Improving Quality Management Systems (QMS) for Pipeline Construction Activities

Overview of the Research

Contract Number DTPH56-13-T-000014

PHMSA - Office of Pipeline Safety

October 1, 2015

Agenda

- Welcome and Introductions
- Summary of Project Results
  - Driving Force
  - Background
  - Project Activities
  - Project Deliverables
- Q&A and Discussion
- Adjourn

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Improving Quality Management Systems (QMS) for Pipeline Construction Activities

- **Project Objectives:**
  - develop guidance pertaining to issues related to construction quality of a new pipeline and how these issues could be addressed through standards, specifications, and in the field;
  - develop general guidelines for a QMS for pipeline projects to provide greater assurance of consistent and acceptable quality;
  - suggest enhancements to regulations and standards to improve the overall quality of new pipelines through application of a QMS.

Improving Quality Management Systems (QMS) for Pipeline Construction Activities

- For more project information and final reporting, please visit http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=504

- This presentation will be posted on the above web-site.

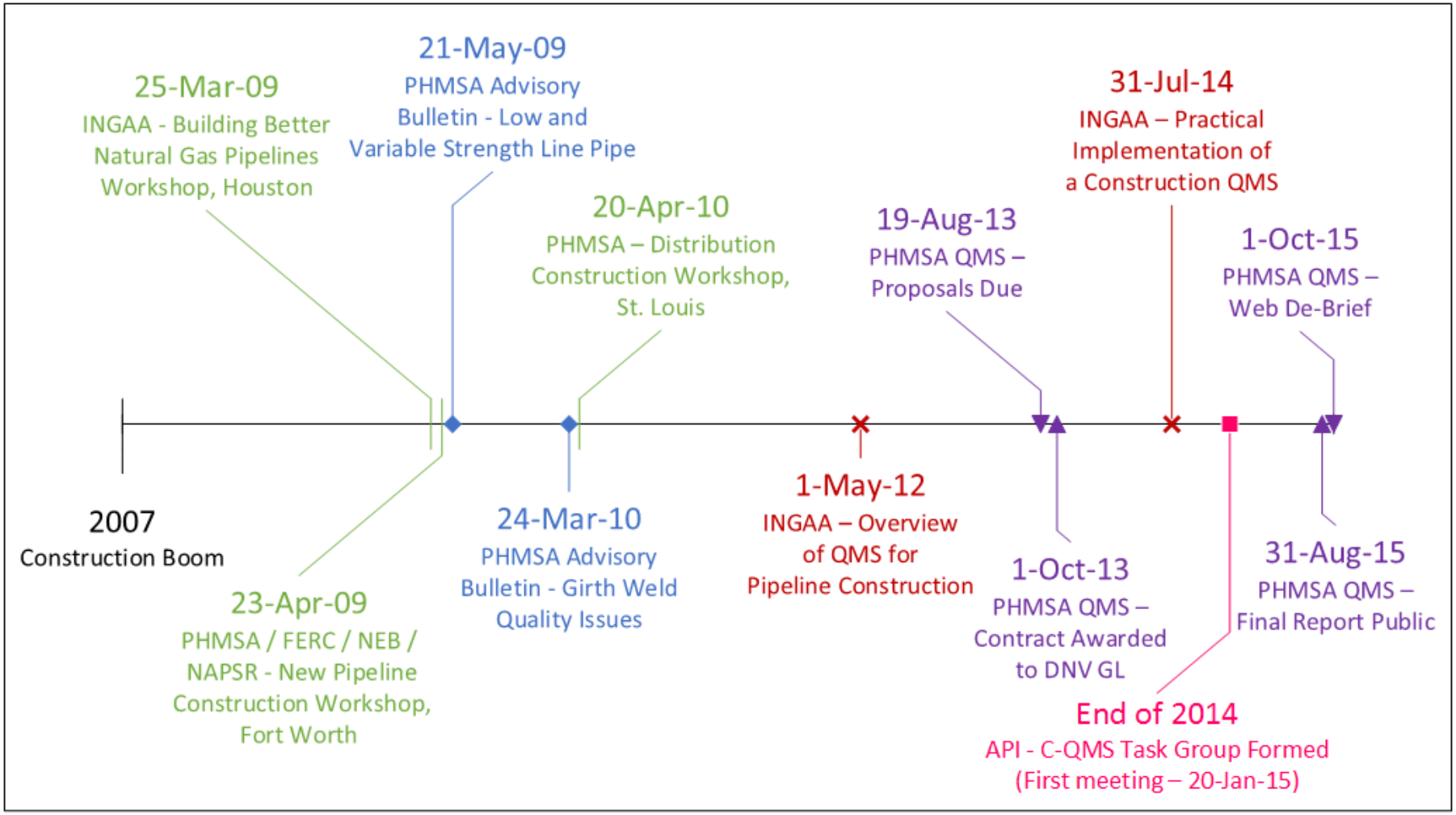
Summary of Project Results

Project Driving Force

Driving Force

- **The US pipeline construction industry has experienced unparalleled growth since 2007**
  - Increased construction inspections by PHMSA
- **Pipeline construction quality was identified as a source of concern**
  - PHMSA inspection findings
  - Pressure test failures
  - First year in-service failures
  - Issues identified during in-line inspection or coating surveys

Industry Response Time Line



Background

- **Management Systems**
- **Quality Management Systems (QMS)**
- **QMS in the Pipeline Industry**
- **Quality Culture**

Background

- **Management Systems**
- Quality Management Systems (QMS)
- QMS in the Pipeline Industry
- Quality Culture

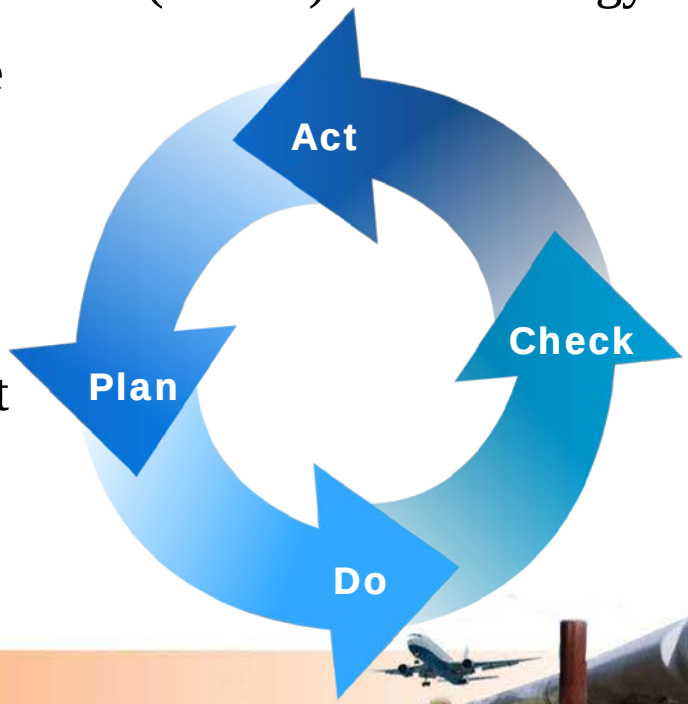
Management Systems

- A management system is a systematic framework for managing and continually improving an organization's policies, processes, and procedures.

How an organization ensures things are done properly

Management Systems

- A formal management system is a documented set of interrelated and interdependent processes with a clearly defined scope.
  - It is more than a set of documents: it is a documented system of working that follows the Plan-Do-Check-Act (PCDA) methodology.
  - Effective management systems include documented processes, clear responsibilities, ongoing training, communication requirements, compliance checks, processes to correct non-compliances, management reviews, and continual improvement.



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- Management Systems
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Quality Management Systems (QMS)

- A QMS is the documented set of processes and procedures required for planning, executing, and continually improving the ability of a process, activity, or product to **meet defined requirements.**
  - A QMS should follow the PDCA methodology to achieve high quality and continuous improvement.

"A quality management system can provide the framework for continual improvement to increase the probability of achieving customer satisfaction and the satisfaction of other interested parties. It provides confidence to the organization and its customers that it is able to provide products that consistently fulfil requirements."

ISO 9001: Quality Management Systems, Requirements

Quality Management Systems (QMS)

- A properly developed and implemented QMS should:
  - Document all requirements in appropriate locations;
  - Confirm employees and contractors receive applicable training;
  - Define processes, procedures, and activities needed to meet quality requirements;
  - Require proper and timely communication between interrelated processes, procedures, and activities;
  - Produce evidence the quality requirements are met;
  - Measure, monitor, and analyze changes to the requirements;
  - Audit and analyze system processes and outcomes; and
  - Improve quality.

Background

- Management Systems
- Quality Management Systems (QMS)
- **QMS in the Oil & Gas Industry**
- Quality Culture

QMS in the Oil & Gas Industry

- Oil and gas industry-specific QMS standards:
  - ISO/TS 29001: Petroleum, Petrochemical and Natural Gas Industries – Sector-specific Quality Management Systems – Requirements for Product and Service Supply Organizations;
  - API Specification Q1: Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry; and
  - API Specification Q2: Specification for Quality Management System Requirements for Service Supply Organizations for the Petroleum and Natural Gas Industries.

QMS in the Oil & Gas Industry

- In July 2014, INGAA published Report No. 2104.04, Guidelines for Practical Implementation of a Construction Quality Management System.

- An American Petroleum Institute (API) task group was formed in 2015 to develop a recommended practice for pipeline construction QMS.

INGAA's White Paper

- The INGAA Foundation also published a white paper in 2012 which explored the benefits of applying QMS principles to the field implementation phase of pipeline construction projects.

"A QMS does not guarantee a flawless product or service without defects, but provides a framework for maximizing the delivery of the product or service."

"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."

Pipeline QMS Benefits

INGAA White Paper:

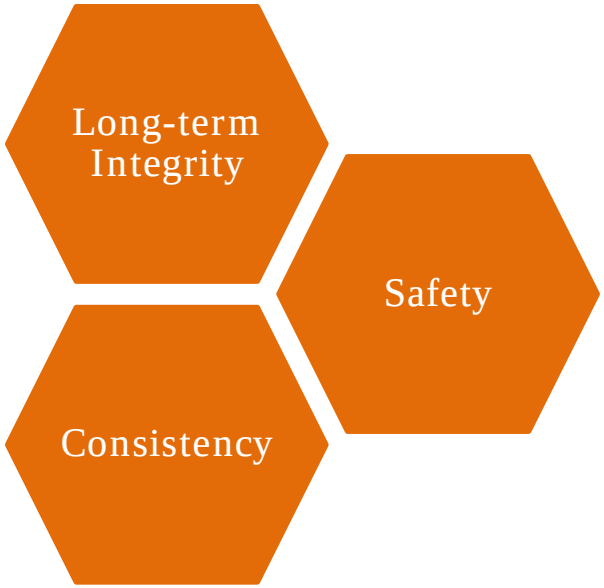
- Process Improvement
- Enhanced Stakeholder Satisfaction
- Increased Efficiency

"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."

Reduced failures and rework = increased safety and reliability of the energy supply

Pipeline Construction QMS

- Applying current QMS standards to pipeline construction may be difficult:
  - Each pipeline construction project is unique.
  - A risk-based and process-based approach should be adopted to allow a QMS to be used to manage the individual quality concerns for each pipeline construction project.



Pipeline QMS and other Management Systems

A pipeline construction QMS can be a component in a corporate management system. Or can be integrated into a safety management system (SMS).

API RP 1173, Pipeline Safety Management Systems

"8.2.2 Manufacturing and Construction The pipeline operator shall maintain (a) quality control procedure(s) so that materials and construction are in accordance with the design and purchase specifications."

Background

- Management Systems
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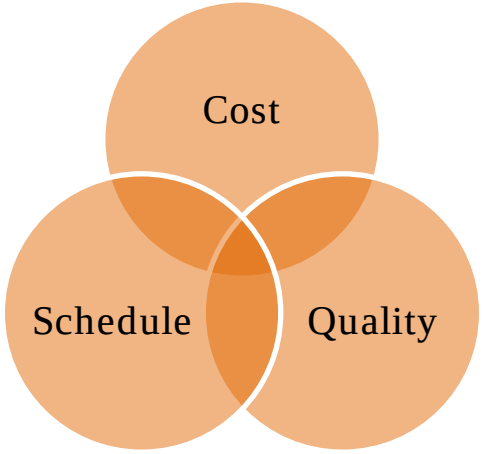
Quality Culture

- Improvement of construction quality, requires a “quality culture” to be developed and fostered in the pipeline construction industry
  - Operating companies
  - Manufacturers
  - Suppliers
  - Contractors.



- Quality should be elevated to a level equivalent to that of safety, at which time it would become acceptable and expected to stop work for a quality issue.

Project Activities

Information Gathering

- **Literature Review**

- **Industry Surveys and Follow-up Interviews**
  - Operating companies
  - Contractors
  - Regulators (PHMSA, NAPSR and NEB)
  - Industry Groups (AGA, AOPL, API, CEPA, INGAA, PLCA, PRCI, and PSTrust)

Framework

- The framework is intended to assist pipeline operating companies, contractors, and suppliers in the development and implementation of a company-specific QMS for pipeline construction.
  - Risk-based, process approach
  - Scalable for a wide range of pipeline construction projects, including liquid and gas transmission pipelines and gas distribution lines.

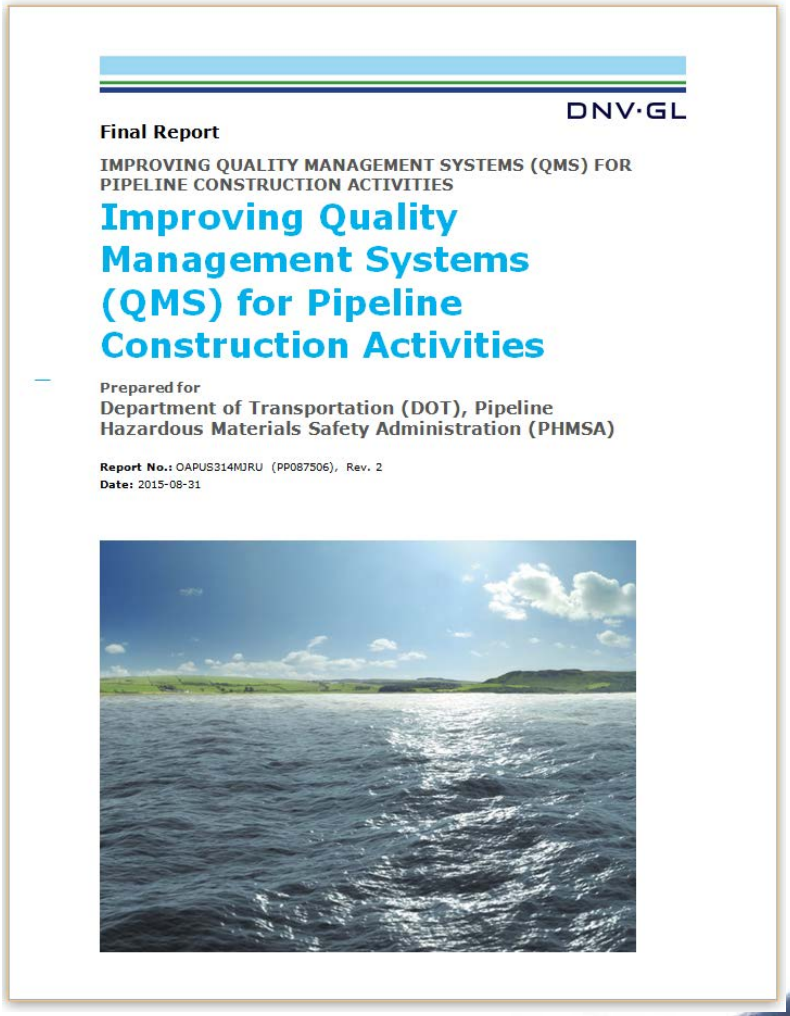
- Associated Guidance Document

Project Deliverables

Final Report

- Report Body
- Appendix A – QMS Framework
- Appendix B – Guidance Document

- Intended to be used either as a stand-alone management system or as the quality component in a company's corporate management system


DNV·GL

Final Report

IMPROVING QUALITY MANAGEMENT SYSTEMS (QMS) FOR PIPELINE CONSTRUCTION ACTIVITIES

Improving Quality Management Systems (QMS) for Pipeline Construction Activities

Prepared for
Department of Transportation (DOT), Pipeline Hazardous Materials Safety Administration (PHMSA)

Report No.: OAPUS314MJRU (PP087506), Rev. 2
Date: 2015-08-31

QMS Framework

- The framework addresses the following:
  - Responsibilities of the pipeline owner/operator, construction contractor(s), and supplier(s)
  - Management commitment
  - Communications, documentation, and management of change of the QMS
  - Resource management and training

QMS Framework (con.)

- Project implementation of the QMS, including:
  - Identification of task-specific or process-specific quality concerns
  - Identification, development, and application of quality control/ quality assurance options to address each concern in order to prevent, detect, mitigate, and eliminate near-misses and non-conformances
  - Training and competency of personnel performing the tasks as well as personnel inspecting and monitoring the tasks and deliverables
  - Identification and description(s) of applicable inspection requirements
  - Construction project documentation requirements
- Continuous improvement via assessment of the achievement of quality objectives throughout the implementation of the QMS and construction project(s).

Guidance Document

- Appendix B is Appendix A with <u>additional guidance information</u>
  - Recommendations, suggestions, and examples that may be considered when developing the details of how to meet the requirements of the framework

5.3.2 Control of QMS Documents

The operating company shall establish procedures for the control and dissemination of QMS documents, including:

- Identification of documents that are required for the effective implementation of the QMS;
- Identification and review of documents that require access control and/or distribution control;
- Approval of documents, including assurances of legibility and accessibility;
- Identification of the current revision of each document, including procedures for removal of obsolete/invalid documents from circulation and use; and
- Maintenance of documents, including back-up and archival of critical or obsolete documents.

Guidance

The operating company may already have a document control process/system in place for existing company document or records which can be used to manage the QMS documents.

Scope

Materials Procurement and Inspection

- Manufacturer and Supplier Selection
- Manufacturer Procedure Specs. (MPS)
- Inspection and Test Plans (ITP)
- Traceability
- Manufacturing and Inspection
  - •Welding
  - •NDT
  - •Pressure Testing
  - •Surveillance
- Marking and Identification
- Transportation

Construction

- Construction Specifications
- Contractor Selection
- Construction Inspections
- Construction Activities
  - •Receipt and Offloading
  - •Storage
  - •Construction Surveying and Staking
  - •Ditching
  - •Stringing
  - •Field Bending
  - •Fusion Processes
    - •Welding
    - •Joining
  - •NDT
  - •Field Coating
  - •Coating Holiday Inspection and Repairs
  - •Ditch Padding
  - •Lifting and Lowering In
  - •Local Pipe Attachments
    - •CP System and Corrosion Monitoring
    - •Post-Commissioning Condition Monitoring
  - •Pipe Weighting

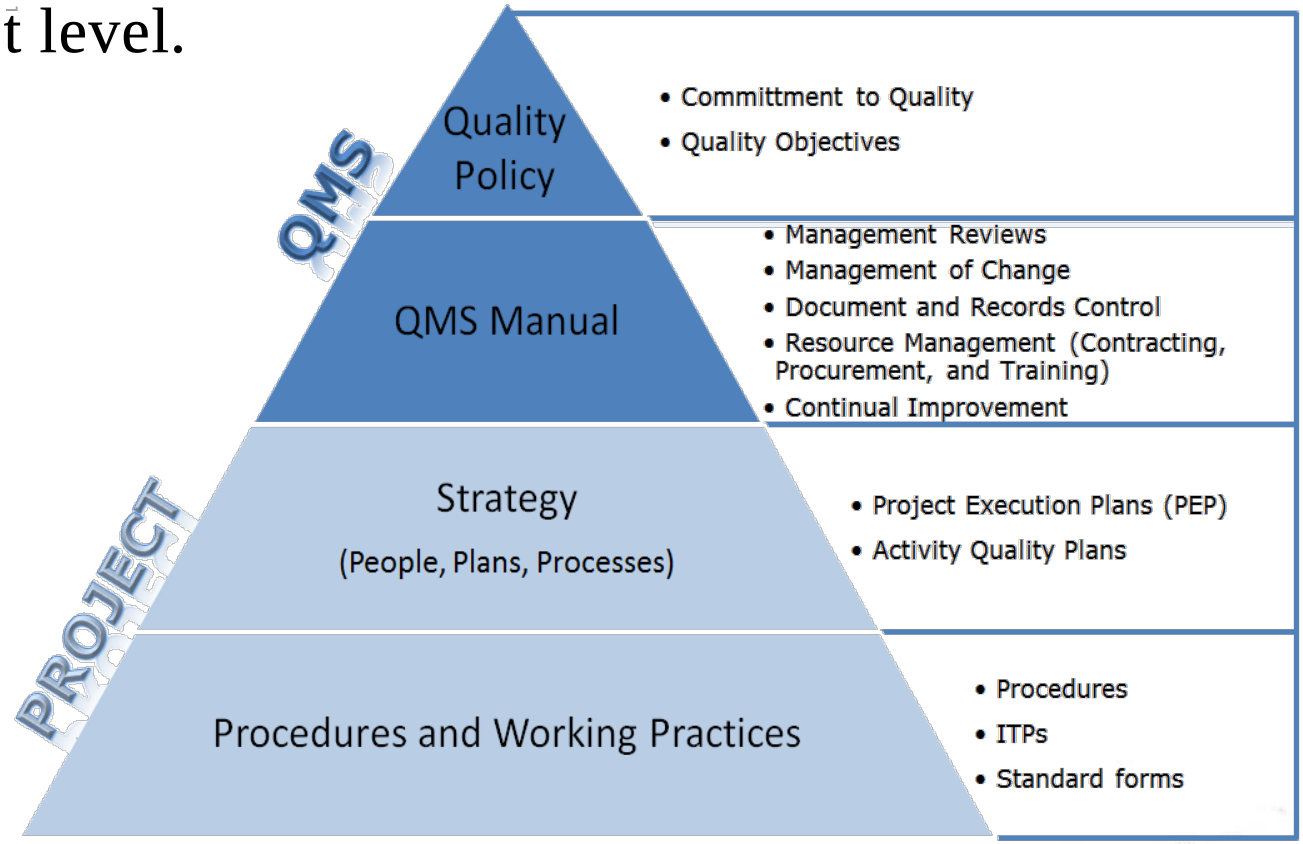
Pre-Commissioning

- Pressure Testing
- In-Line Inspection
- Above Ground Surveys
- Excavations
  - •As-Built Surveying
  - •Backfilling
  - •Tie-Ins
  - •Special Cases
    - •Horizontal Direction Drill (HDD)
    - •Cased Crossings
    - •Fabrications
    - •Tracer Wires
  - •As-Built Documentation *
  - •Final Tie-Ins (Golden Welds) *

* Final construction activities may coincide with pre-commissioning activities.

QMS Documentation

- The quality management of pipeline construction requires documentation at two levels: the QMS level and the project level.



QMS Reviews

- Multiple levels of review
  - Any quality issues or nonconformances identified should be elevated to the next level of review to be appropriately addressed.

Framework Contents

1.0 Introduction
2.0 Scope
3.0 Terms and Definitions
4.0 Abbreviations
5.0 General
6.0 Management Responsibility
7.0 Resource Management
8.0 Project Implementation
9.0 Continual Improvement

"Comprehensively address the construction deficiencies identified since 2009 and derived from the 2009 New Construction Workshop, the 2010 Distribution Workshop, and findings provided by PHMSA/NAPSR."

PHMSA RFP

5.0 General

- Description of a Quality Management System
- Approach
- Control of Documents and Records
- Management of Change

6.0 Management Responsibility

- Owner company and Contractors/Suppliers
  - Management commitment
  - Policy
  - Communications
  - Organization
  - Management reviews

7.0 Resource Management

- Provision of Resources
- Human Resources
  - Training and Competency
  - Contractor Services
- Infrastructure
- Work Environment

8.0 Project Implementation

- Project Quality Risk Management
- QMS Scalability
- Pre-Construction Considerations
  - Planning & Review
  - Regulatory and Statute Requirements
  - Additional Requirements
  - Design Control and Verification
- Contractors and Suppliers
  - Bid Process and Evaluation
  - Exceptions and Contract Terms
  - Risk Sharing and Warranties
  - Project Execution Plans

8.0 Project Implementation (con.)

- Project Management
  - Organizational Stakeholders
  - Planning
  - Project Change Control
  - Project Review
- Materials Procurement and Inspection
  - Manufacturer Procedure Specifications (MPS)
  - Inspection and Test Plans (ITP)
  - Traceability, Inspection, Welding, NDT, Pressure-Testing, Surveillance, Non-conformances, Marking and Identification, Transportation and Handling

8.0 Project Implementation (con.)

- Construction
  - Control of Construction
  - Field Identification and Traceability
  - Quality Plans for Construction and Installation Activities

Receipt & Offloading **Storage** **Construction Surveying & Staking**
Ditching **Stringing** **Field Bending** **Welding** **Joining** **NDT** **Coating**
Holiday Inspection/Repairs **Ditch Padding** **Lifting/Lowering-In**
CP System/Corrosion Monitoring **Post-Commissioning Monitoring**
Pipe Weighting **As-Built Surveying** **Backfilling** **Tie-Ins** **HDDs**
Cased Crossings **Fabrications** **Tracer Wires** **As-Built Documentation**
Pressure Testing **In Line Inspection** **Above-Ground Surveys** **Excavations**
Final Tie-Ins

9.0 Continual Improvement

- Management Review and QMS Audits
- Addressing Findings and Recommended Actions
- Learning from Events
  - Reactive
  - Proactive
  - Informal opportunities for learning
- Management of Change
- Monitoring and Measurement

Construction Quality Plans

- Section 8.8.3 – Quality Plans for Construction and Installation Activities

"A specific quality plan shall be developed for each construction activity performed on the project…"

"Guidance
Tables are provided below for each listed construction activity which may assist the operating company and contractor, as applicable, to develop a quality plan for each construction activity. The listed information provided may not be all-inclusive for each activity."

Example – Ditching (1 of 2)

Table 8.8.3.4-1 Minimum Considerations for Development of Ditching Procedures and Quality Plan

Potential Quality Concerns	• *Ditch profile not in compliance with company specification or pipeline map*
	  ○ *Depth and/or width incorrect*
	  ○ *Points of inflection out of alignment*
	  ○ *Undulating or rocky ditch bottom*
	• *Spoil pile improperly placed or layers improperly segregated*
	• *Equipment unsuited for terrain or soil condition*
	• *Flooding of ditch*

QA/QC and Mitigation Options	• *Contractor selection process used to select appropriate, competent contractor* • *Audit of contractor responsible for ditching which would include inspection of equipment and procedures* • *Review of expectations and route with ditching contractor* • *Verify ditch location as it is created* • *Consistent documentation procedures/ forms for inspections and verifications*

Example– Ditching (2 of 2)

Training/Competency of Personnel Performing Activities	• *Able to operate ditching equipment* • *Experience with ditching activities* • *Knowledge of company specifications and procedures* • *Competence and licensure in alternative ditching methods, if applicable, such as ditch blasting*
Inspection Requirements	• *Verification of ditch location with regards to marked route* • *Verification of ditch profile (depth, width, points of inflection, and bottom condition)*
Training/Competency of Inspection Personnel	• *Understanding of company specifications* • *Ability to take required measurements*
Records Requirements	• *Daily Inspection Reports* • *Abnormalities or deviations from specifications, recorded as NCR, to be addressed prior to pipe lowering-in activities*

Example – Backfilling (1 of 4)

Table 8.8.3.16-1 Minimum Considerations for Development of Backfilling Procedures and Quality Plan

Potential Quality Concerns	• *Coating damage or denting due to backfill materials* • *Coating damage or denting due to pipeline contact with backfilling equipment* • *Unsupported pipeline due to non-compacted backfill material between sand-bags or pillows* • *Reduced effectiveness of cathodic protection system due to improper rock shielding, backfill voids, or foreign materials adjacent to the pipe surface*

Example – Backfilling (2 of 4)

QA/QC and Mitigation Options	• *Inspection and documentation of backfill materials prior to use to determine appropriateness (rock to soil ratio) and verify it is free of foreign objects*
	• *Backfill procedures documented and known to relevant personnel*
	  ○ *Approved backfilling equipment, including required screen size for padding machines*
	  ○ *Required clearance between backfilling equipment and installed pipeline*
	  ○ *Lift heights, compaction requirements, and watering requirements, as applicable*
	  ○ *Backfill crown requirements and minimum depth of cover*
	• *Documentation of type and locations of rock shield utilized when backfill materials may cause coating damage*
	• *Documented pipe and coating repair procedures*

Example – Backfilling (3 of 4)

Training/Competency of Personnel Performing Activities	• *Ability to determine suitability of backfill materials and requirements for rock shield based on comparison of project specifications and available backfill* • *Understanding of company backfilling procedures* • *Ability to operate backfilling equipment* • *Ability to judge the acceptability of pipe and coating damage and perform pipe and coating repairs in accordance with project specifications*
Inspection Requirements	• *Inspection of backfill materials prior to use to confirm and document appropriateness* • *Witnessing and documentation of the backfill activities to verify no damage to the pipe or coating occurs* • *Monitoring and documentation of compliance with compaction requirements*

Example – Backfilling (4 of 4)

Training/Competency of Inspection Personnel	• *Understanding of company backfill procedures* • *Ability to take required measurements (lift heights, compaction, crown height, depth of cover, etc.)* • *Ability to perform inspections applicable to the types of repairs performed and to judge the acceptability of the repairs based on comparison to project specifications*
Records Requirements	• *Daily inspection report, including location and type of non-native backfill or rock shields* • *Improper backfilling immediately halted, recorded as NCR, and addressed prior to continuation of backfilling activities* • *Damaged pipe or coating, recorded as an NCR, and addressed prior to continuation of backfilling activities* • *Backfill temperature, if needed for thermal load calculations* • *Documentation of repairs in appropriate format*

Developing a QMS

- The QMS framework was developed for use by operating companies of varying size and scope.
  - The QMS elements will apply to each company, but the application of these elements should be appropriate for the size of the operator, the scope of the project, and the risk to the public and environment.

- The developed QMS can be stand-alone or part of a corporate management system

Applying the QMS

- Each project is unique!
  - It is the operating company's responsibility to consider unique quality issues applicable to their projects and address them accordingly through their company-specific QMS.
  - Other construction activities may be relevant and should be addressed on a project by project basis, utilizing the principles of the QMS framework.
- The quality practices of the operating company, materials suppliers, and construction contractors should all align.

Q&A and Discussion

Thank You

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