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Pipeline Construction:
Quality Issues and Solutions Action Plans

Overview of Quality Management Systems – Principles and Practices for Pipeline Construction

The INGAA Foundation, Inc.

Overview of Quality Management Systems – Principles and Practices for Pipeline Construction

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Background

Early in 2007, the United States experienced a significant increase in pipeline construction activities, including construction of "80% special permit" pipelines. During PHMSA's inspections of these projects, quality issues, such as, issues with pipeline coating, welding and backfilling were experienced. By late 2007, PHMSA and industry began discussing these quality issues and recognizing the need for improvement.

In March 2009, the INGAA Foundation responded to these discussions by hosting a two day workshop focused on the "areas of concern" seen during different construction phases. In April 2009, PHMSA also hosted a workshop in collaboration with its State partners, the Federal Energy Regulatory Commission (FERC) and Canada's National Energy Board (NEB) aimed at informing the public, alerting the industry, reviewing the lessons learned from these inspections, and improving new pipeline construction practices prior to the 2009 construction season.

From the two meetings, INGAA held a Pipeline Summit to identify working groups to address specific issues. The format was designed to communicate experiences and progress from construction contractors, pipeline companies, INGAA Foundation member companies and others. PHMSA also made presentations to the group assembled. INGAA developed an action plan to address specific issues with workgroups.

An INGAA Foundation workgroup was created to review quality management system (QMS) concepts and how they might be applied to pipeline construction projects. This white paper is the result of this collaborative effort.

White Paper Objective

The objective of this white paper is to provide an overview of quality management system principles and outline the benefits of applying these principles to the field implementation phase of pipeline construction projects.

INGAA's Integrity Management Continuous Improvement (IMCI) Initiative

Since quality management systems (QMS) are central to the management of pipeline system assets throughout their lifecycle, INGAA has included QMS for construction projects as a focus area within the IMCI initiative. In 2011, drawing on the experience of the team that has developed this document, INGAA formed a second team to examine how management systems can be applied more broadly in verifying pipeline integrity.

The IMCI team working on management systems began its work by providing guidelines on improving safety culture, and improving management of change practices. The team began with safety culture as INGAA members have embraced a goal of zero incidents within their personnel safety programs and within their pipeline integrity management programs. Understanding how operators have designed their personnel safety programs to achieve the goal of zero was the place to begin as safety culture is a key aspect of a broad-based management system.

The team is currently developing an overview of management systems in industries where the consequences of failure can be unacceptable, including the chemical manufacturing, petroleum refining, nuclear power, aviation, as well as the medical field. In many instances, the regulators in

these industries have elected to use management systems to audit and evaluate the effectiveness of safety, as well as environmental programs. Standards being reviewed include those of the Federal Aviation Administration (FAA), Occupational Safety and Health Administration, the Environmental Protection Agency and the as well as international standards.

Implementing a QMS on pipeline construction projects improves material and construction quality by providing a structured approach to quality management. INGAA intends to clarify and improve its application of QMS. Through effective QMS, pipeline construction project sponsors can achieve consistent conformance to established quality standards and specifications, reducing rework and unexpected construction issues. Project sponsors, suppliers, contractors and service providers, all need to work together to embrace higher standards of quality through the application of QMS principles.

Achieving a consistent and uniform level of quality management across the pipeline construction industry is a challenge well suited for the INGAA Foundation, Inc. (Foundation), which represents pipeline operators, suppliers, contractors and service providers. INGAA formed the Foundation in 1990 to advance the use of natural gas and to facilitate the efficient construction and safe, reliable operation of the North American natural gas pipeline system. The Foundation has proven to be an effective forum to tackle construction issues because all key industry sectors are represented. The Foundation has sponsored and will continue to sponsor workshops aimed at achieving a consistent and uniform level of quality management across the pipeline construction industry.

In addition to this white paper, the INGAA Foundation published guidelines on Personal Protective Equipment (PPE), Standards for Procurement and Installation of Field Segmentable Bends and Field Applied Coatings Best Practices. These documents, along with other industry wide guidelines, are posted on the www.ingaa.org website. Also, the INGAA Foundation will publish other white papers and guidelines in 2012. Improved construction practices will include:

1. Pipeline Construction, Fabrication, and Testing – Training Guidance for Construction Workers and Inspectors for Welding and Coating
2. Best Practices in Applying API 1104, Appendix A

Construction safety guidelines will include:

1. Overhead lines;
2. Excavations, and
3. Hydrostatic Testing will be published in 2012. Other Guidelines will follow.

The INGAA Foundation is presently evaluating study proposals that will continue to build on the work and white papers described above in the area of Construction QMS. This future work will be aligned and linked to the strategy and efforts of the IMCI work team at INGAA.

Development of Modern Quality Management Systems

Quality systems have evolved over time. Until the early 19th Century, individual craftsmen ensured the quality of their goods and services. With the Industrial Revolution, which transformed manufacturing from using individual craftsmen to groups of laborers performing specialized tasks, it was found that since no one person was responsible for the complete product, the methodology of assuring quality had to change. Quality was principally managed by inspection from that point on,

and defective products were either scrapped or reworked. This was the introduction of the Quality Control era.

During World War II, the military relied on civilian manufacturing to produce munitions and military equipment. Quality issues and safety concerns required the inspection of every piece. This method of Quality Control required military scale inspection resources that were simply not sustainable after the conflict ended. A new quality methodology was developed which utilized statistical data to improve processes throughout the manufacturing cycle. Now only a portion of the products being produced would have to be inspected, since the production processes were stable, and produced few defects. This was the era of statistical quality control.

By the 1980's, most manufacturers had embraced a total quality management (TQM) system, which focused on not only statistics, but quality approaches that encompassed the entire organization. The Europeans had developed the ISO 9000 series of quality management standards, introducing the idea that confidence in a product or service could be gained through the use of an approved quality management system. Since the 1990's, the ISO 9001 quality management standard has proven itself to be the most used and most effective basis for building an effective and efficient system to control the quality of a wide range of products and services. It is universally accepted.

Over time, industry sectors recognized the need to develop more industry specific standards to reduce risks, meet industry specific needs and maintain compliance with statutory and regulatory requirements. In 2002, American Petroleum Institute (API) and ISO worked together to develop ISO/TS (Technical Specification) 29001, *Petroleum petrochemical and natural gas industries – Sector-specific quality management systems – Requirements for product and services supply organizations.* API published its 7th edition of API Specification Q1, *Specifications for Quality Programs for the Petroleum, Petrochemical and Natural Gas Industry* on June 15, 2003 and the jointly developed ISO/TS 29001 was published three months later. The documents are identical, except for an annex in Q1 relating to API administration. On December 1, 2007, the second edition of ISO/TS 29001 was published and subsequently back-adopted by API as the eighth edition of API Spec Q1.

API Spec Q2, Specification for QMS Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries, was published by API in late 2011. Spec Q2 seeks to address service-specific quality concerns in the upstream petroleum industries. With the release of API Spec Q2, API Spec Q1 is now under revision (future ninth edition) to remove the references to the provision of services and focus the scope of the document on manufacturing activities only. While not directly applicable to the construction of pipeline systems, contractors who provide services to the pipeline construction industry may find Q2 to be a valuable reference.

Current Pipeline Construction Quality Practices

Companies have always written specifications for their projects, provided those specifications to the Contractors, and the Contractors have been building these projects in accordance with the specifications. Companies have traditionally provided inspection services, and are responsible to assess them to ensure the work was done correctly and to specification.

Companies approach both pipeline construction and quality in different ways and have relied on regulations, standards, specifications, company construction personnel, and third-party inspection contractors to address quality within pipeline construction. However, these typically require only quality control measures and there are not generalized requirements for quality assurance or for a complete Quality Management System (QMS).

Benefits of Using Modern Quality Practices

A QMS does not guarantee a flawless product or service without defect, but provides a framework for maximizing the delivery of a product or service. Three major benefits of implementing an effective QMS are:

- *Process Improvement and a Factual Approach to Decision Making*
  Auditprocesses, management review and improvement processes based on collected data are outlined within a QMS. Improvements are carefully planned and implemented based on facts, using a system of documentation and analysis, to ensure the best decisions are made. Overall communication is enhanced.

- *Enhanced Stakeholder Satisfaction*
  Internal and external stakeholder confidence is increased through the application of QMS principles. Stakeholder satisfaction is ensured by improving consistency of services performed.

- *Increased Efficiency*
  Developing a QMS requires some thought on the scale / nature of the project, the associated processes, and how to maximize quality and efficiency. A fully implemented QMS provides the processes and guidelines to follow, making training, transitions, and trouble-shooting easier.

Other benefits can include:

- *Better Planning* - resulting in fewer emergencies and surprises, less stress, less "firefighting", reduced costs from reductions in waste and effort, and increased effectiveness of training;
- *Continual Improvement* - providing a Corporate Memory which avoids repeating issues/re-work that carries lessons learned to future projects;
- *Improved Employee Morale*- through defined roles and responsibilities, accountability of management, established training systems and a clear picture of how their roles affect quality and the overall success of the company;
- *Stronger Supplier Relationships* - requiring thorough evaluation of suppliers (new and existing)and subcontractors before a change is made and/or consistency with respect to how and where orders are placed; and
- *Improved Control over Documentation* - requiring documentation of all processes (and changes therein), errors and discrepancies, ensuring consistency throughout production, accountability of all personnel, and traceability through records.

Benefits of a QMS for Pipeline Construction

A QMS developed for pipeline construction incorporates the same principles of a QMS for any other industry. All processes from front end design, procurement, route selection and pipeline construction are defined, outlined and documented, minimizing room for error. Even the process of making changes to a process is documented, ensuring that changes are well planned and implemented in the best possible way to maximize efficiency. Therefore, the benefits of a QMS for pipeline construction is similar to those listed above.

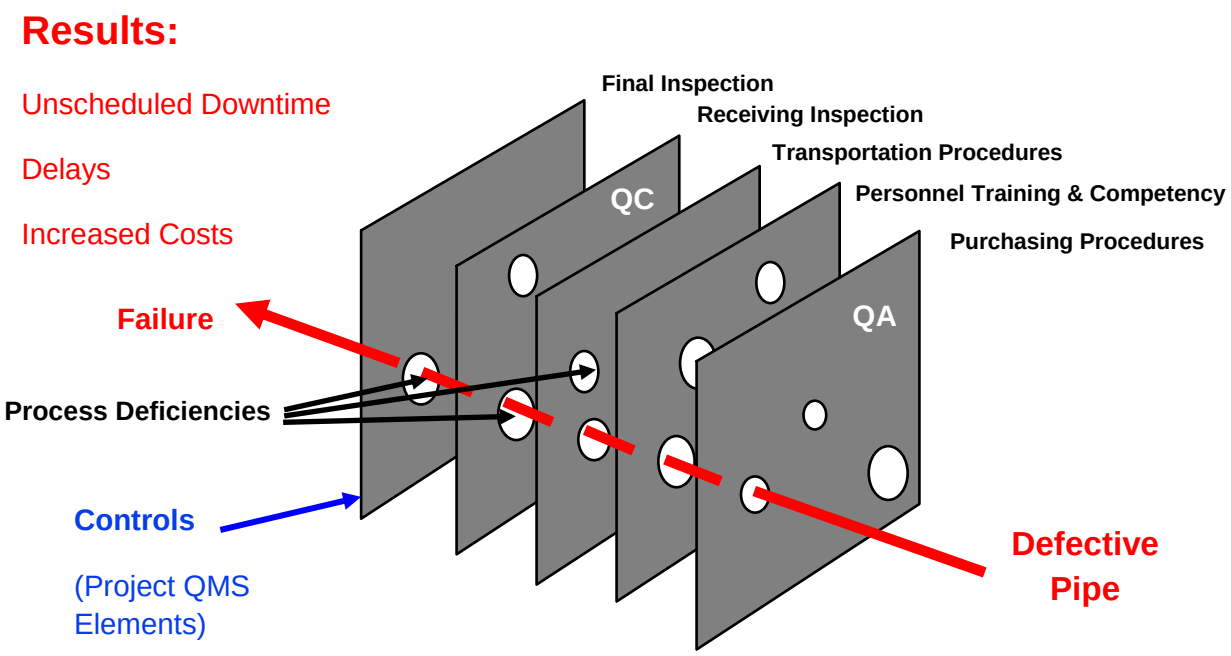
Regulatory compliance is a benefit of implementing a QMS for a pipeline construction project, but this is not the underlying goal. An effective QMS will provide far more benefit than just regulatory compliance. The purpose of quality management is to promote conformance and discourage repeat non-conformances relative to performance requirements established by a project.

Thinking of a construction project as a collection of processes is central to the success of the QMS; a benefit being the QMS provides **effective organization of the processes required to produce a conforming construction project,** using a capable and efficient approach. The QMS is essentially a management tool that organizes work practices, which over time will lead to continual improvements in pipeline and station construction.

Cost avoidance is a potential residual benefit of a structured QMS for a pipeline construction project, because the primary focus of the QMS is to minimize failures/rework, improve conformance to company and industry specifications and to maintain compliance with regulations.

The following diagram illustrates the concept of a pipeline project with ineffective quality management processes. Each plate represents a process within the QMS and the holes represent deficiencies within each of the processes. Individually, each process may be "adequately" defined for the task at hand. On a case-by-case basis, each deficiency in the process may be relatively insignificant and appear to pose no immediate threat to the project's success. However, as in this example, the aligning holes represent deficiencies that lead to overall project failure. Therefore, as seen in this example, a pipeline construction project can successfully meet its goals and objectives if it can eliminate deficiencies by better establishing the key processes of the QMS. The poorly defined processes in this example resulted in failure, due to defective pipe ending up on the right-of-way.

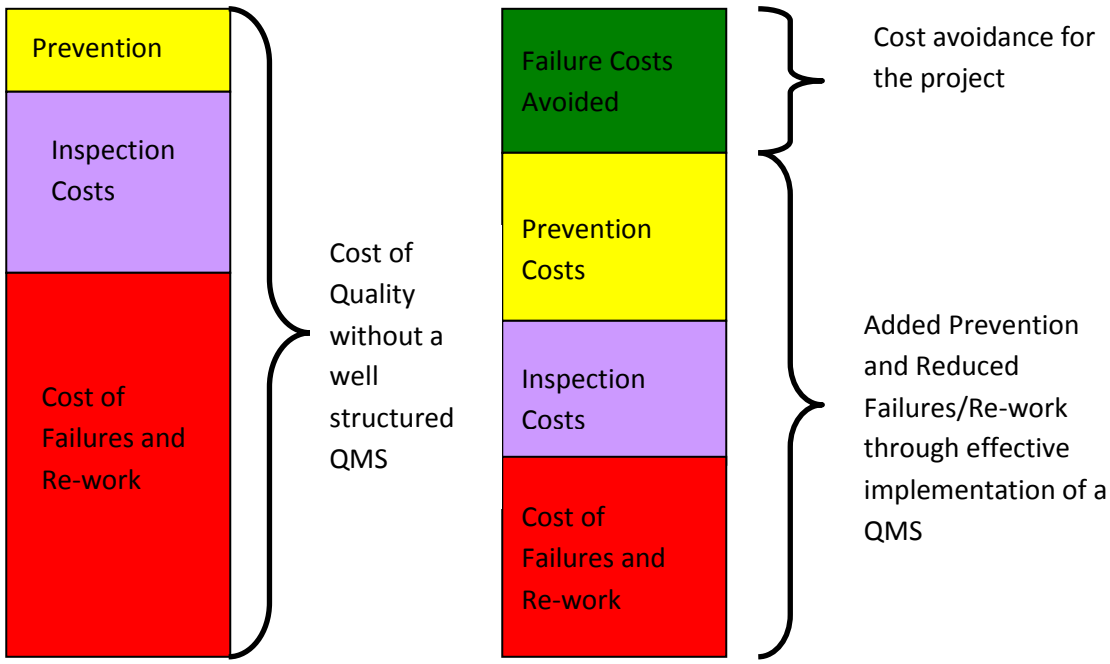
When Quality Does Not Happen



Implementation of a QMS requires well-defined processes and properly trained and competent personnel that continually work to reduce or eliminate the deficiencies in each process. When an organization implements a QMS, it will likely undergo a transformation where there is more investment on the development of the key processes to prevent failures and rework. As shown in the previous Figure, by shoring up the deficiencies in each of the key processes, a QMS will help a project avoid costs by preventing fewer failures and less rework.

The Figure below is focused on rework and the return of investment of a QMS. It illustrates a representative model of how an organization that implements a QMS will realize an overall cost avoidance. The left chart shows a project without a well defined QMS and the chart on the right

shows a project with well defined QMS processes.



The pipeline industry is no different than any other industry that has implemented a QMS. Predominately the return on investment realized has been equal to or greater than the cost of implementing the QMS.

In pipeline construction, quality is often simply defined as conformance with specified requirements. If a project conforms to the specified requirements, it will satisfy its customers. The customers of pipeline construction projects include project sponsors, shippers and downstream customers, regulators, landowners, the owner company's internal departments, their construction partners (such as, the external engineering firms and the construction contractors)and other special interest groups.

Basic Requirements of a QMS for Pipeline Construction

The following are the basic requirements for developing a pipeline construction QMS:

a. Identifying the processes needed for the QMS and their application throughout the multiple organizations involved in the project.

b. Determining the sequence and interaction of these processes, and respective roles/responsibilities of the parties.

c. Determining criteria and methods needed to ensure that both the operation and control of these processes are effective.

d. Ensuring the availability of resources and information necessary to support the operation and monitoring of these processes.

e. Monitoring, measuring, and analyzing these processes, and

f. Implementing actions necessary to achieve planned results and continual improvement of these processes.

A process is an activity that uses resources and is managed to enable the transformation of inputs into outputs. The application of a system of processes within an organization, together with identification and interactions of these processes, and their management, can be referred to as the "process approach".

Under a QMS, pipeline construction projects are completed in accordance with quality management principles. The project is constructed utilizing a process approach, focusing efforts on planning, procedures, provisions for effective documentation, document control, effective corrective actions and continual improvement activities.

Within a QMS structure, written procedures are established for all significant construction activities. Field inspectors have written instructions on what is expected of them. Construction specifications, drawings and the contracts provide clear work output and records requirements. Processes are audited to confirm conformance. Construction project goals typically involve delivering a project that conforms to the desired specifications and, also, are delivered in a consistent and repeatable manner. Conformity means the project meets customer, legal, regulatory, HS&E, Company specifications and other defined requirements. Consistency means the business or project strives to continually improve the effectiveness, efficiency and repeatability in which the project is delivered. Both conformity and consistency goals are required to maximize the value attained by a QMS.

Furthermore, a QMS is a structured way of controlling the core processes of a project and is not just focused on the end goals. By organizing, managing and continually improving the processes within the QMS it will lead to the delivery of a better overall project. A key aspect of a QMS is the documentation of procedures to support all the key processes to ensure a project's QMS is sustainable and is not dependent on certain people resources or infrastructure to function properly.

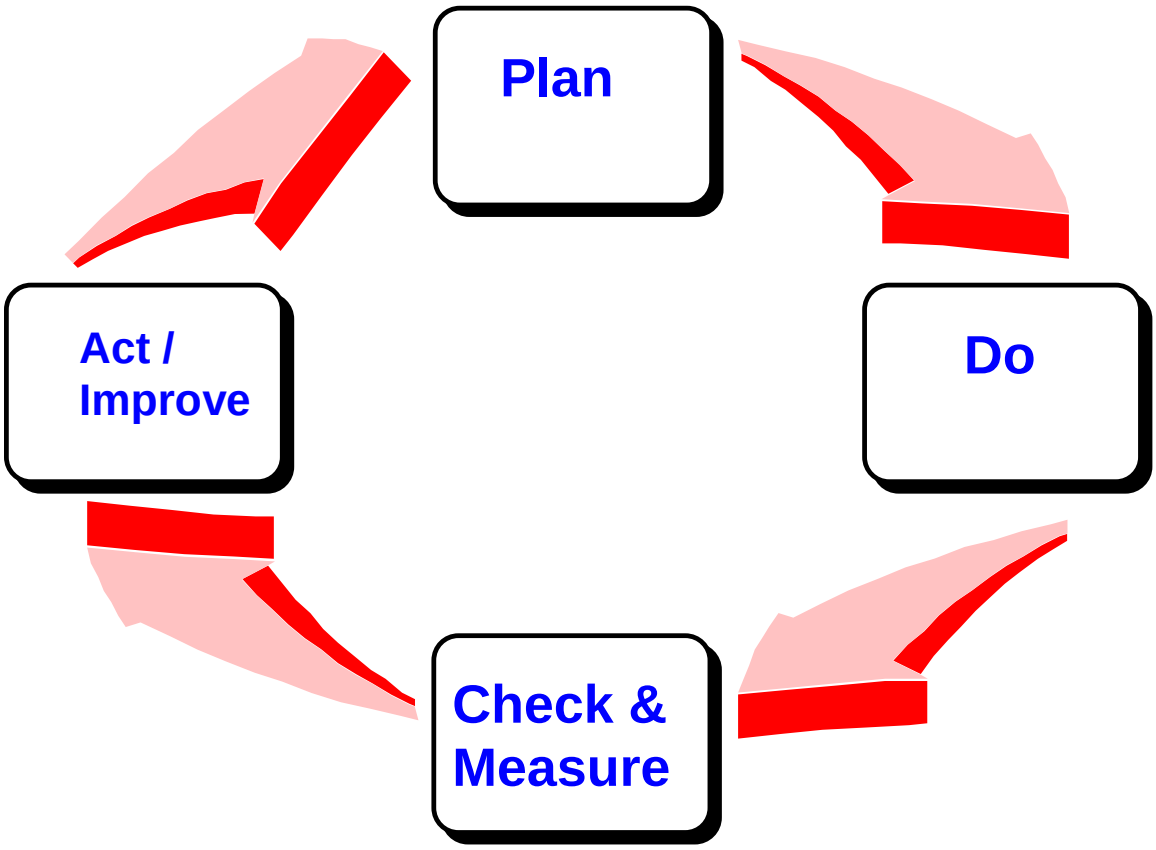
There are several common terms often used, and, sometimes misunderstood in the context of a QMS.

The degree to which a set of inherent characteristics fulfills requirements.

Quality Management:	Coordinated activities to direct and control within an organization with regard to quality.
Quality Policy:	Defines the goals and objectives of a QMS for a business or project.
Quality Control ("QC"):	Quality activities focused on confirming that quality requirements have been fulfilled.
Quality Assurance ("QA"):	Quality activities focused on providing confidence that quality requirements will be fulfilled. Quality assurance applies to the processes used to create the deliverables.

Below is an illustration of a simple four step QMS process. Each core process identified within a pipeline construction project follow these same repeatable steps. All four of these steps are required and must be maintained to have a properly functioning QMS.

Step 1 – Plan the processes, products or services for your project.
Step 2 – Do the work to execute your project in accordance to your Plan
Step 3 – Check and measure to assure that activities within the project meet the desired requirements and accomplish the project goals.
Step 4 – Act to continually improve all processes and strive in improving the delivery of the project.



For a QMS to work and deliver maximum results, it is important for an organization to establish the appropriate degree of flexibility within the key and supporting processes and to have the right level of documentation of records, procedures and reports. These are important considerations to ensure that a QMS does not become overly complex and bureaucratic and become a reason why a project does not achieve its goals. When a QMS is well designed it makes it easy to succeed and difficult to fail.

Core Elements of a QMS

The following core elements are contained within both the ISO 9001 and the industry-specific ISO 29001 (API Q1) quality standards and are applicable to pipeline construction projects. There are other additional elements that should be considered, but the elements described below are considered core. By incorporating these elements into a QMS it ensures the key and supporting processes and the interaction between processes will function as intended.

1.	**Management Commitment**
	• All levels of management are involved and contribute to achieving an organization's goals and objectives. • Top down management is important to foster a culture that understands the value of a QMS for pipeline construction projects. • Management ensures that proper infrastructure and resources are available to support the QMS. • Management reviews the QMS on a regular basis to ensure it is functioning properly and to ensure conformance to requirements.
2.	**Resource Management**
	• Determine the necessary resources and information to implement and monitor the key processes of a QMS. This also includes the people to manage the resources. • Qualified and competent people are available to support the QMS and the key processes within. These people require appropriate experience and training to achieve the desired level of qualification. People operating within the QMS are evaluated for performance and continued competency. • Training programs including core and job specific requirements are established. Core training is included within the QMS. In addition to job-specific training, each quality critical position will have a written job description that describes the necessary educational and work related experience to adequately perform the required tasks.
3.	**Plan and Develop Processes**
	Process Control
	• Identify and implement the processes and determine the interaction between them. • Establish the roles and responsibilities for controlling the processes and records. • Written procedures are established for all significant construction activities. • The field inspectors have written instructions on what is expected of them.
4.	**Measurement, analysis and improvement**
	Monitor, Measurement, and Analysis
	• Monitoring and measuring activities are conducted to ensure that key processes are effective. For pipeline construction projects this would include the various inspection activities. • Determine criteria and methods needed to ensure that both the operation and control of the processes are effective. Monitor, measure, and analyze these processes.
	Audits (Process Assessments)
	• Audits, sometimes called Assessments, are conducted to ensure the integrity and continual improvement of work processes. • Audits may be are performed on planned intervals or on an as needed basis. • Through audits, non-conformances are identified and immediate actions are taken to remedy these situations.

	The following types of audits can occur within the operation of the QMS: *Internal Audits:* Internal audit programs typically are established by the project owners to ensure the integrity and continuous improvement of the work processes, including the QMS. *Stakeholder Audits:* Quality audits by various stakeholders are permitted and typically require adequate notification to conduct. *Regulatory Audits* The business or project offers full cooperation to all regulatory audits to confirm compliance with applicable regulatory requirements.
	Continual Improvement
	• Non-conformances are identified and immediate actions are taken to remedy these situations. • Corrective actions identified prevent the reoccurrence of similar non-conformances by addressing and eliminating the root causes. • Lessons learned are shared with other project teams.
5.	**Documentation and Records**
	• Establish the core documentation requirements and controls for the overall QMS, key and supporting processes and procedures. • Includes documenting industry specifications and standards, inspection testing plans and determining records that need to be maintained for the project. • All documents used on the project must be current and approved, and available for the users.
	Documentation Control
	• QMS policies and procedures are maintained under document control, as are quality-critical documents such as construction drawings and specifications, work processes, process maps and procedures. • Documents required by the QMS are controlled. Written procedures are in place for controlling document approval, revision of documents and document retention.
	Records Control
	• Records are generated to confirm conformance and compliance with project requirements and applicable regulations and codes. These are maintained in a secure environment for the project. In the case of projects, records are part of the final turn-over to the owner for operations. • Records are established and maintained to provide evidence of conformity and compliance to demonstrate the effective operation of the QMS.

Conclusion

Recent industry work has demonstrated that quality processes implemented in production processes for plate, pipe and coating mills has been successful in producing products that consistently meet requirements. The recommendation, based on the pipeline construction quality issues, is to establish and implement a QMS for construction practices on the right-of-way.

Implementing a QMS for pipeline construction projects does not guarantee flawless projects, but provides a framework for consistently maximizing the quality of the overall project. This framework should include provisions for training and qualification of specific construction procedures, audits and corrective actions. Incorporating these elements at an early stage of these processes will help to ensure project quality objectives are consistently met.

There are many ways to go about developing a QMS and Operators will have to decide what works best for their organization.

ISO 9001 is a useful resource and ISO/TS 29001 (API Spec Q1) offers industry specific guidance on the development of a QMS for the Oil and Natural Gas industries.

The following appendices provide examples of how a QMS can be applied to pipeline construction projects (pipe coating and welding, a simple QMS for a pipeline construction project and some alternate QMS models).

Appendix A – Example Applications of the QMS Elements for Pipeline Construction Projects pertaining to Pipe Coating and Welding

<table>
<tr><th>1. Management Commitment</th><th>2. Resource Management</th><th>3. Plan and Develop Processes</th><th>4. Measurement, Analysis & Improvement</th><th>5. Documentation and Records</th></tr>
<tr><td rowspan="2">Coating & Welding

Top-down support of the QMS provides a quality culture that will motivate the team

• Training, qualification and re-qualification records are generated and maintained
• Adequate resources are verified and maintained
• Inspection and non-destructive examination (NDE) records (as applicable) are created and retained
• Audit reports are created, retained and analyzed
• Non-conformance report logs and corrective actions are analyzed and are part of the lessons learned process
• Act on lessons learned</td><td>Coating

Equipment, specifications and documented procedures are required.

• Specifications and procedures for the work and inspection of the work are required
• Training, qualification and re-qualification of personnel
• Required equipment verified and maintained
• Audit personnel and procedures
• Non-conformance report logs and corrective actions are recorded and managed</td><td>Coating

Process to develop procedures that:
• Clearly outline roles and responsibilities
• Outline Owner Company’s requirements (Typically an engineering specification)
• Specify Manufacturer’s application and storage requirements
• Outline proper application equipment
• Outline training of application and inspection personnel
• Production method and repair methods and controls
• Outline procedural changes to respond to changes in environmental and physical conditions
• Environmental conditions for storage of the unapplied products
• Environmental conditions for the application of the products
• Environmental conditions for the curing of the applied product
• Temperature control during application and cure
• Properties of the finished product – perhaps hardness, thickness, adhesion
• Training of the QC personnel</td><td>Coating

• Inspect to demonstrate conformance to procedures and specifications
• Audit a sample of completed work.
• Take dry film thickness readings
• Adhesion tests
• Audit training and qualification of coating resources
• Issue non-conformance reports and identify corrective actions
• Follow through on corrective actions and also evaluate effectiveness of corrective actions
• Jeep, ACVG and DCVG tests
• Management of change to incorporate improvements with processes, procedures, etc., is established
• Process and share lessons learned with stakeholders</td><td rowspan="2">Coating & Welding

• Procedures and specifications are documented for performance of work and inspection tasks
• Training, qualification and re-qualification records are generated and maintained
• Resource qualifications are verified and maintained
• Inspection and NDE records created and retained
• Audit reports are created and retained
• NCR logs and corrective actions are recorded
• Document lessons learned</td></tr>
<tr><td>Welding

Equipment, specifications and documented procedures are required.

• Specifications and procedures for the work and inspection of the work are required
• Training, qualification and re-qualification of personnel
• Required equipment verified and maintained
• Audit personnel and procedures
• Non-conformance report logs and corrective actions are recorded and managed</td><td>Welding
Consideration for welding processes include:
• Directions given by Owner Company’s (Typically engineering specifications and field joining plans)
• Direction given in consumables manufacturer’s storage requirements
• Directions given by the supplier of the welding equipment
• Confirmation process to demonstrate that for each weld, consumables, welding procedures, welding procedure qualifications, welder qualifications, equipment to be used, wall thickness transition limitations, misalignment tolerances, etc. all meet requirements
• Welding foreman’s project-specific direction, including risk analysis and tactical response plan to risks such as weather
• Control over sub-contractors
• Control over all welding processes – production, poor-boy, repair welding
• Environmental conditions for storage of the consumables
• Environmental conditions for all stages of the welding – e.g. pre-heat, inter-pass temperatures, post weld heat treatments
• Environmental conditions for the controlled cooling of the finished welds
• Tactics to deal with environmental challenges during welding
• Fit-up limitations and tactics to deal with out of spec conditions
• Confirmation of time to hold internal clamps
• Regular confirmation of welding parameters
• Non-destructive examination (NDE) requirements, including required time delays, if any
• NDE Contractor’s qualified processes
• Production of required welding records including qualification of the welders, qualification of the welding procedures
• Production of NDE records including qualifications of the NDE personnel
• Interaction of NDE records with survey contractor’s records</td><td>Welding

• Inspect to demonstrate conformance to procedures and specifications
• Audit a sample of completed non-destructive examination (NDE) records (radiographs, UT scans)
• Audit training and qualification of welding and NDE resources
• Audit that proper procedures are being applied to welding and NDE
• Issue non-conformance report and identify corrective actions
• Follow through on corrective actions and also effectiveness of corrective actions
• Management of change to incorporate improvements with processes, procedures, etc., is established
• Process and share lessons learned with stakeholders</td></tr>
</table>

Note: Refer to the following White Papers at the INGAA Foundation for more information Field Applied Coatings and Welding best practices and procedures:

1. **Training Guidance for Construction Workers and Inspectors: Welding & Coating, published 2012**
2. **Field Applied Coatings Best Practices, published 2012**

Appendix B – Example of a Simple QMS

The following is an example of a framework of a QMS from a pipeline owner company. This Company has established, documented and implemented a QMS as a means of ensuring that its pipelines and facilities conform to specified requirements and to foster an environment of continual improvement.

The Company's QMS is comprised of Core and Support Business Processes. Processes such as QP 4100and the others shown in the example below are available on the Company's intranet site.

Core Processes:

The core processes describe all the processes that are necessary for the Company to realize and deliver the desired service to its customers. QP 4100 is an overview of the processes and their interactions. The Core Processes are listed below:

Business Development Process	(QP 4101)
Detailed Engineering Process	(QP 4102)
Procurement Process	(QP 4103)
Pipeline Construction Processes	(QP4104)
Facilities Construction Processes	(QP4105)
Commissioning Processes	(QP4106)
Process for Control of Services Providers	(QP4107)

Support Processes:

The Company's support processes describe all other business requirements that are necessary to manage and control resources, and to conduct business in an orderly manner. They include:

Quality Management	(QP4100)
Document Management, Records Management	(QP4230, QP4240)
Information Technology Management	(QP6301)
Human Resources Management	(QP6220)

Appropriate levels and types of monitoring and measurement of core and supplemental processes have been determined and are documented within the relevant procedures. The criteria and methods required to ensure the effective operation and control of these processes are defined and documented. This is typically referred to as quality control (QC).

The sequence and interaction of the Core and Support Business Processes are described by the QMS planning provisions in QP4100. This is typically referred to as quality assurance (QA).

All QMS documentation and other key information necessary to support the operation and monitoring of Company business processes are available to all employees, and other parties requiring access such as consulting engineering firms, on the Company's intranet.

The QMS includes policies and procedures for implementation of actions required to achieve planned results, and for continual improvement of the business processes.

When non-conformance is observed, the Company assesses the consequences, applies immediate correction, determines the root cause, and assures that the process is adjusted so that the non-conforming condition is not created again in the future. Errors are traced back through the process that created them to remove the cause of the error.

Appendix C – Example QMS models

Two examples of QMS models are shown below that a pipeline construction project can adopt. These models expand the concepts within the basic QMS model discussed previously (PLAN, DO, CHECK & MEASURE and ACT/IMPROVE) along with highlighting several core elements. These models are still at a high level and they further outline key processes and how they interrelate with one another. These models incorporate the identification of requirements, goals and objectives of a project. These models include processes for monitoring, measuring and analysis and the concept of continual improvement and feedback. Feedback is a valuable process for consideration to improve the overall QMS to ensure customers and stakeholders are satisfied with the results delivered.

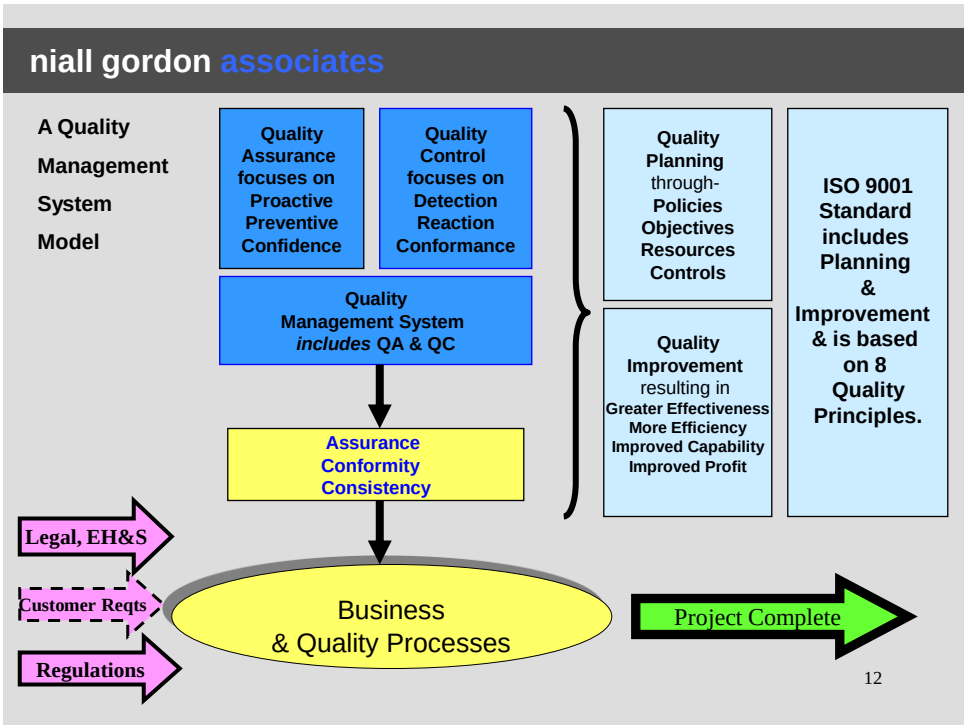


Figure C.1 – QMS example model #1

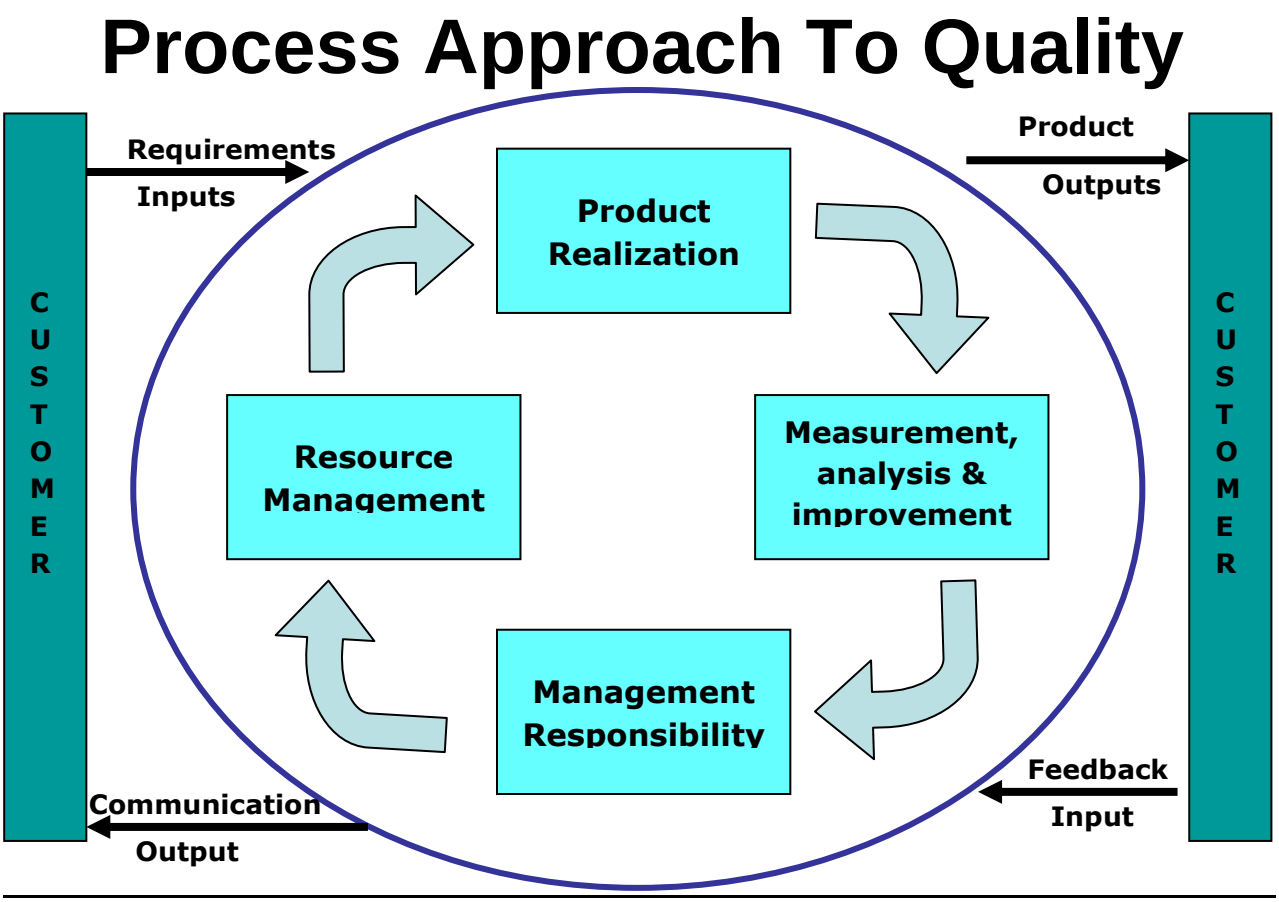


Figure C.2 – QMS example model #2