ASME PTB-12-2017

Guidelines for Addressing Data Gaps and Recordkeeping for ASME B31.4, B31.8 and B31.8S for Pipeline Integrity Management

ASME
SETTING THE STANDARD

PTB-12-2017

GUIDELINES FOR ADDRESSING DATA GAPS AND RECORDKEEPING FOR ASME B31.4, B31.8 AND B31.8S FOR PIPELINE INTEGRITY MANAGEMENT

Prepared by:

Andrew R. Lutz, P.E., DNV-GL
Elizabeth King, DNV-GL
Dr. Thomas Bubenik, DNV-GL
Dr. William Harper, DNV-GL

ASME
SETTING THE STANDARD

Date of Issuance: June 28, 2017

This guideline was prepared by ASME Standards Technology, LLC (ASME ST-LLC) and sponsored by The American Society of Mechanical Engineers (ASME) Pressure Technology Codes & Standards.

Neither ASME, the author, nor others involved in the preparation or review of this document, nor any of their respective employees, members or persons acting on their behalf, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe upon privately owned rights.

Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer or otherwise does not necessarily constitute or imply its endorsement, recommendation or favoring by ASME or others involved in the preparation or review of this document, or any agency thereof. The views and opinions of the authors, contributors and reviewers of the document expressed herein do not necessarily reflect those of ASME or others involved in the preparation or review of this document, or any agency thereof.

ASME does not "approve," "rate," or "endorse" any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assume any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME is the registered trademark of The American Society of Mechanical Engineers.

The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990
ISBN No. 978-0-7918-7171-3

TABLE OF CONTENTS

LIST OF FIGURES

List of Tables

FOREWORD

The San Bruno event on September 9, 2010 was paradigm shifting for the pipeline industry. This guideline represents a continuing effort to learn from our mistakes, to learn from outside sources, to share knowledge and to improve the pipeline industry in the interest of public safety.

The following individuals are acknowledged for their technical and editorial peer review of this guideline: David Anderson, Michael Rosenfeld, Marvin Hovis, Joel Brandt, Keith Leewis, David Johnson, Michael Zerella, and Rick Kivela. In addition, the efforts of Richard Lucas of ASME and Carlton Ramcharran of ASME ST-LLC are acknowledged for their management of the peer review group, review of the manuscript prior to publication, editing and document preparation resulting in the publication of this document. Finally, a special thanks is offered to the pipeline operators who invested in developing processes and technologies over the past five years that supported the development of this document.

Established in 1880, ASME is a professional not-for-profit organization with more than 135,000 members and volunteers promoting the art, science and practice of mechanical and multidisciplinary engineering and allied sciences. ASME develops codes and standards that enhance public safety, and provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community. Visit (https://www.asme.org/) for more information.

ASME ST-LLC is a not-for-profit Limited Liability Company, with ASME as the sole member, formed in 2004 to carry out work related to new and developing technology. The ASME ST-LLC mission includes meeting the needs of industry and government by providing new standards-related products and services, which advance the application of emerging and newly commercialized science and technology, and providing the research and technology development needed to establish and maintain the technical relevance of codes and standards. Visit (http://asmestllc.org/) for more information.

ABSTRACT

This guideline provides a recommendation and potential guidance to address observed gaps in data and recordkeeping practices that are currently prescribed in the ASME pipeline standards B31.8, Gas Transmission and Distribution Piping Systems, B31.8S, Managing System Integrity of Gas Pipelines, and B31.4, Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids. The authors reviewed pipeline industry standards and standards from other industries to identify potential best practices and lessons learned.

In practice, once operators have established upgraded data and recordkeeping systems, the systems will need to be managed and maintained, or else there would be risk of repeating old mistakes, and the need to re-create the system from the ground up. A records maintenance team and controlled processes are required to manage and maintain the systems effectively. This guideline endeavors to summarize guidance that a pipeline operator could use to enhance a data and recordkeeping structure in accordance with modern standards.

It is recommended that each operator maintain a chief source of pipeline system information, so he can make auditable, repeatable, and trustworthy decisions such as those needed for fitness-for-service calculations and risk assessments. The authors of this guideline recommend a practice of maintaining digital source records directly linked to specific pipeline components within an operator's geographic information system (GIS) (i.e., a pipeline information database). This recommendation is based on a philosophy of providing the operator's decision makers easier access to the source records.

Guidance is provided on bounding likely values to address data gaps through research. The purpose of the research is to gather information that allows the team to assign conservative, realistic ranges of values for missing parameters.

Guidance is provided to develop a quality and reliability process for pipeline system data. If the existing quality and reliability determination process is found unacceptable or it is found that one does not exist, then a new process must be created. A team should be assembled to research information to accurately develop a quality and reliability determination process. If the existing quality and reliability determination process is found to be acceptable, then it should be communicated to relevant personnel. This process is to be adopted and will be used to verify the pipeline information database.

Data collection, as it pertains to information about a pipeline system, has always occurred continuously in the pipeline industry. Operators and their contractors are constantly recording observations and documenting measurements as part of field, survey, and testing activities. These new observations and measurements in effect create new source records with respect to the pipeline information database. An ongoing data collection process is described to maximize the utility of this data towards filling gaps, increasing confidence, and maintaining the database into the future.

ABBREVIATIONS AND ACRONYMS

Acronym / Abbreviation	Meaning
ADB	Advisory Bulletin
AGA	American Gas Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
APDM	ArcGIS Pipeline Data Model
CFR	U.S. Code of Federal Regulations
DOT	U. S. Department of Transportation
DPI	Dots per inch
FAQ	Frequently Asked Questions
FDA	U.S. Food and Drug Administration
GIS	Geographic Information System
GPS	Global Positioning System
HCA	High Consequence Area
IMP	Integrity Management Program
ISO	International Organization for Standardization
MAOP	Maximum Allowable Operating Pressure
MOC	Management of Change
MOP	Maximum Operating Pressure
NACE	NACE International (formerly) National Association of Corrosion Engineers
NPMS	National Pipelines Mapping System
NTSB	U.S. National Transportation Safety Board
O&M	Operations and Maintenance
PDF	Portable Document Format
PHMSA	U.S. Pipeline and Hazardous Materials Safety Administration
PODS	Pipeline Open Data Standard
PPI	Pixels per Inch
PRCI	Pipeline Research Council International
QA/QC	Quality Assurance/ Quality Control
SCADA	Supervisory Control and Data Acquisition
SME	Subject Matter Expert
SMYS	Specified Minimum Yield Strength
UPDM	Utility and Pipeline Data Model

DEFINITIONS

1 Access: right, opportunity, means of finding, using, or retrieving information
2 Bayesian Network: graphic statistical model that represents probabilistic relationships between variables. This type of analytic process can model the probabilities of cause and effect relationships in order to make predictions based on known distributions and values (see Appendix A).
3 Company segment: A natural division within a company that may drive a separate document structure, such as a legacy acquisition, or geographic region (e.g., "southwest district") where a unique document organization may exist.
4 Complete record: a record that is "finalized by a signature, data, or other appropriate marking."
5 Conversion: process of changing records from one format to another.
6 Data Gap: missing information.
7 Data mining: the practice of searching through large amounts of information, to locate specific data or identify useful trends.
8 Database: a large collection of data organized for quick access and retrievability.
9 Database Owner: a person responsible for managing and maintaining the data within the Pipeline Database for the relevant section of pipe.
10 Decision Maker: The staff and stakeholders whose decisions require the information from the Pipeline Database, which may include critical operations decisions (e.g., pressure reductions and fitness-for-service analysis). Examples of Decision Makers include company management, integrity engineers, and risk engineers.
11 Destruction: process of eliminating or deleting a record beyond any possible reconstruction.
12 Disposition: range of processes associated with implementing records retention, destruction, or transfer decisions which are documented in disposition authorities or other instruments.
13 Flowchart: a graphical representation of a process.
14 Media: the physical form of the documentation such as paper, or electronic.
15 Metadata for records: structured information which enables the indexing, sorting, retrieval, and use of records.
16 Metric: a standard of measurement by which quality, performance, or progress may be measured.
17 Microfiche: a flat piece of film containing microphotographs of the pages of a newspaper, catalog, or other document. [1]
18 Microfilm: a length of film containing microphotographs of a newspaper, catalog, or other document. [1]
19 Other Communications (pertaining to regulatory requirements): U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA) Emails, Letters, Advisory Bulletins, and FAQs.
20 Pipeline Information Database: an organized collection of data specific to the needs and decisions of the pipeline company.
21 Record(s): Recorded information or data on a particular subject, collected and preserved to demonstrate compliance with a rule or process requirement. [2]
22 Records Librarian: a person who is familiar with the hard copy records pertaining to the data that are or will be used to populate the Pipeline Database.
23 Records management: field of management responsible for the efficient and systematic control of the creation, receipt, maintenance, use, and disposition of records, including processes for capturing and maintaining evidence of, and information about, activities in the form of records.

24 Records system: information system which captures, manages, and provides access to records over time.

25 Researcher: a person who is available to conduct the necessary research into the background information related to the desired information.

26 Schema: logical plan showing the relationships between metadata elements, normally through establishing rules for the use and management of metadata specifically as regards the semantics, the syntax, and the optionality (obligation level) of values. [3]

27 SCADA: Supervisory control and data acquisition system, used for monitoring and control.

28 Source Records: a record that is original for the data included within.

29 Subject Matter Expert (SME): An individual recognized as having a special skill or specialized knowledge of a process in a particular field, or of a piece of equipment. [4] Types of SMEs include welding and materials experts, pipeline construction project experts, legacy acquired company experts, etc.

30 Traceable record: a record that can clearly be linked to original information about a pipeline segment or facility.

31 Useable: (pertaining to records) a record/data that is accessible to the Decision Maker within a reasonable time period. [5]

32 Verifiable record: a record that contains information that can be "confirmed by other complementary, but separate, documentation."

1 PURPOSE AND USE

This guideline provides a recommendation and potential guidance to address observed gaps in data and recordkeeping practices that are currently prescribed in the ASME pipeline standards B31.8, B31.8S, and B31.4. The authors reviewed pipeline industry standards and standards from other industries to identify potential best practices and lessons learned. The industry needs a go-forward approach that will manage new records and data in a way that will maximize the utility of available records wherever practical, and improve upon record keeping practices for the future to take advantage of modern technology and lessons learned.

In practice, once operators have established upgraded data and recordkeeping systems, the systems will need to be managed and maintained, or else there would be risk of repeating old mistakes and the need to re-create the system from the ground up. A records maintenance team and controlled processes are required to manage and maintain the systems effectively. This guideline summarizes guidance that a pipeline operator could use to enhance a data and recordkeeping structure in accordance with modern standards.

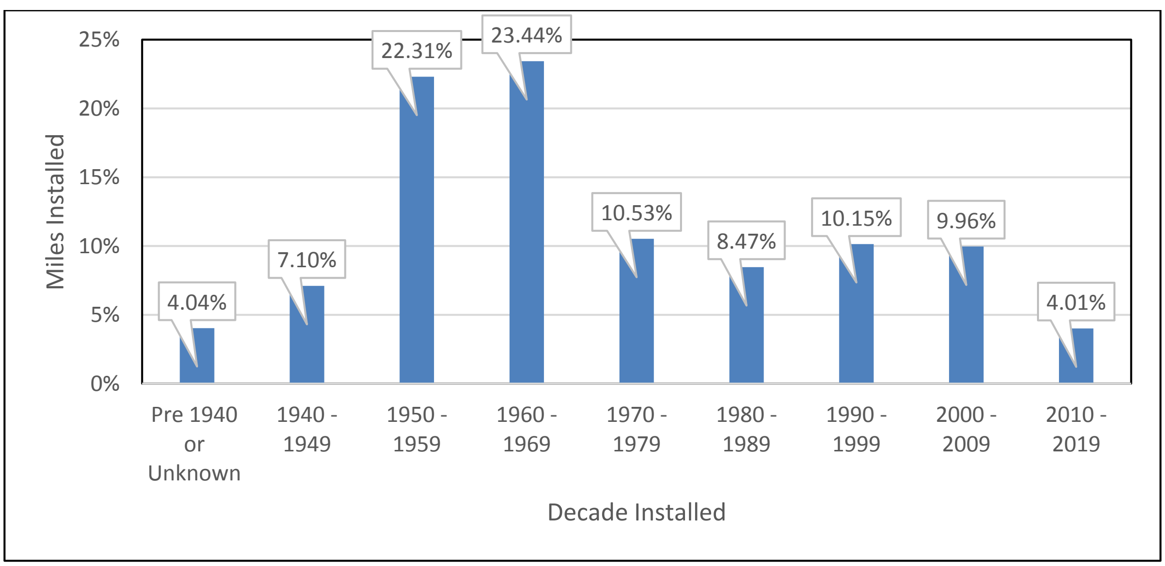
1.1 Background of Data and Recordkeeping in the Pipeline Industry

The pipeline industry's data and recordkeeping systems are a product of the industry's historical practices. In order to identify ways in which ASME codes and standards can provide guidance to industry, it is important to first understand historic pipeline record keeping practices and to understand how the industry's infrastructure and regulatory history steered the records to their current state.

1.1.1 United States

In the United States (U.S.), over one half of the transmission pipeline network in the country was installed prior to 1970 (and prior to any federal pipeline safety regulations with records requirements). Figure 1-1-1 shows gas transmission pipeline installation activity by decade, which peaked in the 1950s (22.31%) and the 1960s (23.44%). [6]

Figure 1-1: Gas Transmission Lines by Decade of Installment



Prior to the first U.S. pipeline regulations in late 1960s, the industry's only record keeping requirements were provided by industry standards. Rosenfeld and Gailing summarized the situation well, "It would be reasonable to expect that a variety of documents related to the design and construction of a pipeline facility be retained long-term. However, retention of technical documents was not addressed by the engineering standards of the day. It was generally thought that a copy of the specifications under which the pipeline was built (and supplemented by commercial documents, e.g. contracts and purchase orders) would generally be adequate to provide evidence of the work that was done." [7]

The authors have made similar observations during their professional experiences with records review and management. There are occasions where operators have stored what are now recognized to be highly valuable records, but it is highly unusual that they stored them to meet any specific regulatory requirement. When highly valuable documents are discovered (particularly for pipe that was constructed prior to regulation and/or pipe that was acquired), they are frequently met with pleasant surprise.

In 1938, American Standards Association ASA B31.1 first required that records be kept on welder qualifications and their identifying marks. Subsequent revisions expanded welder related record keeping. In 1955, B31.1.8 (which eventually became B31.8) first recommended basic risk based design concepts with 4 location class factors. It required the pipeline operator, or contractor, to maintain records related to welders and pressure testing. The standard was the first to recommend operations and maintenance records mentioning external and internal corrosion related to leaks and repairs, and inspection reports. A later revision in 1968 required recordkeeping related to corrosion inspection and leak investigation.

The federal pipeline regulations were passed in the 1960s with the first federal laws effecting liquid pipelines and the Natural Gas Pipeline Safety Act of 1968. Concurrent to these shifts in pipeline records requirements and expansion of the U.S. pipeline infrastructure indicated above was large amounts of population growth over the past 50-60 years. Pipelines had to be re-routed to accommodate the additional infrastructure (e.g., highways, waterlines) in congested areas, which created more records and/or additional pipeline system materials to track.

The Natural Gas Integrity Management Rule 49 CFR Part 193 Subpart O was introduced in 2003, three years after a similar rule for liquid pipelines (49 CFR Part 195). Following the integrity management rules, operators were more frequently audited, which required them to focus more on material properties as part of risk modeling and fitness-for-service analysis. The gas (and, similarly, the liquid) integrity management (IM) rule specified how pipeline operators must identify, prioritize, assess, evaluate, repair, and validate the integrity of gas (or liquid) transmission pipelines that could, in the event of a leak or failure, affect High Consequence Areas (HCAs) within the U.S. The IM rules required large improvement in HCA-related record keeping for most operators in the U.S. [8]

The industry heightened its focus on data and recordkeeping following the San Bruno failure in 2010, when the U.S. National Transportation Safety Board (NTSB) included in its findings that the pipe had been incorrectly listed as "seamless." The first records quality criteria in the U.S. were provided in 2011, with PHMSA's issuance of Advisory Bulletin (ADB) ADB-11-01 [15], which made operators aware that operational decisions should be based on documents that are "traceable, verifiable, and complete" (PHMSA provided definitions for the terms approximately 16 months later in ADB-12-06) [16]. Many operators had to satisfy this requirement[1] by locating, sorting, deciphering, and prioritizing decades of legacy and historic records. It was found that many records, particularly pre-regulation, were not retained as there were no requirements to keep them on file. Economic shifts have caused mergers and acquisitions (creating situations where the records may not have been transferred from one operator to the next). There are many other reasons for loss of records, including lack of retention of hardcopy after poor quality archiving to

[1] The requirement to review system records and verify MAOP was made into law by the U.S. Congress when the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011 was passed on January 3, 2012. [17]

microfilm or digitization. Disasters such as a fire or flood, or clerical mishandling[2] have also destroyed invaluable records that are costly to reproduce. Operators of these pipelines have been placed in a difficult situation.

1.1.2 CSA Z662

Canadian Standard Association (CSA) standard Z662-15 provides a more flexible view of historical records with its requirements: "The format and level of detail associated with the material records specified in Clause 5.7 is not defined and is therefore at the discretion of the company. Although detailed documentation, such as mill test reports, often provide useful historical data for future reference (e.g., for engineering assessments pertaining to failure investigations or development of in-service welding procedures), it is not mandatory that such detailed documentation be retained as part of the permanent record. It is the intent that basic material data, such as material standards, specifications, grades, and dimensions, at a minimum, be included in the permanent records."

While the requirements of CSA Z662-15 may be a bit more flexible with respect to management of the pre-regulation era records, it allows operators to discard source records and doesn't require operators to manage their data with any type of reliability or quality criteria.

1.1.3 AS 2885

The Australian Standard 2885 series of standards (AS 2885.0 through AS 2885.5) [9][10][11][12][13][14] include some extensive lists of specific records requirements. For example, AS 2885.5 – 2012 (Field Pressure Testing) [14] contains approximately fifty specific and itemized reporting requirements for each test. It also provides an example of an acceptable format for a pressure test "certificate" that serves to record the required information.

The AS 2885 standards also require a Records Management Plan, and AS 2885.1 – 2012 (Design and Construction) [10] states "all pressure-containing materials installed on a pipeline system shall be traceable to the purchase documentation, the manufacturing Standard, the testing standard, and to inspection and acceptance documents. The pipeline Licensee shall maintain the records until the pipeline is abandoned or removed."

The Australian Design and Construction standard (AS 2885.1 – 2012) makes recommendations about digitization of records, as follows: "Electronic records that can be accessed by common text, database or spreadsheet programs are preferred. Where documents are only available on paper, they should be scanned into an appropriate format." And the standard requires the following link between materials and source records: "The identity of all materials shall be recorded and this identity shall include reference to the test certificates and/or inspection reports."

1.1.4 International

The International Organization for Standardization (ISO) standard 13623 [18] prescribes generally that "records shall be kept and maintained throughout (the pipeline's) lifetime to demonstrate compliance with the requirements of this international standard" and includes brief statements that require:

- Leak detection surveys.
- Records to demonstrate the system is "operated and maintained in accordance" to operations and maintenance and integrity plans and they are "effective."
- Pre-commissioning and commissioning records.

[2] "An anecdote reported to [Rosenfeld and Gailing] was an occasion where a clerical worker, instructed to photocopy hydrostatic test records, first separated the pressure charts from the test report forms which had been stapled together into separate piles, irreversibly breaking the link between pressure records and test segments." [7]

- Pressure test records, with specific itemized requirements including testing procedure, instrument calibrations, test charts, explanation and disposition of pressure discontinuities, etc.
- For construction records, it specifies some general document types. It prescribes a specific requirement that these documents should be made "permanent in reproducible and retrievable form," which seems to imply they should be available upon demand if someone needs them for an audit or analysis.

While the ISO standards are a bit more specific in some areas (e.g., pre-commissioning/commissioning), and less specific in others (e.g., operations and maintenance), the standard doesn't provide much records management guidance except for the last bullet related to construction records. The ISO standard recognized a specific need to continuously have access to the construction records. This improvement in practice of providing more access to records is also recognized by the nuclear industry in the next section.

NACE International (NACE) standard SP0113-2013 "Pipeline Integrity Method Selection" [19] provides an overview of available assessment methods and selection guidance to choose an appropriate method to assess the integrity of liquid or gas pipelines for external corrosion, internal corrosion, and SCC threats. This standard is primarily focused on records collection and prescribes very little (if any) records management. It does not prescribe or require any records from the selection process to be stored in any specific manner or for any specific amount of time. The NACE standard describes selecting a second assessment based on information from the first but doesn't describe how to store the information in between.

The reason the NACE document doesn't prescribe record keeping practices is because it is intended to complement a robust integrity management and operations and maintenance program, which should contain recordkeeping requirements. The NACE document provides technical guidance, but it may not be able to serve its purpose without adequate recordkeeping guidance provided by another standard.

1.1.5 Recent Improvements

The industry will need a go-forward approach that will manage new records and data in a way that will maximize the utility of available records as much as practical, and improve upon record keeping practices for the future, to take advantage of modern technology and lessons learned.

Modern records management programs have been presented at various U.S. pipeline operator conferences and forums frequently since around 2012. Operators in the U.S. have taken action in response to the NTSB's, PHMSA's, and U.S. Congressional recommendations and rules. Presenters across the industry have valued peer review of their data and records management review programs. Common themes of the review programs include organizing and searching source records, creating a document ranking system, and creating a cross-reference between the source records and the verified pipeline system materials data.

Some operators have found that digitization has allowed them to create a system that is more sustainable and allows more of the operators' employees to access data and recordkeeping system, which is perceived as an increase in value on the investment. Specific examples include operators that have digitally captured or transferred source records into a records management system, which allows the operator to initially conduct research efficiently, but ultimately links source records to GIS. The GIS system provides an interface with the pipeline records system that allows access for a much wider set of employees. These GIS-based systems can provide more accessibility than most traditional analogue systems (e.g.., like maps, or alignment sheets) because they can often be navigated more quickly and intuitively and on a system-wide scale. They can also provide more accessibility than a spreadsheet based cross-reference between source records and verified data because of the barriers to understanding the spreadsheet cross-reference.

Once established, operators have understood these upgraded data and recordkeeping systems will need to be managed and maintained, or else there would be need to re-create the system from the ground up. A records maintenance team and controlled processes are required to manage and maintain the systems effectively.

This guideline endeavors to summarize guidance that a pipeline operator could use to enhance a data and recordkeeping structure in accordance with modern standards.

1.2 Review of Data Management Challenges and Solutions in Other Industries

Comparisons of the general data and recordkeeping practices of the pipeline industry to other industries have highlighted some key observations. The pipeline industry has the following unique combination of characteristics that create challenges for data and recordkeeping. In the U.S., the pipeline infrastructure is:

- By majority more than 50 years old.
- Materials dependent (i.e. subject to degradation mechanisms like corrosion and cracking).
- Typically buried underground (and can't be readily seen or inspected).
- Vastly spread out geographically, and
- Highly critical to society's safety, environmental, and infrastructure (e.g., energy, economy) requirements.

The other industries reviewed for this guideline exhibit some of the same characteristics, but the authors couldn't identify an industry which exhibited all of these same characteristics. The authors reviewed practices within the following industries to evaluate how the recordkeeping practices might be transferred to the pipeline industry.

1.2.1 Medical Industry

Recordkeeping practices were reviewed for the implanted medical device sector of the medical industry. This part of the medical industry shares the following characteristics with the pipeline industry:

- Critical to safety;
- Can't be readily seen or inspected (once installed); and are
- Materials dependent.

Tracking requirements and practices are quite rigid within the U.S. Code of Federal Regulations (CFR) for implanted medical devices. Specifically, the medical industry requires a unique device number assigned to all medical devices implanted within patients, so the manufacturer can retrieve manuals, install dates, etc. for any of its devices for the U.S. Food and Drug Administration (FDA) within ten days of any request. [20]

This level of tracking is beyond what is required for most of the pipeline industry. For example, the marking and naming requirement is similar to what is required for valves [21] (where a unique id, nameplate, and body markings are required), but the requirements for how the information will be tracked after the valve is installed is currently very general.

The pipeline industry could benefit from a practice of uniquely tracking each component that is installed (although it would be tedious) and storing the information in a retrievable manner. This practice is more realistic as a future goal, since it may not be practical to retroactively obtain this level of detail from project records (i.e., from past or current projects).

1.2.2 Nuclear Industry

Recordkeeping practices were also reviewed for the nuclear industry. The nuclear industry shares the following characteristics with the pipeline industry:

- Can't be readily seen or inspected (once installed);
- Materials dependent; and
- Highly critical to society's safety, environmental, and infrastructure (e.g., energy, economy) requirements.

The nuclear industry in general was reviewed with respect to the recordkeeping requirements for comparison with the pipeline industry. There were a number of key findings during this review. The nuclear industry has a substantial number of robust practices related to data and recordkeeping requirements. Quality Assurance Requirements for Nuclear Facility Applications [22] prescribes requirements for:

- Identification of traceability of items;
- Authentication of records;
- Receipt control of records; and
- Maintenance of records.

Some of the requirements, like "Identification of traceability of items," specify that a heat number may be used to trace a material grade, but they don't elaborate with specific guidance on how this should be performed (e.g., within documentation).

"Authentication of records" serves to set the expectations of a source record (i.e., an "authentic data source"). For example, "Documents shall be considered valid records only if stamped, initialed, or signed and dated by authorized personnel or otherwise authenticated. Corrections to documents shall be reviewed and approved by the responsible individual from the originating or authorized organization."

These criteria are similar to the types of markings that often appear in pipeline industry construction documents. The authors of this guideline have reviewed construction and maintenance documentation from the pipeline industry and subjected it to similar criteria on a project-to-project basis. Although many operators have procedures, and forms that require signatures, dates, etc., the first requirement for all records to have such markings was PHMSA's advisory bulletin ADB-11-01 [15], which required pipeline operators to have "complete" records to verify their operating pressures.

The Nuclear Standard section on "receipt control of records" designates a role for receiving records, with the responsibility and organizing them in both temporary and permanent storage. A requirement for dedicated records personnel is one that many pipeline operators have begun to realize is needed. Operators have developed teams to "review" records initially, and they have maintained the teams as permanent records management fixtures once the initial review is complete.

The "maintenance of records" has requirements about accessibility, management of change, and version control of records, but it doesn't go into detail about how this will be completed.

In the ASME Boiler and Pressure Vessel Code Section III Division 3 (BPVC-III-D3) "Containments for Transportation & Storage of Spent Nuclear Fuel & High Level Radioactive Material & Waste," [23] there are also requirements that the pipeline industry could potentially learn from.

This standard also provides itemized tables of lifetime quality assurance records and nonpermanent quality assurance records, which are as follows in Figure 1-2.

Figure 1-2: Prescriptive Quality Assurance Records Requirements from BPVC-III-D3

Table WA-4134.17-1
Lifetime Quality Assurance Records

Record	Record
1. Index to lifetime records (NCA-4134.17)	9. Final nondestructive examination reports
2. Code Data Reports (WA-8400)	10. Repair records when required by Code (Article WB-4000, Article WC-4000)
3. Design Specification (WA-3300)	11. Weld procedures
4. Design Documents (WA-3300)	12. Audit and survey reports (NCA-4134.18)
5. As-built drawings (WA-3300)	13. Process sheets, travelers, or checklists
6. Certified Material Test Reports (CMTR) and documentation providing traceability to location used, if required (WB-4100, WC-4100)	14. Joint-welder identification records when such records are used in lieu of physical marking of welds (WB-4300, WC-4300)
7. Heat treatment records [Note (1)]	15. Fabrication Specification (WA-3300)
8. Final hydrostatic and pneumatic test results (Article WB-6000, Article WC-6000)	16. Casting Plan (WB-2126, WC-2126)

GENERAL NOTE: Nonconformance reports that affect those records listed shall be incorporated into the record or be retained with the records.

NOTE:
(1) Either heat treatment charts or certified summaries of time and temperature data may be provided. These data may be included as part of the CMTR.

Table WA-4134.17-2
Nonpermanent Quality Assurance Records

Record	Retention Period
1. QA Program Manual	3 yr after superseded or invalidated
2. Design procurement and QA procedures (NCA-4134.5)	3 yr after superseded or invalidated
3. NDE procedures (WB-5112, WC-5112)	10 yr after superseded or invalidated
4. Personnel qualification records (WB-5520, WC-5520 and WB-4322, WC-4322)	3 yr after superseded or invalidated
5. Purchase orders	10 yr after superseded or invalidated
6. Final radiographs not covered in Table WA-4134.17-1	10 yr after completion
7. Calibration records (NCA-4134.12)	Until recalibrated

GENERAL NOTE: Nonconformance reports that affect those records listed and are not incorporated into the record shall be retained for the retention period applicable to the record the nonconformance report affects.

These tables show the exact document set that is required to be available for each nuclear facility. The nuclear industry's requirements for records appear far more normalized (i.e., have an effective minimum uniform dataset that everyone should meet) than the requirements of the pipeline industry. There are other examples from BPVC-III-D3 that show a higher level of normalization from the nuclear industry, such as specifications for nameplates, which are required to match a specified form-type for "each containment or part to which a Certification Mark is applied."

There are also examples of a higher standard of normalized documentation in the ASME BPVC-XI "Rules for In-service Inspection of Nuclear Power Plant Components." This standard provides standard forms for repair/replacement activities that include bill of material tables, which are required to be completed by the individuals that carry out the repair activities. The following figure, Figure 1-3, shows a direct capture of a portion of Report of Contracted Repair/Replacement Activity.

Figure 1-3: Partial Standard Repair/Replacement Form from BPVC-XI

5.	Items Affected by the Contracted Repair/Replacement Activities			
	Description of Item	Item Identification No. Assigned by Owner	Name of Manufacturer	Manufacturer's Model/Serial No.
(a)				
(b)	(5)	(6)	(7)	(8)
(c)				
(d)				
(e)				
(f)				
(g)				
(h)				
(i)				
(j)				

6.	Items Installed During Contracted Repair/Replacement Activities						
Identification			Construction Code for Fabrication of Installed Item				
Description of Item installed	Name of Manufacturer	Manufacturer's Model/Serial No. and Unique Traceability No.	Const Code/ Sect/Div.	Edition/ Addenda	Code Cases	Code Class	Installed into (Line No. from Section 5)
(10)	(11)	(12)	(13)	(14)	(14)	(14)	(15)

It may not be practical to expect a single list of document types to cover all required information about all types of systems, materials, and components that could populate a pipeline system during its lifetime. It also may not be practical to require a specific "form-type" of nameplate be attached to all pipe components, or a standard form to fit all pipeline repair/replacement activities, provided how much flexibility is required to handle the unique challenges within the pipeline industry. It does make sense, however, for the pipeline industry to move toward better normalization with improved and specific minimum data requirements and formats.

The nuclear standard BPVC-XI specifically requires a "records index" in the Quality Assurance Records section. The requirement states that "The records shall be indexed. The records and the indices thereto shall be accessible to the Owner, Owner's designee, and Authorized Nuclear Inspector." This type of accessibility allows for more effective decision making because the Decision Maker has access to the record itself and not just a transcribed version, like an alignment sheet. When a decision (i.e., fitness-for-service analysis or maximum allowable operating pressure (MAOP) determination) is made based on original construction documents, the Decision Maker can observe first-hand any items within the documents that could impact the specific decision, like the type of test that was performed or instrument used. In contrast, when the information is transcribed onto an alignment sheet, the ability to scrutinize the source is taken away from the Decision Maker.

Computer networking and software developments of the past one to two decades have provided the pipeline industry with an opportunity to change the philosophy of what is feasible from an accessibility standpoint for records. Twenty years ago, it wouldn't have been possible to provide source records digitally and instantaneously throughout an organization. In the past few years, pipeline operators have used the records-review initiative, following the San Bruno failure, to index their records thoroughly with document management systems and are using GIS to interface with records for specific pipeline component(s). This document management index provides them with an easier and more efficient document review, and the GIS interface provides the operator and the operator's designees (i.e., the Decision Makers) more efficient on-going access to the pipeline system data and records.

1.3 Recommendations

Practices from industries, such as the automotive, airline/aerospace, and food processing industries, were also reviewed, but the pipeline industry's unique set of characteristics made direct comparisons challenging. For example, the airline industry is highly critical to safety and is materials dependent, but all of the components of an airplane can be removed and/or inspected from a single hanger and without the need to excavate. This makes the data and recordkeeping needs fundamentally different from pipelines, which are hidden from view across a widespread geographic area and must be excavated to be inspected.

Lessons learned from studying international pipeline standards in Section 1.1, Background of Data and Recordkeeping in the Pipeline Industry, and from other industries reviewed in Section 1.2 have pointed to the following improvements that can potentially be made in the near term and longer term, including:

1. Normalize the data and record types that should be maintained.
    a. The authors propose a legacy normalization process that utilizes a common reliability ranking system (or document hierarchy; See Section 5).
    b. The authors propose a go-forward normalization approach of common minimum data forms and report templates like those found in the ASME BPVC standards for the nuclear industry.
2. Formally dedicate resources specifically to recordkeeping roles and responsibilities.
3. Provide more accessibility of the data and records to company deputies.

These lessons are likely to be a continuous improvement effort, as opposed to a one-time fix, but the text in the remainder of this guideline is provided as guidance to help the industry take the next steps to address these lessons learned.

The ISO standard 15489-1 would suggest the actions taken to make records more "useable" ensures "a user has the ability to access the necessary data within a reasonable time period." [24]

1.4 Recommendations for Revisions to ASME B31.4, B31.8, B31.8S, and Future Work

"Prior to pipeline regulations and modern evolutions of the ASME Code, there were no mandated levels of data quality, which suggests that the prevailing levels of quality in present data as a result of historical practices are no longer viewed by the public or regulators as adequate. Data quality requirements set forth by the Code today are overly general and are inadequate for the future. The issue then is what can ASME do to enable an operator to evaluate and assure data quality?" [25] ASME B31.4, B31.8, and B31.8S were reviewed for potential locations for revision based on the recommendations and lessons learned described in previous sections.

Current Revision Recommendations

Two locations in ASME-B31.8S show direct relevance, above others, to the lessons learned of the previous section. Paragraphs 4.3 Data Sources, and 4.4 Data Collection Review and Analysis each describe system-wide research efforts to collect and evaluate pipeline system data. Section 4.4 recommends "A plan for collecting, reviewing, and analyzing the data shall be created and in place from the conception of the data collection effort." ASME-B31.8S has provided specific guidance based on proven industry experience collecting, reviewing, and analyzing data (and rating it for reliability). It also provides specific guidance on how the data should be stored and made accessible to company Decision Makers, how they should be cross-checked and updated, and how the team in charge of maintaining this pipeline system information database should be structured.

The contents in Sections 2 through 6 and Appendices A, B, and C of this guideline have more current data collection and recordkeeping guidance than what is currently in ASME B31.8S Sections 4.3 and 4.4. The plan consists of the following (by guideline section):

- Section 2 - An overview of the program with roles and responsibilities.
- Section 3 - A description to structure the pipeline information database to optimize access to source records.
- Section 4 - A process to determine likely boundaries for unknown values.
- Section 5 - A process to determine quality and reliability of data based on attributes of the source records.
- Section 6 - A process for on-going data collection and management of the records database.
- Appendices A, B, and C to support the main text.

The most relevant location for this guidance would be as a supplementary appendix to these sections in ASME B31.8S. Sections 4.3 and 4.4, which would remain in-full and a reference to the supplementary appendix could be added as the "recommended guidance to develop a plan for collecting, reviewing, and analyzing data."

Future Revision Recommendations

The guidance within this document is a product of the authors' and industry's experience over the last half-decade and was developed for MAOP verification. The focus of these efforts was typically on construction and maintenance records, which included pressure tests and material installation records. While the guidance in this document has been tested thoroughly for pipeline system materials and pressure test records, it has not been tested for some other types of data that ASME B31.8S Sections 4.3 and 4.4 require (e.g., SCADA, soil resistivity/moisture levels, one-calls). It is the authors' hope that the guidance and philosophies regarding accessibility and dedicated recordkeeping resources contained in this guideline could extend beyond materials and be adjusted to apply more effectively to other data types as future work.

During the review, there were many locations where records requirements were "overly general" as described above. A prime example follows, where the requirement is clearly adamant about the importance of detail, but provides no guidance on what details are needed or how they should be stored or tracked: "Records shall be made covering all leaks discovered and repairs made. All pipeline breaks shall be reported in detail." [26] Providing a form with minimum data requirements could provide operators with a valuable information gathering tool (particularly smaller operators who may not have the resources to call upon SMEs for each occurrence).

Meeting the spirit of the normalization standard set by the ASME-BPVC standards for the nuclear industry would require many specialized forms and report templates with minimum data requirements. Providing a recommendation on how to normalize each type of data needed for operations and maintenance and integrity and risk management practices in ASME B31.4, B31.8, and B31.8S is not possible within the scope of this guideline. Multiple subject matter experts will likely be needed to meet the normalization requirements consistent with the level of the ASME BPVC standards for the nuclear industry.

The remaining notable paragraphs from ASME B31.4, B31.8, and B31.8S that are candidates for normalization were itemized into tables shown in Appendix D.

2 PROGRAM OVERVIEW AND TYPICAL ROLES AND RESPONSIBILITIES

An operator who is interested in upgrading or maintaining a modern data and records management system as described in this guideline should include personnel and resources to fill the roles and responsibilities indicated below. These roles and responsibilities are referenced throughout the processes described within this guideline. The following roles[3] will need to be delegated to the appropriate personnel upon starting this process:

Table 2-1: Roles and Responsibilities

Role	Responsibility	Examples Title
Database Owner	Must be responsible for managing and maintaining the data within the Pipeline Database for the relevant section of pipe.	• Pipeline Integrity Manager • Pipeline Integrity Engineer • Risk Engineer
Records Librarian	Collection, storage, organization, and manipulation of data and/or documents (a data mining expert). Must be familiar with the hard copy records and "soft" data that is (or will be) used to populate the Pipeline Database. Must provide technical support to the Research teams about source records, their locations and formats.	• Pipeline Integrity Engineer • Risk Engineer • Administrator • GIS specialist
Subject Matter Expert (SME)	Provides extensive knowledge about the relevant integrity practices, pipeline construction and procurement, materials, company knowledge, etc. Typically provides technical support about this knowledge to others in the company.	• Pipeline Integrity Engineer • Procurement personnel
Records Engineer	Oversees teams of Researchers and Data Miners and performs quality assurance (including process controls and design) and quality control on their work.	• Pipeline Integrity Engineer • Risk Engineer
Researcher/ Data Miner	Conducts the necessary research into the background information related to records gaps or document reliability. Must be familiar with industry standards, compliance and regulator communications, and/or company information and documentation. Reviews new records/information and compares them to the database. Carries out the MOC process listed within this guideline and is responsible for resolving data discrepancies.	• Pipeline Integrity Engineer • Documents and Records Management Team • GIS specialist
Decision Maker	Makes decisions that require the information from the Pipeline Database, which may include critical operations decisions (e.g., pressure reductions and fitness-for-service analysis).	• Company management • Pipeline Integrity Engineer • Risk engineers
Company Management	Ensures compliance of the pipeline system, which includes the records and data management. Responsible for ensuring others on this list have the resources necessary to carry out their roles and responsibilities.	• VP of Engineering • Compliance Manager • Pipeline Integrity Manager

[3] Depending on the size of the operator and the number of records to maintain, it may be appropriate for some individuals to fill multiple roles.