(DRAFT – PREDECISIONAL)

Pipeline Safety Voluntary Information-Sharing System Working Group

Recommendation Report to the U.S. Department of Transportation for the Development of a Voluntary Information-sharing System

December 2018

KEY	
(yellow)	**Content Pending**
(green)	**Acronym/Abbreviation**
(magenta)	**Definition/Terms**

Letter to the Secretary

Pending review and approval from the VIS WG Chair

Disclaimer

This report was developed and produced by the Voluntary Information-sharing System Working Group (VIS WG or Committee). The VIS WG was established under Section 10 of the Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (Public Law 114-183), to provide recommendations to the Secretary of Transportation on 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 U.S. Department of Transportation (the "Department) established the VIS WG in December 2016 in accordance with the provisions of the Federal Advisory Committee Act (FACA), as amended, 5 U.S.C. App. 2. FACA helps ensure the independent nature of the body and requires that the Department not exercise influence over the advice and recommendations in its report. Consistent with this provision, neither this report, nor the final recommendations it contains, have been cleared or approved by the Secretary of Transportation, the Department, or the Pipeline and Hazardous Materials Safety Administration (PHMSA), and, as such, the views expressed in this report should not be regarded as those of the Secretary, the Department, or PHMSA. The report represents the collaborative work and VIS WG final recommendations.

Acknowledgments

The Voluntary Information-sharing System Working Group (VIS WG or Committee) is grateful to the many individuals and organizations that have provided expertise, knowledge, and important insights about the need for a voluntary information sharing system. The VIS WG would like to thank the many experts and individuals who presented and shared invaluable information at the committee meetings. These presentations were vital to our work, and informed the Final Report. Specifically, we thank XX. The VIS WG also appreciates the individuals and organizations that provided public comment. The public comments provided insights and information that helped inform the committee's work and final recommendations.

The Committee offers its sincere gratitude to the Pipeline and Hazardous Materials Safety Administration (PHMSA) and Administrator Howard Skip Elliott for his interest in and support of the Committee. PHMSA's financial and operational support was critical to the success of the final report. We sincerely thank Alan Mayberry, Associate Administrator of Pipeline Safety, and Dr. Christie Murray, Designated Federal Officer, for their leadership and their deep commitment to advancing pipeline safety.

Finally, thank you to the volunteers on the seven short-term subcommittees and PHMSA staff members and support personnel whose participation and expertise have made significant contributions to the work of the Committee – Cheryl Whetsel, Janice Morgan, Michelle Freeman, Max Kieba, Karen Lynch, Hung Nguyen, Sherry Borener, Chris McLaren, Douglas White, Amy Slovacek, Amal Deria, Ahuva Battams, Amy Nelson, and Nancy White. Their expert technical assistance and support helped guide the development of the final report.

Table of Contents

Executive Summary

A pipeline safety voluntary information sharing-system is a safety management system (SMS) that relies on voluntary sharing of information related to real-time or near real-time factors used in assessing pipeline integrity and risk, including (but not limited to): historic pipeline integrity data from pipeline operators and safety inspectors; incident/accident investigations and reports; in-line inspection (ILI) data; direct assessment data (ECDA, ICDA, SCCDA); hydrostatic testing data; non-destructive examination (NDE) data; leak detection data; location and marking data; geohazard identification data; near miss data; and human performance data.

The report recommends ways to develop this voluntary information-sharing system that encourages a collaborative effort between pipeline operators, industry stakeholders, and third-party data management teams. In addition, the report recommends processes and best practices with regards to communicating safety data and risks not only between industry stakeholders but also with and between the public, labor, and environmental stakeholders. One of the guiding principles behind the report is that transparency is just as important as collaboration to fostering an environment of information sharing and exchange. By de-identifying the data, establishing a secure system and best practices to protect proprietary and security-sensitive data, and encouraging full pipeline industry participation, only the most relevant information to analyzing overall pipeline safety will remain in the system and a safe process can be created for genuine and timely reporting and feedback. With this voluntary shared system, we have an opportunity to encourage continual improvement in the exchange of pipeline safety information, the research and development of pipeline inspection technologies, and improved risk analysis of gas transmission, gas distribution, and hazardous liquid pipelines and facilities, leading to a safer overall environment.

Collectively, the VIS Working Group recommends:
Add when finalized…..

Next steps….

Key Terms, Acronyms, Definitions

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.

Stakeholder

A party that has an interest in PHMSA and can either affect or be affected by its pipeline safety regulations, policy, and applicable pipeline safety mandates/laws. The primary stakeholders are Congress; federal, state, local, and tribal governments; industry associations and service providers; pipeline operators and owners; safety advocates and non-government organizations; and, public representatives and the public.

VIS WG: Voluntary Information-sharing System Working Group

A Federal Advisory Committee established to fulfill Section 10 of the Protecting our Infrastructure of Pipelines and Enhancing Safety (PIPES) Act of 2016The VIS WG will provide the Secretary of Transportation with independent recommendations on the development of a voluntary information-sharing system.

FASB: Financial Accounting Standards Board

The board responsible for establishing and improving financial accounting and reporting standards for public and private companies, nonprofit organizations, and state and local governments in the United States.

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).

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).

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

CGA: Common Ground Alliance

A non-profit 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.

Dig Verification Data

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

DIRT: Damage Information Reporting Tool

A secure online database that allows damage prevention stakeholders to anonymously submit information about underground damages and near-misses incidents that determines root causes, promotes underground damage prevention education and training efforts, and creates an industry-wide picture of opportunities to improve safety. One call centers, facility owners, municipalities and government regulatory entities are among those who voluntarily submit data to DIRT.

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.

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.

Form 8-K: [Add formal name of form]

Commented [Lynch, Ka1]: Is this important enough to list under this section?

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.

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.

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.

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.

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.

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.

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.

KPI: Key Performance Indicator

A measurable value that demonstrates how effectively a company is achieving key business objectives. High-level KPIs may focus on the overall performance of the enterprise, while low-level KPIs may focus on processes in departments such as sales, marketing or a call center.

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.

Form 10-Q: [Add formal name of form]

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A Securities and Exchange Commission 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.

COS: Committee 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 of shore industry in safety management systems, industry continuous improvement, outreach and facilitation with government and external stakeholder.

NAPSR: National Association of Pipeline Safety Representatives

A non-profit 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.

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.

SMS: Safety Management System

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.

API: American Petroleum Institute

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API is the largest U.S. trade association for the oil and natural gas industry and is the only national trade association representing all facets of the natural gas and oil 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 natural gas industry.

API RP: Recommended Practice

API documents that communicate recognized industry practices that may include both mandatory and nonmandatory requirements.

SME: subject matter expert

ILI: In-Line Inspection

Typically refers to the tool but can also refer to the process of in-line assessment.

ITD: In the ditch

Methods used by technical personnel to examine anomalies on pipe.

HUB:

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

TO BE ADDED:

PRCI

ASIAS

NDE

AGA

INGAA

GTI

NTSB

NIST

POD & POI

FIPS 199

POF

RCFA

NPMS

ASME

DA

HT

ASAP

FOQA

FRA

IMP

SGA

VIS:

FAA:

R&D:

Background & Introduction

Congressional Mandate

The Voluntary Information-sharing System Working Group (VIS WG or Committee) is an advisory committee that was mandated under Section 10 of the Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (Public Law 114-183), to provide recommendations to the Secretary of Transportation on 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 U.S. Department of Transportation (U.S. DOT) established the Committee in December 2016. The Committee is comprised of 23 members appointed by the Secretary of Transportation for a term of 3-years, and includes: representatives from PHMSA; industry stakeholders, including operators of pipeline facilities, inspection technology, coating, and cathodic protection vendors, pipeline inspection organizations; safety advocacy groups,; research institutions; state public utility commissions and state officials responsible for pipeline safety oversight; state pipeline safety inspectors; labor representatives; and, other entities as determined appropriate by the Secretary.

The Committee was tasked with considering and providing recommendations to the Secretary by December 2018 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).

Details of the VIS WG Charter, Bylaws, and Establishment can be found in Appendices xx-xx.

Overview

To address the task, the Committee established seven subcommittees to consider different aspects of the tasks within the jurisdiction of the Committee and to complete the write-up of the final recommendation report. The subcommittees include: (1) Mission and Objectives (Governance); (2) Process Sharing; (3) Competency, Awareness, and Training (formerly Training and Qualifications); (4) Technology and R&D; (5) Best Practices; (6) Regulatory, Funding, and Legal; and, (7) Reporting.

Critical Industry Challenges

The Nation's network of more than 2.7 million miles of pipeline is largely regulated by the U.S. Department of Transportation's (U.S. DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) and state entities. Information sharing is essential to the protection of this critical infrastructure and to further advance national pipeline safety. A voluntary information-sharing system that encourages collaborative efforts and the exchange of pipeline inspection information can bridge this gap and improve integrity risk analysis for gas transmission and hazardous liquid pipelines, as well as gas distribution pipelines, and help ensure their safe maintenance and operation.

In the development of a voluntary information sharing system the critical safety challenges can be separated into four distinct types, as follows:

1) Legal Challenges to Data and Information Sharing.
    a. Legal repercussions that may arise out of information sharing as they relate to antitrust rules.
    b. Legal issues that may arise during identification of potential safety issues through information sharing with DOT that could lead to legal jeopardy for participants.

2) Organizational and Governance Challenges.
    a. If a VIS is non-governmental who could afford to participate and how would it be managed.
    b. Requires 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.
    c. Participants expressed a desire to use the information sharing environment to benchmark in-line-inspection providers of service; this would create a very different type of information sharing system.
    d. As technology develops with much faster pace, key is clarity of objectives so that proper information technology is employed effectively and efficiently.

3) Relationship/Trust Challenges.
    a. Trust among industry participants and competition between industry vendors.
    b. Organizational environment needs to be constructed in such way that allows for the members to share information. Given this highly competitive industry, would it be possible for the members to develop trust?

4) Cost Challenges.
    a. Ownership of the system and costs; information sharing hub, management of data and distribution of results.
    b. Technology development costs and the need to acquire or adapt data sharing technology used previously by the FAA.

The Need for an Information Sharing System

These critical safety challenges stem from current ad-hoc or limited information sharing and exchange among pipeline industry stakeholders, whether related to data inputs, risk analyses, lessons learned, training, or research and design. There is no existing industry-wide culture of consistent data sharing and trust. Additionally, public, environmental, and labor stakeholders are increasingly alarmed by what they perceive as a lack of transparency with regards to pipeline safety information. Building a reliable voluntary information sharing system 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 overall safety of pipeline infrastructure in the United States.

An effective information sharing system is critical to ensure the integrity, reliability, and safety of our pipeline infrastructure and to bridge the gap between XX to advance pipeline safety. It is equally important for the pro-active 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 Safety Management System (SMS) 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.

Alignment with Safety Management System (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 in industries that manage significant safety risks, including aviation, petroleum, chemical, electricity generation, nuclear, and others.

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. SMS is useful for investing in predictive analysis capabilities, improving integrity verification procedures and utilizing data to stay ahead of technical developments that could pose new and unforeseen safety risks. This approach is in alignment with how the VIS WG has approached developing the report and recommendations. 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 absolutely every single aspect of a pipeline management system. Throughout the report, alignment of each recommendation with API's RP 1173 on SMS is noted where appropriate.

VIS/SMS Alignment

- Aligns well with Pipeline Safety Management System practices
- American Petroleum Institute's Recommended Practice 1173
- Focuses on improving pipeline safety through:
  - Exchanging relevant pipeline safety information
  - Sharing of lessons learned
  - Leveraging best practices
  - Engaging with stakeholders
  - Fostering continuous improvement

Strategic Mission Statement

The VIS WG mission statement is: *to provide the Secretary of Transportation with independent advice and recommendations on the development of a secure, voluntary pipeline information-sharing system(s) (VIS) 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 overarching goal of the development of the VIS is to provide a collaborative environment that is proactive in nature, facilitates continuing safety improvements and technological advancements, and leads the industry to actionable outcomes.

The objective of this report is to develop recommendations that will lead to the development of a voluntary information sharing system that will be a repository for and a source of pipeline integrity information that individual operators will consistently use to proactively eliminate pipeline risk. Considering the challenges facing the pipeline industry, it is also essential that the processes of governance, security and confidentiality, stakeholder participation, regulatory environment, and funding be addressed to ensure the system is successful. The scope of this report is governed by PHMSA's jurisdictional framework. The system/process will provide a tiered approach to information sharing.

Guiding Principles

The Strategic Mission, Goals, and Objectives of the PHMSA VIS WG were approved on _________. They provide initial framing on how a pipeline safety VIS program might be governed, who might use it, what data sharing processes might be used, how proprietary information can be protected to ensure industry buy-in, and possible funding mechanisms. This document is issued exclusively as a recommendation and is not indicative of current PHMSA regulations. This document is U.S. Department of Transportation property and is to be used in conjunction with official PHMSA duties. As PHMSA continues to develop, examine, and revise the VIS policies and procedures, the goals, objectives, and recommendations may be modified and the scope may be broadened or narrowed; however it is intended that the underlying mission of *developing a secure, voluntary pipeline information-sharing system(s) that encourages collection and analysis of integrity inspection and risk assessment information and other appropriate data to improve pipeline safety in a measurable way* should remain consistent. In addition, the VIS WG recommends that the following guiding principles be used in leading future implementation of these recommendations:

1. Submission of safety sensitive data to the VIS is always voluntary
2. Transparency is paramount in how data are managed and utilized
3. Analysis and issues addressed are approved by a governing VIS Executive Board
4. Procedures and policies of VIS are based on collaborative governance
5. Operator and vendor date are de-identified
6. Data and analysis is used solely for advancement of safety

Scope and Audience

The scope of this report is 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

The audience for the report is narrowly the Secretary of Transportation and DOT staff, and more broadly, anyone interested in safety, governance, and technology related to the gas and hazardous liquids pipeline industry, including pipeline operators, pipeline inspection organizations, inspection technology vendors, public safety advocacy groups, university research institutions, tribal governments, state public utility commissions, state pipeline safety inspectors, labor representatives, worker health and safety advocacy groups, environmental advocacy groups, and others.

Methodology

The VIS WG Recommendation Report was drafted with the goal of providing recommendations and advice for the establishment of a voluntary information-sharing system and process that will allow efficient risk analysis to minimize near misses, pipeline malfunction, incidents and accidents of varying levels of seriousness.

The Committee developed an outline and milestone plan, formed subcommittees, developed task statements, invited SMEs to present and join subcommittees.

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; identification and validity of information that is subject to sharing among various stakeholders. All tasks were deliberated internally within the subcommittees and extensively during the VIS Parent Committee regular meetings.

To identify recommendations for the development of a voluntary information-sharing system, the VIS WG examined the 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 voluntary information-sharing systems; and, analyzed safety practices. The evidence obtained provides a reasonable basis for the final recommendations.

Over the course of XX public meetings and XX subcommittee meetings, the Committee and subcommittees gathered information, performed research, and collaborated with pipeline and technical experts. The Committee deliberated and achieved consensus on the recommendations that are provided in this Report and submitted to the Secretary for consideration.

Recommendations

Governance Structure

A subcommittee was formed to define the overall mission, objectives, and governance of the VIS.

Task Statement:

Recommendation G-1: Governing Principles

Commented [Simona Pe4]: See consolidated recommendations report for Options A, B, C, D

Structure(s)

Recommendation G-2: Federal Involvement

Recommendation G-3: Executive Board

Recommendation G-4: Issue Analysis Teams

Recommendation G-5: Third Party Data Provider

Commented [Simona Pe5]: See consolidated recommendations report for Options A, B, C, D

Data Sharing and Information Dissemination

Recommendation G-6: Information Dissemination and Board Selection

The VIS should establish a tiered Information Sharing System. The Information Sharing System should consist of tiers of information dissemination, transparency and confidentiality. One example might be as follows:

- Tier 1, unlimited access to all data. This level of access would require Non-Disclosure Agreements (NDA) for all individuals with this access and would be limited to the Third-party Provider.
- Tier 2, access to all data, except the name of the reporting company and geographical data, to the extent that it was not a direct contributor to the incident. This level of access would require NDAs for all individuals with this access and would be limited to the members of the issue analysis teams.
- Tier 3, access to all reports and data issued by the VIS. Operators would sign an agreement with VIS pledging not to disseminate this data. This level of access would be limited to the participant Operators who volunteer to share their data through the VIS process.

- Tier 4, access to select reports and data issued by the VIS (this data would consist of critical notices of specific individual risks, facility failures, or summaries of risks that constitute a potential threat to pipeline safety). This level of access would be limited to all industry Operators.
- Tier 5, any publicly disclosed information released by the Executive Board.

Recommendation G-7: Confidentiality

- Confidentiality policies should include issues of redaction, security, and data and information dissemination.
- Confidentiality policies would also be included in contracts between participants and the third-party data provider.
- Individuals performing work in this environment would be required to sign NDAs in accordance with the policies established by the Executive Board to include Executive Board members.

Process Sharing

A subcommittee was formed to define the processes for sharing information. The subcommittee began work by defining a task statement:

In the spirit of improving pipeline safety and technology development, this subcommittee will produce a recommendation to the VIS working group for identification and improvement of the types of information and data shared among key stakeholders. Examples of stakeholders may include; congress, state and federal regulators, industry associations and service providers, hazardous liquids and gas transmission operators, gas distribution operators, public representatives and the public. This will be accomplished through subcommittee deliberation, coordination with other subcommittees, consultations with outside experts, and synthesis of information collected during the subcommittee deliberation period. This includes (but is not limited to) Root Cause Analyses, "Good Catches"– Close Calls (near misses), Safety Management Systems Lessons Learned, Mitigative Measures and Pipeline Assessment Processes and Data.

Need for an Information Sharing System - see Background/Introduction narrative sections, p. 15

Types of Information and Data to be Shared and Purpose(s)

The subcommittee defined the types of information and data to be shared from presentations by SMS experts to the Parent Committee and discussions with the full committee and based on existing pipeline SMS (API RP 1173). These include:

1. Learnings from reportable incidents and accidents[1], and near misses (PSMS – 9)
2. Learnings from routine use of integrity assessment technology (ILI, DA, HT, Other Technology) (PSMS – 9)
    a. Lessons Learned – descriptive of rule-based take-aways
    b. Discrete Integrity Assessment and Excavation Data
3. Learnings about specific risks (SMS – 6)
4. Sharing Information and Learnings with our public stakeholders (SMS – 2)

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 Kresig, Vice President, Asset Integrity, Enbridge Liquid Pipelines
- Center for Offshore Safety

Subcommittee members wanted to know what these experts had learned in standing up an information sharing system. Each expert was also asked what they would do differently if they were starting today; things they would do more of as well as less of.

The information sharing system that became the model for the process sharing recommendations for the VIS was the FAA's ASIAS program, so it is useful to describe this program in some detail. ASIAS is governed by six key principles including:

1. voluntary submission of safety-sensitive data
2. transparency for how data are managed and utilized

1 "Incident" is the term of art used for gas pipelines, whereas "accident" is the comparable term used for hazardous liquid pipelines (refer to 49 CFR 191.3 for gas and 195.50 for hazardous liquid pipelines.)

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

While many of these pertain to governance, they do help define information to be shared and how process sharing might work.

ASIAS manages data from a series of reports filed with the FAA.

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. These are a blend of alpha-numeric, numeric data and text.

2. Flight Operations Quality Assurance (FOQA) – the objective of a 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 FOQA are a part of the operator's safety management system. Data are collected from the aircraft by using special acquisition devices such as a Quick Access Recorder or Flight Data Recorder. These are a blend of alpha-numeric and numeric data.

Figure PS-1 provides a view of the commercial aviation continuous improvement cycle using ASIAS.

Figure PS-1 – Aviation Continuous Improvement Cycle – Building On ASIAS

Recommendation PS-1: Define and develop a community of practice that fosters the voluntary sharing and exchange of information related to 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 integrity assessments, managing risk and improving pipeline safety performance. We recommend first building the community of practice with a "coalition of the willing," that grows as successes are realized. Stakeholders should include operators, service providers, regulators, research organizations, organized labor, and public safety representatives. One example to build upon inside the pipeline industry is the Pacific Gas and Electric (PG&E) Correct Action Program (see Appendix VII).

Recommendation PS-2- Define the types and what information are to be shared to enhance integrity management including integrity assessments and risk management.

More detail will be defined based on recommendations made by the Best Practices and Technology and Research and Development Subcommittees.

Subcommittee discussions and work defined a set of requirements for process sharing. These include

- 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

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. CAST can request a study to be made using ASIAS to address concerns raised by pilots and mechanics. The ASIAS Executive Board can also make such requests. The request is typically made as a "defined use case." The Issues Analysis Team reviews the use case and works with the Third-Party Contractor who manages the ASIAS data to define a work scope. When the analysis is completed and reviewed by the Issues Analysis Team, the ASIAS Executive Board reviews findings and recommendations made by the Issues Analysis Team and shares them with CAST. CAST then typically develops documents to share the learnings referred to as "InfoShares." These are presented in meetings of operators, CAST and ASIAS staffs throughout the year.

An example InfoShares is provided in Appendix VII.

Common Data Exchange Protocol

Recommendation PS-3: Develop a plan (design) for an information sharing center, hereafter referred to as a voluntary information sharing hub.

The VIS will share information defined in PS-2 among members of the community of practice defined in PS-1 under Governance defined by the Mission, Values and Governance Subcommittee.

Subcommittee members developed an example Use Case to help readers understand how the use case concept could be applied to energy pipelines. The Use Case is shown below.

Use Case - Benefits of VIS to Nondestructive Evaluation (NDE)

ID:	New Concept – VIS and NDE
Title:	The potential to improve and expand the use of Nondestructive Evaluation

	methodology for pipeline anomaly detection.
Description:	Voluntary Information Sharing among pipeline operators and NDE vendors would expand the knowledge of the advantages and disadvantages of various technologies, improve the technology by linking verification data to NDE results, and enable collaborative analysis by a broad-based community of experts to provide superior risk reduction.
Primary Actor:	The VIS environment would support data exchange between one or more pipeline operators and one or more vendors.
Preconditions:	External corrosion is a threat often not detected through mandated in-line inspection tools. It is identified using NDE direct assessment tools, and confirmed through the fusion of several different types of data and logic. It is often present where pipelines have experienced a loss of cathodic protection (coating holidays), electronic interference with cathodic protection or when a pipeline has been injured by external excavation activity. External corrosion must be assessed through direct assessment methods but often can only be confirmed through excavating pipeline (digging). Significant uncertainty exists as to whether the detected anomaly is, in fact, a potentially unsafe condition. Digging based upon this uncertain information is undesirable to the operator because there is only a small amount of information to use as the basis for the decision. This is a costly measure action and can also result in damage to the pipeline.
Postconditions:	By engaging in a VIS, the operator and the vendor would be able to evaluate how the results of NDE assessments align with the results of similar assessments for other operators and vendors. Decisions to excavate pipeline based upon the analysis of the collected data would be made using a broader base of knowledge and guidance that is developed using the excavation experience of multiple operator/vendor evaluations. Uncertainty about whether to dig based upon the results of the anomaly detection method is reduced significantly because of the use of data from multiple cases, vendors and operators. Only significant and potentially unsafe anomalies are chosen for excavation. The result of the excavations and safety outcome are shared among the VIS community and thus improves the understanding of similar future cases.
Main Success Scenario:	Currently NDE is the standard for validating the performance of other integrity assessment tools. VIS provides an information base to the whole industry for

	verification and validation and tool and service evaluation. Using VIS to establish some industry-wide standards for performance for tools, detection capability, actionable results and expected outcomes, NDE can help industry to understand missed calls, signatures of potentially actionable issues and reduce erroneous pipe excavation and unnecessary pipeline replacement. Blended data reduce false alarms, missed calls and undetected leaks.
Priority:	This is a high-priority use case because of the frequency with which NDE is used by the industry and the frequency of unnecessary pipe excavation and replacement. Data sharing via VIS for NDE evaluation would be a very frequently used process.

After analyzing and evaluating the FAA model, the following table was identified to compare the current state of information sharing in the larger context of managing within a safety management system with that of energy pipelines.

Table PS-1 – Comparison of Safety Continuous Improvement – Current State

	Aviation Safety	**Energy Pipelines**
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

Recommendation PS-4: Adopt 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.*** 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 institutional 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. 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.*** Integrate the lessons learned process established herein into the management review process

After spending time understanding the history of successes in the FAA, FRA, COS, CGA and others it became apparent that there was an opportunity to draw upon established voluntary information sharing in the energy pipeline industry, and specifically using API RP 1163, In-Line Inspection System Qualification Standard.

The standard provides the pipeline industry with a consistent means of assessing, using, and verifying in-line inspection equipment and the results of inspections. 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.

The current state of information sharing in bilateral or simply, two-way between the operator and ILI service provider. While the use of API RP 1163 is widespread it is not applied by all operators in all uses of ILI. The current state is depicted in Figure PS-

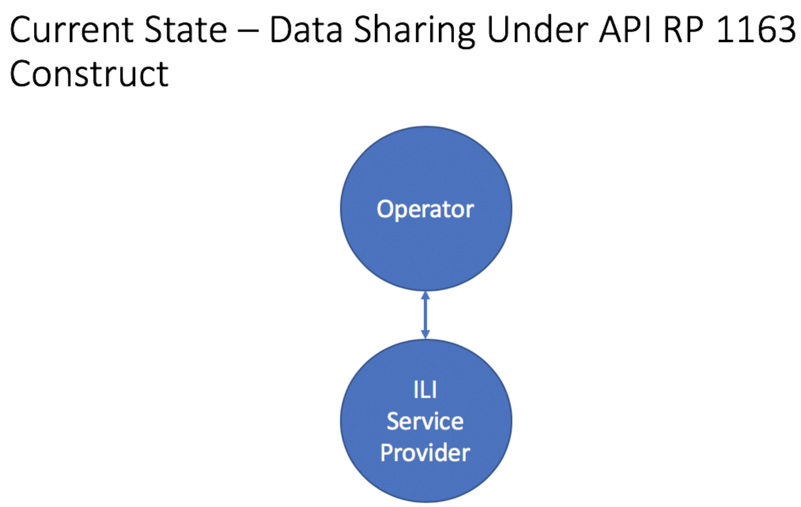


Figure PS-X – Current State of Information Sharing Under API RP 1163

The standard is an umbrella document that provides performance-based requirements for ILI systems, including procedures, personnel, equipment, and associated software. It 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

There was and continues to be broad involvement in the standard. It is currently undergoing revision under the API ANSI standards development process. It was developed enabling service providers and pipeline operators to provide **rigorous processes** that will **consistently qualify the equipment, people, processes, and software utilized** in the in-line inspection industry.

The use of an in-line inspection system to manage the integrity of pipelines requires **close cooperation and interaction** between the provider of the inspection service (service provider) and the beneficiary of the service (operator). The standard provides requirements that will enable service providers and 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 in-line inspection (ILI) systems for onshore and offshore gas and hazardous liquid pipelines. A process view is provided in Figure PS-X. 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.

The standard is performance based and provides requirements for qualification processes. One objective of this standard is to **foster continual improvement** in the quality and accuracy of in-line inspections

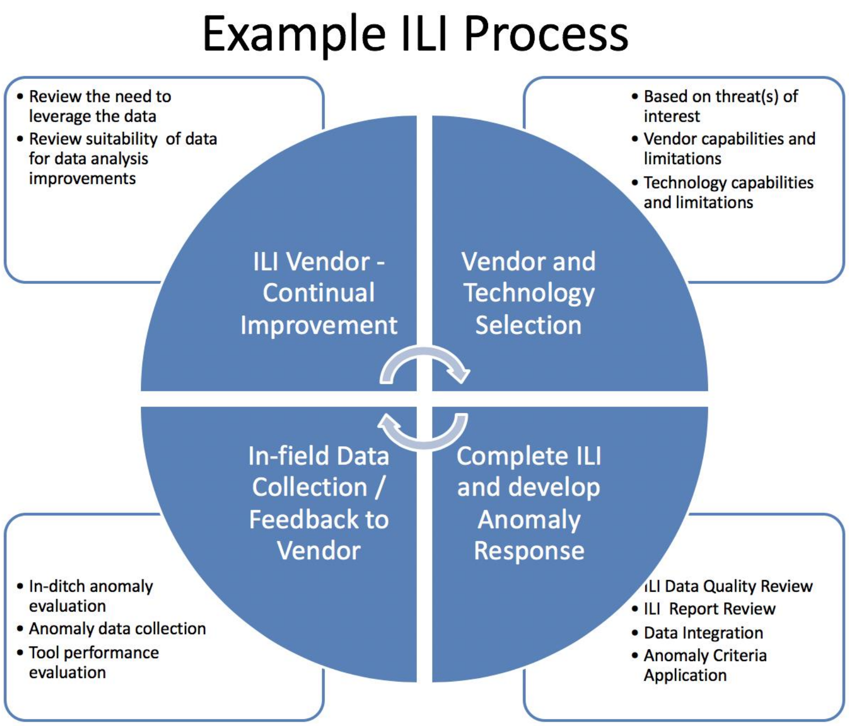


Figure PS- X - Example Application of API RP 1163

Recommendation PS-5: Develop a process for pipeline operators to share lessons learned from the planning, execution and evaluation of 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. Required information is defined in recommendation x.x (developed by the Technology and Research and Development Subcommittee).

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

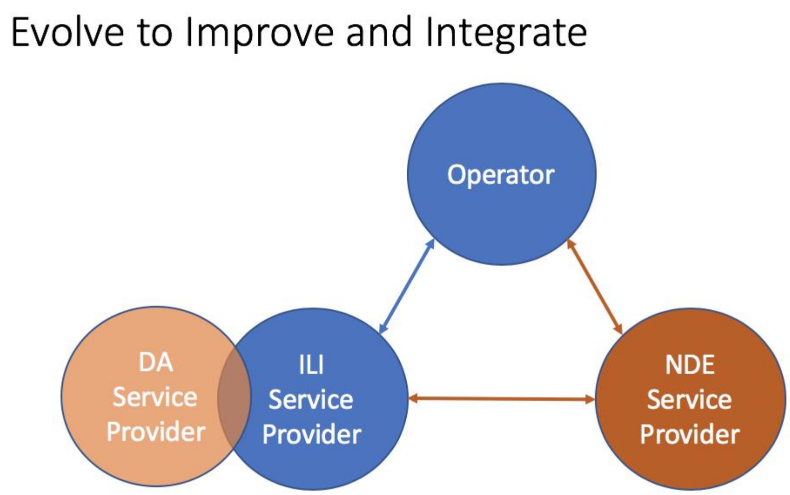
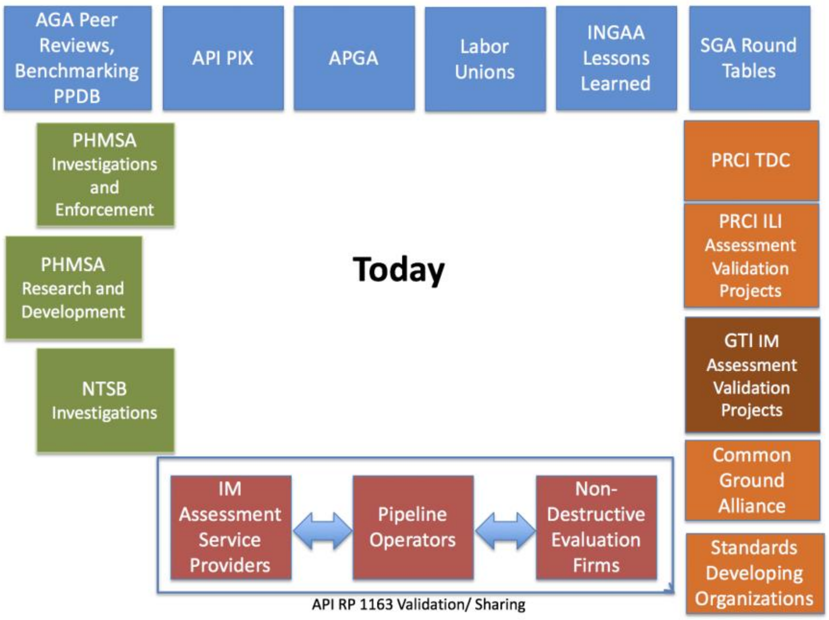
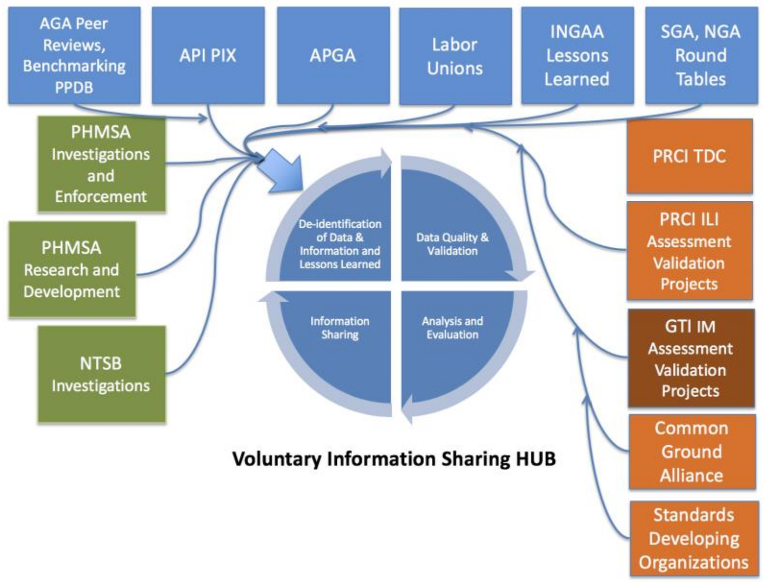


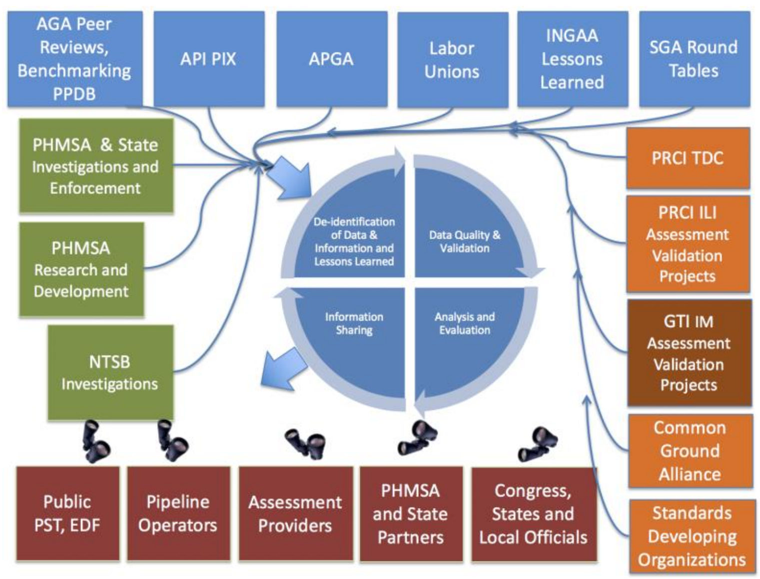
Figure PS- X – Depiction of How Information Sharing Might Evolve

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 database with great depth. The sharing of discrete data will enable assessment providers to accelerate learning and advancement of technology and process development.

Recommendation PS-6 - Define the processes to be used in a VIS Hub to facilitate the sharing of discrete data from integrity assessments using information management and sharing technology defined in recommendation x.x (developed by the Technology and Research and Development Subcommittee).




AGA Peer Reviews, Benchmarking PPDB
API PIX
APGA
Labor Unions
INGAA Lessons Learned
SGA, NGA Round Tables
PHMSA Investigations and Enforcement
PHMSA Research and Development
NTSB Investigations
PRCI TDC
PRCI ILI Assessment Validation Projects
GTI IM Assessment Validation Projects
Common Ground Alliance
Standards Developing Organizations
De-identification of Data & Information and Lessons Learned
Data Quality & Validation
Information Sharing
Analysis and Evaluation
Voluntary Information Sharing HUB


AGA Peer Reviews, Benchmarking PPDB
API PIX
APGA
Labor Unions
INGAA Lessons Learned
SGA Round Tables
PHMSA & State Investigations and Enforcement
PHMSA Research and Development
NTSB Investigations
PRCI TDC
PRCI ILI Assessment Validation Projects
GTI IM Assessment Validation Projects
Common Ground Alliance
Standards Developing Organizations
De-identification of Data & Information and Lessons Learned
Data Quality & Validation
Information Sharing
Analysis and Evaluation
Public PST, EDF
Pipeline Operators
Assessment Providers
PHMSA and State Partners
Congress, States and Local Officials

Recommendation PS-7: 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 the foundation for information sharing of ILI information among operators and service providers.

PRCI Pipeline Data Hub

Description of Intent

Primary Basis
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 the 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
-

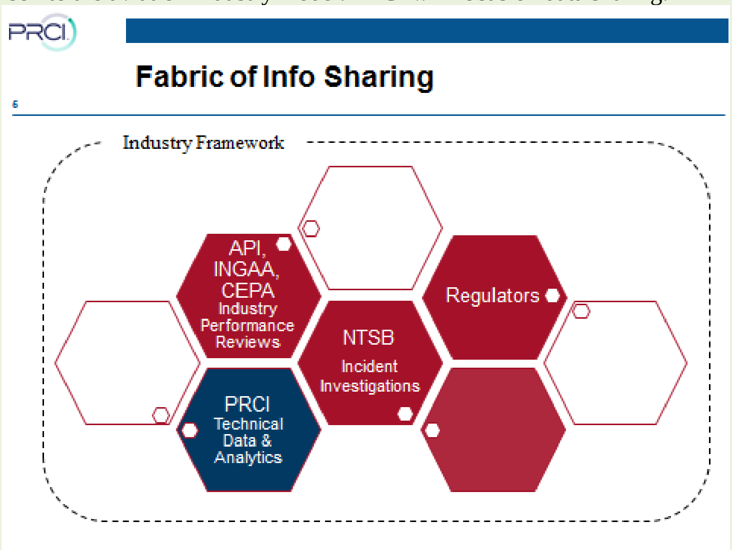
General Structure
- PRCI is a ready-made structure that currently warehouses a great deal of data, conducts scientific analytics, and disseminates results and drives knowledge transfer. The aim of the data hub is to expand this capability.
- The mandate is rooted in improving the engineering and operations 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

Commented [Simona Pe6]: Not sure if this should be kept in the report as narrative-- part of a recommendation? Or moved to Appendices?

Commented [Lynch, Ka7]: I recommend the appendices for this document. I have also cleaned it up into one table.

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

Execution Plan

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.

Recommendation PS-8: Develop a process for integrity assessment service providers to share lessons learned from the planning, execution and evaluation of integrity assessments; including in-line inspection, direct assessment, pressure testing and applications of other technology.

The process may start with 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. Required information is defined in recommendation x.x (developed by the Technology and Research and Development Subcommittee).

Recommendation PS-9: Develop a process for non-destructive evaluation (NDE) service providers to share lessons learned from the planning, execution and evaluation of 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. Required information is defined in recommendation x.x (developed by the Technology and Research and Development Subcommittee).

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.

Recommendation PS-10: Define a process for disseminating lessons learned:

> ***For operators and identify the operator organizations to receive the Lessons Learned, including AGA, AOPL, APGA, API, INGAA, as well as PRCI, GTI, NYSEARCH.***
>
> ***For government stakeholders and agencies to receive the Lessons Learned, including PHMSA, state and local pipeline safety regulatory authorities.*** Define why and how the information shared with these organizations is different that the organizations in recommendation x.x. Examples include …
>
> ***For public stakeholder organizations to receive the Lessons Learned, including organized labor and public interest groups such as the Pipeline Safety Trust and the Pipeline Safety Coalition, as well as interested Federal, state, local, and tribal officials.*** Define why and how the information shared with these organizations is different that the organizations in recommendation x.x. Examples include …

Recommendation PS-11: Consider development and periodic update of an Integrity Assessment [Management] Compendium to share the state of the art with regard to integrity assessment technology, risk assessment, including data integration, and NDE technology.

Best Practices

The Best Practices Sub-Committee (BPSC) task statement was developed to guide the development of a pipeline safety VIS as follows:

Evaluate existing processes (including other industry VIS models and practices) and make recommendations on best practices that will promote the sharing of data and information.

Evaluations and resulting recommendations are intended 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 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 advocacy, public*

Voluntary Information Sharing Concepts/Considerations

Commented [Simona Pe8]: Pieces of this narrative could be appropriate for Background/Introduction section or Conclusions section

The VIS system should allow for anonymous or open as well as deliberate (peer to peer) sharing of data, information or knowledge as the case or context may dictate. The VIS Committee was established to specifically consider the sharing of In-line Inspection data and that context is sufficiently addressed in this report along with the other Sub-committees.

In the case of a peer to peer sharing process there are many examples and practices in place today within the pipeline industry. However, this existing process could be further enhanced by encouraging or ensuring that the process results in an actionable or definitive result and/or a collaborative process improvement ensues. An improved process for this kind of sharing might be characterized by the following:

- **High Value –** the opportunity results in 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 (data → information → **knowledge → understanding → 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 or more efficiently than an individual company might otherwise accomplish on their own.

- **Deliberate** - The sharing process is via active engagement between one or more parties and is a pitch/catch relationship; at a minimum at least one party is learning/gaining knowledge or wisdom from another or they are engaged in process improvement.
- **Actionable** – The result of the engagement generates action by one or more parties and processes or practices change within that entity (industry or service providers).
- **Measurable** – The sharing process as well as the results of the improvements/actions are measurable up to and including measurable safety improvement.

The result of the VIS engagement in this manner generates action by one or more parties and processes or practices change within that entity (industry or service providers). *Comment: Consider ways to make it measurable; may not be measurable, or at least all aspects of the process. See next section for examples of how the outcomes could be measured.*

The following attempts to describe high level the outcomes or targeted improvements. The data and/or information required to facilitate the improvement opportunity is different (quantitative versus qualitative) depending on the context and the outcomes or elements of the outcome. For each of the contexts below the data/information required can be defined including how is it gathered, processed and analyzed from a process and technology perspective.

1. Improve (industry consistent/best in class) application and deployment of existing technology whether it be ILI tools, DA, hydrotesting, etc. Operators deploy a comprehensive, systematic and integrated process relative to integrity assessments:
    a. Identify the right technology(ies) for the threat (can be NDE and assessment technologies)
    b. Specify data and analytics appropriate for the threat(s)
    c. Service provider sensor technology, delivery to the pipe, data analysis and reporting
    d. Operator data integration and direct assessment decision making process
    e. In-the-ditch measurement accuracy, precision and competency
    f. Integration and feedback of field data to assessment service providers and Operator knowledge base (PDCA) (refer to new RP 1178 on data integration)
2. Improve existing technology capabilities via Operator/Industry gap analysis
    a. How to improve existing tool and process technology for unique circumstances such as a certain morphology or interacting threats
3. Drive development of new and/or improved technology(ies) (sensors, analytical techniques) via Operator/Industry gap analysis
4. Identify unique (low probability, high consequence) integrity threats and approaches to assess susceptibility and threats (Operator transparency relative to emerging/found threats – “I was not expecting to find this but we did, you might consider that”)

The following table offers high level examples for illustration purposes:

Context	Data/Information	Participants	Value of Outcome	Measures
Bolster deployment of best practices and technology	As-found defect data, ILI as-called data, relevant physical, environmental and operational data	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 defect data, ILI as-called data, relevant environmental and operational data, lessons learned	Operators, Service Providers	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-ditch assessment tools	Physical samples and data for unique or rare defects/interaction	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	Operators, Regulators, Service Providers	Realization and mitigation of unique threats	

Stakeholder Communications	Industry integrity assurance capability, process and performance metrics, VIS outcomes	Operators, Regulators, Public and Advocacy groups	Industry credibility and stakeholder confidence	**TBD**

Future refinement and/or maturity of the energy pipeline VIS could lead to increased value beyond the previously mentioned contexts:

- Offer enhancement of PHMSA data used for analysis, evaluation, inspection prioritization and NPMS. Position PHMSA in sharing of lessons learned of accident/ incidents and operator responses; could also improve consistency in enforcement. Issues with consistency is expanded even more amongst/across States.
- Create an opportunity for industry to increase cooperation and share engineering standards, specifications, procedures, including welding procedures, coating procedures, line pipe specifications, among others. (could be its own recommendation)

PRCI/Industry Collaboration based operating procedures and integrity management practices – common approaches and practices for like assets/situations. (could be together with second bullet above)

Integrity Management Process and Technology Improvements

Post-Incident Related RCFA's and Learnings

Recommendation BP-1: A Voluntary Information Sharing system for the energy pipeline industry should not be limited specifically to pipeline in-line inspection 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 from incidents or process improvements, technology deployment practices and solutions to common problems.

Pipeline integrity management as required by pipeline safety regulations and referenced within industry standards has been developed to be a comprehensive, systematic and integrated process. An effective pipeline integrity management program involves a very rigorous process that is applied to each pipeline system. See simplified pipeline integrity management process flow diagram below (ASME B31.8S Supplement to B31.8 on Managing System Integrity of Gas Pipelines – Fig 2-2).

The process of managing safety and integrity involves trained and qualified personnel, deployment of technology and analytical tools, management systems and defined processes. A VIS that would be focused on a single element or process step (ILI data and in-ditch data) is potentially limiting the value to be realized. While the threat assessment process step is a crucial one, many other aspects of integrity management lead one to selecting the right technology for the threats at hand and utilizing the data and information gained from that assessment to make decisions about repair, prevention and mitigation. Therefore, the recommendation is to expand the VIS to include the entire realm of the integrity management process and in this broader context the types of data and information to be shared likewise expands to include but not be limited to:

Data and Information Relative to IMP:

- Pipeline threat susceptibility data and information
- Threat assessment technology applicable to specific or interacting threats
- Threat assessment data - ILI Data
- In-the-ditch defect characterization and measurement data
- Specific threat or interacting threat characterization and examples/samples
- DA, locate information, leak and survey information
- Prevention and mitigative measures
- Repair methods
-

Information Relative to Process Improvement

- Operator Integrity Management and Operational Lessons Learned
- Enhancing the utilization of existing technology
- Sharing of enhanced processes and practices i.e. solutions to known problems including experience with new data/information technology to improve detection and characterization
- R&D Projects to address gaps
- Identification of current gaps in technology and/or analytics that need to be closed
  - Sharing occurs between technology providers and operators
- Training and education of lessons learned with respect to execution of the various integrity management and O&M processes
  - Individual contributor (SME) observations, near miss, safety moment

    - Improved analytics
    - Near misses
    - Unexpected outcomes/observations
- Near Miss Data and Information Operator Actions to Prevent Reoccurrence
- Operator and Service Provider Best Practices/Procedures
- Post incident related RCFA's and subsequent company/regulator learning
    - Systemic or acute process improvements
    - Cultural improvements
    - Technology/Technology deployment improvements
- Operator and Engineering Service Provider Engineering Standards
-

Performance Metrics/Leading Indicators on VIS

- Number of active participants in the sharing process
- Quantitative statistics relative to data and information available
- How do you demonstrate improvement?
- Show impact in terms of pipeline safety improvement
- What did we learn from others that would be relevant for VIS?
- Etc.

Recommendation BP-2: A Voluntary Information Sharing system for the energy pipeline industry should leverage existing practices, processes, procedures and governance models currently being utilized within the pipeline industry as well as those in other industries.

As a result of the VIS effort the BPSC is familiar with or has become aware of several existing and ongoing processes that focus on data and information sharing for the purpose of improving safety performance. In some cases, the level of sophistication and overall systems are quite elaborate and have been developed over time. The BPSC highly recommends that any future VIS effort consider adoption or development of processes and procedures based on best practices embodied in the programs highlighted below:

Commented [Simona Pe9]: Should the examples be in Appendix?

Aviation Safety Information Analysis and Sharing (ASIAS) - The Aviation Safety Information Analysis and Sharing (ASIAS) program connects approximately 185 data and information sources across government and industry, including voluntarily provided safety data. 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 this 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/OEM/MRO date are de-identified
   - 4.6. Data used solely for advancement of safety

The BPSC recognizes the ASIAS system as the leading example and best model to be emulated by the pipeline industry for information sharing; it can potentially provide initial studies and reports used as a catalyst for its formation. Considerable reference material is available including chronological development, process framework, governance framework, funding, lessons learned, etc. The BPSC highly recommends that any future Voluntary Information Sharing System for the pipeline industry consider and utilize to the fullest extent possible the information and knowledge available from the ASIAS program, it's developers, managers and user community. Additionally, and equally useful, are existing governance documents, operating procedures, cooperative agreements, etc. that might be applicable to the pipeline industry model. This information is included in the appendices.

Center for Offshore Safety - The Center for Offshore Safety COS) is 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 practices. 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

Guiding Principles

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 will not compromise safety
4. Safety processes, equipment, training, and technology undergo continual improvement
5. Members share learnings 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. 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.**

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. Presentations by PRCI have been made to the VIS Committee and a report has been authored for the purposes of a reference document for both the BPSC and the Technology SC. This report provides an overview of the project (NDE-4E In-line Inspection Crack Tool Performance Evaluation) and offers recommendations and guidance for such an effort. The case study *NDE-4E* describes the performance of ILI tools as they relate to the measurement of crack-like features in pipelines. The recommendations contained in the report focus on process and technology gaps to be addressed to support information sharing.

Additionally, the report provides guidance relative to the implementation of an existing industry recommended practice; *API 1163 ILI Systems Qualification Standard.* API 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 recommendations contained in the report focus on improvements in the application of best practice(s) to meet the intention of the codes and standards (e.g. *CFR, API 1163*, etc.) which will facilitate information sharing across the industry.

Industry Associations - Build upon current trade association initiatives without disrupting or changing their current approaches. Guidance documents and workflow are available from the various associations (API, AOPL, PRCI, INGAA, SGA, AGA, APGA, CGA others) that describe their processes, best practices, protections, performance measures, etc. Industry-wide VIS would enable a broader context for sharing and allow them to share their own lessons but benefit from all lessons (cross-associations).

- Lessons Learned from failures (including near misses)
- Lessons from unique or unexpected situations and solutions
- Lessons Learned from routine assessments
- Provide specific examples from each on how they help this effort? Use some examples. Develop chart with cross references. Who has good examples of information sharing? De-identification of data? funding models? (may be different examples for each)

Interstate Natural Gas Association of America/INGAA Foundation Lessons Learned

The COS system for sharing information relative to offshore oil and gas operations provides a possible best practice capturing, categorizing and prioritizing safety related information.

American Petroleum Institute Virtual Tailgate

American Petroleum Institute Pipeline Information eXchange (PIX) - The Annual Pipeline Information eXchange (PIX) provides operators with a learning and sharing opportunity about pipeline incidents.

Communications to and With Stakeholders

Recommendation BP-3: A Voluntary Information Sharing system for the energy 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 graphical representation of the various information sharing processes currently in place is included in Figure 2 below.

Commented [Simona Pe10]: Where is Figure 2?

Figure 2 (Note: Reorganize Change De-Identified Data/Data Quality per figure 3)

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 illustration suggests the concept that these organizations could or should potentially have an active role in a VIS system and/or at a minimum be a consumer of the available information and ongoing efforts and result of the process. The illustration also attempts to convey that there are various information sharing processes and activities within the entities represented by each oval as well as across common entities and to some extent across the functional groups. As an example, there is active and ongoing interaction and information sharing/collaboration 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 and Figure 2, this activity and results would/should be more transparent to the entire universe and open pathways for those not currently aware and not participating to do so.

VIS should include a means, processes and systems to share data, information, and knowledge amongst the above stakeholders and entities. Developing and disseminating lessons learned is aided by the appropriate learning taxonomy. A taxonomy that takes a wide range of learning opportunities into account in a purposeful manner should be the taxonomy objective. An example of such a taxonomy can be found in the appendices.

Recommendation BP-4: A Voluntary Information Sharing system for the energy pipeline industry should provide a framework of best practices found in other information sharing contexts or industries to manage the sharing context and include fundamental elements found in various other businesses or entities 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
- Communication of results and performance measures

Examples and specific details for the above can be found in reference documents included herein or available as referenced. [Specific references will be made as needed] The core process of information sharing should embody a continuous improvement cycle:

Figure 3

Commented [Simona Pe11]: Where is Figure 3?

Recommendation BP-5: A Voluntary Information Sharing system for the energy pipeline industry should provide for transparency and communication of industry capabilities, processes, procedures, technologies, improvements and safety results relative to the value that the sharing process generates.

- Define data, information and messaging for the industry and public communications
- Describe/define the state of the state not just in terms of what industry is capable of but how well we deploy that capability.
- Provide more details… similar to process sharing PS-12

Technology and R&D

The Technology and R&D (Tech) Subcommittee was commissioned as part of the broader Voluntary Information Sharing Task Team. The Tech task statement was developed to guide the actions as follows:

Support Committee by Recommending Secure System(s) Architecture. Make recommendations required for continuous improvement and/or needed development of Technologies and Methodologies.

The primary mandate requirement(s) addressed by the Tech Subcommittee were;

- (c)(2) Ways to encourage the exchange of pipeline inspection information and the development of advanced pipeline inspection technologies and enhanced risk analysis.

- (c)(3) 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.

- (c)(4) 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.

The Tech Subcommittee pursued 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.

Task Description(s);

1. Identify Assumptions from other Subcommittees for our inputs and outputs (Process Sharing & Best Practices) and define Taxonomy.

2. Determine/Define and standardize the applicable pipeline inspection information (quantitative) and its native data format (tabular, geospatial, etc.)

3. Conduct historical studies that help in the understanding of current best practices for; managing and sharing pipeline inspection information and the associated areas for continuous improvement. (See Appendix VIII- ILI Case Study Analysis)

4. Analyze/define data security and protection to safeguard the proprietary nature of the pipeline inspection information shared (quantitative).

5. Determine the Quality Control Procedures required to facilitate the accurate exchange of the pipeline inspection information.

6. Determine the feasibility of integrating the pipeline inspection information with other relevant pipeline safety data that is already available or envisioned to be developed. Are there data format, completeness, and/or platform issues that need to be addressed?

7. Determine the needed interpretation of the pipeline inspection information shared and the areas that could be addressed;

a. understanding the capabilities/limitations, and best practices,

b. data maintenance, continuous improvement, and/or further research and development,

c. and perspective predictive analysis capabilities for threat and risk analysis purposes.

Deliverables Table:

Commented [Simona Pe12]: No other subcommittee provided this type of table. Should we make a table like this for the other subcommittees, remove this because it does not fit in the narrative flow, or leave it in.

Deliverable name	Purpose	Description
Pipeline Inspection Information WG: Assumptions	Need to understand the applicable information, that when shared, can be used to meet the purpose.	Explore and determine the types of information that can be shared to meet the purpose. This will include and is not limited to inspection information as well as any essential variable data that assists in understanding the relevance and/or quality.
Assessment Technology/Methods WG: Assumptions	Need to understand the associated assessment technologies and methods that provide the subject inspection information.	Explore and determine the different assessment (inspection) techniques/technologies and associated methods, e.g. ILI technology applied, Direct Assessment methodology, and the associated methods to validate (i.e. field verification NDE).
Other Pipeline Risk Analysis Technology WG: Assumptions (monitor) / Continuous Improvement/R&D	Need to understand the associated risk methods that can be enhanced by having available the shared inspection information.	Explore and determine the associated connectivity of the inspection information shared and the ability for it to be utilized in associated threat and risk analysis. This will include, as applicable, the understanding of the

		importance of the assessments, methods and quality procedures.
Data standards and formats WG: Architecture/IT	To set a vision for how key processes and systems shall be integrated into enterprise infrastructure	Explore and determine the current (or needed) data standards and formats for both the sharing of the information as well as the needed data architecture to ensure that it can be used for continuous improvement and future development.
Quality Procedures WG: Assumptions	For the information shared, all need to have quality procedures established by which the usability is established and trusted.	Explore and determine the needed quality procedures for how the information can be qualified, trusted and used for its purpose(s). This will include understanding the current, or needed, procedures to collect the information and the method of collection, e.g. procedure for collecting information with ILI, the personnel analyzing the ILI information, the field measurement technique/technology procedure used and the personnel collecting and analyzing that information.
Auditing and Monitoring WG: Architecture/IT	Need to consider the necessary QA/QC to ensure that the usability of the shared information is established and/or maintained.	Assessing the administration or actual audit of the systems, practices, and personnel associated with the information, software routines (and maintenance) that are applied to systems to ensure the quality is understood and/or preserved, etc.

Secure System(s), Development and Architecture WG: Architecture/IT	Provide clear input to Business or IT project SMEs on issues relevant to Enterprise Architecture	Explore and determine existing, or needed, systems and how they can be used for purpose. Outline the requirements to be successful.
User Interfaces (confidential/public viewers) WG: Architecture/IT	To demonstrate and communicate information shared to relevant end users for the appropriate purposes.	Explore and determine existing, or needed, systems and how they can be used for purpose. Outline the requirements to be successful. Consider dashboards that could provide compiled information to operators, public or government.
System Security Authorization and Access WG: Architecture/IT	To demonstrate and communicate information shared to relevant end users for the appropriate purposes.	Explore and determine existing, or needed, systems and how they can be used for purpose. Outline the requirements to be successful.
Software considerations WG: Architecture/IT	Provide clear basis for information collection.	Explore and determine existing, or needed, systems and how they can be used for purpose. Outline the requirements to be successful.
Integration/interoperability with other systems WG: Architecture/IT	Provide clear basis for information collection.	Explore and determine existing, or needed, systems and how they can be used for purpose. Outline the requirements to be successful.
Scalability (able to accommodate future information sharing needs) WG: Architecture/IT	As the amount of relevant information shared increases, ensure that the architecture is suitable as well as the connectivity is ensured so that the purpose is maintained or enhanced accordingly.	Explore and determine existing, or needed, systems and how they can be used for purpose. Outline the requirements to be successful.

Needed Interpretation of pipeline inspection information WG: Continuous Improvement/R&D	Information collected is interpreted. Understand the interpretation and how it meets the purpose.	Explore and determine the current, or needed, interpretations of the associated information and how these can be used to meet the intent of the purpose (e.g. interpretation of the difference between reported ILI results and the field verification measurement results, what does this tell us and how do we establish proper interpretation?). Consider dashboards that could provide compiled information to operators, public or government.
Determination of "gaps" and associated needs WG: Continuous Improvement/R&D	Create a determination/analysis/communication for a "gap" analysis based on the interpretation of the associated information.	From the interpretation of the information shared, "gaps" may be recognized, establish guidelines for sharing these "gaps" and understand how needed improvements can be communicated and realized.
Determination of development needs, e.g. advances in technology or methods WG: Continuous Improvement/R&D	Create a determination/analysis/communication process based on the interpretation of the associated information that leads to perspective development needs.	From the interpretation of the information shared, and the "gaps" that may be recognized, establish guidelines for sharing and understand how perspective development or advances can be communicated and realized.

Assumptions

Recommendation Tech-1: The Voluntary Information Sharing system shall define the qualitative and quantitative inputs needed to support meaningful analysis.

- The inputs will be defined to support the analysis required that reveal lessons learned and determine gaps that lead to continuous improvements.
- The input definition will specify possible values for categorical data types, attribute names, codes and acronyms. For numerical data, the input definition will

specify the data formats, data types, measurement units, measurement process and the resolution of the data captured for profiles and volumetric parameters.

- The input definition will specify essential elements/variables; the required minimum data set needed for meaningful analysis which will vary by analysis type (reported outputs).

Recommendation Tech-2: The Voluntary Information Sharing (VIS) system 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/standards represent best practice consensus among the industry stakeholders and include common and consistent terms, definitions, nomenclatures, data types, data formats, procedures and process flows.
- For In-Line Inspection (ILI), the most relevant recommended practices/standards include (see Appendix VIII):

  .i. API Standard 1163 'ILI Systems Qualification Standard',

  .ii. NACE SP0102 'Recommended Practice: ILI of Pipelines', and

  .iii. 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:

  .i. NACE SP0502 ECDA,

  .ii. NACE SP0206 ICDA,

  .iii. NACE SP0204 SCCDA,

  .iv. API 1176 - 'Recommended Practice for Assessment and Management of Cracking in Pipelines', and

  .v. API 1178 - 'Integrity Data Management and Integration Guideline.'

  .vi.

Recommendation Tech-3: The Voluntary Information Sharing system shall consider the mechanisms and associated requirements for input validation, to ensure quality, and consistency for ingestion into 'the system'.

- Data validation 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 will also enable a tiered approach to quantifying the quality/trust whereby the applicable learnings can be warranted and followed up on accordingly for applicable lessons learned and/or continuous improvement.
- This can be envisioned in a few different ways:
    - .i. Through conformance to industry recommended practices/standards
    - .ii. Having a dedicated resource (personnel) to vet the information prior to ingress into the system
    - .iii. Through automated routines of the architecture/IT for ingress into 'the system'.

Taxonomy

Applicable Pipeline Inspection Information and Formats

Recommendation Tech-4: The Voluntary Information Sharing system shall recommend that the appropriate Standards Developing Organization (SDO) create the consensus requirements for the field verification data to be included in 'the system'. This should include, and is not 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, etc.). 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 before-mentioned. ILI has ASNT-ILI-PQ, ITD NDE needs something similar.

Quality Control Procedures

Recommendation Tech-5: The Voluntary Information Sharing system shall recommend that the appropriate Standards Developing Organization (SDO) establish a consensus protocol for comparing tool 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.
- Avoidance of inappropriate comparisons between ITD/NDE field measurements and tool results. For example, with ILI comparison concerns include:
  - 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.

Best Practices for Pipeline Inspection Information and the Associated Areas

Recommendation Tech-6: The VIS should provide analyses and outputs that serve to encourage adoption of best practices across the industry and stimulate continuous improvement in technology. The analyses and outputs should ensure anonymity is maintained, but possible options 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 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, etc.

Data Security and Protection

Recommendation Tech-7: It is proposed that all data types should be categorized using an established industry framework such as FIPS 199 to ensure confidentiality, integrity and availability. The VIS hub should be protected following an established industry standard such as NIST 800-53. It is proposed that this baseline be implemented according to the aforementioned 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.

Information Integration of Pipeline Safety Data

Recommendation Tech-8: A Pipeline Safety Data system 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 application is to prevent accidents and incidents by encouraging 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 subsystems and tools for analysis and reporting purposes.

Secure Systems Development and Architecture (see Appendix IX for detailed descriptionsof IT Architecture, Data Handling, Cybersecurity)

Recommendation Tech-9: Secure System(s) Development and Architecture (M), High-level requirements

The VIS hub will require infrastructure that allows for self-service, resource pooling and delivery of on-demand computing resources, possessing scalability, elasticity and resiliency. Scalability exists at the application layer, highlighting capability of a system, network or process to handle a growing amount of work, or its potential to be enlarged in order to accommodate that growth. Elasticity in infrastructure involves enabling the virtual machine monitor (or hypervisor) to create virtual machines or containers with the resources to meet the real-time demand. Resiliency refers to the system being operable and able to provide and maintain an acceptable level of service. The proposed Cloud Computing and Big Data Architecture addresses all aspects of the following components: infrastructure, analytics, data structures & models, and security. It is the whole complex of components to store, process, visualize and deliver results for consumption in targeted business applications.

Recommendation Tech-10: Secure System(s) Development and Architecture (M), User Authorization and Access

The VIS hub should utilize a role-based access control mechanism to control access to subsets of specific data (or data marts) for data integration and case-driven analysis. These roles and their appropriate permissions should be configured into the system including, but not limited to: Regulators, Public Service, Providers, Researchers/Universities, Asset Operators, and Trade Associations. The 3rd party data manager should have full access to the data warehouse. The governance committee should be the sole responsible party to define the authorized access of data in the data mart.

Recommendation Tech-11: Secure System(s) Development and Architecture (M), User Interfaces (confidential/public viewers)

The VIS Hub should operate and present information on the foundation of group and role-based access. 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 system will provide public or role-based reports that require de-identification. Methods for de-identification include; Removal of ID's, or other identifiable information when reported; Remove all personally identifiable information for persons when the data enters the system, like name, organization, and/or email address; and abstraction of geographic context of pipeline assets when reporting publicly.

Recommendation Tech-12: Secure System(s) Development and Architecture (M), System Security and Protection

The VIS hub should be protected following an established industry standard such as NIST 800-53. Cybersecurity 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 do so. Availability refers to the system being operable and able to respond to a request when 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 security risk of an information system.

Recommendation Tech-13: Database/Software considerations. 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 is proposed to consist of a data warehouse containing relational and non-relational data with access to subsets of specific data (or data marts) for data integration and case-driven analysis.

Recommendation Tech-14: Data standards and formats. Data management solutions are designed with big data and analytics at the forefront. Modern enterprise architecture requires dedicated data management tools for running complex analysis on data from disparate and potentially diverse sources. The qualitative data should be qualified with domain validated values and ingested via a standard web portal or through JavaScript Object Notation (JSON) or Extensible Markup Language (XML) formatted document submissions. The quantitative data sets should be normalized using automated routines before ingress into a data warehouse.

Recommendation Tech-15: Integration/Interoperability with other systems. The VIS Hub's data ingress layer will connect 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 Application Programming Interface (API) libraries, web services, web map services or other web automation. The VIS Hub's data abstraction layer will combine related data into views. Various subsystems and tools for data conflation will be required to store, analyze and distribute data including machine learning.

Recommendation Tech-16: Scalability (able to accommodate future information sharing needs). The VIS hub will require infrastructure that allows for self-service, resource pooling and delivery of on-demand computing resources, possessing both scalability and elasticity. Scalability exists at the application layer, highlighting capability of a system, network or process to handle a growing amount of work, or its potential to be enlarged in order to accommodate that growth. Elasticity in infrastructure involves enabling the virtual machine monitor (or hypervisor) to create virtual machines or containers with the resources to meet the real-time demand.

Recommendation Tech-17: Auditing and Monitoring. Auditing and monitoring controls should be implemented as part of an overall framework and strategy. This framework includes assurance that is needed through 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.

Development of Advanced Technologies: Continuous Improvement and Needed R&D

Varied Stakeholders' Need for Continual Improvement

Commented [Simona Pe13]: Is there a Recommendation Statement (1-2 Sentences) to go along with this great narrative?

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

Currently, the public has little visibility into pipeline integrity efforts or effectiveness. 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 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.

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 an 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 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 integrity assessment technologies and processes, could also fuel a continuous improvement cycle.

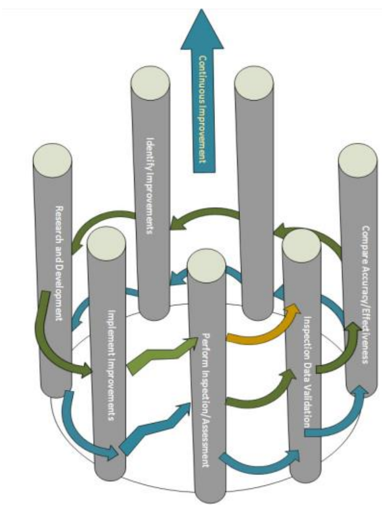
The researchers and developers of technologies and processes would make their investments with greater confidence concerning the gaps they were trying to fill. While service providers would be motivated by the awareness of their performance as compared to other technologies or other de-identified service 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 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, 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.

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 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.



Step #	What	Who
1	Perform inspection/ assessment	Carried out by the pipeline operator as part of normal operations using existing technology & processes
2	Inspection data collection & validation	Submitted by operator for validation and incorporation into database
3	Compare accuracy/effectiveness	Could be carried out by the organisation managing the database, or via database queries made by participating entities
4	Identify improvements	Comparison of technology performance between vendors, and against published specification will highlight gaps
5	Research & development	Vendors and/or research organisations choose to spend their own budgets, or receive funding, to close the gaps identified in step 4
6	Implement improvements	New improved tools, techniques and processes adopted by the industry

Applicability to Varied Integrity Assessment Technologies

This virtuous cycle could be initiated for many different 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 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 defect 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 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 misses' experiences of 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.

Motivating Participation

It is conceivable that not all service providers and operators will participate in the data gathering effort. It is likely to take time to develop the trust and awareness of value before a significant number of operators and service providers 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 maybe 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.

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.

The development of trust will be critical for the success of a VIS. Trust will grow as the VIS faithfully stays focused on the safety learnings from the data collected and the motivation provided to individual companies who can assess their own performance as compared to average or top quartile performance. This will necessitate that protections be established to ensure the data isn't 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 won't be used by their peers to put them at a disadvantage.

Foundational Requirements for Success and Suggested KPIs

Foundational to the success of such a data 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, standards to define data formats, and training to ensure consistent measurement practices will need to be resolved.

Further work is also necessary to define metrics to assess successful implementation of the VIS, such as:

- database size,
- number of inspections submitted
- number and variety of operators and technology service providers participating,
- size of operators participating,

- some metrics that operators and service providers can use to assess their own performance as compared to the average or top quartile, and

documentation on any new threats or technologies improvements that were advanced because of the VIS.

With these in place the public, regulators, operators, and service providers can identify the benefit of the VIS and its impact on pipeline safety.

R&D Case Study - ILI

Commented [Simona Pe14]: Should the three case studies be put into an Appendix?

How might Voluntary Information Sharing contribute to continuous improvement of ILI technology?

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 system (underlying models plus analyst training and procedures) to recognize the presence of a defect, 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, 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, defect 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).

Describe broad 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 Standard 1163 (2nd Edition 2013) for In-Line Inspection Systems Qualification describes the overall In-line Inspection 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 defects.

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 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 vendors are constantly trying to improve their respective technology systems, as the performance specification forms the basis of much of the competition between vendors 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 vendors, will feed a virtuous cycle of technology improvement. Shortcomings in performance specification can be identified and addressed by ILI vendors, resulting in improved specifications that in turn enable operators to make better informed decisions regarding the ongoing management of the integrity of their pipelines.

Discuss standards for data delivery/validation

API Standard 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 API1163, 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.

Define 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.

Discuss 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 operators have built their own program 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 defect. 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 vendor, 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 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, 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).

Discuss 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 vendor. 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 vendors, collected by many different 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 vendors 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.

Discussion of how the outputs would encourage/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 vendors 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 defect morphologies can help 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.

R&D Case Study – External Corrosion Direct Assessment (ECDA)

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:

<u>Operators</u>

If an Operator is aware that its performance is below average, there may be motivation to:

- compare prioritization criteria with other 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, 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

R&D Case Study 3

Lessons Learned – VIS Continuous Improvement

Process – With an effective system for sharing and accessing relevant "Lessons Learned", 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 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 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:

Operators

If an 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 Operators and Service Providers. The improved awareness and easy access to relevant a specific Operator or Service Provide will enhance the likelihood that lessons learned spread to relevant parties and changes are implemented to improve safety.

Competence, Awareness, Training

A subcommittee was formed to look at the competence, awareness, and training aspects of developing a pipeline safety VIS. Task Statement:

Competency and Training Needs

- Will add 'introductory' paragraph(s) later

  Perhaps a sentence or two identifying connections & interrelationships with other subcommittee sections - from Subcommittee form submission

Recommendation CAT-1: Job descriptions be authored that define the education, knowledge, skills, abilities, and experience necessary for those working with confidential data and information. This will foster hiring criteria for third-party data administrator.

Expanding Knowledge of Inspection Technologies and Methodologies

Recommendation CAT-2: A process be established to pair VIS analytical staff with Pipeline Operator and other industry subject matter experts (SMEs), including in-line-inspection (ILI) companies and in-the-ditch (ITD) assessment companies. The collaboration is intended to ensure those analyzing the data understand industry lore and discuss 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 and methodologies. (Section 10 mandate)

Recommendation CAT-3: An evaluation process be developed for employees working within the VIS (the "Hub") to ensure they will:

- Protect data security
- Preserve member anonymity and confidentiality
- The executive board, a third-party data administrator, will mutually agree upon and authorize the evaluation process.

Encourage Exchange of Information/Sharing

Recommendation CAT-4: Educational materials based on tenants of trust and leadership be developed to market the VIS with the intent to motivate and compel stakeholders to join. 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. (Section 10 mandate).

Institutions and stakeholders that will benefit from and utilize these materials include:

- Trade Associations – Websites, Literature and Conferences
- Labor Union - Websites, Literature and Conferences
- Contractor Associations - Websites, Literature and Conferences

- Regulatory Agencies - Websites, Literature and Conferences (e.g. PHMSA R&D)
- State Agency advocacy for intra-state participation
- Pipeline Safety Advocacy Conferences, Websites, Literature, Social Media
- Industry Websites and Public Relations

Content for the 'Awareness' aspect should include benefits of participation and emphasize a non-punitive environment that fosters collaboration among stakeholders. Examples for each stakeholder group follow:

- Industry
    - Opportunity to benchmark and compare performance with others in the industry.
    - Raising the pipeline safety bar for all those who participate (and those who don't).
    - A common venue and program in a pursuit to prevent the next accident.
    - Raising the awareness for continuous improvement efforts that are more proactive and less reactive.
    - Discover system vulnerabilities
    - Larger sets of data and information to identify systemic trends that an operator may not discover with their own set of data and information
    - Enhance an Operator's Pipeline Safety Management System
- PHMSA
    - Fulfilling Congressional mandate
    - Seen as formal proponent for sharing pipeline safety information
    - Builds trust with industry
- Safety Advocacy Groups
    - Forum for unifying safety advocacy membership and followers
    - Common source for data and information
- Research Institutions
    - Readily available statistics
    - A data and information rich environment for metrics and performance indicators
- State Stakeholders
    - Knowledge of new initiatives/innovation in their states
    - Identifying potential issues before an event occurs
- Labor Representatives
    - Safer work spaces for employees and the public
    - Proactive input into the process
    - Opportunity to engage the workforce into pipeline safety improvement
- Public
    - Greater sense of safety
    - Have an impact on decisions for the public
    - Public Portal allowing for interaction
    - Opportunity not just to look at data but to add to the data / aka reporting (similar to EPA's Echo)

In the process of developing 'Awareness' materials, seek opportunities to:

- Leverage the outstanding safety improvements made by the FAA. Showcase FAA metrics.
- Leverage API 1163 as the framework for ILI Vendor / Operator collaboration
- Leverage the success that CGA has had marketing the 811 program
- Author a FAQ document that identifies barriers and how the VIS will overcome them
- Include a glossary of terms and acronyms

Recommendation CAT-5: Initial training be developed to enable the development and implementation of VIS. Distinct Audiences to be trained include:

- 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 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. (Section 10 mandate)
    - Data Rich (ILI as-found versus as-called feature dimensions and feature signature calibration)
    - Information Rich (info sharing re: unwanted events and continuous improvement)
    - Regulatory Agencies (federal, state, local)
    - 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

Sharing of Lessons Learned and Best Practices

Recommendation CAT-6: Training modules be developed that instruct participants the workflow processes and protocols as recommended by the Process Sharing sub-committee. 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
- Train 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.
- Train confidentiality requirements as recommended by the Governance sub-committee.
    - Robust rules with degrees of separation to preserve anonymity
    - Training modules shall be successfully complete before being allowed to work within the 'data room'

Recommendation CAT-7: The development of training modules be tailored for the participants, specifically for those working with quantitative data and those working with qualitative information.

Regulatory, Funding, and Legal Barriers

A subcommittee was formed to address the regulatory, funding, and legal barriers to establishment of a pipeline safety VIS.

Task Statement

The RFL subcommittee recognized the need to establish a voluntary information sharing ("VIS") system that encourages the exchange of pipeline safety information and enhances risk analysis as a critical element of Safety Management Systems that are now being implemented by pipeline operators. The RFL subcommittee further recognized the need to protect safety-related, security-related, proprietary and other sensitive information to encourage and allow pipeline operators, employees and vendors to share this information with the industry, regulators and others.

Barriers

The RFL subcommittee identified the following Barriers to the voluntary sharing of information between pipeline operators, PHMSA, and other pipeline safety stakeholders.

Barrier No. 1 The absence of existing PHMSA authority and related governance models 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 regulatory protections to pipeline operators that are necessary to establish and operate a successful VIS. The 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 at a later date into a "mandatory" program.

Barrier No. 2 The 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.

Participation in the VIS is highly unlikely unless the participants are confident that information submitted to the VIS will be protected from disclosure, including personal confidential information, confidential proprietary business information, commercially sensitive information, sensitive pipeline security information, information that has not been properly de-identified, information that could be used by PHMSA or other agencies for enforcement action, and information that could be used in litigation.

Barrier No. 3 The ability of any party to obtain voluntarily submitted information through 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.

Barrier No. 4 The potential that voluntarily submitted information will be used by PHMSA or other federal and state agencies to initiate enforcement or other punitive actions.

It is highly unlikely that pipeline operators will voluntarily share information due to the reasonable fear that the information could be used by PHMSA or other governmental agencies for enforcement actions.

Barrier No. 5 The potential that voluntarily submitted information will be used by litigating parties in discovery or for admission into evidence in federal, state, local or tribal litigation.

No reasonable pipeline operator will voluntarily share information with a VIS, or any other entity or person for that matter, if there is a risk that the volunteered information could be obtained and used by adverse parties in litigation.

Barrier No. 6 The absence of an existing funding model to stand up and sustain a working VIS.

Adequate funding is essential to stand up and sustain a VIS program to ensure its success in delivering the intended benefits. PHMSA, the pipeline industry, individual pipeline operators, pipeline employees, ILI vendors, pipeline contractors, and all pipeline safety stakeholders will reap the many benefits of a properly funded, robust VIS, especially improved pipeline safety and fewer incidents.

Factors Supporting the Recommendations

The RFL subcommittee has researched and analyzed potential solutions for overcoming the Barriers described above. Building upon lessons learned from voluntary information sharing systems established in the aviation and other industries, the RFL subcommittee believes 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 believes that such protections are consistent with a Safety Management System (SMS) philosophy and with PHMSA's pipeline safety responsibilities. There are similar protections in place for aviation-related information sharing.

The RFL subcommittee also believes 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 required, such as lengthy rulemaking proceedings.

General Principles Underlying the Recommendations

- Assurance that volunteered information will remain anonymous, confidential, and not subject to FOIA release
- Assurance that volunteered information will not be used for enforcement
- Assurance that volunteered information will not be used in litigation
- Provide protections to encourage the voluntary sharing of information by pipeline operators
- Provide specific protections applicable to: entities; individual persons; and information/data
- Exclude the following from eligibility for the protections:
    - Criminal activity
    - Intentional falsification
    - Alcohol or controlled substance abuse
- The VIS will not protect from disclosure information that must be submitted to PHMSA by regulation, such as information contained in PHMSA F 7000-1 Accident Reports.

Regulatory

Recommendation 1: Authorize and establish a governance structure for a VIS.

Legal

Recommendation 2: Protect VIS Information from disclosure.

Recommendation 3: Exempt VIS information from FOIA release.

Recommendation 4: Protections for Voluntary Sharing of Information.

Recommendation 5: Prohibit the use of VIS information in litigation.

Funding

Recommendation 6: Provide adequate and sustainable funding for the VIS.

Commented [Simona Pe15]: Exact recommendations to be determined by which Governance Structure (A,B,C,D) is recommended

Agreements (MOUs, etc.)

Conclusions

Appendices

Appendix VII: Process Sharing Examples

Case Study – Pacific Gas and Electric (PG&E) Correct Action Program

The Corrective Action Program (CAP) is a program that empowers employees at all levels of PG&E to speak up and identify issues that are in need of improvement. It is similar in many respects to ASAP used by operators within commercial aviation. It is an essential part of "find it, so we can fix it" to empower PG&E employees to have an observable impact on asset, personnel and public safety.

PG&E's Gas Operations launched CAP in 2013 to enable employees with a simple method to identify and report issues related to gas assets and processes. In 2017, the CAP program was deployed to all lines of business throughout PG&E. The types of issues submitted include employee concerns or suggestions, operational events, audit findings, near misses ("good catches") or issues with facilities, tools, procedures, records, training and safety.

The CAP process employs a standardized approach (Figure PS-2), including a CAP Review Team, composed of subject matter experts from various Gas organizations, that meets daily to review CAP issues submitted the previous day. The team's function is to categorize each issue, assess it for risk, and assign it to an owner. The role of the issue owner is to investigate and identify the causes underlying the issue and to address them appropriately by implementing corrective actions to mitigate risks or prevent recurrence. Initiators receive an email when the item they submitted is assigned and again when it is closed. The CAP provides real- time data and ensures transparency and accountability. The system is designed to provide trending capabilities and a continuous improvement loop to capture lessons learned and to improve the safety and reliability of PG&E's operations.

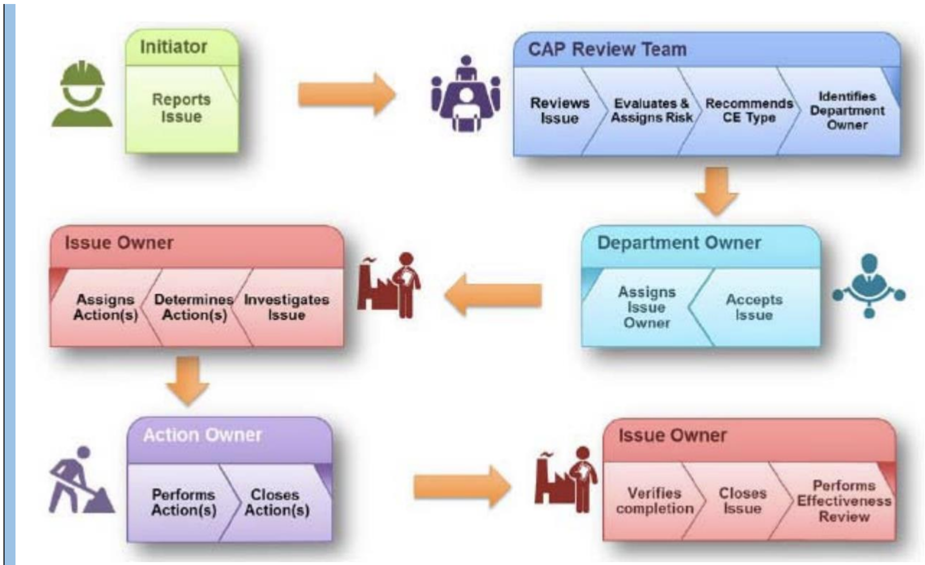


Figure PS-2 – PG&E CAP Process

The CAP team conducts monthly quality closure reviews on all high and medium risk issues, as well as a sampling of low risk issues. These closure reviews are performed to confirm that issues are adequately addressed and properly documented.

Since 2017, the CAP team has hosted regular user group forums to identify user needs and preferences as well as CAP enhancement opportunities. Additionally, members of gas leadership attended over 50 Cap Review Team meetings to provide input on the CAP process. Face- to- face CAP training was also provided to field employees at safety summits, all- hands meetings, and other employee meetings and training sessions. A web- based CAP training module is available for all employees, and real- time data are available on the CAP dashboard. The CAP process continues to mature and serves an important role in Gas Operations to identify and correct safety issues and implement process improvements.

Reference: PG&E Public Filings

Commented [Simona Pe16]: This should probably be moved to appendix or incorporated by reference.

Appendix VII: Process Sharing Examples (Con't)

Case Study: Example Infoshare

At a previous InfoShare, air carriers and flightcrews 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 flightcrew. Others occur while the flightcrew 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 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

Commented [Simona Pe17]: Move to Appendices

Appendix VIII: R&D/Technology Subcommittee ILI Case Study Analysis

In-Line Inspection (ILI) as a Best Practice

Introduction

The recommendations in this section are based on a review and gap analysis informed by two published works: 1) best practices, presented in API 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 Standard 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 recommendations below focus on improvements in the application of best practice(s) to meet the intention of the codes and standards (e.g. CFR, API 1163, etc.) which will facilitate information sharing across the industry. Secondly, the case study NDE-4E describes the performance of ILI tools as they relate to the measurement of crack-like features in pipelines. The recommendations below 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 integrity assessment method to employ as part of an integrity management program (IMP).

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

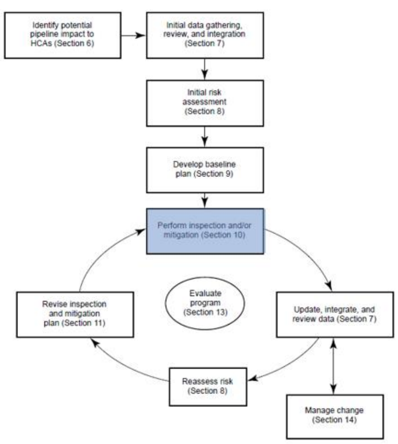


Figure 1 - Integrity Management Process

ILI has been effective in helping the pipeline industry reduce failures for dents/deformations, metal loss, “crack-like”/crack and coincident anomalies. It does this by detecting and measuring pipeline features 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 an increased focus on R&D to develop 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 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 others 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.

API Standard 1163, ‘ILI Systems Qualification Standard’, describes the overall ILI process. An ILI System includes procedures, personnel, equipment, and associated software. API 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, 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.

API 1163 as a Best Practice

Introduction

The development of API Standard 1163, ILI Systems Qualification Standard, was initiated in 2001 and was first published in 2005 (first edition). The Standard is not 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 the provider of the ILI service provider and the pipeline operator. This Standard provides requirements that enable service providers and 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, 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,

d) and confirm inspection results.

Scope

API 1163 covers the use of ILI Systems for onshore and offshore gas and hazardous liquid pipelines. This includes, but is not limited to, tethered, self-propelled or free flowing systems for detecting metal loss, cracks, mechanical damage, pipeline geometries, and pipeline location or mapping, The Standard applies to both existing and developing technologies.

ILI System Selection

One of the important aspects covered in section 5 of API 1163 is ‘ILI System Selection’.

It includes the following main sections;

5.1 General

5.2 Inspection Goals and Objectives

5.3 Physical and Operational Characteristics and Constraints

5.4 Selection of an ILI System

5.5 Performance Specification

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,
- 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 the ability of the analysis system (underlying models/algorithms plus analyst procedures, training and competence) to recognize the presence of a defect, identify it and size it with confidence.

Section 5 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 (section 5.5).

Section 5.5 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.

Section 6 describes the requirements and understanding of how an ILI Systems Performance Specification is qualified.

6.0 Qualification of Performance Specifications

6.1 General

6.2 Performance Specifications

6.3 Qualification Requirements

6.4 Documentation and Other Requirements

Section 6.2 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 pull-tests of the ILI System through pipe sections of varying grades and wall thicknesses, invariably containing artificial anomalies. There are many instances whereby "real" anomalies are provided to determine the applicable performance.

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).

Section 6 allows the operator to find out about the Performance Specification and adherence based on historical data (in section 6.3.4).

6.3.4 Validation Based on Historic Data

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 (section 5) an appropriate ILI System for a new or upcoming assessment.

System Results Validation

This leads to section 8, "System Qualification and Validation", another important part of API 1163.

It covers such important aspects as;

8.1 Introduction

8.2 Evaluation of System Results

8.3 Using Validation Measurements

8.4 Conclusions on Using Validation Results

8.5 Assessment of ILI Performance

The Performance Specification is subsequently confirmed by comparing predicted results from the ILI System against results as measured on the exposed pipe. However, obtaining such field results in sufficient volume relies on operators being willing 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 1163, section 8.2.6 Validation Measurements, "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, 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.

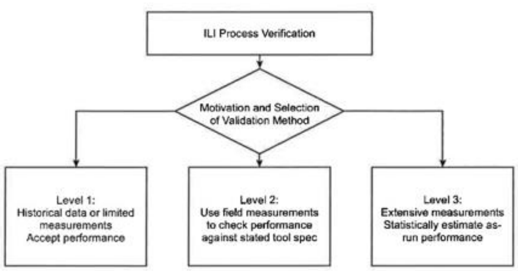


Figure 5 from API 1163, Overview of Three Levels of ILI Validation

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 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 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.

The next section explains a Case Study that considers API 1163 as the basis.

Current Practice / Case Study

The best practices described in the previous section are critical for a data sharing initiative, however, key elements missing from these standards are recommended to facilitate data sharing. These include rigorous data definition standards, data gathering protocols, software infrastructure, database architecture, intellectual property protection and data sharing protocols. In cases where best practices specify data sharing between ILI service providers and pipeline operators, the data to be shared and how it is shared is vague. In the context of a broader sharing initiative, these deficiencies should be addressed.

Beyond best practices, published data sharing case studies provide additional insights on the requirements of a data sharing initiative. The Pipeline Research Council International (PRCI) has lead several data sharing initiatives, most notably the NDE-4E project, "In-line Inspection Crack Tool Performance Evaluation". The NDE-4E project collected data from 10 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 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 to describe a pipeline feature by NDE field staff. These must be consolidated and standardized for industry-wide sharing. For example, an axial flaw measured by an ILI tool may be categorized by NDE field staff as an: arc strike, artificial defect, 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 IX: R&D/Technology Subcommittee IT Architecture, Data Handling Recommendations, Cybersecurity Requirements

Architecture/IT

Summary of IT Related Objectives

Define a system for sharing dig verification between ILI and pipeline operators in a secure and confidential manner

Discover methods for exchanging pipeline inspection information to improve techniques and better perform risk

Share dig verification and other data between pipeline operators and ILI vendor to better understand pros/cons of different ILI technologies .

System must be secure, protect proprietary data, while encouraging exchange while reducing regulatory, funding and legal barriers to sharing information

Support gas distribution/transmission and hazardous liquids pipelines

Identify advanced analytical techniques, tools and practices for performing enhanced risk analysis

Conceptual Model Graphic

The graphic below is the representation of a system comprised of concepts which were used to define and understand the VIS IT architecture
model.

Facets of IT Architecture/Data Management

- 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.
  - Role Based Access Control (RBAC) – is an approach to restricting system access to authorized users.
  - Privacy

Accepted Paradigm/Technology/Framework for advanced computing

Cloud computing is shared pools of configurable computer system resources and higher-level services that can be rapidly provisioned with minimal management effort, accessible via the Internet. Cloud computing relies on sharing of resources to achieve coherence and economies of scale. Some key points surrounding this technology include, but are not limited to:

- Scalable – can add compute, storage, memory, etc. on demand
- Elastic – can scale up or out, or shrink as needed
- Secure – skin in the game, shard-ing, regions, multiple implementation
- Cost Effective – OpEx not CapEx expense, reduced IT
- Functional – multiple data storage technologies, advanced analytics
- Managed – consumer driven on need, IT infrastructure is managed
- Agnostic – multiple top tier vendors, technologies, etc. available

Static, Dynamic or Streaming

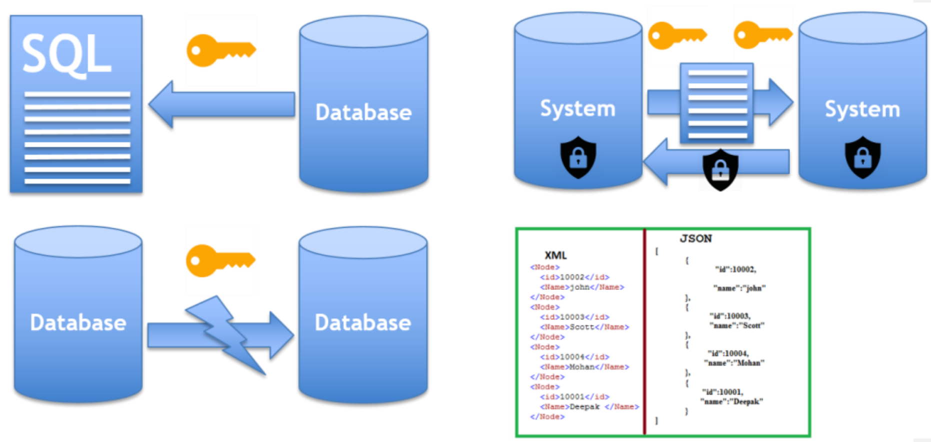
In data management, the time scale of the data determines how it is processed and stored. Data is fixed, it is updated, or it is continuous. Consideration for how data is processed and stored must be addressed by the architecture.

- Static (or persistent) – Is 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) – Is information that is periodically updated, meaning it changes asynchronously over time as new information becomes available. This data is created, and updated, it changes, 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)

Data Transfer

Data transfer refers to the collection, replication, and transmission of large datasets from one system to another. Consideration for how data is transferred between systems must be addressed by the architecture.

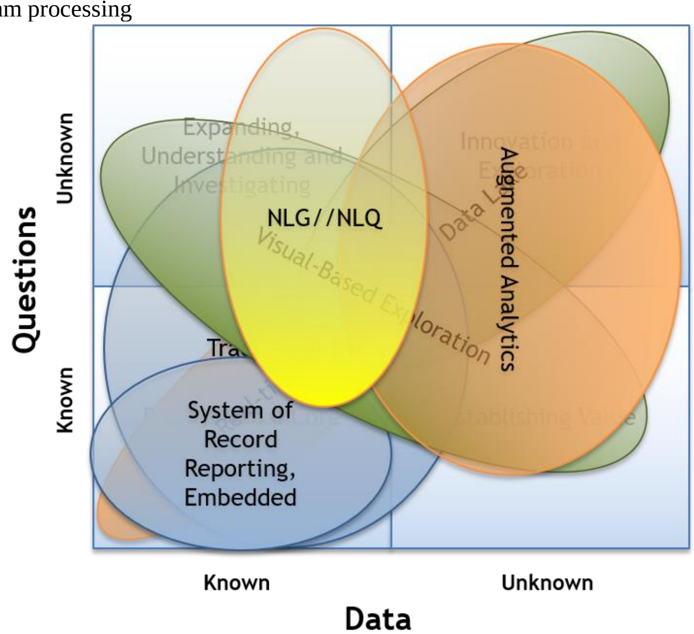
- Structured Query Language (SQL) (pull) to ETL (push)
- Application Programming Interface (API)
  - Exposure, security, encryption, processing, and return
- • Formats
  - SQL, Javascript Object Notation (JSON), Extended Markup Language (EML)
- • Standards
  - Guidance around format of content (PODS Data Exchange Specification DES)



Data paradigms

- Data management solutions are designed with big data and analytics at the forefront. Modern enterprise architecture requires dedicated data management tools for running complex analysis on data from disparate and potentially diverse sources. These requirements can be met using cloud platforms that allow for flexible deployment, ingestion, integration, and security.
- Data management and access paradigms – The value of master data lies in the ability for multiple applications to access a trusted data asset that can serve up the unique representation of any critical entity relevant within the VIS Hub user community.
- Logical Data Warehouse [DMSA (data management solutions for analytics) Use Cases] – Consideration for broad solutions that address multiple data types and offer distributed processing and repository is advised. Modern logical data warehouses use a multiengine approach to fulfill conflicting demands.
- Analytics and Business Intelligence – Big data analytics applications are able to include data from a myriad of systems and external sources. In addition, streaming analytics applications are available in big data environments, allowing users to do real-time analytics on data fed

into stream processing



engines.

Data Storage Technology

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, identify the solution to the problem, identify the type of database that is optimized for that type of solution and lastly identify 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 Model (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. JavaSript Object Notation – JSON, XML, etc.). 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) – Raw volumes of storage are created and 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.

Architecture and Technology Selection

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

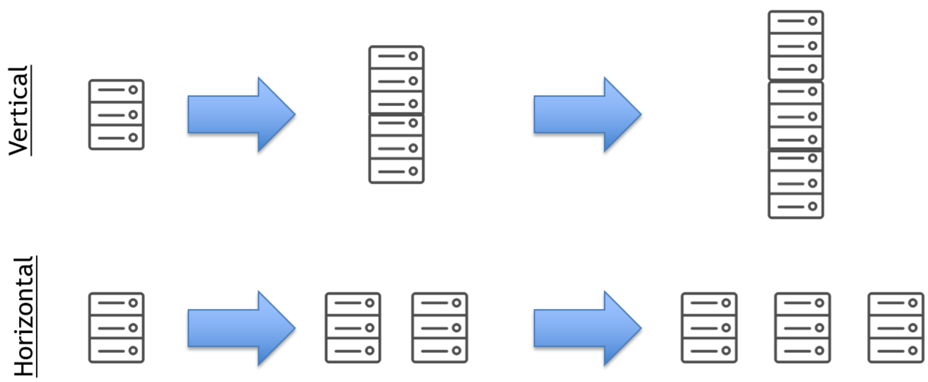
The evaluation criteria are usually listed in three main categories: economics, technology and commercial, with a corresponding weighting for each category. Each of these categories is identified below, in turn.

- 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.

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. Vendors 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.

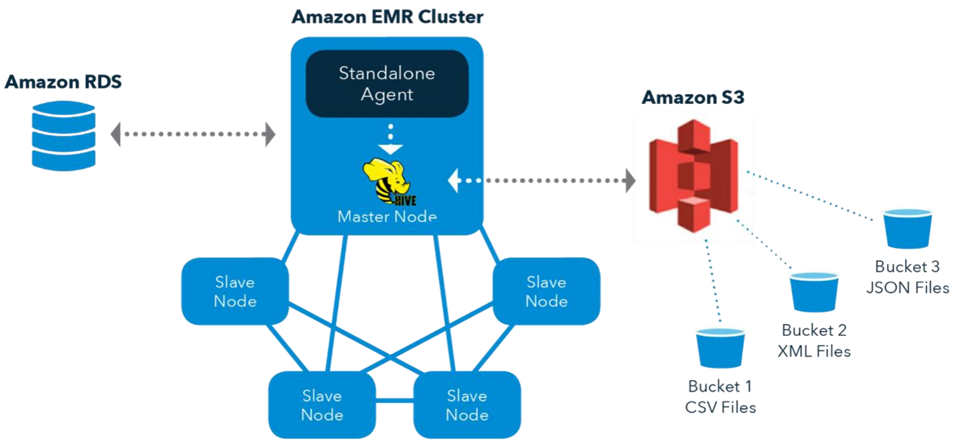


MapReduce

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.



Business Intelligence

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:

- 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
  - “Climb the hill to see the world more clearly.”

Cyber Security

Introduction

- Cybersecurity 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. These definitions and recommendations in this text are based on the NIST 800 standard. NIST 800 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.

- The recommended Voluntary Information Sharing (VIS) System (or Hub) would contain sensitive information and requires strong cybersecurity 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 vendor and any others who input data into the 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)}.

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. It is our recommendation that this baseline be implemented according to the standard. Implementation of this standard would include many normal InfoSec practices, like system patching, vulnerability assessments, incident response planning, encryption and many other good practices.

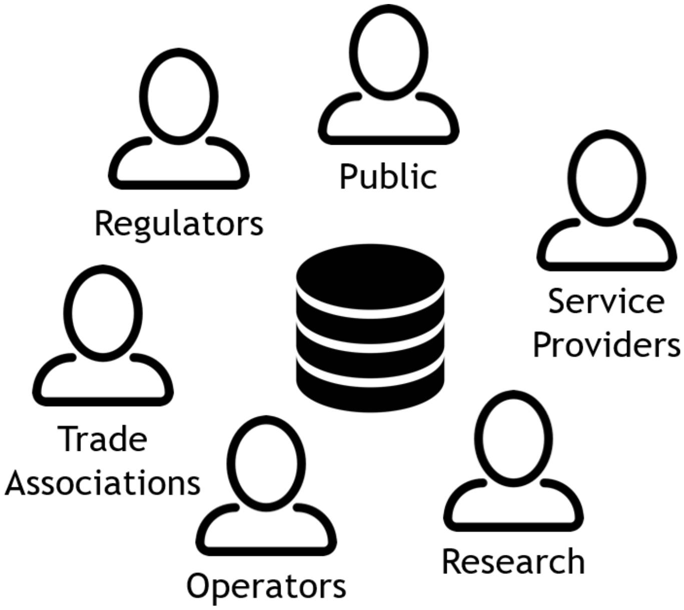
As required by the NIST 800-53 standard a security operations team would need to be put in place. This team would be responsible for responding to cyber security incidents and performing audits of the environment to ensure expected outcomes. The security operations team would likely be in a shared services capacity within the organization housing the VIS environment.

Roles Based Authentication

The NIST 800-53 standard calls for specific account management activities as part of the AC-2 control. The committee wanted to point out the specific requirements for establishing the conditions for group and role-based access. 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.

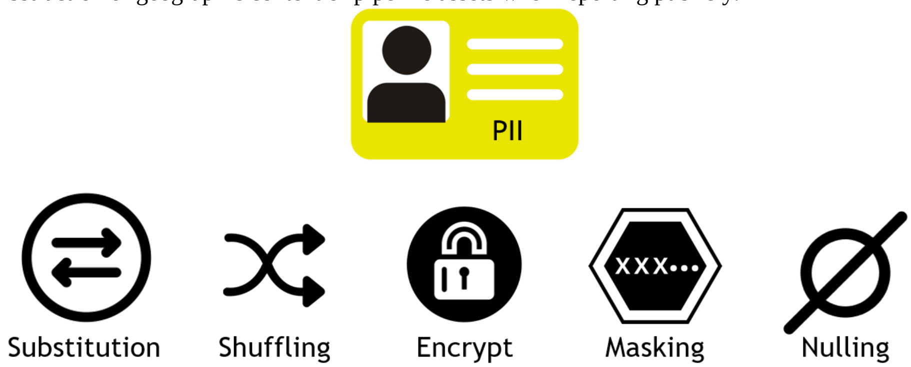


Information Privacy

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:

- Removal of ID's, or other identifiable information when reported.
- Remove all personally identifiable information for persons when the data enters the system.

- Abstraction of geographic context of pipeline assets when reporting publicly.



De-identify or obfuscation

Governance

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

Concept – PHMSA VIS Cloud Computing and Big Data

The VIS hub will require infrastructure that allows for self-service, resource pooling and delivery of on-demand computing resources, possessing scalability, elasticity and resiliency. Scalability exists at the application layer, highlighting capability of a system, network or process to handle a growing amount of work, or its potential to be enlarged in order to accommodate that growth. Elasticity in infrastructure involves enabling the virtual machine monitor (or hypervisor) to create virtual machines or containers with the resources to meet the real-time demand. Resiliency refers to the system being operable and able to provide and maintain an acceptable level of service. The proposed Cloud Computing and Big Data Architecture addresses all aspects of the following components: infrastructure, analytics, data structures & models, and security. It is the whole complex of components to store, process, visualize and deliver results for consumption in targeted business applications.

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.

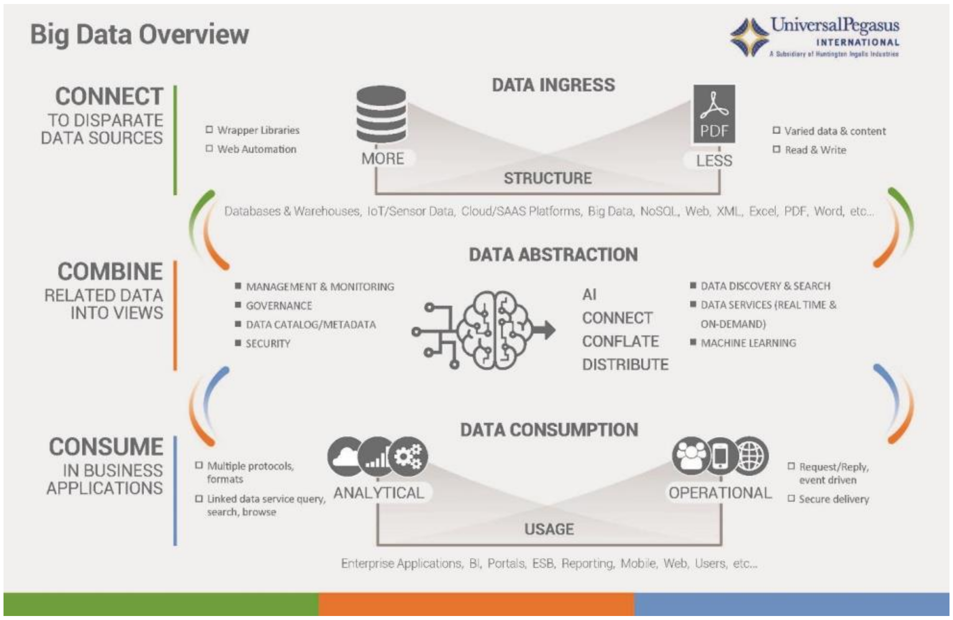
Combine

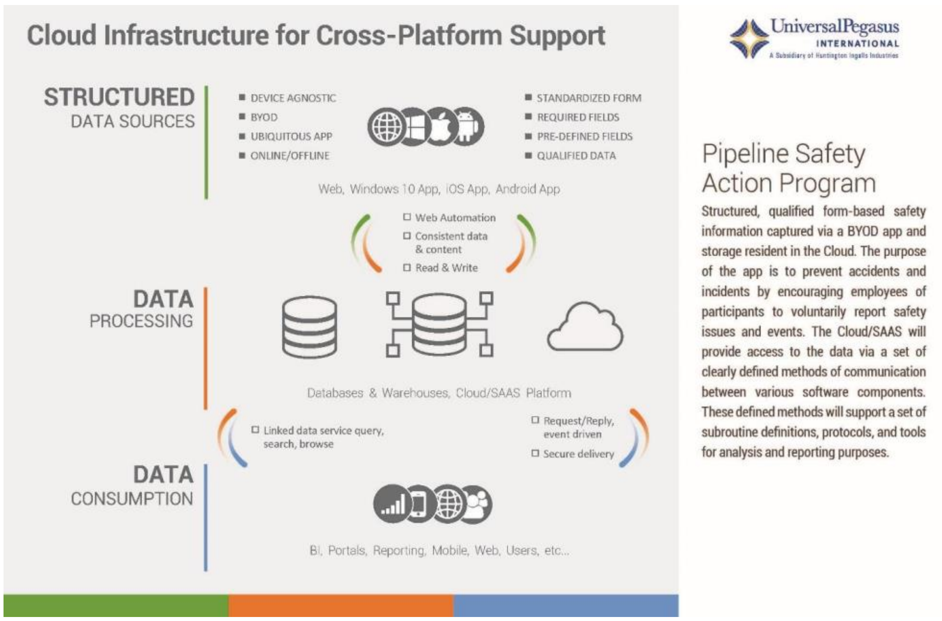
The data abstraction layer combines related data into views. Various techniques and tools for data conflation may be required to store, analyze and distribute data including machine learning.

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.

Concept Overview – PHMSA VIS Cloud Computing and Big Data



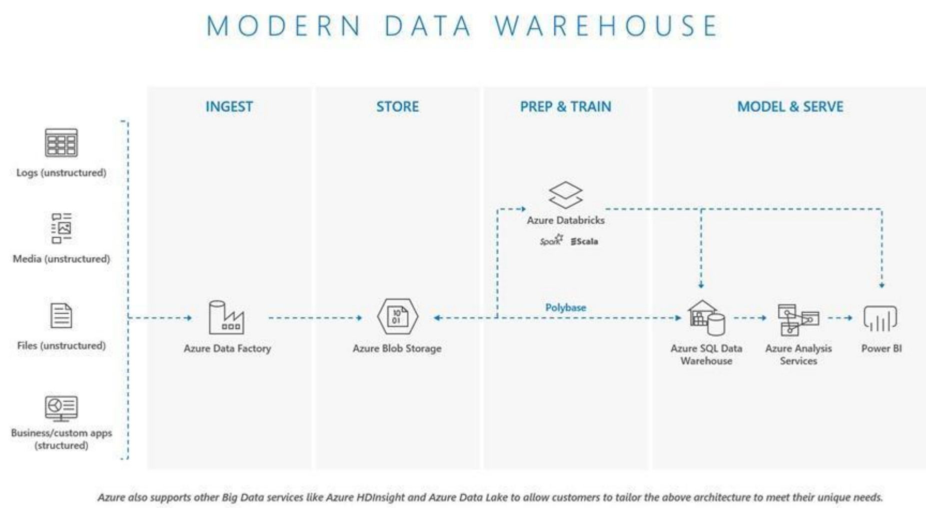


Implementation patterns for big data and data warehouse on Azure

Various options exist 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.

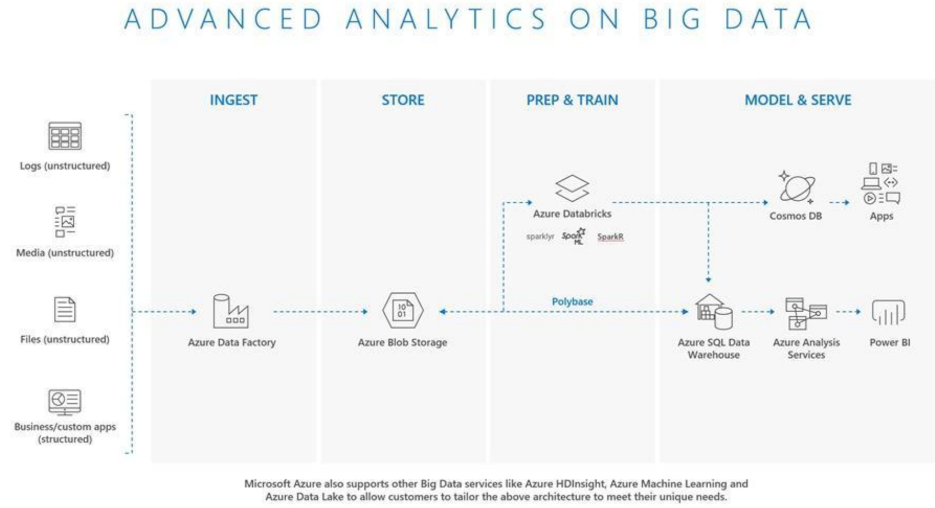
Modern data warehouse

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.



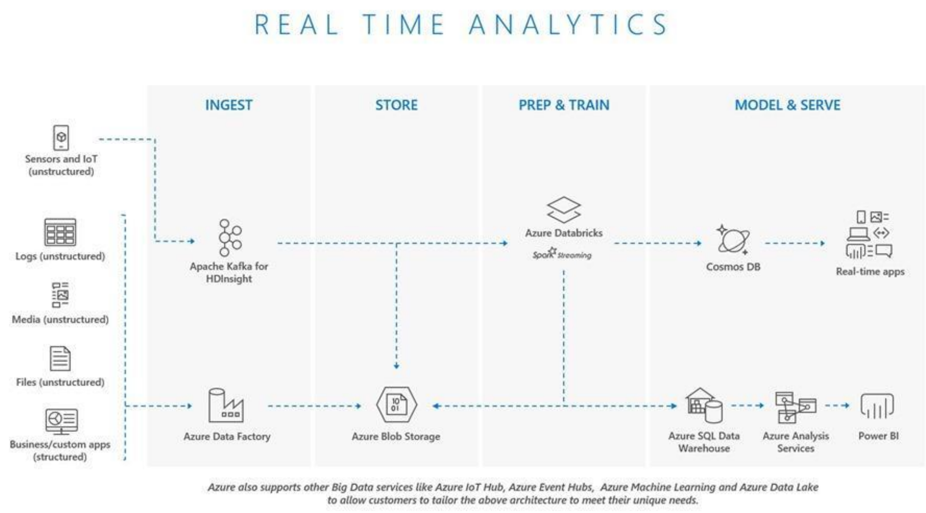
Advanced analytics on big data

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.

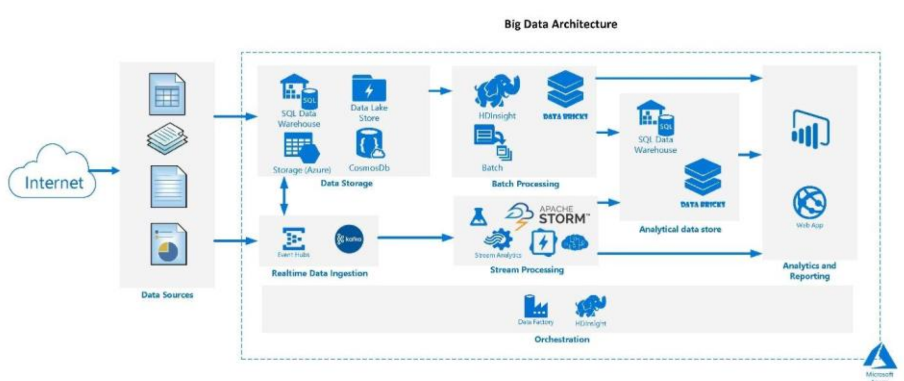


Real-time analytics (Lambda)

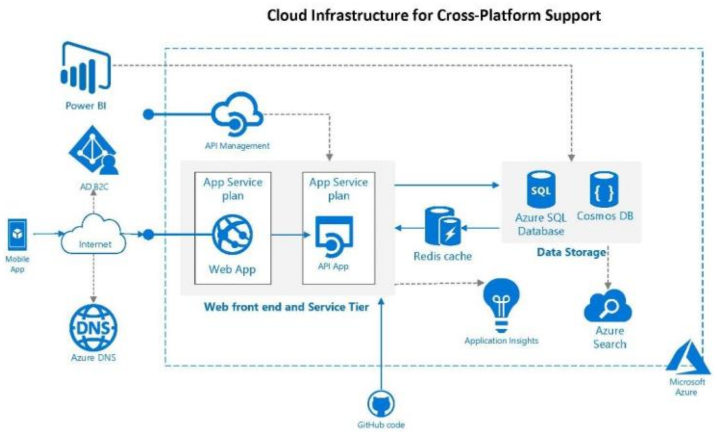
We introduce Azure IOT Hub and Apache Kafka alongside Azure Databricks to deliver a rich, real-time analytical model alongside batch-based workloads. Here we take everything from the previous patterns and introduce a fast ingestion layer which can execute data analytics on the inbound data in parallel 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.



IT Architecture Diagram – PHMSA VIS Cloud Computing and Big Data



IT Architecture – PHMSA VIS Phased Approach



Cloud Computing and Big Data Architecture Definitions

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.

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Reference System(s) - Aviation Safety Information Analysis and Sharing (ASIAS)

MITRE's (a third-party contractor) data analytics capabilities and secure data environments are playing a key role in a safety analysis and data sharing collaboration. The Federal Aviation Administration and the aviation community are improving aviation safety by using these capabilities to proactively analyze extensive and diverse data.

This collaboration is known as Aviation Safety Information Analysis and Sharing, or ASIAS. Members of ASIAS include government agencies, aviation stakeholder organizations, aircraft manufacturers, and dozens of airlines and corporate operators.

Information Analysis

The initiative 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.

Information Sharing

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's the only such center of its kind in the world.

Information Systems

ASIAS leverages two (2) primary systems; Aviation Safety Action Program (ASAP) and Flight Operational Quality Assurance (FOQA).

Aviation Safety Action Program (ASAP)

The purpose of ASAP is to prevent accidents and 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 encourage the employee 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 reoccurrence 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 various employee groups, such as flight crewmembers, mechanics, flight attendants, and dispatchers.

Flight Operational Quality Assurance (FOQA)

FOQA is a voluntary safety program designed to improve aviation safety through the proactive use of flight-recorded data. Operators will use these data to identify and correct deficiencies 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. This chapter will define the elements of a FOQA program, the FOQA program approval process, and the role of the principal operations inspectors (POI) and air carrier inspectors in monitoring continuing FOQA 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 operator's overall operational risk assessment and prevention program. Being proactive in identifying and addressing risk will enhance safety.