology pipeline data between pipeline stakeholders.

Reporting Subcommittee

To serve as the integration point for all VIS WG subcommittees and by delivering strategic direction/management of a comprehensive report that will enable the VIS WG to provide the Secretary of Transportation with independent advice and recommendations on the development of a secure, voluntary information-sharing system(s).

Appendix VI: How VIS Could Contribute to Continuous Improvements

Varied Stakeholders' Need for Continual Improvement

There are five key stakeholders in the effort to assess and mitigate pipeline integrity concerns; the public, universities and research institutions, pipeline operators, regulators and pipeline integrity assessment service providers. A VIS would be a benefit to each of these key stakeholders by providing vital information that enhance pipeline integrity assessments and improve pipeline integrity. Some of the needs and benefits to these stakeholders are discussed in the following paragraphs.

Pipeline operators utilize the guidelines in API RP 1162 to communicate the presence of and threats to pipelines. However, the public has little visibility into pipeline integrity efforts or effectiveness of those efforts. Increasingly, the public is concerned about the safety and environmental impacts of existing and proposed pipelines. A VIS would enhance awareness of the integrity verifications being performed and the effectiveness of these assessments. Although the current public risk is relatively low, continuous improvement to pipeline integrity assessments would result in increasing public safety and decreasing environmental risk.

Universities and research institutions are working to identify potential opportunities to apply the insights from their research endeavors or to support applications for research funding. An effective VIS could enhance awareness of the limitations associated with current pipeline integrity assessments. Universities and research institutions could leverage these limitations to promote current research endeavors or justify research funding. The resulting improvements could lead to continuous improvement of pipeline integrity assessment technologies to the extent of additional needed R&D.

Regulators determine the appropriate response to new threats, and routinely evaluate emerging technologies and unique operator needs in response to special permit applications and changing operating conditions. The technical analysis required to evaluate new threats, special permit applications and state waivers can be time consuming, costly, and of limited applicability. A VIS could provide the data warehouse to assess the magnitude of new threats, the effectiveness of new technologies and the justification for special permits or waivers.

Pipeline operators assessing the integrity of their pipelines are faced with a wide array of integrity threats and potential tools/technologies from multiple service providers to choose from. There do exist industry standards/best practices and needed guidance on selecting and validating available tools/technologies and their applicable service providers. This process of tool/technology testing and service provider validation can be significantly enhanced by having the applicable data shared and available in a VIS. A VIS with metrics on the effectiveness of technologies for identifying specific threats will enhance a pipeline operators' decision-making when it comes to tool/technology selection as well as helping to establish confidence in that chosen with the associated service provider.

The global community of service providers who supply pipeline integrity assessment tools/technologies and services spend millions of dollars every year on continuous improvement, research and new product development. The service providers in question target their R&D activities at what they believe to be gaps in the industry's toolkit, hoping that by doing so they will be able to provide tools and services that will enhance pipeline operators' ability to identify and mitigate the threats to pipeline integrity. A VIS would enable these service providers to better identify these gaps and assess their technologies' performance when compared to the 'qualified' field verification measurements from live pipeline operations.

The 'Virtuous Cycle' for Continual Improvement

The ability to inform varied stakeholders and identify needed improvements or "gaps" would be likely to motivate a "Virtuous Cycle" where the stakeholders' priorities reinforce a cycle of continually improving technology, threat identification and pipeline integrity improvements. A VIS that shared information with pipeline operators, service providers, regulators, universities and research institutions and the public on the relative performance of the various pipeline integrity assessment technologies and processes, could also fuel a continuous improvement cycle.

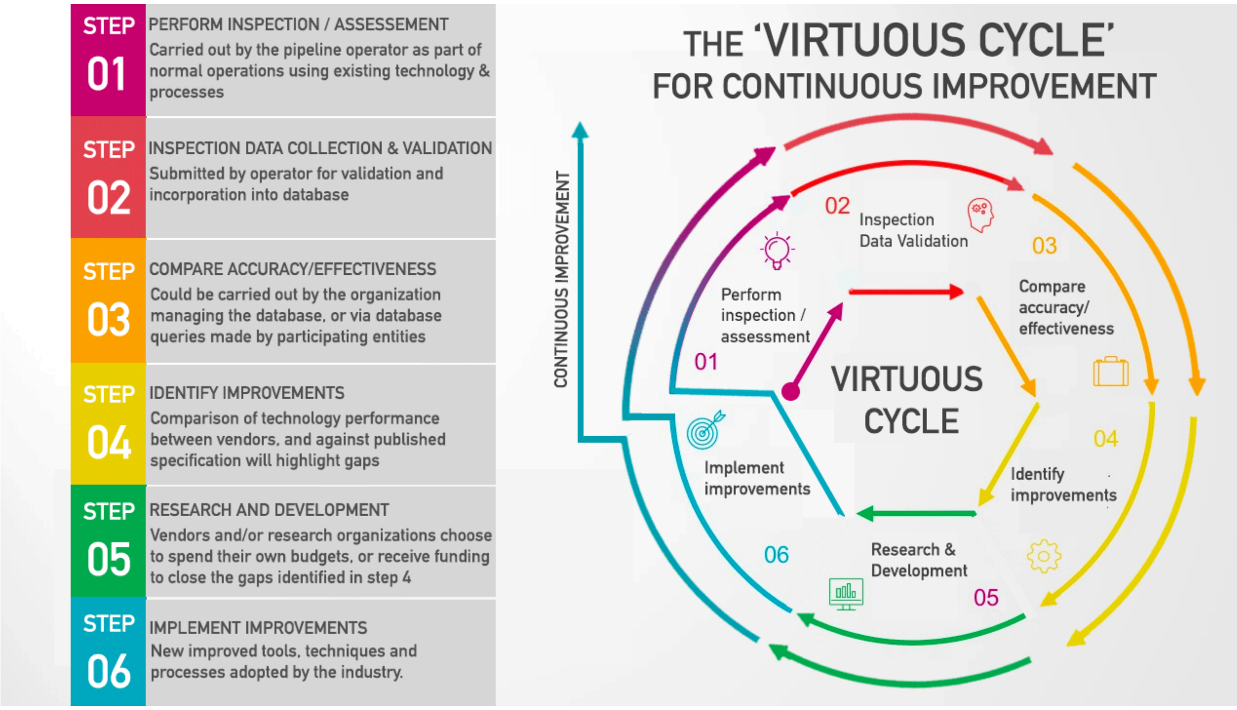
The researchers and developers of technologies and processes would make their investments with greater confidence concerning the gaps they were trying to fill. While service providers would be motivated by the awareness of their performance as compared to other technologies or other de-identified service providers. This awareness would be a strong motivation for quality improvements and/or technological investments.

Pipeline operators would be more aware of threats identified during other pipeline operators' integrity assessments and be able to assess the frequency of their actionable anomalies as compared to the frequency of other de-identified operators. This information would help them to better assess the effectiveness of their integrity management programs and their service provider or the operating/environmental conditions that may be affecting their performance. Once identified, pipeline operators would be motivated to seek technological or performance improvements that addressed the gaps identified and the result would be improved identification of integrity threats.

Pipeline operators, service providers, and regulators may also see benefit from a data sharing system that could help inform the technical analysis necessary to support permit applications, whether based on existing or new technology, and changes to regulations, thereby offering a potential route to streamline these processes.

Finally, the public would have better understanding of effectiveness of pipeline integrity assessment programs and various tools/technologies applied. The improved understanding could reduce public concern about pipeline operations but may also lead to pressure to utilize/develop new technology, enhance processes/procedures or modify/enhance regulations.

The gathering and sharing of data on tool/technology performance in real-world environments (e.g. 'live' pipeline operations) can thus be used to power a virtuous cycle that harnesses and focuses the existing dynamics around the pipeline industry to boost the process of technology improvement and adoption. In that regard, consideration should be given to development of strategies to particularly emphasize the value of data that indicates opportunities for technology improvement or helps identify technologies in need of additional development.



Virtuous Cycle of Technology Improvement

Applicability to Varied Pipeline Integrity Assessment Technologies - This virtuous cycle could be initiated for many different pipeline integrity assessment tools/technologies and processes, including but not limited to in-line inspection, direct assessment, non-destructive examination, leak detection, mark and locate, hydrotesting, geohazard identification, near misses, etc. Brief summaries for each of these technologies and potential outputs is provided below. A more detailed discussion of how the virtuous cycle could be initiated is provided in Attachments 1 & 2, case studies for In-Line inspection and ECDA respectively.

In-Line Inspection (smart-pig) – Different tool/technology types run inside the pipeline to identify and characterize anomalies caused by manufacturing, corrosion, cracking, or third-party damage. The type of data that could be analyzed includes:

- # of anomalies identified by type
- # of actionable anomalies
- # of actionable anomalies that required repair
- Size of actionable anomalies (w, l, d) as compared to in field measurements
- % of assessment with data collection issues (over speed, sensor loss, power loss)
- Miles assessed

Direct Assessment (ECDA, ICDA, SCCDA) – Standardized processes that utilize data integration, above ground testing of cathodic protection and environmental factors, direct examinations of the pipe at the locations most likely to have experienced damage and an overall assessment of the process' effectiveness. The types of data that could be analyzed includes:

- # of Immediate, scheduled and moderate anomalies identified
- # of actionable anomalies
- Correlation of DA anomalies to Direct Examination
- Miles assessed

Hydrostatic Testing – This pipeline integrity assessment pressurizes a pipeline to a level that results in the failure of any anomalies that would have grown to failure prior to the next assessment. The types of data that could be analyzed includes:

- Miles of hydrostatic testing
- # of failures per mile of testing
- # of failures per mile of pipe that was previously integrity assessed
- Type and dimension of anomaly that failed with associated pressures

Non-Destructive Testing – This testing is performed with a section of the pipeline exposed for examination. Usually this testing is performed to assess the significant anomalies identified by one of the other pipeline integrity assessments. The skill of the technician, the type of data collected, and the quality of the data collection are key to validating the effectiveness of the assessment tool.

Leak Detection – On gas distribution systems, the number of leaks and the type of leaks are key indicators of the main's integrity. The effectiveness of the leak detection process and identification of the leak cause could provide valuable data to the Operator. Key data includes:

- Leaks/mile by Material
- Leaks/mile by Age
- Leaks/mile by Coating
- Leaks/mile by Company (Data will be anonymous but could report average and top/bottom quartiles)
- Frequency of survey
- Type of survey
- # leaks and leak types

Locate and Mark – A key component for reducing 3rd Party Damage is an accurate and timely Locate and Mark process. Poor or late markings can result in avoidable 3rd Party Damage. Key data includes:

- Locator (Operator or Contractor)
- # tickets
- # tickets/locator-day
- # late locates
- # locate errors
- # 3rd Party Damage incidents

Geohazard Identification – A pipeline's integrity can be threatened by geohazards such as erosion, landslides or seismic activity. Geohazard identification techniques and the frequency of geohazard remediation may be useful to reduce geohazard threat. Key data could include:

- Identification techniques and frequency
  - Aerial surveys
  - Ground surveys
  - GIS files
- Geohazard events that resulted in actionable responses by the Operator

Near Misses – Collecting the "near miss" experiences of pipeline operators and service providers, will educate the industry on threats that may benefit from additional mitigation or controls. This data may be the most challenging to compile and analyze.

A summary of some of the different ways in which a VIS could motivate change and provide benefits in the future is expanded upon in the following table:

Summary of Possible Benefits from a Pipeline Integrity VIS

Context	Data/Information Type	Stakeholders	Benefit/ Outcome Value	Measures
Bolster deployment of best practices and technology	As-found anomaly data, ILI as-called data, relevant physical, environmental and operational data	Pipeline Operators, Service Providers	Assure consistent performance from best available technology and processes	Improved characterization and response, lower incident rates
Perfect the deployment of existing technology and analytical techniques	As-found anomaly data, ILI as-called data, relevant physical environmental and operational data, lessons learned	Pipeline	Improve performance from best available technology and processes	Improved characterization and response, lower incident rates
Improve state of the art of ILI technology or in-the-the-ditch assessment tools	Physical samples and data for unique or rare anomalies/interaction	Pipeline Operators, Regulators, Service Providers	New or significant improvement in technology including sensors and analytics	Success rate for identification, characterization and mitigation of problematic threats, lower incident rates
Identity and transparency of false negatives, low probability high consequence threats	Lessons learned, Case Studies, RCA Recommendations	Pipeline Operators, Regulators, Service Providers	Realization and mitigation of unique threats	New threats identified RCAs submitted
Stakeholder Communications	Industry integrity assurance capability, process and performance metrics, VIS outcomes	Pipeline Operators, Regulators, Public and Advocacy groups	Industry credibility and stakeholder confidence	**TBD**

Appendix VII: Technology and R&D ILI Case Study

Introduction

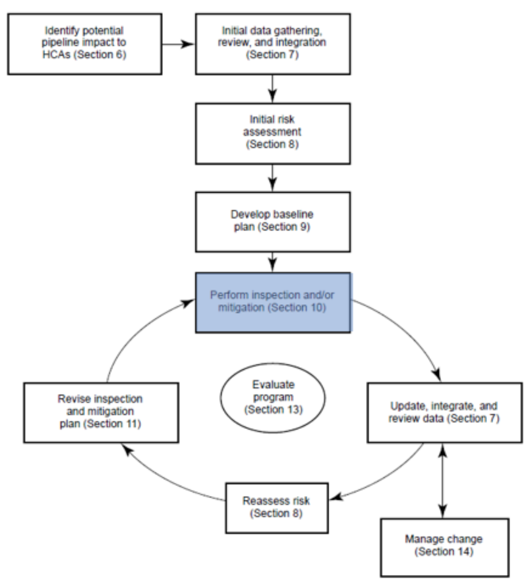
The considerations offered thus far are based on a review and gap analysis informed by two published works: 1) best practices, presented in API RP 1163, 'ILI Systems Qualification Standard', and 2) a case study, published as the PRCI Project NDE-4E, 'In-line Inspection Crack Tool Performance Evaluation'. Firstly, API RP1163 broadly describes the best-practice related to the use of in-line inspection technologies including data requirements, system validation, and qualification of technology and personnel and management systems. In practice, the broad nature of such a standard means that the possible range of implementations intended to satisfy the standard varies widely, increasing the chance for inconsistency and misinterpretation of data records. The considerations focus on improvements in the application of best practice(s) to meet the intention of the codes and standards (e.g. US CFR, API RP 1163, etc.) which will facilitate information sharing across the industry. Secondly, the case study PRCI ProjectNDE-4E describes the performance of ILI tools as they relate to the measurement of crack and 'crack-like' features in pipelines. The considerations based on this case study focus on process and technology gaps to be addressed to support information sharing.

General

In-Line Inspection (ILI) is an efficient and effective pipeline integrity assessment method to employ as part of an integrity management program (IMP).

From API RP 1160 and ASME B31.8S, the IMP process is depicted as follows:

Integrity Management Process



ILI has been effective in helping the pipeline industry reduce failures for dents/deformations, metal loss, "crack"/"crack-like" and coincident anomalies. It does this by detecting and characterizing pipeline anomalies and identifies potential anomalies before they fail resulting in the opportunity to manage "near misses". Despite this, pipelines sometimes fail after an ILI inspection indicating the need for continuous improvement and necessary focus on Technology and R&D to further improve ILI Systems, technology and applications. The Voluntary Information-sharing System (VIS) initiative aims to help address these opportunities to improve by sharing best practices and aggregating data from across the industry.

Continuous improvement and Technology and R&D efforts have been ongoing for many decades within the facilities of service providers, some pipeline operators as well as research organizations and engineering firms. This has been driven by market needs; the demand for these services have increased significantly over the past decade and a half, in-line and parallel to the changes to IMPs for High Consequence Areas (HCA's). It is envisioned that sharing the lessons learned (qualitative) and some discrete data points (quantitative) that a continuous improvement cycle can be established in the pipeline industry, similar to what has been done in other industries such as commercial aviation.

Traditionally, inspection programs have been ILI tool/technology driven. As with an IMP, ILI has a process driven approach. ILI involves much more than simply running a smart pig through the pipeline; rather the tool run, and subsequent data analysis are only one input into an engineering decision process that ultimately leads to action by the pipeline operator to ensure the ongoing integrity of their asset.

As referenced previously, API RP 1163, 'ILI Systems Qualification Standard', describes the overall ILI process. An ILI System includes procedures, personnel, equipment, and associated software. API RP 1163 references NACE SP0102, 'Recommended Practice: ILI of Pipelines', which outlines a process of related activities that a pipeline operator can use to plan, organize, and execute an ILI project. It describes the typical responsibilities of the operator and service provider in that process. It also references ASNT ILI-PQ, 'Personnel Qualification Standard', which establishes the general framework for the qualification and certification of industry specific personnel using nondestructive testing methods in the employment of ILI Systems. In addition, the document provides minimum education, experience, and training and examination requirements for different types of nondestructive testing methods used by ILI tools/technologies. These three documents form the basis for the successful implementation of ILI into an IMP.

Introduction

The development of API RP 1163, ILI Systems Qualification Standard, was initiated in 2001 and was first published in 2005 (first edition). The Standard is not ILI technology specific and can, therefore, accommodate present and future ILI System technologies. It is performance-based, but it does not define how to meet qualification requirements. One of the main objectives of this Standard is to foster continuous improvement in the quality and accuracy of ILIs. The Standard describes requirements (what, not how) for the qualification of ILI Systems used in natural gas and hazardous liquid pipelines, including the following:

a) Inspection service providers make clear, uniform, and verifiable statements describing ILI System performance;

b) Pipeline operators select an inspection system suitable for the conditions under which the inspection will be conducted. This includes, but is not limited to, the pipeline material characteristics, pipeline operating conditions, and types of anomalies expected to be detected and characterized;

c) The ILI System operates properly under the conditions specified;

d) Inspection procedures are followed, before, during and after the inspection;

e) Anomalies are described using a common nomenclature; and

f) The reported data and inspection results are within the expected accuracy and quality and described in a consistent format.

The use of an ILI System to manage the integrity of pipelines requires cooperation and interaction between ILI service provider and the pipeline operator. This Standard provides requirements that enable service providers and pipeline operators to clearly define the areas of cooperation required and ensures the satisfactory outcome of the inspection process. While service providers have the responsibility to define ILI System capabilities, their proper use, and application, pipeline operators bear the ultimate responsibility to;

a) Identify specific risks (threats) to be investigated,

b) Choose the proper inspection technology,

c) Maintain operating conditions within Performance Specification limits, and

d) Confirm inspection results.

ILI System Selection

One of the important aspects covered in section 5 of API RP 1163 is 'ILI System Selection'.
The selection of an ILI System relies upon:

- understanding, very clearly, the target threat(s) to integrity,
- understanding the physical and operational characteristics of the pipeline to be inspected, and more specifically any constraints,
- understanding the selection of the appropriate ILI System(s) capable of detecting, characterizing the expected threat(s) to integrity,
- understanding the needed sensitivity of the applied ILI System(s) to detect and characterize the objective threat(s) with sufficient fidelity, resolution and repeatability, and
- understanding the ability of the analysis system (underlying models/algorithms plus analyst procedures, training and competence) to recognize the presence of an anomaly, identify it and size it with confidence.

This important step of ILI System selection allows for an operator to initiate the discussion with the ILI service provider as to the selection of the appropriate ILI System(s) to meet the objective threat(s) to integrity based on the Performance Specification.

Performance Specification

The service provider shall state whether the chosen ILI System can meet the written Performance Specification in that pipeline and under the existing operating conditions, including the specific tool configuration for the proposed run. Filtering or data retention thresholds should be reviewed and established in consideration of the anticipated anomaly population, when applicable.

Another important step is in the understanding of how an ILI Systems Performance Specification is qualified.

It is in this step that requires the ILI service providers to describe the capabilities of their ILI System by means of the Performance Specification.

The Performance Specification covers the following important aspects of the ILI System;

- applicable anomalies, components, features and characteristics
- detection thresholds and probability of detection
- probability of identification
- sizing accuracy
- sizing capability
- limitations

It is important to note the typical anomalies, components, features and characteristics that might be applicable for a given ILI System(s);

- Metal loss
    - Corrosion (external and internal): minimum depth, length, width, and orientation.
    - Gouges: minimum depth, length, width, geometry and orientation
- Cracking anomalies (pipe body or weld). Minimum depth, length, width (opening), orientation, and proximity to other cracks, anomalies, or pipeline components
- Deformation
    - Dents: minimum depth, or reduction in cross-section, or reduction in diameter and orientation
    - Pipe ovality: minimum ovality
    - Wrinkles or 'ripples': minimum height and spacing & orientation
    - Buckles: minimum depth or reduction in cross-section or diameter & orientation
    - Expansion
    - Blisters or mid wall delaminations
- Metallurgical
    - Cold work: presence of and severity
    - Hard spots: minimum diameter of hard spot and difference in hardness between the hard spot and the base material
    - Manufacturing anomalies (such as slugs, scabs, and slivers): minimum dimensions and position
- External coating faults: minimum dimensions
- External coating transitions

- Girth welds, seam welds
- Other anomalies, conditions, or pipeline components as required, dependent on industry standards or practices
- Spatially coincident features (e.g. crack in corrosion)

The Performance Specification covers/defines the statistical confidence with which the ILI System (tool plus analysis process) can detect, locate, discriminate and size pipeline anomalies. Such specifications are typically derived using data obtained (statistically valid) by performing large scale tests (pull-, pump-tests) of the ILI System through pipe sections of varying grades and wall thicknesses, invariably containing artificial and/or anomalies.

Section 6.3.2, Essential Variables, is the common set of characteristics or analysis steps for a family (series) of ILI tools (Systems) that may be covered within one Performance Specification.

The Performance Specification shall define and document the essential variables for the ILI System being qualified. Essential variables are characteristics or analysis steps that are essential for achieving desired results. Essential variables may include, but are not limited to:

- Constraints on operational characteristics, such as inspection tool velocity.
- Inspection tool design and physical characteristics, such as:
  - Inspection parameters (e.g. magnet strength, ultrasonic frequency, amplitude, and angle).
  - Sizing system components (e.g. sensor type, spacing, and location relative to the source of the inspection energy).

Changes to the essential variables of a system shall require a new performance specification and qualification. Service provider shall notify operator if any of the essential variables are out of specification for a run so that the operator can make an informed decision as to how to leverage the data.

The Performance Specification for detection and identification of anomalies are typically described as probabilities and expressed as percentages; probability of detection or POD, and probability of identification or POI. The specification for sizing accuracy is typically described by both a tolerance and a certainty; e.g. depth sizing accuracy for metal loss is commonly expressed as ± 10% of the wall thickness (the tolerance) 80% of the time (the certainty).

In addition to large scale testing of ILI systems in order to understand performance, the use of Historic Data is also allowed.

Validation measurements from previous runs of an ILI System may be used to qualify a Performance Specification. Validation measurements are dimensions and characteristics that have been physically measured after anomalies have been exposed.

An understanding of the historical uses of ILI by tool/technology, diameter, wall thickness, etc. can be referenced when selecting an appropriate ILI System for a new or upcoming assessment.

System Results Validation

Another important aspect of API RP 1163 is specifically pertaining to the "ILI System Qualification and Validation".

It covers such important aspects as;

- Evaluation of System Results
- Using Validation Measurements
- Conclusions on Using Validation Results
- Assessment of ILI Performance

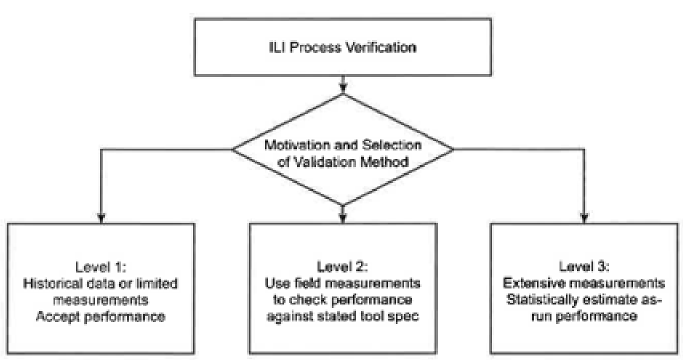
The Performance Specification is subsequently confirmed by comparing predicted results from the ILI System against results as measured in the field on the exposed pipe. However, obtaining such field results in sufficient volume relies on the willingness of pipeline operators to share the findings with their ILI service providers. Moreover, to fully test the Performance Specification, ILI service providers need information not only in those instances where the Performance Specification has not been met, but also those cases where the prediction was successful, across a range of feature/anomaly types, whether potentially injurious or not.

The pipeline operator uses the results from the ILI System to perform detailed engineering assessments on the reported features/anomalies to determine which of them might require attention as part of a preventative maintenance plan. In doing so, they rely on an understanding of the sizing tolerance of the ILI System as described in the Performance Specification.

System qualification and validation is an essential part of anomaly management. Transparency is a pre-requisite to achieve confidence in the results. The feedback loop between operator and service provider is consistent with API RP 1163, "validation data information from field measurements should (previous edition, shall) be given to the service provider to confirm and continuously refine the data analysis processes".

Also, pipeline operators currently collect information that compares the ILI results with what was subsequently found when the pipeline was excavated, and the anomaly measured using NDE. Analysis of such field verification data would help quantify the frequency with which ILI Systems missed, or mis-classified, or incorrectly sized, thereby providing a means to quantify any gap in capability.

API RP 1163, Overview of Three Levels of ILI Validation



After an ILI run, the actual performance of the ILI through proper field verification/validation helps pipeline operators manage pipeline integrity threats and is a key input to risk models. Field verification measurements and associated feedback helps the ILI service provider understand any performance gaps which leads to continuous improvement and the possible need for R&D advancements.

Although data sharing between the operator and ILI service provide does occur, an improved approach is required. API RP 1163 has been in place, first edition, since 2005. It is now moving towards a fourth edition, and as well, being referenced in the 49 CFR part 195 and 49 CFR part 192. This reference in the CFR's will require pipeline operators and ILI service providers to more closely collaborate, specifically when considering the performance of an ILI System and the need feedback of field verification measurements.

This collaborative approach is required to understand, with sufficient transparency, the successful implementation of an ILI System for a given pipeline segment and/or integrity management program.

Appendix VIII: Continuous Improvement with ILI Technology Case Study

Introduction

In-line Inspection has been a force for good in the pipeline industry helping reduce failures for corrosion and now doing the same for cracks. However, the VIS initiative started from the premise that pipelines are sometimes failing despite having been inspected, and that ILI technology is therefore in need of further improvement.

ILI is a system that relies upon:

1. Selection of the appropriate tool capable of finding the expected threat.

2. Sensitivity of the sensing technology to see any anomalies with sufficient fidelity and resolution to reliably characterize and measure them.

3. Ability of the analysis process (underlying models plus analyst training and procedures) to recognize the presence of an anomaly, identify it and size it with confidence.

What aspects of ILI performance need improvement? Seeing more things? Being better at discriminating bad things from non-bad things? Being better at sizing bad things? What data is required to help target technology improvement efforts?

Data describing ILI related incidents can help by identifying the limit state events where ILI was found wanting; something was not seen by the tool, or seen but not correctly identified, or identified but mis-sized.

Also, pipeline operators currently collect information that compares the ILI results with what was subsequently found when the pipeline was excavated, and the anomaly measured using NDE. Analysis of such field verification data would help quantify the frequency with which ILI tools missed, or mis-classified, or sized wrongly, thereby providing a means to quantify any gap in capability.

Gathering field verification data and incident information across the industry can thus help build a comprehensive picture of ILI capabilities across tool technologies, anomaly morphologies, pipe types (grades and wall thicknesses and vintage). This would serve to demonstrate both where ILI performs well, and the technology's shortcomings.

An additional side benefit of collecting large volumes of dig verification data would be to better describe variability in susceptibility to threats according to pipe type, operating conditions, and geography (soil type, climatic conditions).

Description of the ILI Process:

In-line Inspection (ILI) is one of the most efficient and effective methods for evaluating the integrity of a pipeline. However, it involves much more than simply running a Smart Pig through the pipeline; rather, the tool run and subsequent data analysis are only one input into an engineering decision process that ultimately leads to action by the pipeline operator to ensure the ongoing integrity of their asset. API RP 1163 (2nd Edition 2013) for In-Line Inspection Systems Qualification describes the overall In-line Inspection qualification process, while NACE SP0102 lays out the respective responsibilities of the operator and service provider in that process.

In-line inspection providers describe the capabilities of their technology by means of a performance or reporting specification. The specification defines the statistical confidence with which the in-line inspection system (tool plus analysis process) can detect, locate, discriminate and size pipeline anomalies. Such specifications are typically derived using data obtained by pulling the inspection tools through pipes of varying grades and wall thicknesses, invariably containing machined anomalies.

The performance specification is subsequently confirmed by comparing predicted results from the tool against results as measured on the exposed pipe. However, obtaining such field results in sufficient volume relies on pipeline operators being willing to share the findings with their service providers. Moreover, to fully test the performance specification, service providers need information not only in those instances where the specification has not been met, but also those cases where the prediction was successful, across a range of feature types, whether potentially injurious or not.

In-line inspection service providers are constantly trying to improve their respective technology systems, as the performance specification forms the basis of much of the competition between service providers in the industry. Improvements might come in the form of detection of anomalies that were previously undetectable, better discrimination of anomalies that were previously difficult to identify, or improvements in the sizing accuracy with which the dimensions of an anomaly are reported.

The performance specification for detection and identification of anomalies are typically described as probabilities and expressed as percentages; probability of detection or POD, and probability of identification or POI. The specification for sizing accuracy (probability of sizing or POS) is typically described by both a tolerance and a certainty; e.g. depth sizing accuracy for metal loss is commonly expressed as ± 10% of the wall thickness (the tolerance) 80% of the time (the certainty).

The pipeline operator takes the output from the smart pig run and performs a detailed engineering assessment on the reported features to determine which of them might require attention as part of a preventative maintenance plan. In doing so they rely on an understanding of the tolerance of the tool system as described in the performance specification. Sharing of data that compare ILI predictions with real world findings, between pipeline operators and In-line Inspection service providers, will feed a virtuous cycle of technology improvement. Shortcomings in performance specification can be identified and addressed by ILI service providers, resulting in improved specifications that in turn enable pipeline operators to make better informed decisions regarding the ongoing management of the integrity of their pipelines.

Standards for Data Delivery/Validation

API RP 1163 In-line Inspection Systems Qualification links the various components of the In-Line Inspection process and establishes the requirements of all parties involved in implementing in-line inspections. The standard goes into details regarding the validation of performance specifications and encourages the development and implementation of new and improved technologies in the future.

The Pipeline Operators Forum (POF), working together with several in-line inspection service providers, produced a document in 2012 entitled Guidance on Field Verification Procedures for In-Line Inspection. Intended as a companion to AP RP I1163, it represents industry best practice regarding field data verification and reporting procedures that can be used to support the ILI process.

The Pipeline Operators Forum's Specifications and Requirements for Intelligent Pig Inspection of Pipelines documents industry efforts to standardize the nomenclature used to describe different types of anomalies and their characteristics.

Inputs needed for meaningful analysis and comparison:

Dimensions of the anomaly reported by ILI, compared to the actual dimensions as measured in the field. The field data would need to be validated to allow for differences in measurement technologies, and variability in technician performance. Standardization of terminology will be required to facilitate comparison of like for like anomalies.

Known limitations:

Methods for in-ditch validation and data collection vary greatly

- Lack of standardization for in-ditch dig verification is a familiar industry lament. Faced with this challenge, many pipeline operators have built their own program that is bespoke to their own needs. The POF guidance document referenced above was an attempt to drive a common approach.

Variation in results can often exist between field technicians using the same NDE equipment

- Even though NDE field technicians go through a certification process, it is well known in the industry that variability can exist between technicians in the results they might each obtain using the same equipment to measure the same anomaly. With investments in training and procedures, many service providers have been able to overcome this source of variation, but it is nevertheless a potential source of measurement error that needs to be managed.

In the absence of a forum and mechanism for sharing data, ILI validation results are kept in-house.

- Gathering field verification data allows an operator to trust the results provided by their ILI service provider, and therefore build confidence in the efficacy of their overall pipeline integrity assurance program. However, keeping that knowledge within the confines of the operator's business is of limited benefit to the industry at large, whereas gathering such data across multiple pipeline operators facilitates pooling of knowledge and sharing of experience to the benefit of all industry stakeholders.

Choice of in-ditch validation technology.

- Not all technologies can be used in all circumstances. Depending on the nature of the anomaly being measured and the context (wall thickness, steel grade, and coating), some will be more successful than others. Moreover, differing techniques vary in their ease of deployment, and have different inherent accuracy.
- It's important that the technique chosen for verification measurements be an order of magnitude more accurate than the primary method (ILI).

Potential Outputs that Ensure an "Apples to Apples" Comparison

Today, in-line inspection validation results tend to be kept within an operator, or at best shared between operator and ILI service provider. There have been relatively few attempts to collate and share field validation results more broadly, but the most notable recent success has been the NDE-4E project (In-Line Inspection Crack Tool Performance Evaluation) undertaken by Pipeline Research Council International.

The project gathered and analyzed over 50,000 crack features discovered using ILI technologies from 4 different service providers, collected by many different pipeline operators, and validated using a range of field Non-Destructive Evaluation techniques. Consequently, the project team of necessity needed to develop methodologies to manage the completeness, consistency and accuracy of the data gathered.

The output of the project served to validate the performance specifications published by the ILI service providers in terms of both detection and sizing. But interestingly the study also highlighted opportunities for improvements in tool specification, and opportunities to improve in-ditch measurement technologies and techniques. As such the study provided valuable signposts for future technology direction.

How the Outputs May Encourage or Motivate Continuous Improvement

PRCI's project NDE-4E is a good example of how data sharing can lead to technology improvement. Indeed, since publication in 2015 of the insights generated by Phase 1 of the project, several ILI service providers have acted to improve their specifications, moving away from sizing cracks within depth "bins" that are based on a maximum depth measurement, toward providing discrete depth sizing with a tolerance.

The output of NDE-4E Phase 1 led to Phase 2 in which results from a broader range of crack detection technologies was incorporated into the project database.

Knowing how different ILI tool types perform when confronted by different anomaly morphologies can help pipeline operators in their selection of which technology to deploy in their system. The crack data gathered during NDE-4E came from relatively few, large pipeline operators. However, the results are available to all members of PRCI who are now able to build their own crack management programs with a lower cost of entry, benefiting from the experience of others who have paved the way.

Appendix IX: External Corrosion Direct Assessment (ECDA) Case Study

Process – The ECDA is one of the three external corrosion assessments approved by CFR 49, Part 192, Subpart O. ECDA is often selected because the operating pressure, flow rate or pipeline's physical configuration make ECDA preferable or because the process provides information that can be used to determine effective mitigation to prevent further external corrosion damage.

ECDA is a four-step pipeline integrity assessment performed by identifying and direct examining the locations on a pipeline with the highest likelihood of significant external corrosion. The four steps are; pre-assessment, indirect inspection, direct examination and post-assessment.

During the pre-assessment step data is gathered to understand the pipeline and corrosion history, and to verify that ECDA is an appropriate tool. Some conditions, such as very deep pipe (depth below grade), DC interference or AC mitigation systems may make it infeasible to obtain meaningful data. The data is utilized to regionalize the pipeline into sections with similar external corrosion characteristics. This regionalization can affect the number of direct examinations performed to assess integrity. The severity of indications identified during the indirect inspections, in concert with the regionalization, determines the number of excavations performed.

The indirect inspection step requires the utilization of 2 or 3 "complementary" indirect inspection tools (IIT) to assess a pipeline's cathodic protection. The tools often identify sections of pipe with insufficient cathodic protection, coating holidays or soils that are more corrosive. The results from the 2 or 3 tools are integrated to identify "Immediate", "Scheduled" or "Monitored" indications and the locations with the highest likelihood of corrosion are selected for direct examination.

The direct examination step physically assesses the pipeline at the locations expected to have sustained the worst corrosion. By assessing the areas with the "worst" corrosion, the operator can determine if the conditions warrant additional excavations or if a re-inspection interval can be conservatively applied using the expected half-life of the worst-case corrosion damage identified.

The final step, post-assessment, requires the operator to evaluate the effectiveness of the process and to establish remediation methods for any issues identified. This final step is key to ensuring the assessment has effectively evaluated the pipeline's integrity and that any active issues are addressed before the next assessment.

How the outputs would encourage/motivate continuous improvement – To ensure participation, the ECDA performance of the individual Operators and service providers needs to remain confidential. However, as the results from ECDA surveys and direct examinations are collected ECDA effectiveness could be provided as bottom quartile, average or top quartile metrics. Knowing these metrics, Operators and ECDA service providers would have the ability to assess their own ECDA processes. These independent assessments should lead to process improvements that raise ECDA effectiveness universally. In addition, the data aggregation could identify preferred techniques or pipeline configurations that aren't effectively assessed by ECDA. Safety enhancements will result as a continually improving ECDA process should be more effective in the identification of integrity concerns and fewer excavations would be required to verify ECDA effectiveness. Specifically, a VIS could improve performance and ultimately safety in the following ways:

Pipeline Operators

If a pipeline operator is aware that its performance is below average, there may be motivation to:

- compare prioritization criteria with other pipeline operators experiencing better correlation,
- review their ECDA process/procedure,
- consider changing specifications for data collection, e.g. whether hole drilling is required in asphalt,
- change the criteria specified for the categorization that determines the number of required excavations,
- assess the combination of tools utilized to perform the surveys, or
- utilize a different service provider and compare to the results of a new provider.

ECDA Service Provider

If an ECDA Service Provider is aware that their performance is below average, there may be motivation to:

- assess the quality of data collected by their crews,
- assess the procedures utilized for data collection,
- enhance the training of their personnel, or
- review the tools utilized for data collection.

Standards for data validation/delivery – To effectively assess ECDA effectiveness, standards for data collection and quality should be specified. The standards for data collection and quality often vary by service provider. It is this standardization of data collected and the requirements for quality control that may result in significant technical improvements.

For the data collected during indirect inspections, Step 2, improvements could be achieved by establishing minimum requirements and technical qualifications that would reduce the erroneous data collected due to field conditions or technical errors. For the direct examinations, Step 3, improvements could be realized by establishing qualifications for the personnel and standardizing the data collected to assess the external corrosion conditions and the extent of damage.

Inputs needed for meaningful analysis and comparison – For the data delivery, it will be important to standardize on the types of data collected and the units for the data collected.

In addition to the data validation, it is important to document minimum standards for how each tool is used, e.g. spacing of the CIS reads, interrupted survey or not interrupted, identify if holes were drilled through asphalt or not, etc. The following table is an example of key inputs for the tools utilized for ECDA.

Tool	Data	Units
CIS	Date, Spacing, Interrupted survey?, Asphalt drilled?, On read, Off read, GPS location	mm/dd/yy, ft.c , Yes/No, Yes/No, mV, mV, Lat/Long,
DCVG	Date, Sub-meter GPS collection of DCVG indication, %IR, Shift – Start, Shift - End	mm/dd/yy, Lat/Long, mV, mV, mV
ACVG	Date, AC current at anomaly, dBµV reading, Current applied	mm/dd/yy, mA, dBµV, mA
PCM	Date, AC current, GPS location	mm/dd/yy, mA, Lat/Long
Soil Res.	Date, Soil res at 5, 10, 20', GPS location	mm/dd/yy, Ohm-cm, Lat/Long

A key part to the assessment is the NDE data from the direct examination. The NDE data is the "control" for assessing the effectiveness of the ECDA survey. To assess the effectiveness, a minimum set of data and consistent units is also necessary. The following table provides some of the data elements required and recommended units.

Data	Units
Dig location	Lat/Long, length of excavation
Pipe diameter	Inches
P/S potential at pipe	mV
Soil resistivity	Ohm-cm
Coating damage	Extent and location of all coating damage
Corrosion damage	Extent and location of corrosion damage, Pf
Coating Type	Create standard list of options
pH of liquid under coating	

A consistent data import structure will be key to ensuring that participation isn't impacted by data import challenges. Since ECDA Service providers typically provide the data in Microsoft Excel, an import module that interacts well with Excel could enhance participation.

Known limitations - The analysis and comparison of ECDA data is challenging because the data collected does not specifically identify anomalies where the pipe material has been affected. Instead, ECDA identifies locations where the pipeline's cathodic protection (coating and current applied) has been adversely affected and may be less effective mitigating external corrosion. The ECDA assessment can be affected by time of year and weather conditions that impact the soil and may change the distribution of cathodic protection to the pipeline. Since much of the assessment is based upon current conditions, historical upsets in the cathodic protection or delayed CP installation after construction, may not have been considered when selecting the locations for the direct examination of the pipeline's integrity. This 'not considered' data could lead to the identification of integrity concerns that are more severe than anticipated from the indirect surveys or may impact the correlation between the anticipated severity of the integrity concern and the severity of the anomalies

Because of these factors, the VIS may want to assess ECDA's effectiveness at categorizing the direct examinations as either "Immediate", "Scheduled" or "Monitored". Analysis of a large number of surveys, could identify process improvements or technological improvements that could enhance the effectiveness of ECDA.

Potential outputs that ensure an "apples to apples" comparison - To motivate continuous improvement, performance indicators will need to be developed so that operators can compare their performance to others. Some possible performance indicators could include:

- Actionable anomalies/100 miles of ECDA
- Number of coating indications identified/mile
- % correlation– coating indications vs. coating anomalies identified in Step 3
- Feet of 'Off' readings/mile - less negative than -850mV
- % correlation – Immediate indications vs. corrosion damage identified in Step 3
- % correlation – Scheduled indications vs. corrosion damage identified in Step 3
- % correlation – Monitored or NI indications vs. corrosion damage identified in Step 3

Appendix X: Lessons Learned – VIS Continuous Improvement Case Study

Process – With an effective system for sharing and accessing relevant "Lessons Learned," pipeline operators and service providers will be able to implement learnings from others to improve the safety and performance of their processes and tools. While there are some vehicles for sharing, lessons learned in industry associations, if the lesson learned comes from a "near miss," the education is often limited to the parties involved.

For example, a few years ago a service provider performing a direct assessment of a cased pipeline, inadvertently damaged the pipeline while grinding to remove the casing. Thankfully, the grinding penetrated just under 90% of the wall thickness and only a "near miss" occurred. The "near miss" led to the implementation of new work processes and protections to ensure future casing removals did not damage the carrier pipe. Because of limited sharing about the incident, the new procedures, which significantly reduced risk to the pipeline operator and service provider, were of little benefit to other operators and service providers who have similar risks.

How the outputs would encourage/motivate continuous improvement – To ensure participation, the parties in the "lessons learned" need to remain confidential. However, as the "lessons learned" are collected, an effective cataloguing and search mechanism could make other pipeline operators and service providers aware of the threat and the mitigative actions implemented to address the threat. Safety enhancements will result as awareness of "near misses" and incidents lead to new processes or techniques that reduce the likelihood of a similar incident occurring.

Compiling and cataloguing "lessons learned" could improve safety in the following ways:

Pipeline Operators

If a pipeline operator is aware of near misses or incidents that could occur during their operations, they may take the following actions to reduce the risk:

- review and enhance existing internal procedures,
- prohibit the use of tools or processes that were contributing factors, and/or
- require Service Providers to develop and utilize procedures that minimize the risk

Service Providers

If a Service Provider is aware of near misses or incidents related to their type of work, they may:

- revise or implement new procedures to minimize the risk, and/or
- change the equipment or tools utilized in the work performance

Standards for data validation/delivery – To effectively access lessons learned, a consistent template would enhance the availability to pipeline operators and service providers. The improved awareness and easy access to relevant a specific pipeline operator or service provider will enhance the likelihood that lessons learned spread to relevant parties and changes are implemented to improve safety.

Appendix XI: Examples of Information Sharing Outside the Pipeline Industry

Center for Offshore Safety - The COS is an industry sponsored group focused exclusively on offshore oil and gas industry safety on the U.S. Outer Continental Shelf (OCS). The purpose of COS is adopting standards of excellence to ensure continuous improvement in safety and offshore operational integrity. Their safety programs were designed to promote the highest level of safety for offshore drilling, completions, and operations through leadership and effective management systems addressing communication, teamwork, and independent third-party auditing and certification. The COS has developed tools for reporting and analyzing incidents and events that are applicable to the VIS effort and should be considered for adoption or at a minimum as referenced best practice. The COS endeavors to achieve operational excellence by:

1. Enhancing and continuously improving industry's safety and environmental performance.
2. Gaining and sustaining public confidence and trust in the oil and gas industry.
3. Increasing public awareness of the industry's safety and environmental performance.
4. Stimulating cooperation within industry to share best practices and learn from each other.
5. Providing a platform for collaboration between industry, the government, and other stakeholders.

In addition, there are a set of eight guiding principles used by COS that should be considered for adoption in the development and implementation of a pipeline safety VIS:

1. COS Members demonstrate a visible commitment to safety.
2. COS Members work together to create a pervasive culture of safety.
3. Decision-making at all levels does not compromise safety.
4. Safety processes, equipment, training, and technology undergo continual improvement.
5. Members share learning experiences and embrace industry Standards and best practices to promote continual improvement.
6. Open communication and transparency of safety information is utilized to build mutual trust among stakeholders and promote collective improvement in industry performance.
7. Collaborative approaches are utilized to drive safe and responsible operations, and mutual accountability.
8. Everyone is personally responsible for safety and empowered to take action.

The COS has developed a relevant, high level strategy for information sharing that is geared more towards learning from incidents and near-misses rather than sharing discrete data. Within this context, the COS provides methods for collecting, analyzing and reporting this kind of data and information, developing best practices for mitigation of incidents and sharing within the offshore industry, and building a culture of honest and open communication with regards to safety among industry stakeholders. The COS has developed a system for capturing and reporting Safety Performance Indicators (SPI) and also produces an annual report. An overview of this information is provided in the appendices.

Aviation Safety Information Analysis and Sharing - The ASIAS program is a collaboration between the FAA and the aviation community to proactively analyze existing and voluntarily provided safety data to advance aviation safety. Members of ASIAS include government agencies, aviation stakeholder organizations, aircraft manufacturers, and dozens of airlines and corporate operators. The ASIAS program works closely with the Commercial Aviation Safety Team (CAST) and the General Aviation Joint Steering Committee (GAJSC) to monitor known risk, evaluate the effectiveness of deployed mitigations, and detect emerging risk. The following characterizes the existing program:

1. A collaborative government-industry initiative on safety data analysis and sharing.
2. A risk-based approach to aviation safety, identifying and understanding risks before accidents or incidents occur.
3. Timely mitigation and prevention.
4. Governing Principles
    4.1. Voluntary Submission of safety sensitive data
    4.2. Transparency for how data are managed and utilized
    4.3. Analysis approved by an ASIAS Executive Board
    4.4. Procedures and policies based on collaborative governance
    4.5. Operator/Original Equipment Manufacturer (OEM)/Maintenance, repair and overhaul (MRO) date are de-identified
    4.6. Data used solely for advancement of safety

While many of these characteristics pertain to governance, they also help define what type of information should be shared and how the process of sharing might work in the pipeline safety context. The VIS WG recommends incorporating the ASIAS characteristics into a pipeline safety VIS. By providing a system to mainstream an industry-wide culture of information sharing, the ASIAS system is the leading example and best model for the pipeline safety VIS to emulate.

ASIAS Program: A Model for Continuous Improvement
The FAA's ASIAS Program's information-sharing system became the model for the VIS WG's recommendations on how the VIS should be implemented to be effective and successful over the long-term, as well as for catalyzing the initial formation of a pipeline safety VIS by providing a way of conducting initial risk analysis studies and generating safety reports on existing data and existing voluntarily submitted pipeline safety data.

Considering the amount of reference material available from ASIAS on chronological development, process framework, governance framework, funding, and lessons learned, the VIS WG recommends that in developing a pipeline safety VIS, the Secretary consider and utilize to the fullest extent possible this material and the expert knowledge available from the ASIAS program, its developers, managers and user community. Additionally, and equally useful, there are existing governance documents, operating procedures, cooperative agreements, and other materials from ASIAS that are applicable to implementing and managing a pipeline safety VIS.

Specifically, the VIS WG recommends the consideration of how ASIAS manages data from two distinct information systems that allows for a cycle of continuous safety improvement:

1. Aviation Safety Action Program – The objective of the ASAP is to encourage air carrier and repair station employees to voluntarily report safety information that may be critical to identifying potential precursors to accidents. Under ASAP, safety issues are not resolved

through punishment or discipline. The ASAP information is a blend of alpha-numeric, numeric data and text.

2. Flight Operations Quality Assurance (FOQA) – The objective of FOQA is to use flight data to reveal operational situations in which risk is increased to enable early corrective action before that risk results in an incident or accident. A FOQA program is part of the operator's overall operational risk assessment and prevention program (as described in part 119, section 119.65 and FAA guidance materials), which in turn are a part of the airline operator's SMS. Data are collected from the aircraft by using special acquisition devices such as a Quick Access Recorder or Flight Data Recorder. The FOQA information is also a blend of alpha-numeric and numeric data.

The figure below provides a schematic of how ASIAS leads to a commercial aviation continuous safety improvement cycle.

Aviation Continuous Improvement Cycle – Building On ASIAS

Information Sharing in ASIAS

ASIAS operates under the direction of an ASIAS Executive Board (AEB), which includes representatives from government and industry. The AEB authorizes ASIAS to conduct directed studies, assessment of safety enhancements, known risk monitoring, and vulnerability discovery. To enhance aviation safety, ASIAS shares the results of these analyses with the participants.

ASIAS has also established key safety benchmarks so that individual operators may assess their own safety performance against the industry as a whole.

ASIAS serves as a central conduit for the exchange of data and analytical capabilities among its participants. The ASIAS vision is to establish a network of at least 50 domestic and international airlines over the next few years—currently it is the only such center of its kind in the world.

Information Data Systems in ASIAS: ASAP and FOQA

ASIAS leverages two (2) distinct information systems: Aviation Safety Action Program (ASAP) and Flight Operational Quality Assurance (FOQA). In developing the pipeline safety VIS recommendations, the VIS WG evaluated these two information systems by taking an in-depth look at their purposes, how the data was collected, the types of data collected, and how each system was managed.

The purpose of ASAP is to prevent incidents by encouraging employees of certificate holders to voluntarily report safety issues and events. ASAPs provide for education of appropriate parties and the analysis and correction of safety concerns that are identified in the program. ASAPs are intended to create a nonthreatening environment that encourages employees to voluntarily report safety issues even though they may involve violation of Title 49 of the United States Code (49 U.S.C.), Subtitle VII, or violation of Title 14 of the Code of Federal Regulations (14 CFR). ASAP is based on a safety partnership between the FAA and the certificate holder and may include any third party such as an employee labor organization. These programs are intended to generate safety information that may not otherwise be obtainable.

The objective of the ASAP is to encourage air carrier and repair station employees to voluntarily report safety information that may be critical to identifying potential precursors to accidents. The FAA has determined that identifying these precursors is essential to further reducing the already low accident rate. Under an ASAP, safety issues are resolved through corrective action rather than through punishment or discipline. The ASAP provides for the collection, analysis, and retention of the safety data that is obtained. ASAP safety data, much of which would otherwise be unobtainable, is used to develop corrective actions for identified safety concerns, and to educate the appropriate parties to prevent a re-occurrence of the same type of safety event.

An ASAP provides a vehicle whereby employees of participating air carriers and repair station certificate holders can identify and report safety issues to management and to the FAA for resolution, without fear that the FAA will use reports accepted under the program to take legal enforcement action against them, or that companies will use such information to take disciplinary action. These programs are designed to encourage participation from all airline employee groups, such as flight crewmembers, mechanics, flight attendants, and dispatchers.

FOQA is a voluntary safety program designed to improve aviation safety through the proactive use of flight-recorded data. Operators use the data to identify and correct anomalies in all areas of flight operations. Properly used, FOQA data can reduce or eliminate safety risks, as well as minimize deviations from regulations. Through access to de-identified aggregate FOQA data, the FAA can identify and analyze national trends and target resources to reduce operational risks in the National Airspace System (NAS), Air Traffic Control (ATC), flight operations, and airport operations.

The FAA and the air transportation industry have sought additional means for addressing safety problems and identifying potential safety hazards. Based on the experiences of foreign air carriers, the results of several FAA-sponsored studies, and input received from government/industry safety forums, the FAA concluded that wide implementation of FOQA programs could have significant potential to reduce air carrier accident rates below current levels. The value of FOQA programs is the early identification of adverse safety trends, which, if uncorrected, could lead to accidents. A key element in FOQA is the application of corrective action and follow-up to ensure that unsafe conditions are effectively remediated.

FOQA is a program for the routine collection and analysis of digital flight data generated during aircraft operations. FOQA programs provide more information about, and greater insight into, the total flight operations environment. FOQA data is unique because it can provide objective information that is not available through other methods. A FOQA program can identify operational situations in which there is increased risk, allowing the operator to take early corrective action before that risk results in an incident or accident. FOQA must interface and be coordinated with the operator's other safety programs, such as the ASAP, Advanced Qualification Program (AQP), pilot reporting systems, and Voluntary Disclosure Reporting Program (VDRP). The FOQA program is another tool in the airline operator's overall operational risk assessment and prevention program that allows for the proactive identification and mitigation of risks, leading to greater safety across the entire industry.

Data Management and Information Analysis in ASIAS

The VIS WG's Technology and R&D subcommittee looked at ASIAS as a reference system for how to analyze, share, and manage the complex and diverse pipeline safety data that would be incorporated into the VIS Hub. MITRE is the ASIAS Third-Party Contractor. MITRE's data analytics capabilities and secure data environments play a key role in the safety analysis and data sharing collaborations that allow the FAA and aviation community to proactively analyze extensive and diverse data.

ASIAS fuses internal FAA datasets, airline proprietary safety data, publicly available data, manufacturers' data, and other data sources. Once analyzed, the aggregated data helps to proactively identify safety trends and assess the impact of changes in the aviation operating environment.

Public data sources include air traffic management data related to traffic, weather, and procedures. Non-public sources include data (stripped of identification markers) from air traffic controllers and aircraft operators. These records include digital flight data and safety reports submitted by flight crews and maintenance personnel. MITRE safeguards the airline safety data in a de-identified manner to foster broad participation and engagement.

Governance agreements with participating operators and owners of specific databases provide ASIAS analysts with access to safety data. Governed by a broad set of agreements, ASIAS has the ability to query millions of flight data records and de-identified textual reports via a secure communications network.

Lessons Learned and Mitigation in ASIAS

In discussions with FAA personnel responsible for managing ASIAS, it became apparent that having a better understanding of how the learnings from ASIAS were used in reporting back to the commercial aviation industry would be useful in developing measurable outcomes of a pipeline safety VIS. As one ASIAS example, CAST might request a study to be made using ASIAS to address concerns raised by pilots and mechanics. (It should be noted that the ASIAS Executive Board could also make such requests.) A study request is typically made as a "defined-use case." The ASIAS Issues Analysis Team would then review the use-case and work with the Third-Party

Contractor who manages the ASIAS data to define a work scope for the study. When the analysis is completed and reviewed by the Issues Analysis Team, the ASIAS Executive Board would review the findings and recommendations made by the Issues Analysis Team and share them with CAST. CAST then would develop documents, known as "InfoShares" to share the learnings and be presented in meetings of operators, CAST and ASIAS staff throughout the year. See Appendix XIV for a more detailed example of how an InfoShare was developed for one specific use case.

To illustrate the use of ASIAS' overall continuous improvement cycle model to the pipeline safety VIS, the Process Sharing subcommittee created the following table to compare the current state of continuous safety improvement within the aviation industry and the pipeline industry.

Comparison of Continuous Safety Improvement – Current State

	Aviation Industry	**Pipeline Industry**
Safety Management System	FAA Safety Management System	API RP 1173 – Pipeline Safety Management Systems
Information Sharing (Input)	Operators – voluntary, broad adoption	Operators – ad-hoc and limited
Information Analyses	ASIAS – comprehensive, systematic and integrated across carriers and MROs	A mix if ad-hoc and more systematically applied within Trade and Research Associations; largely not across them
Lessons Learned & Mitigation	CAST develops InfoShares - comprehensive, systematic and integrated across carriers and MROs	Within Trade and Research Associations; largely not across them
Future Design & Research	NextGen – in development and maturing	Within Trade and Research Associations; largely not across them

Compared to the airline industry, it is clear from Table 1 that there are inconsistencies and gaps in information sharing across the pipeline industry that need to be filled. The VIS WG recommends establishing a pipeline safety VIS and fostering industry-wide involvement as a way to fill these gaps. The VIS WG recommends that implementation of a VIS for the pipeline industry should provide for a framework of best practices and fundamental information sharing elements found in other information sharing contexts or in other industries including, but not limited to:

- Governance, policies, procedures and recommended practice;
- Quality Assurance/Quality Control of data, information and knowledge;
- Security of Data and Information including methods to de-identify data and provide anonymity;
- Recognition of potential barriers to participation and methods to mitigate; and,
- Communication of results and performance measures.

Appendix XII: Examples of Information Sharing Inside the Pipeline Industry

Pipeline Research Council International (PRCI) - PRCI is a research and technology-based consortium established by and for the energy pipeline industry. The organization was founded in the 1950's on the basis of a voluntary and collaborative approach to solving a very specific pipeline industry problem. Since that time the association has continued in a collaborative manner to solve common challenges via data and information sharing, knowledge transfer and technology development. In particular, PRCI has recently endeavored to collaborate on an ILI data sharing project that is specifically synergistic to the VIS. After their presentation to the VIS WG, PRCI staff developed a report that provided an overview of an example information sharing project (*NDE-4E* In-line Inspection Crack Tool Performance Evaluation) and offers recommendations and guidance for sharing safety information within the VIS context. The case study PRCI Project *NDE-4E* describes the performance of ILI tools as they relate to the detection and characterization of crack and 'crack-like' anomalies in pipelines. The PRCI report focuses on the entire process and technology gaps, including the NDED field measurement processes, which need to be addressed (in order to support a VIS).

Additionally, PRCI's presentation to the VIS WG provided guidance relative to the implementation of *API RP 1163 ILI Systems Qualification Standard.* API RP 1163 broadly describes the best-practice related to the use of in-line inspection technologies including data requirements, system validation, and qualification of technology and personnel and management systems. In practice, the broad nature of such a standard means that the possible range of implementations intended to satisfy the standard varies widely, increasing the chance for inconsistency and misinterpretation of data records. The PRCI report focused on improvements in the application of best practice(s) to meet the intention of the codes and standards (e.g. *CFR*, *API RP 1163*, etc.) which will facilitate greater information sharing and improved consistency with regards to safety across the industry.

Industry Trade Associations - Various pipeline industry trade associations have developed initiatives for sharing and improving best practices and lessons learned, performance measures, and other SMS efforts. To implement the pipeline safety VIS, the VIS WG recommends improving upon current trade association initiatives without disrupting or changing their current approaches. Some examples of these current initiatives include INGAA Foundation Lessons Learned, API Virtual Tailgate, and API's Pipeline Information eXchange (PIX).

Guidance documents and workflow available from the various associations (API, AOPL, PRCI, INGAA, SGA, AGA, APGA, CGA others) describing their specific initiatives, processes, best practices, protections, performance measures, etc. should be used in the design and initial implementation of the VIS. An industry-wide pipeline safety VIS would enable a broader context for information sharing and allow greater sharing between pipeline operators of the following:

- Lessons learned from failures (including near misses)
- Lessons from unique or unexpected situations and solutions
- Lessons learned from routine assessments

As a result of this evaluation, the VIS WG recommends that the development and implementation of a pipeline safety VIS be considered and implemented by first refining, expanding on, and increasing use of the current practices, processes and types of data being shared based on API RP 1163, specific corrective action programs already created by specific utility companies and operators, and other existing and already accepted industry best practices and standards.

Opportunities for Pipeline Safety Information Sharing Across the Industry

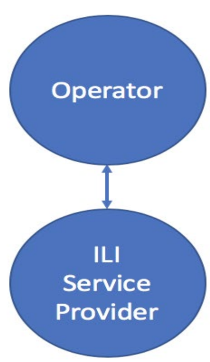
API RP 1163 provides a consistent means of assessing, using, and verifying in-line inspection (ILI) equipment and the results of inspections across the industry. The standard covers equipment as it relates to data quality, consistency, accuracy, and reporting. The objective is to assure at minimum the following:

- Inspection companies make clear, uniform, and verifiable statements describing tool performance
- Pipeline companies select inspection equipment suitable for the conditions under which the inspection will be conducted, including but not limited to the pipeline material characteristics, pipeline operating conditions and the types of indications or anomalies to be detected
- The inspection equipment operates properly under the conditions specified and inspection procedures are followed before, during and after the inspection
- Anomalies are described in inspection reports using a common predetermined vocabulary set as described in this standard.
- Tool performance and physical characteristics are reported in a common format;
- The reported data provide the accuracy and quality anticipated in a consistent format using a common set of terms defined in this standard.

Current Information Sharing and Management for ILI of Transmission Pipelines

The current state of information sharing under API RP 1163 is bilateral between the pipeline operator and ILI service provider. While the use of API RP 1163 is widespread it is not applied by all pipeline operators in all uses of ILI. The current state is depicted in the figure below.

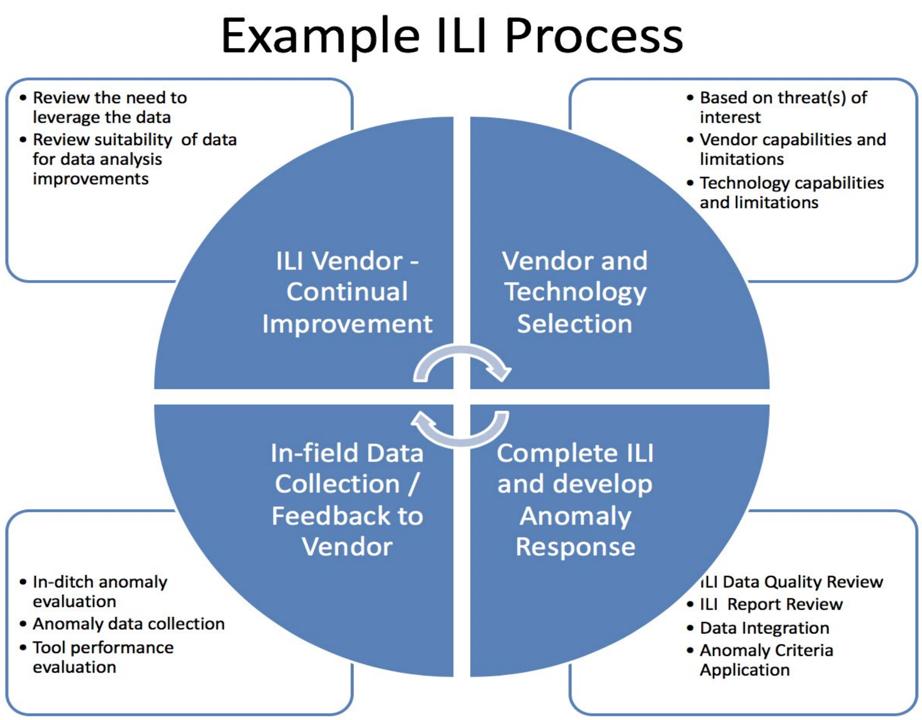
Current State of Information Sharing Under API RP 1163



API RP 1163 serves as an umbrella document to be used with and complement companion standards: NACE SP0102, In-line Inspection of Pipelines and ASNT ILI-PQ, In-line Inspection Personnel Qualification and Certification. As an umbrella document the standard provides performance-based requirements for ILI Systems, including procedures, personnel, equipment, and associated software. There was and continues to be broad involvement by the pipeline industry in the standard. It is currently undergoing a cyclical revision under the API ANSI standards development process.

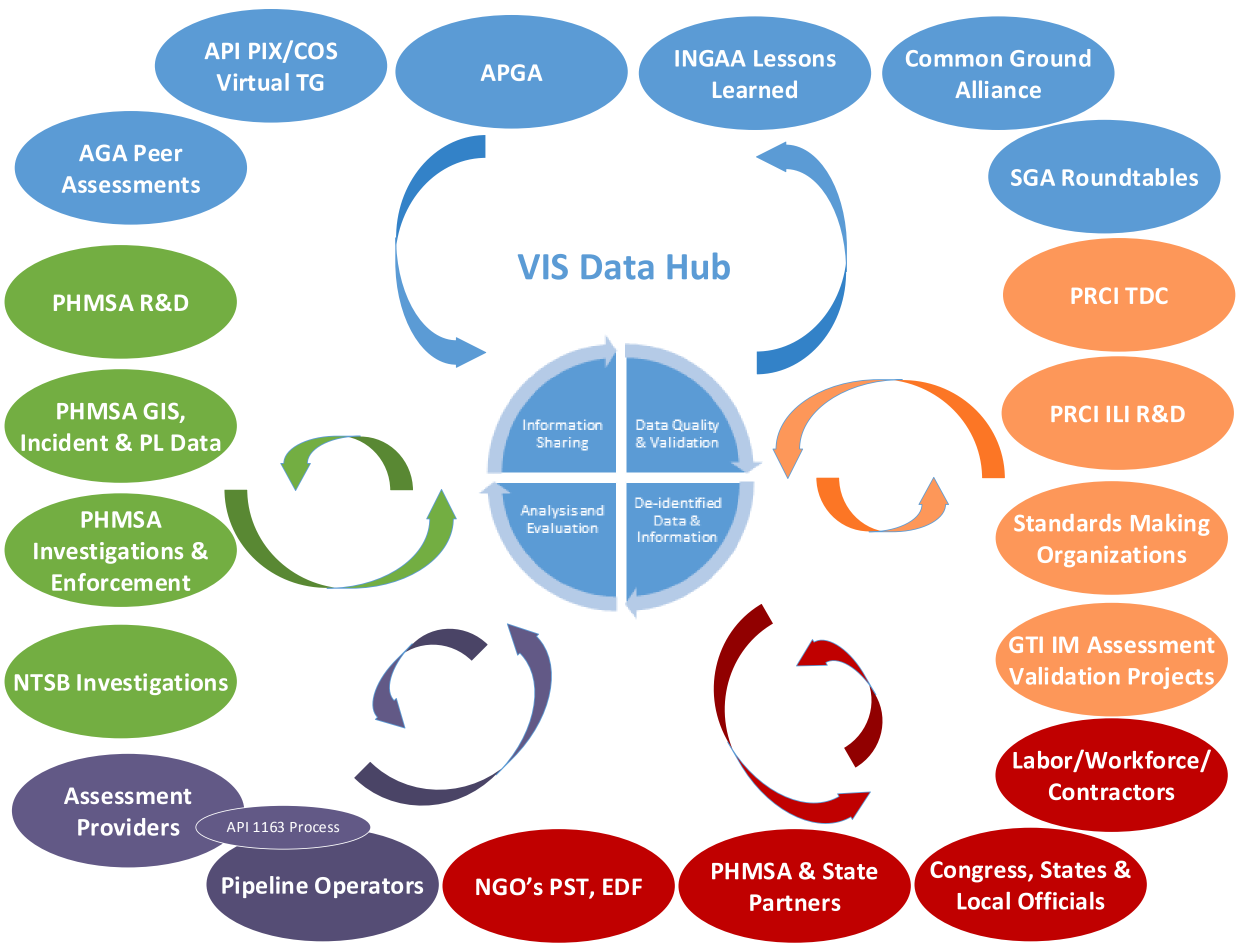
It was developed to enable ILI service providers and pipeline operators to provide rigorous processes that will consistently qualify the equipment, people, processes, and software utilized in the ILI industry. The use of an ILI System to manage the integrity of pipelines requires close cooperation and interaction between the provider of the inspection service (ILI service provider) and the beneficiary of the service (operator). The standard provides requirements that will enable ILI service providers and pipeline operators to clearly define the areas of cooperation required and thus ensure the satisfactory outcome of the inspection process. The standard covers the use of ILI Systems for onshore and offshore gas and hazardous liquid transmission pipelines. An example of the ILI process is provided in the figure below. This includes, but is not limited to: tethered, self-propelled, or free flowing systems. The standard is applicable for detecting: metal loss, cracks, mechanical damage, pipeline geometries, and pipeline location or mapping. The standard applies to both existing and developing technologies. It is not technology specific. It accommodates present and future technologies used for in-line inspection systems. One objective of this standard is to foster continual improvement in the quality and accuracy of in-line inspections.

Example Application of API RP 1163



The VIS WG recommends that the participation in and implementation of a VIS for the pipeline industry should complement, build upon, and/or leverage existing information sharing that currently occurs at the operator level, within industry associations or between Operators and Service Providers. The VIS should provide a means to share information, knowledge and solutions relative to high value learning events from existing industry efforts and programs for the benefit of all Operators (regardless of affiliation or not with specific associations or interest groups) and broader audiences or stakeholders. A recommended framework of the various information sharing processes currently in place is included in the figure below.

Framework for a VIS Data Hub



This illustration captures the various industry segments relative to their primary function within the energy pipeline industry as follows:

- Light Blue: Industry Associations
- Orange: Standards Making Bodies and R&D Consortiums
- Red: Non-governmental Organizations, Safety Advocacy Groups, Legislative Bodies, Labor Organizations
- Dark Blue: Pipeline Operators and Service Providers
- Green: Pipeline Safety Regulatory Agencies, Safety Boards.

The framework introduces the concept that these organizations should have an active role in a VIS and/or at a minimum be a consumer of the available information and ongoing efforts and result of the process. The framework in Figure 16 also illustrates that there are various information sharing processes and activities within the stakeholder groups represented by each oval as well as across common stakeholders and to some extent across different types of stakeholder groups. As an example, there is active and ongoing interaction and information sharing and collaboration on safety issues. In the context of VIS and Figure 16, this sharing activity and the results of such sharing should be more transparent across the stakeholder groups and move beyond just industry stakeholders to the entire universe and open pathways for those not currently aware of such information sharing and not participating in the sharing to participate. The pipeline safety VIS framework should include the means, processes and systems for sharing data, information, and knowledge among all industry and public stakeholders.

PRCI Data Sharing/Data Hub Examples

PRCI Pipeline Data Hub

Description of Intent

Modern data science is important to all fields of industrial technology and process development. There is a vast, untapped information pool within the pipeline industry awaiting broad industry co-ordination to extract and use it. Being at the forefront of our industry, it is both a need and an opportunity for PRCI to establish a deeper competency regarding the important topic of data mining and analytics and to be a coordinator of data sharing. The data science path for PRCI will aim on being a center for pooled information in support of its current R&D mandate but, the role may evolve in time into broader responsibilities. The center for pooled data will be initially expressed as the "PRCI Pipeline Data Hub."

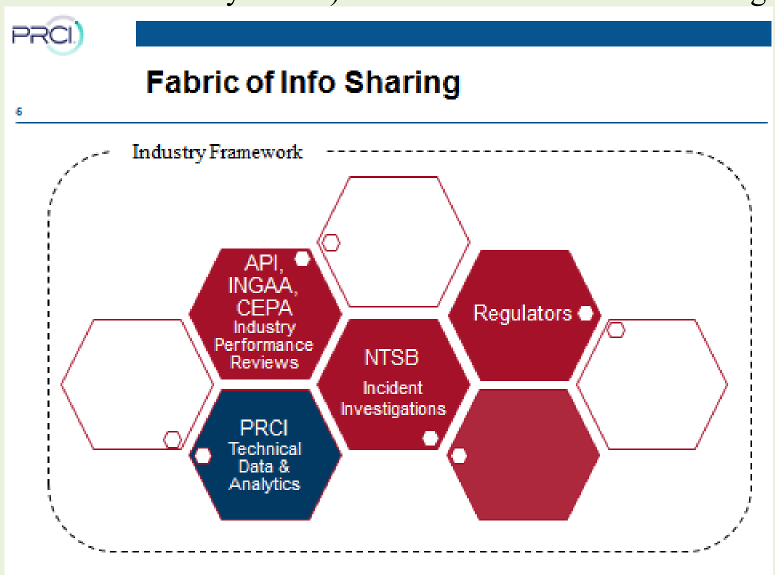
Value Characteristics

- Certain R&D technical challenges are most effectively and/or efficiently resolved as data centered exercises. The IoT, cloud, etc. have dramatically changed the technology development landscape.
- The global reach of PRCI opens the largest possible industry network of data contributors
- As an organization that impartially serves all stakeholders, PRCI is a trusted resource
- The data role played by PRCI will drive a deeper industry collaboration norm
- Demonstrates that PRCI is culturally aligned with the need to be at the forefront of science & technology
- By leading in this area, creates performance-driven industry behavior rather than a gap to be filled through prescriptive measure

General Structure

- PRCI has an already existing governance structure that has access to a great deal of data from previous research projects, conducts scientific analytics, and disseminates results and drives knowledge transfer. The aim of the data hub is to expand this capability.
- The mandate is rooted in improving the engineering and operations of pipelines (materials engineering, inspections & diagnostics, equipment/facility design and operation, other (i.e. human factors) within the existing PRCI framework of consensus, collaborative R&D.
- The basic approach is to develop data sets to be used for analytics and reporting.
  1. Serve as a center for real time data gathering of active pipeline operations (i.e. right-of-way surveillance, geohazard map data, repair data, welding, emission data, leak data, pipeline locating, NDE data).
  2. Drive PRCI R&D projects that leverage data mining and data collaboration
  3. Rearrange data gathered as a byproduct of historical, current, and future PRCI projects to open improved access to this historical data

- There are many possible data-centered projects. In all cases, the PRCI role will be envisioned within the current context of PRCI's relationship to the industry fabric.
- While a formal industry-wide framework for information sharing does not presently exist (in comparison to the aviation industry model). PRCI will focus on data sharing.



- A core, ready-made structure exists within PRCI (mandate, funding, project planning & management, administration, etc.), and the next step will be to conduct enhancements in at least the following organizational areas:
    1. People resource for data engineering
    2. Electronic ecosystem for data management
    3. A charter that defines (a) scope, (b) legal and liability, (c) property ownership, (d) roles of all parties, (e) governance, (f) confidentiality, (g) bylaws for sharing, h), etc.
- Funding for the data hub would be through the following:
    1. Existing member fee structure (ballot, flex fund, research bank, supplemental, Consortium)
    2. Special member fee
    3. Future new services provided to non-members are also contemplated, thereby opening a new funding stream.
    4. Potential government funding if we enable government participation and access to the data
- PRCI will continue to explore the potential for a direct interface model where sanctioned users, need to further define who and how, would be able to access information directly and utilize on-line analytics tools for individual usage outside of the ongoing PRCI project managed activities.
- PRCI relies on other industry organizations to utilize PRCI results for the development of industry standards. This general approach will not change.

<u>Execution Plan</u>

There are various examples of successful and sizeable data pooling initiatives, including that which is found in the aviation industry. The approach for the PRCI pipeline data hub will be to begin simply and grow as the need or capability evolves. The early scope will aim for modest milestones and an expectation that it will take roughly three years to demonstrate a "mature" process. Here are the drafted initial activities, as follows:

1. The PRCI NDE-4E “ILI Crack Tool Reliability and Performance Evaluation” has been utilized as an important test case for the establishment of a data hub.
   a) Firstly, the work under this project entails the world’s largest data pooling of crack ILI versus field NDE information; a matter of vital technical importance.
   b) Secondly, the project has successfully employed measures to mine pipeline Operator in-house data.
   c) Thirdly, a data base structure has been successfully employed and analytic results are broadly available.
   d) This project continues with annual data mining and analytics and is a stepping stone for the data hub. The project results are the most comprehensive representation of crack ILI state-of-art.
2. To establish a single location to gather and organize all data developed within PRCI and contributed by members and nonmembers to be used for current and future PRCI and industry research.
3. It is proposed to launch version V1 of the Data Hub soon, utilizing the results of the NDE-4E to begin, and upon preparation of the Charter. The intent is to begin the journey and build the basics (i.e. organizational behavior, communications, sharing norms, data science experience, stakeholder relationships).
4. Continue to participate and aim to align, within the PRCI mandate, with the PHMSA VIS initiative.

Appendix XIII: Pipeline Industry Data Sharing Case Study

Effective Measures to Sharing Pipeline Safety Information

The types of data and information discussed and the "who" and the "why" of sharing described in the previous sections are critical for a data sharing initiative. However, to facilitate data sharing, the VIS should also establish clear processes for sharing this data and information including: rigorous data definition standards, data gathering protocols, software infrastructure, database architecture, intellectual property protection and data sharing protocols.

As a real-world example of an effective information sharing initiative within the pipeline industry, consider the Pipeline Research Council International's (PRCI) NDE-4E project, "In-line Inspection Crack Tool Performance Evaluation." The NDE-4E project collected data from ten pipeline operators with paired ILI and ITD measurements, producing over 60,000 records; these records were used to assess ILI tool performance for measuring axial crack features in pipelines. This project included several key elements that would be useful in a broader data sharing initiative: the development of data specifications, data gathering protocols, de-identification techniques and data security. The learnings from PRCI NDE-4E are summarized below:

Data Specification: The integrity-related data collected by pipeline operators is not standardized across industry. As a result, each operator defines a specification necessary for internal use. When sharing across companies, interpreting the data and producing aggregated statistics requires the data be validated to a standard data specification to ensure it is consistent across sources. This can include ensuring correct and consistent spelling for categorical data types, data formats, data types and measurement units. The data specification used in the PRCI project can be found in appendix A of the Phase I report, (Skow et al, 2015). Two examples from the project include:

- Feature type called during NDE inspection: there is a wide variety of categories used by NDE field technicians to describe a pipeline feature. For such data to be useful for industry-wide sharing, such nomenclature must be consolidated and standardized. For example, an axial flaw measured by an ILI tool may be categorized by NDE field staff as an: arc strike, artificial anomaly, axial crack, axial corrosion, geometric reflector, weld anomaly, gouge, hook crack, dent with crack, lack of fusion, longitudinal weld crack, pipe mill anomaly, stress corrosion crack, hydrogen induced crack. Due to the variety of terms and the range of interpretations of each, data aggregation must be done carefully to ensure the resulting conclusions are consistent and accurate.
- The relationship between ILI and field records: one record from an ILI tool may be associated with a single field record (one-to-one relationship) or multiple field records (one-to-many relationship). Similarly, many-to-one and many-to-many relationships are possible.

This occurs due to the inherent uncertainties in the measurements and due to differences in the protocols used to interpret each measurement technology. For example, the rules to determine 'interacting features', those that should be grouped into a cluster, are different for ILI-measured features and for field-measured features. As a result, the reported values and groupings may differ between technologies measuring the same feature, even if both measurements are highly accurate.

In this case, a direct comparison between the field report and the ILI report to determine measurement performance is misleading.

Data gathering protocols: In the data collection step, participating companies were provided with the data specification sheet describing the minimum data required as well as the supplementary data that would enhance the analysis. After review by technical personnel at the operating company, a strategy to transform the company records and complete the data collection was formed involving co-operation between the PRCI project team and the operator's technical team. In some cases, a PRCI project team member provided on-site assistance with data collection, extracting data directly from the company's data systems. This enhanced data consistency across operator data sets and reduced the efforts required from each operator to participate in the PRCI project.

Data processing and validation: Data collected from participating companies was processed and validated to ensure consistency with the specification sheet. A summary of any incomplete or invalid data records was produced, and participating companies were contacted to verify and, if possible, update or correct those data records. Similarly, data outliers were reviewed to ensure accuracy. Data outliers were found to sometimes be data errors, in other cases, they revealed key insights on measurement performance.

De-identification techniques: Records often contained information that could be used to identify the operator from a single record. To ensure anonymity, these fields were scrubbed to remove the identifying elements before they were added to the project database. Examples include pipeline name, geographic coordinates, and the names of personnel at the company, field comments identifying location or attributes and a naming convention used for dig sites or feature numbers. In addition, the names of companies were not stored in the database. Instead, the companies were labelled 'A', 'B', 'C', etc. When the reports were produced, several PRCI member companies reviewed the analysis to ensure that the identification of a member company could not be deduced from the presentation of results. In most cases, aggregated data provided adequate protection for this.

ILI tool validation: A simple comparison between field and ILI reported values is not sufficient to assess ILI tool performance. In some cases, the ILI tool and the field are measuring different phenomenon and a direct comparison is not appropriate. One example is in comparison of crack lengths. The ILI tool has a threshold depth, above which, a crack is not measured or reported with consistency. Shallow portions along the axial length of the crack are not reported by the ILI tool. In contrast, the field technique used to measure cracks involves magnetic particle penetration of the crack. The surface breaking length is measured and reported in the field NDE report. As a result, the correlation between the field and the ILI tool reported lengths can differ significantly, even when both measurements are accurate.

Measurement Accuracy: When one measurement is used to validate a second measurement, the accuracy of each measurement must be considered. Attributing the variance in measurement to the first of two measurement techniques leads to an overly-pessimistic assessment of performance of the first measurement technique. Depending on the purpose of the analysis, a pessimistic assessment could lead to incorrect assumptions regarding the value of the measurement activity and its role in integrity management processes.

Appendix XIV: Aviation Industry, ASIAS InfoShare Use Case Study

At a previous InfoShare, air carriers and flight crews reported an increasing trend of incorrect, nuisance, or overly conservative terrain awareness warning system (TAWS) alerts and warnings. As a result, the Commercial Aviation Safety Team (CAST) initiated a directed study of TAWS alerts and warnings using a subset of Aviation Safety Information Analysis and Sharing (ASIAS) data.

The study focused on the following problems:

- Flight crewmembers became desensitized to TAWS alerts because unwanted alerts occurred when the aircraft was not in imminent danger.
- Some TAWS alerts are triggered by the interaction of aircraft flight path trajectories and older versions of Enhanced Ground Proximity Warning Systems (EGPWS) software or EGPWS that is not tied to a GPS position.
- Some hotspots for TAWS alerts are on planned procedures while the aircraft is under the control of air traffic control (ATC) or while ATC is issuing radar vectors to the flight crew. Others occur while the flight crew is manually flying the aircraft on a visual approach near terrain.

The study initially was limited to TAWS alerts and warnings in Northern California, which air carriers identified as an area of concern at early InfoShare sessions. The directed study included Oakland International Airport (OAK), San Francisco International Airport (SFO), and Norman Y. Mineta San José International Airport (SJC). CAST used findings from this regional analysis to identify TAWS hotspots across the National Airspace System.

Based on the results from this study, CAST approved the following three mitigations:

Safety enhancement (SE) 120, TAWS Improved Functionality. SE 120 was already in the CAST Safety Plan. This SE included a recommendation for air carriers to install global positioning system (GPS) navigation data, connected to the TAWS unit. Additionally, it recommended timely revisions to TAWS terrain databases and alerting algorithms. The SE also recommended incorporating optional features into TAWS equipment to ensure the accuracy and timeliness of the TAWS warnings and displays. The Joint Implementation Measurement Data Analysis Team developed a supplemental implementation plan to encourage pipeline operators to upgrade to the latest version of TAWS and to install GPS equipment.

SE 184, TAWS Minimum Vectoring Altitude (MVA) Reevaluation. This SE was added to the CAST safety plan when analysis revealed adjusting some MVAs could substantially reduce or eliminate the number of TAWS alerts. Once this concern was identified, the Federal Aviation Administration (FAA) initiated steps to review all MVAs to ensure adequate terrain clearance.

SE 185, TAWS and Area Navigation (RNAV) Visual or other procedures. This SE was added to the CAST safety plan to address safety concerns regarding flight crew situational awareness, visual approaches at night, and vectoring inbound traffic over high terrain. RNAV visual approaches are intended to provide increased terrain separation and reduce TAWS alerts by providing a consistent, repeatable path for inbound traffic.

The FAA started the Optimization of Airspace and Procedures in the Metroplex (OAPM) initiative to systematically study each metroplex and design/implement performance-based navigation (PBN) procedures and airspace changes to optimize the airspace. The changes are scheduled to be implemented by FY 2018.

The OAPM has joined forces with ASIAS.

- Members of the FAA PBN Integration Team and ASIAS briefed the Northern California Terminal Radar Approach Control Facility (TRACON) OAPM study team on TAWS and TCAS hot spots in Northern California (including OAK), which assisted the team in proposing new routing in the vicinity of Mt. Diablo.
- Members of the FAA PBN Integration Team and ASIAS briefed the Southern California TRACON OAPM study on TAWS and TCAS hotspots in Southern California (including Bob Hope Airport (BUR) and Van Nuys Airport (VNY)). The OAPM study team then recommended the Design Team consider raising the BUR Final Approach Fix by 250 ft and adding a T route to offload traffic from a hotspot near VNY/V186.
- All Study and Design Teams also will have access to new modules in Terminal Area Route Generation, Evaluation and Traffic Simulation (TARGETS) that will allow them to test new procedures to determine if they resolve the current hotspots or generate new ones.

Thanks to InfoShare participants, the issue of TAWS alerts was raised, studied, and mitigated, providing for a 360 degree joint response by industry and government to a safety concern.

Reference: FAA

Appendix XV: Pipeline Integrity Assessment Data and Analyses

In-Line Inspection (smart-pig) – Different tool/technology types run inside the pipeline to detect and characterize anomalies caused by manufacturing, corrosion, cracking, or third-party damage. The type of data that could be analyzed includes:

- # of anomalies identified by type
- # of actionable anomalies
- # of actionable anomalies that required repair
- Size of actionable anomalies (w, l, d) as compared to in field measurements
- % of assessment with data collection issues (over speed, sensor loss, and power loss)
- Miles assessed

Direct Assessment (ECDA, ICDA, SCCDA) – Standardized processes that utilize data integration, above ground testing of cathodic protection and environmental factors, direct examinations of the pipe at the locations most likely to have experienced damage and an overall assessment of the process' effectiveness. The types of data that could be analyzed includes:

- Actionable anomalies/100 miles of ECDA
- Number of coating indications identified/mile
- % correlation– coating indications vs. coating anomalies identified in Step 3
- Feet of 'Off' readings/mile - less negative than -850mV
- % correlation – Immediate indications vs. corrosion damage identified in Step 3
- % correlation – Scheduled indications vs. corrosion damage identified in Step 3
- % correlation – Monitored or NI indications vs. corrosion damage identified in Step 3

To effectively assess ECDA effectiveness, standards for data collection and quality should be specified. The standards for data collection and quality often vary by service provider. It is this standardization of data collected and the requirements for quality control that may result in significant technical improvements.

For the data collected during indirect inspections, Step 2, improvements could be achieved by establishing minimum requirements and technical qualifications that would reduce the erroneous data collected due to field conditions or technical errors. For the direct examinations, Step 3, improvements could be realized by establishing qualifications for the personnel and standardizing the data collected to assess the external corrosion conditions and the extent of damage.
Inputs needed for meaningful analysis and comparison – For the data delivery, it will be important to standardize on the types of data collected and the units for the data collected.
In addition to the data validation, it is important to document minimum standards for how each tool is used, e.g. spacing of the CIS reads, interrupted survey or not interrupted, identify if holes were drilled through asphalt or not, etc.

Hydrostatic Testing – This pipeline integrity assessment pressurizes a pipeline to a level that results in the failure of any anomalies that would have grown to failure prior to the next assessment. The types of data that could be analyzed includes:

- Miles of hydrostatic testing
- # of failures per mile of testing

- # of failures per mile of pipe that was previously integrity assessed
- Type and dimension of anomaly that failed with associated pressures

Non-Destructive Testing (NDE) – This in-the-ditch testing is to obtain information about anomalies identified by the pipeline integrity assessment tools. Usually this testing is performed as the “control” for assessing the effectiveness of a pipeline integrity assessment tool’s results. The skill of the NDE technician, the type of data collected, and the quality of the data collection are key to validating the effectiveness. To ensure consistent evaluations of tools’ effectiveness, a minimum set of data and consistent units is also necessary.

Define and publish key metrics that measure the effectiveness of the VIS. In order to build participation and strengthen trust, metrics need to be established to assess the implementation of the VIS. Some possible metrics include:

- Quantitative statistics relative to data and information available,
- Number of inspections submitted
- Number and variety of pipeline operators and service providers participating,
- Size of pipeline operators participating,
- Documentation on any new threats or technologies improvements that were advanced because of the VIS.

Appendix XVI: Preventative and Mitigative Efforts

Data and Analyses
Leak Detection – On gas distribution systems, the number of leaks and the type of leaks are key indicators of the main's integrity. The effectiveness of the leak detection process and identification of the leak cause could provide valuable data to the Operator. Key data includes:

- Leaks/mile by Material
- Leaks/mile by Age
- Leaks/mile by Coating
- Leaks/mile by Company (Data will be anonymous but could report average and top/bottom quartiles)
- Frequency of survey
- Type of survey
- # leaks and leak types

Locate and Mark – A key component for reducing 3rd Party Damage is an accurate and timely *Locate and Mark* process. Poor or late markings can result in avoidable Third Party Damage. Key data includes:
Locator (Operator or Contractor)

- # tickets
- # tickets/locator-day
- # late locates
- # locate errors
- # 3rd party damage incidents

Geohazard Identification – A pipeline's integrity can be threatened by geohazards such as erosion, landslides or seismic activity. Geohazard identification techniques and the frequency of geohazard remediation may be useful to reduce geohazard threat. Key data could include:

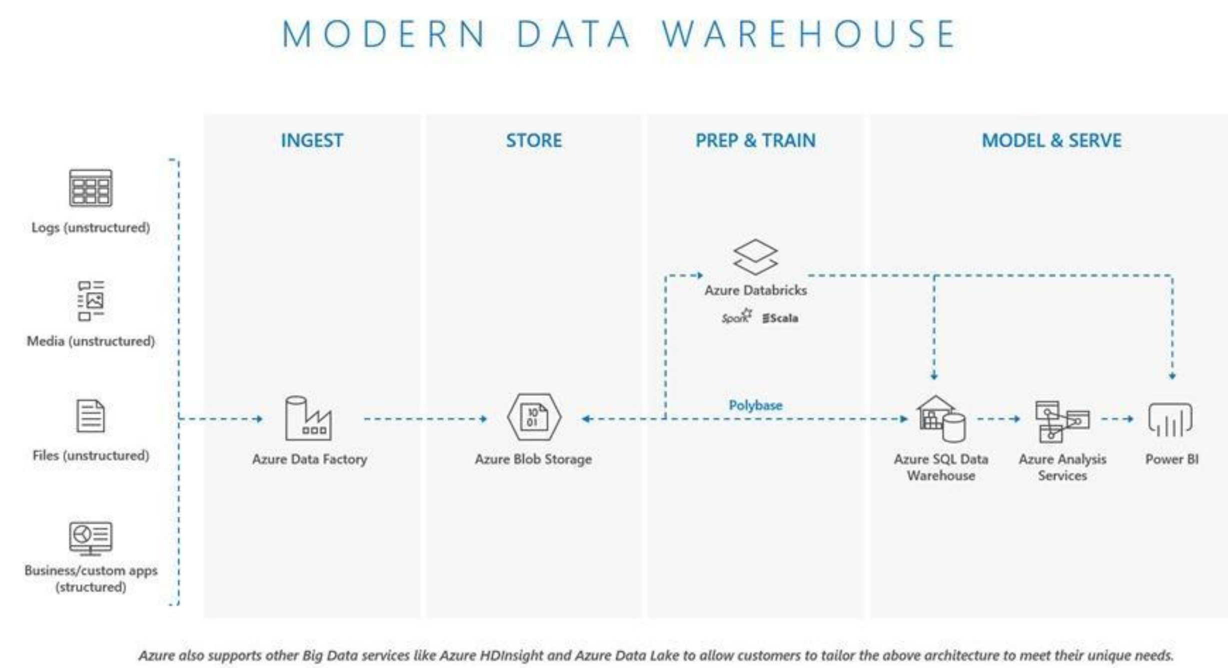
- Identification techniques and frequency
    - Aerial surveys
    - Ground surveys
    - GIS files
- Geohazard events that resulted in actionable responses by the operator

Appendix: XVII: Implementation Patterns

Various options exist in the public cloud from Microsoft, Amazon Web Services and Google Cloud. All examples below are based on Azure services for the implementation of big data and data warehousing workloads. The options and approaches are scalable, extensible and capable on building or evolving upon one another. The following identifies some common adoption patterns which are reference architectures for success.

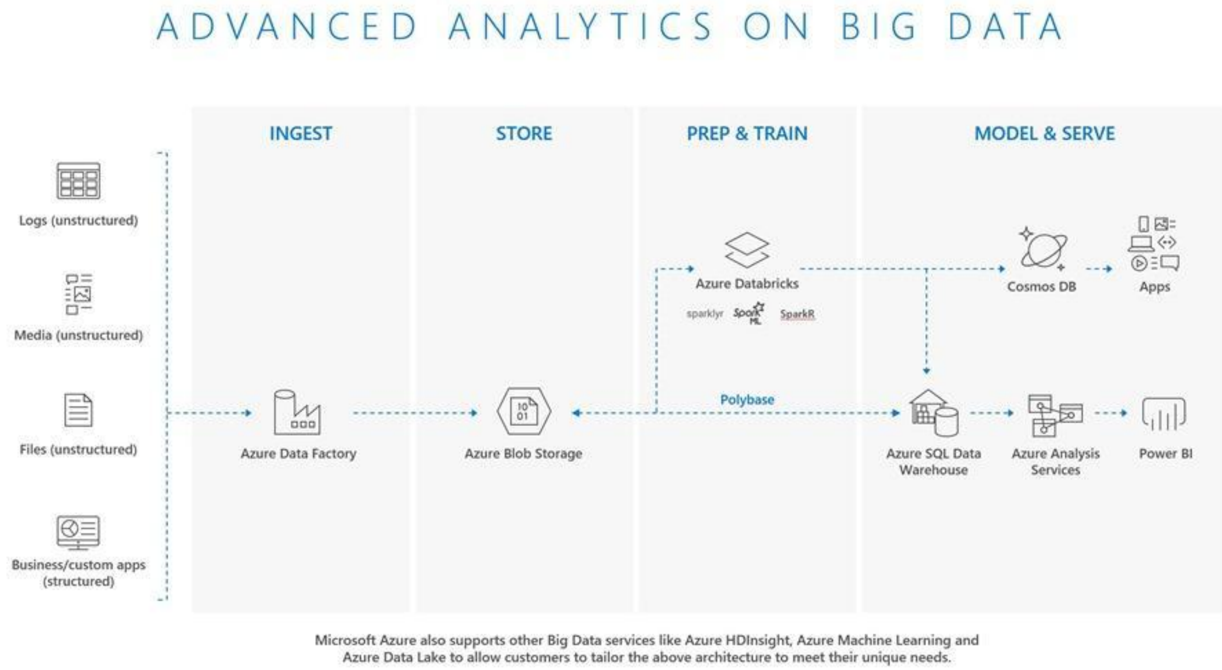
Modern data warehouse

This is the convergence of relational and non-relational, or structured and unstructured data orchestrated by Azure Data Factory coming together in Azure Blob Storage to act as the primary data source for Azure services. The value of having the relational data warehouse layer is to support the business rules, security model, and governance which are often layered here. The de-normalization of the data in the relational model is purposeful as it aligns data models and schemas to support various internal business organizations and applications. Azure Databricks can also cleanse data prior to loading into Azure SQL Data Warehouse. It enables an optional analytical path in addition to the Azure Analysis Services layer for business intelligence applications such as Power BI or other business applications.



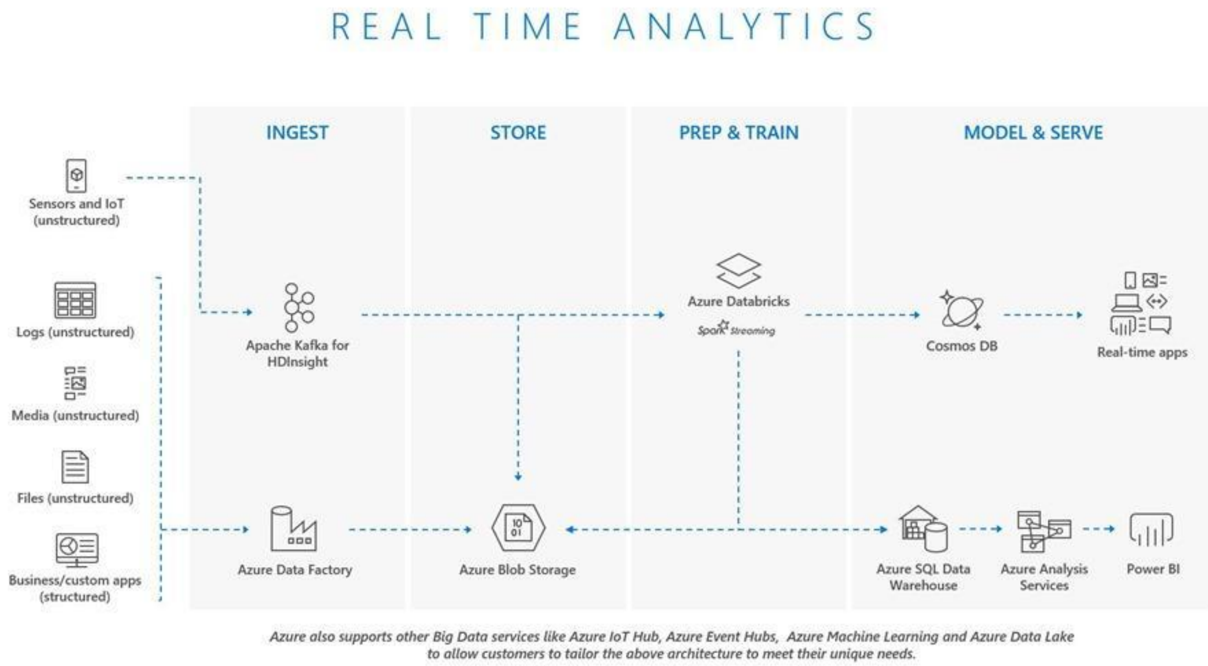
Advanced analytics on big data

Here we introduce advanced analytical capabilities through our Azure Databricks platforms with Azure Machine Learning. We still have all the greatness of Azure Data Factory, Azure Blob Storage, and Azure SQL Data Warehouse. We build on the modern data warehouse pattern to add new capabilities and extend the data use case into driving advanced analytics and model training. Data scientists are using our Azure Machine Learning capabilities in this way to test experimental models against large, historical, and factual data sets to provide more breadth and credibility to model scores. Modern and intelligent application integration is enabled through the use of Azure Cosmos DB which is ideal for supporting different data requirements and consumption.



Real-time analytics (Lambda)

We introduce Azure IOT Hub and Apache Kafka alongside Azure Databricks to deliver a rich, real-time analytical model alongside batch-based workloads. Here we take everything from the previous patterns and introduce a fast ingestion layer which can execute data analytics on the inbound data in parallel alongside existing batch workloads. You could use Azure Stream Analytics to do the same thing, and the consideration being made here is the high probability of join-capability with inbound data against current stored data. This may or may not be a factor in the lambda requirements, and due diligence should be applied based on the use case. We can see that there is still support for modern and intelligent application integration using Azure Cosmos DB and this completes the build-out of the use cases from our foundation Modern Data Warehouse pattern.

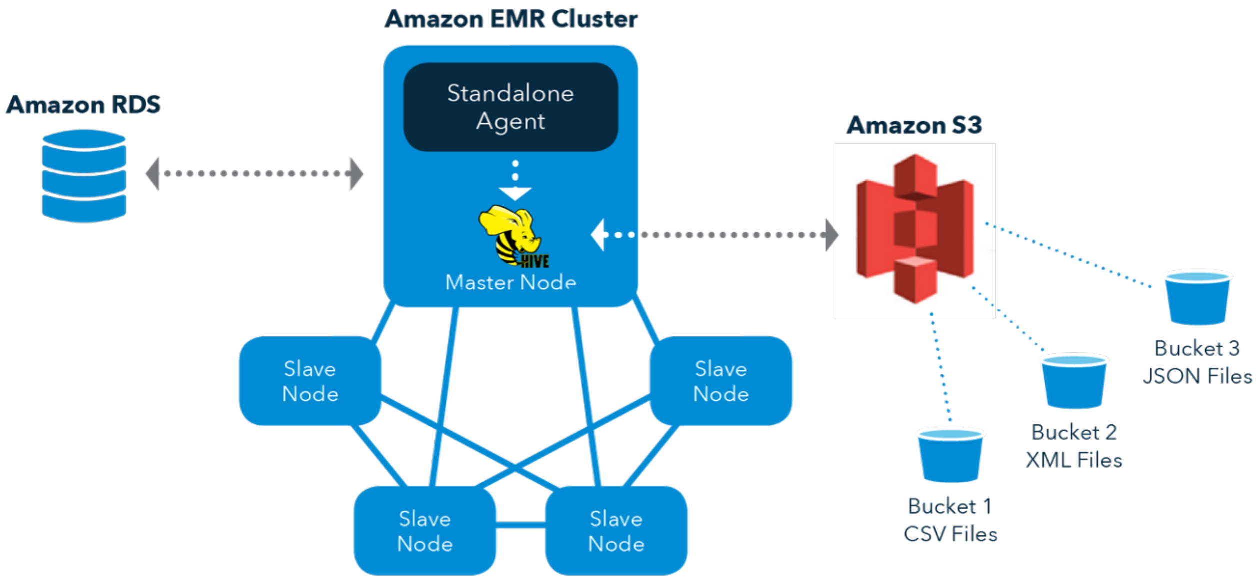


MapReduce

MapReduce is a programming paradigm that was designed to allow parallel distributed processing of large sets of data, converting them to sets of tuples, and then combining and reducing those tuples into smaller sets of tuples. In layman's terms, MapReduce was designed to take big data and use parallel distributed computing to turn big data into little- or regular-sized data.

Parallel distributed processing refers to a powerful framework where mass volumes of data are processed very quickly by distributing processing tasks across clusters of commodity servers. With respect to MapReduce, tuples refer to key-value pairs by which data is grouped, sorted, and processed.

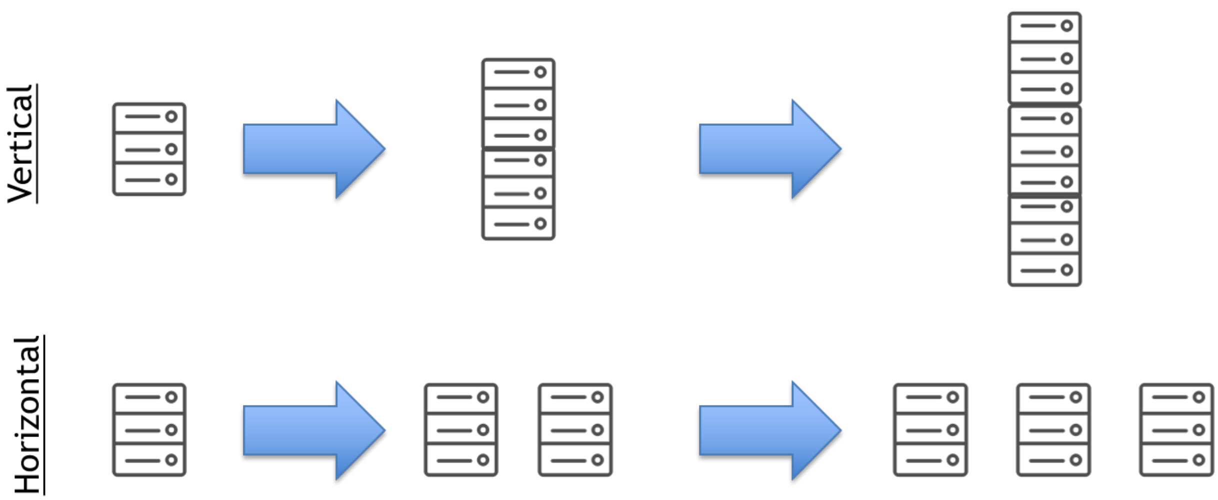
In short, you can quickly and efficiently boil down and begin to make sense of a huge volume, velocity, and variety of data by using map and reduce tasks to tag your data by (key, value) pairs, and then reduce those pairs into smaller sets of data through aggregation operations — operations that combine multiple values from a dataset into a single value. A diagram of the MapReduce architecture can be found here.


Amazon EMR Cluster
Amazon RDS
Standalone Agent
HIVE
Master Node
Amazon S3
Slave Node
Slave Node
Slave Node
Slave Node
Bucket 3 JSON Files
Bucket 2 XML Files
Bucket 1 CSV Files

Appendix XVIII: Paradigms of Data Processing

Most relational database managers have been built on a horizontal storage manager. A horizontal storage manager places all data in a database by row (or record) when a transaction occurs. A database table is represented as a chain of database pages that contain one or more data rows. A horizontal storage manager provides fast online transaction processing (OLTP) support because most transactions occur in a record format. However, when a user requests a record, the database page that contains the data is often moved into memory, which for business intelligence applications can be highly inefficient.

To better support typical user queries found in business intelligence, other storage and indexing techniques are required. Service providers have built vertical storage managers. Instead of storing data by row, these products store the data by columns. This method of storage effectively solves the problem of user queries against large sets of data because a user often seeks only a few columns, versus the large number of columns managed in a row by a horizontal storage manager. With the data stored as a series of page changes, with each page containing column data, query processing time is reduced by a significant factor.



Data Sources

- Databases & Warehouses – A database is an organized collection of data. It is the collection of schemas, tables, queries, reports, views and other objects. A data warehouse is a system used for reporting and data analysis. Data warehouses are central repositories of integrated data from one or more disparate sources.
- IoT/Sensor Data – The Internet of Things (IoT) is the network of physical objects—devices, vehicles, buildings and other items—embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data.
- Cloud/SAAS Platforms – A network of remote servers hosted on the Internet and used to store, manage, and process data in place of local servers or personal computers.

- XML – Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format which is both human-readable and machine-readable.
- Excel – Microsoft Excel is a spreadsheet developed by Microsoft for Windows, macOS, Android and iOS. It features calculation, graphing tools, pivot tables, and a macro programming language called Visual Basic for Applications.
- PDF – The Portable Document Format (PDF) is a file format used to present documents in a manner independent of application software, hardware, and operating systems. Each PDF file encapsulates a complete description of a fixed-layout flat document, including the text, fonts, graphics, and other information needed to display it.

Data Storage

- SQL Data Warehouse - SQL Data Warehouse is a cloud-based Enterprise Data Warehouse (EDW) that leverages Massively Parallel Processing (MPP) to quickly run complex queries across petabytes of data. SQL Data Warehouse is commonly used as a key component of a big data solution.
- Data Lake Store - Azure Data Lake Store is an enterprise-wide hyper-scale repository for big data analytic workloads. Azure Data Lake enables you to capture data of any size, type, and ingestion speed in one single place for operational and exploratory analytics. Azure Data Lake Store can be accessed from Hadoop (available with HDInsight cluster) using the WebHDFS-compatible REST APIs. It is specifically designed to enable analytics on the stored data and is tuned for performance for data analytics scenarios.
- Storage (Azure) - Azure Blob storage is Microsoft's object storage solution for the cloud. Blob storage is optimized for storing massive amounts of unstructured data, such as text or binary data. Blob storage is ideal for: Serving images or documents directly to a browser, Storing files for distributed access, Streaming video and audio, Writing to log files, Storing data for backup and restore, disaster recovery, and archiving, Storing data for analysis by an on-premises or Azure-hosted service and
- CosmosDb - Azure Cosmos DB is Microsoft's globally distributed, multi-model database. A database for low latency and scalable applications anywhere in the world, with native support for NoSQL

Batch Processing

- HDInsight - Azure HDInsight is a fully-managed cloud service that makes it easy, fast, and cost-effective to process massive amounts of data. Use popular open-source frameworks such as Hadoop, Spark, Hive, LLAP, Kafka, Storm, R & more. Azure HDInsight enables a broad range of scenarios such as ETL, Data Warehousing, Machine Learning, IoT and more.
- Data Bricks - Azure Databricks is a fast, easy, and collaborative Apache Spark-based analytics platform optimized for Azure.
- Batch - Azure Batch runs large-scale parallel and high-performance computing (HPC) batch jobs efficiently in Azure. Azure Batch creates and manages a pool of compute nodes (virtual machines), installs the applications to run, and schedules jobs to run on the nodes.

Analytical Data Store

- SQL Data Warehouse - SQL Data Warehouse is a cloud-based Enterprise Data Warehouse (EDW) that leverages Massively Parallel Processing (MPP) to quickly run complex queries across petabytes of data. SQL Data Warehouse is commonly used as a key component of a big data solution.
- Data Bricks - Azure Databricks is a fast, easy, and collaborative Apache Spark-based analytics platform optimized for Azure.

Real-time Data Ingestion

- Event Hubs - Azure Event Hubs is a hyper-scale telemetry ingestion service that collects, transforms, and stores millions of events. As a distributed streaming platform, it provides low latency and configurable time retention, which enables you to ingress massive amounts of telemetry into the cloud and read the data from multiple applications using publish-subscribe semantics.
- Kafka - Kafka for HDInsight is an enterprise-grade, open-source, streaming ingestion service that's cost-effective and easy to set up, manage, and use. Supports real-time solutions such as Internet of Things (IoT), fraud detection, clickstream analysis, financial alerts, and social analytics.

Stream Processing

- Apache Storm - Apache Storm is a free and open source distributed real-time computation system. Storm reliably processes unbounded streams of data, doing for real-time processing.
- Stream Analytics - Azure Stream Analytics is an on-demand real-time analytics service to power intelligent action. Supports massively parallel real-time analytics on multiple IoT or non-IoT streams of data using simple SQL like language. Leverages custom code for advanced scenarios.

Analytics and Reporting

- PowerBI - Power BI is a suite of business analytics tools that deliver business/project insights. Connect to hundreds of data sources, simplify data prep, and drive ad hoc analysis. Produce reports, then publish for consumption on the web and across mobile devices.
- Web App - Azure App Service Web Apps (or just Web Apps) is a service for hosting web applications, REST APIs, and mobile back ends. Enables build and host web applications in various programming language.

Orchestration

- Data Factory - The Azure Data Factory service is a fully managed service for composing data storage, processing, and movement services into streamlined, scalable, and reliable data production pipelines.
- HDInsight - Azure HDInsight is a fully-managed cloud service that makes it easy, fast, and cost-effective to process massive amounts of data. Use popular open-source frameworks such as Hadoop, Spark, Hive, LLAP, Kafka, Storm, R & more. Azure HDInsight enables a broad range of scenarios such as ETL, Data Warehousing, Machine Learning, IoT and more.

General Definitions

- Cloud – A network of remote servers hosted on the Internet and used to store, manage, and process data in place of local servers or personal computers.
- Data
  - Static – data that does not change after being recorded. It is a fixed data set.
  - Dynamic – or transactional data is information that is periodically updated, meaning it changes asynchronously over time as new information becomes available.
  - Streaming – data that is generated continuously by thousands of data sources, which typically send in the data records simultaneously, and in small sizes
- Database Storage Technology – Currently, the most common types of databases are: relational databases and non-relational databases. Differences exist in how they're built, the type of information stored, and how they store it. Relational databases are structured, and consist of two or more tables with columns and rows. For a relational database to be effective, the data being stored should be known and structured in a very organized way (a clearly defined schema). Non-relational databases are document-oriented and distributed, offering much greater flexibility and capability to assemble related information of all types. If data requirements aren't clear at the outset or the project entails massive amounts of unstructured data, developing a relational database with clearly defined schema may not be an option.
- Data Transfer - the transmission of data (a digital bit stream or a digitized analog signal over a point-to-point or point-to-multipoint communication channel.
- Data Visualization – a general term that describes any effort to help users understand the significance of data by placing it in a visual context. Patterns, trends and correlations that might go undetected in text-based data can be exposed and recognized easier with data visualization.
- Data Repository Modes – a storage area, where metadata of a data model is stored. The data stored is different from the software perspective, organization's perspective and usage perspective. Repository can be stored anywhere; either in a data base or locally within any system.
- Advanced Processing\Analytics – is the autonomous or semi-autonomous examination of data or content using sophisticated techniques and tools, typically beyond those of traditional business intelligence (BI), to discover deeper insights, make predictions, or generate recommendations.
- Security – is the protection of internet-connected systems, including hardware, software and data, from cyberattacks. In a computing context, security comprises cybersecurity and physical security -- both are used protect against unauthorized access to data centers and other computerized systems.

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Appendix XIX: Governance Model Options and Alternatives

Voluntary Information Sharing - Governance Alternatives

PHMSA Administered	Privately Administered
• Drawing upon experience of Federal Aviation Administration – ASIAS • PHMSA administers	• Drawing upon experience of Commercial Aviation – CAST • Private entity administers

- VIS Governing Board – PHMSA, pipeline operators, service providers, NAPSR representatives, trade associations, public representatives, labor unions and universities
- Third-Party Information Manager – Private Entity
- Issues Analysis Team(s) – comprising representation of Governing Board with deep technical knowledge

PHMSA Administered	Privately Administered
• Legal protections through statute • Funding through Federal appropriation • Possible co-funding from private entities	• Legal protections through contract • Funding through private contributions • Possible co-funding from PHMSA

Major Differences Between the Options

Option A

- PHMSA/Industry Co-Chairs
- PHMSA provides day-to-day oversight & operational management of VIS
- PHMSA/Congress funds VIS
- Legislative protections on confidentially & non-punitive reporting. Notwithstanding Congressional action, confidentiality, NDAs, MOUs and other types of implementation agreements
- Issue Analysis Team Make-up: NAPSR-appointed State agent (or designated representative), labor and technical experts from industry and PHMSA

Option B

- Industry Chair, PHMSA Board Member
- VIS CEO provides day-to-day executive management
- VIS Operations Group provides day-to- day management
- Industry participants fund VIS. Confidentially provided by confidentially Agreements & NDAs, Non-Punitive Reporting by PHMSA Agreement
- Issue Analysis Team Make-up: Participants with expertise in specified subject matter

Option C

- Industry/PHMSA Co-Chairs. Motions require unanimous Chair consent
- VIS CEO provides day-to-day executive management
- VIS Operations Group provides day-to- day management
- Split funding between industry, PHMSA, grants, etc. fund VIS
- Legislative protections on confidentially & non-punitive reporting
- Issue Analysis Team Make-up: Participants with expertise in specified subject matter

Option D

- Industry/PHMSA Co-Chairs. Motions require unanimous Chair consent
- PHMSA provides day-to-day oversight & operational management of VIS
- Tabled for the VIS Parent Committee Meeting
- Legislative protections on confidentially & non-punitive reporting. Notwithstanding Congressional action, confidentiality, NDAs, MOUs and other types of implementation agreements
- Issue Analysis Team – Step 1, Issue Analysis Selection Committee (subset of the Executive Board made up of NAPSR-appointed State agent (or designated representative), labor and technical experts from industry and PHMSA) responsible for populating the Issue Analysis Technical Working Group with technical and non-technical expertise. Step 2) Issue Analysis Technical Working Group that conducts the analysis and provides reports and products to the Board

Appendix XX: Detailed Example Timeline for Authorization, Initiation, and Deployment of a VIS

	1Q	2Q	3Q	4Q	5Q	6Q	7Q	8Q	9Q	10Q
Attain Congressional Authorization Including Legal Protections										
Stand-Up PHMSA VIS Staff										
Stand-Up VIS Executive Board										
Establish Governance Principles										
Identify and Select VIS Analysis Team Members										
Develop RFP and Select VIS Support Contractor										
Broaden Incident/ Accident Lessons Learned Sharing Processes										
Establish Lessons Learned Sharing Process with External Stakeholders										
Establish Integrity Assessment Lessons Learned Sharing										
Establish Discrete Integrity Assessment Data Sharing Process										
Establish Risk Management Lessons Learned Sharing Process										
		Duration of Process Development								
		Potential Early Start or Extended Development Time								
		Execution of Processes								

	11Q	12Q	13Q	14Q	15Q	16Q	17Q	18Q	19Q	20Q
Attain Congressional Authorization Including Legal Protections										
Stand-Up PHMSA VIS Staff										
Stand-Up VIS Executive Board										
Establish Governance Principles										
Identify and Select VIS Analysis Team Members										
Develop RFP and Select VIS Support Contractor										
Broaden Incident/ Accident Lessons Learned Sharing Processes										
Establish Lessons Learned Sharing Process with External Stakeholders										
Establish Integrity Assessment Lessons Learned Sharing										
Establish Discrete Integrity Assessment Data Sharing Process										
Establish Risk Management Lessons Learned Sharing Process										
		Duration of Process Development								
		Potential Early Start or Extended Development Time								
		Execution of Processes								