Guidelines for Practical Implementation of a Construction Quality Management System

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Foreword

The INGAA Foundation has developed a series of reports and guidelines[1] to aid its members in improving design, constructability and engineering of pipelines. The collective body of resources is shown in Figure 1, and includes this document shown in the red box.

Figure 1 - INGAA Foundation Construction Quality Resources

1 http://www.ingaa.org/Foundation/17991.aspx

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1.0 Background

Early in 2007, pipeline construction activities in the United States increased dramatically, including construction of pipelines under Special Permits to operate at higher stress levels than allowed by regulation. During U.S. Department of Transportation, Pipelines and Hazardous Materials Safety Administration's (PHMSA) inspections of the Special Permit projects, some apparent quality problems were identified, such as issues with pipeline coating, welding and backfilling.

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) to inform the public, alert the industry, review the lessons learned from these inspections, and improve new pipeline construction practices.

Following the two meetings, the INGAA Foundation held a Pipeline Summit to identify working groups to address specific construction-related 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. The INGAA Foundation developed an action plan and workgroups were formed to address specific issues.

One workgroup was created to review quality management system (QMS) concepts and how they might be applied to pipeline construction projects. The Foundation published a white paper, entitled Overview of Quality Management Systems - Principles and Practices for Pipeline Construction, in May 2012.

As a logical follow-up to that paper, INGAA Foundation members saw a need to provide practical, "how-to" guidance on implementation of a Construction Quality Management System (C-QMS), and authorized a project. Process Performance Improvement Consultants LLC (P-PIC) was selected to lead development of the report under the guidance of a steering team, and Richard Hoffmann, the executive director of the INGAA Foundation. This report provides guidelines on the practical implementation of a C-QMS. The guidelines reflect the findings of leading practices and standardized methods for C-QMS for pipeline owner/operators, contractors and suppliers. The process used to develop these guidelines is presented in Appendix A.

The white paper sets forth a structure of a C-QMS and provides implementation guidance using that structure.

The need for this guidance continues as the industry undergoes another period of construction expansion brought about by shale production in a variety of locations across North America.

2.0 Introduction

The purpose of this document is to provide practical "how-to" guidance for owner/operators, contractors, service providers and other INGAA Foundation members[2] on implementing a QMS for pipeline construction projects in their company. It utilizes the structure of the Foundation white paper, entitled Overview of Quality Management Systems - Principles and Practices for Pipeline Construction May 2012 (hereafter referred to as the "QMS overview").[3].

Specifically, this report provides guidance for the elements defined in the referenced white paper. The elements are:

- Management Commitment
- Resource Management
- Plan and Develop Processes
- Measurement, Analysis and Improvement
- Documentation and Records

The scope of these guidelines is directed primarily at the construction process itself. There is no question that quality of design, development of specifications, engineering, constructability reviews and permitting are critical to a projects' success, but they are not addressed within these guidelines. However, it was during construction when most of the problems identified above occurred. Additional guidance related to design and engineering is provided in Appendix B.

In developing these guidelines, work developed by the Construction Industries Institute (CII) was prominent in providing tangible guidance and reinforcement for embracing and using a C-QMS. The CII is a consortium of 130 owner and contractor organizations[4] from the public and private sector working with academic organizations to enhance the effectiveness and sustainability of the capital facility life cycle. The organization is based at the University of Texas in Austin.

Members should review the guidance provided herein and evaluate how it can enhance their current approach to managing construction quality. The guidance is not meant to be prescriptive or intended to indicate that there is only one way to achieve the goals and objectives. There may be alternatives and variations of the guidance herein. Ultimately the goal is to minimize non-conformances and construct a pipeline system that meets the owner/operators specifications as well as regulatory and international consensus standard's requirements.

Developing a fully functional C-QMS is a multiyear effort, not a project with a defined start and finish date. Each time a C-QMS is applied on a specific project provides an opportunity for identifying ways to continually improve, mature and improve effectiveness

CII conducted a survey of its members and asked what elements they found to be most critical in implementing and creating a highly effective C-QMS. The members consistently identified eight elements of highly effective programs, which are summarized below.

[2] The term "owner/operator" is used to describe the organization responsible and accountable for construction. The term "contractor" is used to apply to aspects that relate specifically to contractors and service providers engaged in construction. The term "Foundation members" is used throughout the document to apply to any member engaged in construction of pipelines.
[3] This guidance also conforms to requirements generally set forth within ISO TS 29001, "Petroleum, Petrochemical and Natural Gas industries — Sector-Specific QMS — Requirements for Product and Service Supply Organizations."
[4] Foundation members in the CII include TransCanada, Williams, Jacobs, URS, Wilbros, and Wood Group Mustang.

Construction Industries Institute Elements of Highly Effective C-QMSs

Leadership – Top management takes responsibility for implementing the C-QMS to provide consistent, visible leadership, and demonstrate commitment to use of metrics, as well as the need for QMS training. {Refer to Section 3.0)

Accountability – Organization clearly defines accountability, and develops clear links between training and individual accountability from top management to craft worker levels. (Refer to Section 3.1)

Long-Term Strategy for Improvement – Organization engages in regular reviews of the C-QMS, formalizing the C-QMS organization-wide, with standardized management of change, planning and execution processes.

Training – Organizations require employees engaged in construction to participate in QMS-specific training. (Refer to Section 6.4)

Supplier/Contractor C-QMS – Organizations require use of a C-QMS and effective auditing of the contractor's program. May include use of the owner/operator's C-QMS, (Refer to Section 6.3)

Metrics, Measurement and Analysis – Organizations consistently apply a formalized system of metrics and analysis. Top management has line of site to key performance indicators (KPIs), with regular reviews of trends. (Refer to Section 5.2)

Process Management and Work Process Improvement – Organizations identify improvements in work processes, as the most important improvement in the preceding ten years. (Refer to Section 3.0)

Certification – Organizations regularly reviewed certifications required by standards. Contractors are more likely to have certifications, like ISO, than owner/operators. (Refer to Section 6.4)

Scalability

These guidelines are intended to be scalable to pipeline construction projects of varying size, scope and complexity. While projects can entail hundreds of miles of construction, more typical projects involve installation of loops to optimize or increase capacity and laterals to tie in to a new customer(s). A larger project might benefit from robust, detailed, formal procedures and large designated team, whereas smaller uplands projects may only incorporate the appropriate aspects of a larger project. A smaller project entailing construction on a variety of slopes with multiple water crossings due to its complexity may also benefit from robust, detailed, formal procedures with dedicated personnel. Regardless of the project size, the need for inspection and QA/QC is present in all cases. The elements of a C-QMS described below provide a framework and are broadly applicable to projects of any size and sophistication. Specific application of those elements to the processes and practices of a given pipeline owner/operator and constructor will reflect the scale of the project. Examples of how scale can impact the implementation of a C-QMS are provided throughout Section 6.0.

3.0 Development of a Construction Quality Management System

During workshops conducted to share leading practices related to C-QMS and review drafts of these guidelines, it was recognized that Foundation members' C-QMS programs are in various states of development, ranging from mature, well-tested programs to ones that have key elements, built upon strong

procedures, but can benefit from more formalization of existing processes. The QMS overview developed by the Foundation provides a framework for C-QMS. Additional resources include:

- API Specification Q2 - Specification for Quality Management System Requirements for Service Supply Organization for the Petroleum and Natural Gas Industries,
- API Specification Q1 - Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry,
- ISO TS 29001- "Petroleum, Petrochemical and Natural Gas industries — Sector-Specific QMS — Requirements for Product and Service Supply Organizations", and
- CII IR 254-2 - "Implementation & Improving Quality Management Systems in the Capital Facilities Delivery Industry."

The QMS overview provides guidance on key points to consider for each of the core elements in developing a C-QMS. The text that follows builds upon those key points and provides additional insights into developing a C-QMS.

3.1 Leadership and Management Commitment

Management commitment is recognized as critical to the success of any management system. It begins with top management[5] establishing the quality mission, articulating a policy and establishing goals and objectives. Additional guidance is not provided herein, as these will need to align with the organization's mission, policies and goals.

Top management plays a critical role in fostering a culture that understands the value of a C-QMS. Fostering is demonstrated through periodic reinforcement of the mission, policy and goals, as well as a regular review of objectives.

Leadership is often recognized as being critical to the success of a QMS. As described above in the inset showing elements of highly effective C-QMSs as recognized by CII members, leaders provide consistent, visible direction, and demonstrate commitment to the use of metrics and training of personnel.

Management, aided by top management, ensures that the proper resources are available to manage and administer the C-QMS. Finally, management reviews of the C-QMS on a regular basis are an essential part of demonstrating management commitment, ensuring that the C-QMS is functioning properly and meeting established objectives.

3.2 Resource Management

A Foundation member's C-QMS should have defined requirements for resource management. The requirements include:

- Resources for developing and maintaining the C-QMS;
- Resources for developing and maintaining a project specific C-QMS, or alternatively implementing the C-QMS for a specific project; and

[5] "Top management" is a person or group of people that direct and control the organization at the highest level. "Management" is persons or a group of people that direct and control all or part of a facility, location, department or other function and has the fiscal responsibility for the organization and is accountable for ensuring compliance with legal and other applicable requirements.

- Resources for planning, executing and completing a construction project with quality (meeting contractual and client requirements).

Resource management for developing a C-QMS is addressed within three sub-elements. They are:

1. Providing the required resources, including personnel, technology and time to develop and maintain the C-QMS;
2. Ensuring that qualified and competent people are available with appropriate experience and training to develop and maintain the C-QMS; and
3. Training programs, including job-specific requirements and understanding the elements of a C-QMS.

Resources required for development are dependent upon the current state of a C-QMS, and specifically, whether development is starting with little or no QMS or enhancing an existing C-QMS to conform to the elements of the QMS overview or other reference materials such as those identified above. Development of a complete first version C-QMS likely will require three to six person-months of time, depending on the level of expertise of the person(s) undertaking the development. Ample time should be provided for review and input by key personnel from parts of the organization that will use or be subject to the C-QMS. There can be value in meeting with organizations with experience using a C-QMS and as appropriate, formally benchmarking how organizations have developed the core elements of their C-QMS.

Owners, contractors or service providers may elect on larger projects to develop and implement a project-specific C-QMS. Resources required for development of a project-specific C-QMS are dependent upon the level of experience with project-specific plan. Development of a complete first version project-specific C-QMS likely will require one to four person-months of time, depending upon the level of expertise of the person(s) undertaking the development. Adaptation of an existing project-specific C-QMS will likely require one to three person months depending on project complexity.

An essential part of developing a C-QMS is ensuring that qualified and competent people are available with appropriate experience and training to develop and maintain the C-QMS. 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 C-QMS. In addition to job-specific training, each quality critical position should have a written job description that describes the necessary educational and work-related experience to adequately perform the required tasks.

Finally, each person working on a construction project must exhibit personal integrity. Project quality at its most basic level is predicated on individual integrity. A tested and mature C-QMS, with exemplary, detailed specifications cannot fully offset a possible impact of a lapse in attention or integrity. This expectation of integrity is consistent with expectations for personal safety and a positive safety culture.

3.3 Plan and Develop Processes

Development of a C-QMS builds upon time-tested and proven procedures by identifying and establishing a set of overarching processes. The references above in 3.0 provide guidance on how they may be integrated. Examples of processes include:

- Measurement and analysis;

- Continuous improvement (these first two items were combined into a single overarching process in the QMS overview– refer to the subsection that follows);
- Management of change; and
- Documentation and record control.

After defining processes to be developed (or improved), The C-QMS should define authority, accountability and responsibility for developing and maintaining processes. It is important to recognize that many organizations elect to manage these processes across the organization, at a level higher than the C-QMS. Personnel developing and maintaining the C-QMS are then accountable and responsible for integrating organization-wide processes into the C-QMS.

3.4 Measurement, Analysis and Improvement

Monitoring and measuring activities, typically within a process, are defined in developing a C-QMS. Monitoring and measurement is conducted to ensure that both the operation and control of these processes are effective.

Audits are performed to ensure that processes, standards and procedures are being properly implemented and documented. A variant of an audit, referred to as an evaluation, can be conducted to ensure the integrity and continual improvement of work processes. The C-QMS should specify that audits be performed on planned intervals, or as needed, based on performance and measurement process defined in the C-QMS. Through audits, non-conformances are identified and immediate actions are taken to remedy these situations.

Examples of types of audits under a C-QMS include,

- *Internal Audits:* The project owners to ensure the integrity typically establish internal audit programs 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 should offer full cooperation with audits and evaluations.

Continuous improvement is an essential part of a mature C-QMS. 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.

3.5 Documentation and Record Keeping

In developing a C-QMS, the owner/operator or contractor establishes the core documentation requirements and controls for the C-QMS, including key and supporting processes and procedures. It includes documenting industry specifications and standards, inspection testing plans and determining records that need to be maintained for the project. The C-QMS specifies that documents used on a project must be current and approved, and available for review by project personnel, including contractors.

C-QMS policies and procedures are maintained under formal document-control procedures; 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 are generated to validate 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 turnover to the owner/operator for commissioning and operations. Records are established and maintained to provide evidence of conformity and compliance to demonstrate the effective operation of the QMS.

4.0 Leadership and Management Commitment

Foundation members[6] should demonstrate a commitment to quality, enable and encourage leadership to strive for these goals at all levels within their respective organizations. The commitment to quality should be put on the same level as the commitment to safety because they go hand in hand. INGAA published a white paper, Foundation for an Effective Safety Culture, in October 2012.[7] The INGAA Foundation produced a safety culture video to demonstrate its commitment to safety and provide practical insights to its members.

This report identifies several factors that result in a strong safety culture – for both safety and quality. These are:

- The company encourages employees to report and raise concerns;
- The company routinely emphasizes safety, and encourages mindfulness;
- The company recognizes informal leaders; and
- The company consistently reports using a defined set of key performance indicators.

The Importance of a Quality Culture

When people in an organization believe that quality is important, they behave with care and concern about how they do their jobs and the quality of what they do. It starts with Top Management establishing quality as a core value. People are persuaded that quality is an organizational value only when organizations and their leaders consistently demonstrate that quality is valued. When it comes to quality, there must be "constancy of purpose." Achievement of this will determine the ultimate success or failure of the organization. When the employees of a company identify with quality, it is contagious – employees interact with each other and reinforce this value. Sharing it creates a sense of purpose and influences how employees conduct everyday work.

While employees performing tasks safely is important, how they "own" and "buy-in" to their role in ensuring quality construction, is at least as important. Every action on an asset, or decision made on behalf of the system at large, is seen as connecting to the quality of the project. The ongoing practice of caring about quality strengthens the overall organization's belief in its value and acts as a unifying force. When the value is shared extensively in every level of the organization, and a widespread level of commitment to overall quality performance is expected, then everyone is doing what is right, even when no one is looking. Then one can say a quality culture thrives.

6 The Term "Foundation members" is used throughout the document to apply to any member engaged in construction of pipelines.

7 Foundation for an Effective Safety Culture. The INGAA Foundation, Inc. http://www.ingaa.org/18542.aspx

A C-QMS should include a quality policy and emphasize goals and objectives. The policy, goals and objectives should be emphasized at each meeting. Objectives should be measurable and consistent with overall quality policy and business objectives. Some examples of goals for a construction project might include:

- Achieve zero defects (and zero rework) to enable the owner/operator to achieve the broader INGAA Foundation goal of zero incidents;
- Promote an effective safety and quality culture;
- Identify and mitigate risks, directing efforts towards prevention of non-conformances;
- Make recommendations for process improvements; and
- Deliver the project to specifications, on time, in budget, without injury, incidents or near misses.

Experience has shown that the most effective way to move toward achieving zero defects is to place emphasis on identifying, reporting, defining corrective actions and tracking non-conformances and negative trends. Emphasis on zero defects should include appropriate reporting, corrective action and tracking systems to create an environment where personnel report and raise issues.

When implementing a C-QMS, to demonstrate leadership and commitment to quality, an owner/operator's or contractor's executive (note: executive not manager or project manager) responsible for the project should lead off and participate in key meetings during project initiation, a so called kick-off at construction commencement. For larger projects or longer duration projects, the executive may consider meeting periodically during construction and when any major non-conformances are found or data shows a trend that will adversely affect the project.

Promoting an effective safety and quality culture can be accomplished by the executive as well as project manager initially emphasizing and periodically reinforcing the importance of the key elements in the white paper, Foundation of an Effective Safety Culture noted above. Specifically, the executive and project manager should:

1. Demonstrate consistent focus on quality with an uncompromised commitment to safety.
2. Encourage adherence to defined processes and procedures.
3. Foster mutual trust and openness, communicating that safety and quality are shared responsibilities among employees and contractors.
4. Encourage learning, internally and externally, from non-conformances as well as positive developments during the project.
5. Encourage employees and contractors to identify threats to quality so they can be addressed
6. Encourage non-punitive reporting and ensure timely response to reported issues.

Reinforcement can be accomplished verbally in meetings, site visits, and tailgate meetings and through written materials such as flyers and newsletters, among others.

Perspectives on Leadership – President, Foundation Member

Management's commitment centers on communication, active participation and demonstration of the company's core values, which are as follows:

1) Do the job the right way the first time.
2) Be your and your brothers/sisters keeper.
3) Two-way communication is critical to success.

The genesis of this practice comes from an examination of "Lessons Learned" from our history of project management and execution. Performance is measured by an examination of quality and safety statistics as well as feedback from all levels of the company. Management commitment and participation includes yearly company-wide project management team meetings, project specific pre-construction foreman's meetings, and the visibility of senior management by remaining active and appearing in regular visits to all projects during construction.

A common practice in the industry when starting a meeting is to place a singular focus on safety by sharing an experience that serves as a learning opportunity. These are referred to as "Safety Moments" or "Safety Shares." Use of a "quality moment" in addition to a "safety moment" is a way of demonstrating commitment to quality and cements the cultural link to safety.

The project manager and construction manager also should demonstrate their commitment to quality by emphasizing the importance of quality consistently throughout the project. Their focus on key performance indicators (KPIs) that reflect quality with regular communication of performance and corrective actions is a means of demonstrating commitment.

The Role of Leadership

Leaders produce a clear set of priorities, accountabilities and a framework in which to allocate resources, commensurate with risk to the employees, the customers and the public. This is especially important in an industry that deals with technologically complex matters where the risk of failure may be unacceptable. Employees, in turn, are inspired by the climate of commitment and are motivated to accomplish the leaders' desired results. Leaders give conducting work to specification. This is equally true of those responsible for quality as well as for the safety, reliability and sustainability of the infrastructure.

We recognize the role of informal leaders. Informal leaders are those people who are recognized as providing leadership to employees because of their longevity, knowledge, experience, personality, and strength, among other factors. It is critical that they become a part of telling the story; connected to the assets they are building, conveying the sense of ownership and ethical responsibility and always practicing good process. Their role is so critical that they often remain a part of the organization after the senior- and executive-level management officials are gone.

4.1 Authority, Accountability and Responsibility

Authority is vested in the project manager for large projects, subject to authorization levels established in corporate policy. On smaller projects, the owner/operator or contractor vests authority in the project or construction manager. Accountability for project quality is assigned by the owner/operator. On large projects, the project manager is accountable for quality and the construction project manager is responsible for quality. On smaller projects, with only a project or construction manager, the accountability and responsibility can be assigned to a single person. The person with primary responsibility can delegate responsibility but should do so in writing to ensure clarity.

The entire project workforce is responsible for contributing to the achievement of quality objectives. The responsibilities of all personnel who manage, perform and ensure the quality of the work include:

- Initiate action to prevent the occurrence of non-conforming work;
- Identify, evaluate, define disposition and document quality problems;
- Recommend or initiate quality-improvement solutions;
- Stop the work when non-conforming work is identified and continue to stop until the deficiency is corrected; and
- Identify corrective actions that can be turned into preventive actions.

Ultimately, the purpose of a C-QMS is to enable personnel engaged in construction to be successful, to understand clearly the work they perform, to provide for a safe work environment, to provide the required tools, procedures, work instructions, equipment and supplies to conduct their work, and to have access to supervision and expertise as needed. Personnel will feel both a sense of responsibility and ownership in the work that they do.

Case Study – Process Improvement & Problem Solving Teams

Members have formed small teams that meet periodically to identify process improvements. Teams are also formed on an *ad-hoc* basis to solve specific problems that have arisen during construction. This practice is extremely effective in ensuring continuous improvement and the involvement of both top management and company personnel at all levels (cross functional and interdisciplinary) is essential. Teams of this type have been applied all across the energy, process and manufacturing industries.

4.2 Management Review

In implementing a C-QMS, top management should conduct periodic reviews, at least annually, to evaluate effectiveness in meeting the policy, goals and objectives (refer to Section 3.1). A review should include assessing opportunities for improvement and the need for changes to the C-QMS. The inputs to the reviews should be the outputs of each of the elements of the C-QMS for the review period. Again, the elements are:

- Management Commitment
- Resource Management
- Plan and Develop Processes
- Measurement, Analysis and Improvement
- Documentation and Records

Specific items that the review should consider including are:

a. The extent to which goals and objectives have been met;
b. Review of KPIs, including conformance with budget and schedule
c. Results of internal audits and evaluations;
d. The results of communication, participation and consultation with employees and other stakeholders;
e. Relevant communication(s) from external stakeholders, including complaints;
f. Performance in addressing non-conformances, corrective actions and preventive actions;
g. Results of lessons learned;
h. Assessing opportunities for improvement and the need for changes to the C-QMS; and
i. Follow-up actions from previous management reviews.

An output of the management review should include a report of the review to be shared with personnel engaged in construction. For owner/ operators, a version of the report should be prepared to share with contractors. The review should include action items requiring follow-up based on the review.

5.0 Resource Management

As described above, a member's C-QMS should set forth the requirements for resource management. The requirements include:

- Resources for developing and maintaining the C-QMS.
- Resources for developing and maintaining a project specific C-QMS, or alternatively implementing the C-QMS for a specific project.
- Resources for planning, executing and completing a construction project with quality (meeting contractual and client requirements).

Resource management for implementing a C-QMS is addressed within three sub-elements. They are:

1. Providing the required resources – people to develop and maintain the C-QMS.
2. Ensuring that qualified and competent people are available with appropriate experience and training to develop and maintain the C-QMS.
3. Training programs including job specific requirements and understanding the elements of a C-QMS.

Resource management in implementing a C-QMS at the project level is addressed within three sub-elements. They are:

1. Providing the required resources, including people, materials and equipment.
2. Ensuring that qualified and competent people are available with appropriate experience and training to execute the requirements. People operating under a C-QMS are evaluated for performance and continued competency.
3. Training programs including job specific requirements and understanding the elements of quality management.

Defining resources required to implement a C-QMS at the project level is dependent on the size and complexity of the project, the nature of the project risks and overall project visibility. Large projects can require a full-time quality manager and quality administrative person, and several field personnel. On smaller projects, the project manager or construction manager may provide management of the quality management system. Owner/operators and contractors may apply a matrix type approach where multiple projects are underway. Under this approach a quality manager and quality administrative person may rotate amongst several assigned projects, while the projects may have dedicated personnel working out on the right-of-way with supervision and crews.

In addition, owner/operators are encouraged to audit the C-QMS. Resource requirements for auditing C-QMS implementation at the project level are also dependent upon the size and complexity of the project, the nature of the project risks and overall project visibility. It is important that these resource requirements are fully scoped, costs developed and incorporated into project plans.

5.1 Required Resources

Managing resource requirements under a C-QMS can be done by applying the Plan, Do, Check and Act (PDCA) steps of quality management throughout construction. This begins with a resource plan - the

required personnel material and equipment - for each step in construction. Materials include line pipe and appurtenances such as valves, fittings, bends, etc. Equipment includes construction equipment (sometimes referred to as "yellow equipment") and other equipment essential in construction spreads. It also includes computers, printers, telephones, data loggers, cameras, office and storage trailers, and file cabinets, among others. While these are not typically as critical, the resource plan should ensure that adequate quantities of materials and equipment are available and in the correct locations on the project. Applying plan, do, check and act as follows:

Plan – Personnel resource planning typically is done using a project management system. Personnel resources are defined for each step of construction. Qualification requirements can be managed in the system or managed in spreadsheets or a database off line. Qualification and training requirements should be checked against the requirements of the contract. Qualifications required in using consensus standards, such as welding qualifications under American Society of Nondestructive Testing or coating application under NACE International, should be identified. A Plan for where equipment and materials are needed and when, also is developed.

The Construction Manager or designee should review the plans prior to initiation of construction. On large projects, it may be advisable to have the Project Manager, Chief Inspector and even some of the Lead Inspectors review the plans so they can provide insight and be aware of the flow of work, and, identify possible pinch points for resources and address problems before they arise.

Do – Resource availability and utilization should be tracked as construction commences and proceeds. On large projects, the Construction Manager typically will have an administrative assistant to track resources and provide reporting.

Case Study – Required Resources – Alaska Airlines

A critical step in ensuring quality is to ensure that resource requirements defined in planning are available and that non-conformances are addressed. The airline industry provides an interesting model for resource management. Non-conformance in that industry is measured by failures to leave the gate on schedule or to land on schedule. And similar to pipeline construction, the airlines face weather and other challenges of the environment in which they work. Alaska Airlines has the best on-time performance record among all commercial airlines. One of the keys to that success they report is resource management. They review the personnel plan every day --are personnel available to do a job activity when it was required versus the plan. They constantly review the plan in light of weather. They strive to have personnel available by committing to the plan and when there is a non-conformance they do a root cause analysis to understand why the resources were not available. Alaska Airlines executives state that the focus on resources is an obsession. It is apparently this commitment as an integral part of managing quality that enables them to achieve their successful performance.

Drawing upon the Alaskan Air practice, one option is to review the resource plan at a pre-determined frequency. On large projects this it may be as frequently as daily, at the beginning of each day, and tracked at the end of each day. The utilization of materials and equipment should be reviewed on a defined frequency, and tracked similarly to personnel, identifying delays and pinch points.

A good practice would be to make resource availability a topic of the morning meeting or tailgate meeting. Potential problems, such as absences, injuries or illnesses can be addressed before work begins. Plans to move personnel can be undertaken if warranted.

Check – Under a C-QMS, the key is to identify non-conformances, failure to have the number of resources planned, persons qualified or both. The non-conformances should be evaluated. A root-cause analysis may be of value under some circumstances. Actual numbers of resources utilized versus planned should be reviewed periodically, and if appropriate daily, drawing upon the Alaskan Air experience.

One of the challenges of pipeline construction is that it is essentially a moving production line. In addition, resources and the pace of work are potentially impacted by weather and precipitation, where heavy precipitation or flooding can impede or stop work.

A review of resources involved in inspection can be as important as resources needed for conducting the work. It is recommended that the review ensure that the utilized versus planned inspection resources are as expected or adjustments are made for non-conformances. For some spreads, a plan may be developed to have inspectors move from one location to another. The owner/operator or contractor should review execution of work and ensure that inspectors are available where and when needed. When an inspector is unavailable, work is stopped until an inspector becomes available.

Act – The owner/operator or contractor should review the non-conformances individually and then evaluate them to identify common trends (both positive and negative). The types of non-conformances may be as simple as not having a sufficient number of personnel, or that the pace of work (rate) is not being achieved or achievable. It is recommended that a corrective action plan be developed, and, where warranted, the resource plans adjusted.

The owner/operator or contractor should periodically review categories of non-conformances and corrective actions taken and evaluate trends and their effectiveness. (Refer to Section 7.2 – Performance Evaluation).

5.2 Competent and Qualified Personnel

Planning requirements for personnel are dependent on the competence and qualifications of personnel required for each construction step. Some steps in construction require qualification under an international consensus standard as described above. Current federal regulations for gas pipelines require qualified personnel to do work on existing infrastructure, and not for new pipeline construction.[8] The C-QMS should specify requirements for personnel as required by international consensus standards, regulations or the owner/operator's own specifications. It is recommended that requirements be in the bid package and specified in the contract to ensure due consideration by the construction contractor, and subcontractors.

A C-QMS should include a job description for each role within inspection. The job descriptions should include required experience, training and certifications as applicable. Job descriptions should be available for:

- Chief Inspector

[8] Regulations at 49 CFR 192, Subpart N, Qualification of Pipeline Personnel.

- Leads by Discipline
- Inspectors by discipline, including senior level(s).

API RP 1169, Recommended Practice for Basic Inspection Requirements —New Pipeline Construction, July 2013,[9] provides example job descriptions for many of the positions required.

At the time of publication of this guidance, a working group of INGAA Foundation members had been formed to proactively evaluate the recently published API RP and the role of qualification and certification of personnel. An essential part of this is to address new personnel coming into the construction, inspection and testing work force.

5.3 Subcontractor Management / Control

Subcontractor management and control practices are keys to ensure the prime contractor's entire scope of work is delivered with quality. A subcontractor may conduct work under its own C-QMS. Whether or not the subcontractor has a C-QMS, it must abide by and follow the contractors and owner/operator's C-QMS, safety policies, procedures and processes. If the subcontractor does not have its own C-QMS, the contractor should specify requirements as part of a subcontract agreement.

The key processes involved in Subcontractor Management are defined for each project and may include:

- Subcontractor selection
- Subcontractor contracting: agreement of conditions, expectations and requirements
- Subcontractor management, controls and development
- Subcontractor performance evaluation

In order to control activities that are subcontracted to third parties in the same manner as internal activities, the contractor shall evaluate all subcontractors prior to placing orders for goods and services. This evaluation involves determining that all subcontractors have the capability to meet the specified requirements and that they control their activities using guidelines established by the contractor. Evaluations, including audits and inspections at the subcontractor's facilities and yards, are performed to ensure human resources, equipment and materials will be in full compliance with awarded contract, and that all parties are in full understanding and agreement of the terms and conditions, specification and requirements of the owner/operator and the overall project at hand.

Only approved subcontractors are allowed to receive subcontracts. The lists are formally recorded and controlled in accordance with contractor's own company policy on vendor and subcontractor approval. Subcontract documents are reviewed and approved prior to issue to ensure that they contain all information necessary to allow the subcontractor to fully comply with the specified requirements.

Performance of subcontractors is regularly monitored to ensure that they maintain their approved subcontractor status. Those falling below the required levels of performance are assisted by the contractor to meet the requirements and continuously improve their capability. Any subcontractor failing to respond to this help and advice is removed from the approved subcontractor list until such time as it can re-qualify for approved status. Periodic audits are conducted to ensure subcontractor quality is conforming to applicable governing project documents. Quality records and documentation issued by subcontractor

[9] API - API Recommended Practice 1169. http://www.api.org/publications-standards-and-statistics/standards/whatsnew/publication-updates/new-pipeline-publications/api_rp_1169.

should also be reviewed and analyzed regularly to monitor performance and detect non-conformances or potential issues early on.

It is recommended that owner/operator and contractor conduct a project closeout and lessons learned session to evaluate the subcontractors' performances. Final evaluations should be discussed, documented and shared to ensure future projects benefit from the outcome of these findings.

5.4 Training and Orientation

A C-QMS should set forth the requirements for training and orientation. The requirements include:

- Training for developing and maintaining the C-QMS;
- Training for developing and maintaining a project specific C-QMS, or alternatively implementing the C-QMS for a specific project; and
- Training for planning, executing and completing a construction project with quality (meeting contractual and client requirements).

Training must be provided on quality concepts, tools and practices to all key construction project team members. This is paramount to ensure all aspects of the job are completed with quality. This training can be provided by in-house quality department members or even by consultants hired for such purpose, as needed according to the magnitude of the project. Certifications are an excellent way to verify quality personnel are qualified for the task. The American Society for Quality (ASQ) offers training and certification exams for the various types of human resources needed to provide support to a C-QMS (e.g. Certified Manager of Quality, Certified Quality Auditor, and Certified Quality Engineer, among many others).

For specific projects, it is recommended that the owner/operator should specify any training requirements. Core job training per se is typically not conducted on a construction project unless under the observation of a qualified supervisor. Contractors and subcontractors are expected to provide employees that are trained and ready for work.

Training in the context of implementing a C-QMS is undertaken to ensure that personnel understand and are familiar with their project specific requirements and the C-QMS process. It is sometimes referred to as project orientation, as it is training that is specifically directed at specific tasks for the construction project and not how to conduct a task or a series of tasks.

Training should address specifically how personnel assure quality in the performance of their work. An essential part of the training is to make personnel aware of the reporting process used by the owner/operator and the construction contractor. Project personnel must know that they have the responsibility to look out for their fellow workers, the owner/operator and the public, raising concerns that they have about the work environment and work practices, including execution of procedures that appear to create an unsafe work environment or fail to conform to the owner/operator's specifications.

As stated above, it may be a good practice for an executive of the owner/operator or contractor responsible for the project to kick-off the training. This provides an opportunity for the executive to reinforce personnel safety and quality, and to address questions that personnel may have.

The training should consist primarily of reviewing project-specific activities and verifying personnel's understanding of inspection, testing and documentation procedures related to each activity. Inspection and

testing should be discussed relative to ensuring quality construction, understanding of construction techniques and procedures, potential problems that commonly occur, safety and communication.

The owner/ operator should assess and evaluate if the personnel understand the project requirements based on their knowledge and experience. Based upon this initial assessment, if further training is required it can be undertaken before the start of the project. Project-specific environmental, safety, specifications and other required information should come from the construction manager or chief inspector.

6.0 Planning and Developing Processes to Implement a C-QMS

One of the primary objectives of a quality management system is to provide a conforming product, which ultimately will prevent in-service failures. This section provides "how-to" guidance for practitioners in a company to use during planning and actual construction to meet this objective.

This section places a strong emphasis on owner/operator oversight in addition to conventional measures used in quality management systems. Emphasis is placed on oversight, that is, the involvement of the owner/operator at various points to ensure that the governing documents are understood and to provide guidance on implementation and be available for questions regarding implementation. Oversight is important because it is simply insufficient to identify non-conformances solely through inspection, testing and even auditing. Oversight is critical to ensuring that non-conformances are detected, addressed and where possible, prevented. While the objective of the C-QMS is to ensure that non-conformances are identified and addressed, there can be great value derived from the program that places emphasis on prevention because the cost of rework and schedule impact of repeated non-conformances is adverse.

This section has seven subsections. They are:

1. Project Initiation
2. Construction Initiation
3. Oversight During Initial Construction
4. Ongoing Oversight
5. Oversight Near Project Breaks and Restarts
6. Construction Close Out
7. Special Considerations for EPC[10]/Turn Key Contracts

Case Study – Defining and Improving Key Processes

As noted by CII members, selection and improvement of key processes is essential to developing a highly effective C-QMS. It is important to identify the critical activities in each process that affect quality. This entails evaluation of performance data from projects and making adjustments to a process to improve its effectiveness. A leading practice entails application of the process improvement in a "pilot" to test the process as changed.

6.1 Project Initiation

This section provides "how-to" guidance for use during project initiation to meet the objective to prevent non-conformances during construction and ultimately in-service failures.

Owner/operator or contractor specifications including drawings and references to company standards and international consensus standards serve as the foundation of a C-QMS. The specifications are supplemented and made actionable through use of owner/operator procedures. These collectively serve as the basis to conduct work. The objective of the C-QMS is to ensure that work is executed according to the governing documents, including applying inspection and testing to demonstrate conformance. Depending upon the size and complexity of the job, an owner/operator may wish to establish a project-specific C-QMS. The owner/operator also may wish to require contractors and subcontractors to establish its own project-specific

[10] EPC – Engineering, Procurement and Construction, all in a single contract

C-QMSs. This may require the contractor to assure that its C-QMS procedures are consistent with the owners/operators'.

One of the most important aspects of managing quality is document control (refer to section 8.1). It is important that document control is managed from project initiation, ensuring that as changes are proposed and agreed upon that the applicable documents are available to those that need them on the project.

As part of a project specific C-QMS or in implementing its C-QMS, an owner/operator may consider developing an inspection and test plan (ITP)[11] drawing upon the quality concepts in Appendix C.[12] The ITP provides a means of formalizing the required inspection and testing for each step in the construction process. The example ITP defines the applicable consensus standards, applicable regulations, as well as training and qualification requirements. This table can be adapted to a particular project by including references to specific procedures in each step, where applicable. The table also includes the frequency of inspection and the type of inspection. Types of inspection define whether the inspection is to be witnessed, whether it is a hold point for workmanship, testing or other evaluation. The owner/operator should consider a pre-project kick off and tailor the project-specific ITP.

The owner/operator should consider applying oversight at various stages as an additional measure. Guidance on oversight is provided in the subsections that follow. **Oversight is provided to reinforce use of the governing documents and to provide guidance on their use. Oversight establishes an environment that prevents non-conformance instead of finding non-conformances solely through inspection and testing, and then applying corrective action. Oversight also helps to eliminate non-conformances and rework. Oversight is separate and distinct from inspection and testing, and auditing as well. Subject matter experts** (SMEs)[13] conduct oversight. Depending on the size and complexity of the project, a SME may be the project manager or construction manager.

The role and responsibilities of an SME can be based on project size and complexity, public profile, terrain difficulty, the construction requirements, and the use of specialized welding or coating specifications.

Note: *This section refers to the roles of SMEs and inspectors in many places. Separation of these roles on large projects is essential as the time demands on the respective roles warrants their separation. For small projects, on owner/operator may elect to have SMEs to serve as inspectors as well as in the SME role. A good practice when having an SME serve in dual roles is to have the project manager or another SME review inspection documentation periodically.*

Case Study – Use of Inspection and Test Plans

ITPs are created with help and input from the owner/operator. Inserted below is an example ITP. The ITP for each phase took into account the specifications for each phase as well as logical hold / verification points, and then also it was decided that the client would be responsible for documenting most of the information for the ITP.

[11] The term ITP also is used in manufacturing of line pipe and the source steel. There is value in using common terminology as part of conveying a consistent commitment to quality to our stakeholders.
[12] Appendix C excerpted from Building Natural Gas Transmission Pipelines, A Primer, (The INGAA Foundation, January 2013)
[13] A subject-matter expert is someone selected by the owner/operator for his or her knowledge and expertise. This expertise and knowledge may be based on training, education and experience to help ensure quality.

Table 1 is an example inspection and test plan and Table 2 shows an example of a welding inspector daily log.

Table 1 | Welding QA/QC ITP (Page 1 Rev. 0)

Item No.	Activity	Project Welding Procedure	Frequency	Acceptance Criteria	Project Responsibilities		Action/Record
					Contractor Responsibility (QC)	Operator Responsibility (QA)	
1	Safety JSA	Safety Manual	Daily[1]	Ensure ALL employees are wearing proper PPE for the relevant task at hand	X	X	• Tailgate safety[1] • Appropriate P.P.E • Complete & sign JSA
2	Verify Weld Procedure	Project Welding Manual	As needed	Applicable weld procedure Correct WPS and PQR for weld	X	X	• Determine proper weld procedure & notify welders • Verify WPS applies to essential variables • Welder Foreman Report
3	Verify Qualified Welders	Operator Specification	• Prior to welding • Change of Welder and/or Procedure	• Welder Qualification Log • Verify Operator Qualification Requirements (as applicable)	X	X	• Verify welders qualified to procedure per Welder Qualification Log • Welder Foreman Report • Field Verification Report or similar (as needed)
4	Pipe Inspection	Operator Specification	Each joint	Pipe free of debris	X	--	• Swab each joint • No record
5	Bevel Prep	Weld Procedures	Each joint	Clean bevel per Weld Procedure	X	X	• Buff bevel • No record
6	Pre heat	Weld Procedures	Each joint	Minimum as specified and verified by temp stick or equivalent.	X	X	• Pre heat bevel • No record • Temp stick
7	Line up	Weld Procedures	Each joint	• Root opening 1/16" • Seams 2"-4" offset • High-low 1/16" & Weld Procedure	X	X	• Appropriate use of line up clamp • No record
8	Inter-pass Temperature	Weld Procedures	Each joint	Minimum as specified and verified by temp stick or equivalent.	X	X	• Temp stick

[1] Any employee that does not attend the morning JSA/Safety tailgate, needs to review and sign, prior to working

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To further ensure that each foreman was following the ITP each day and crew the ITP was incorporated into the daily foreman reports. The foreman then filled out daily foreman reports; the ITP items were checked off and then signed off by the inspector at the end of each day.

Table 2

Document #: XXX-XXX-WIDR Rev0 8 May 2012
Welding Inspector's Daily Report

WORKING CONDITIONS	
Weather Conditions	
Right-of-Way Conditions	

CONSTRUCTION PROGRESS

Work or Operation Inspected	Alignment Station From	Alignment Station To	ML Welds (Tot/Acc/Rej)		Tie-In Welds (Tot/Acc/Rej)	
	+	+	/ /		/ /	
	+	+	/ /		/ /	
	+	+	/ /		/ /	
	+	+	/ /		/ /	
	+	+	/ /		/ /	
	+	+	/ /		/ /	

Technical		Environmental	
All Welders have passed qualification test(s)?	☐ Y ☐ N ☐ N/A		
All welds met qualified/approved weld procedures?	☐ Y ☐ N ☐ N/A		
All welds were visually inspected?	☐ Y ☐ N ☐ N/A		
All weld inspected by required NDE methods?	☐ Y ☐ N ☐ N/A		
All welds properly marked/I.D.'d to Company spec.?	☐ Y ☐ N ☐ N/A	All welding rods and other waste/trash picked up?	☐ Y ☐ N ☐ N/A
Pipe ends/bevels prep'd according to specs.?	☐ Y ☐ N ☐ N/A		
Proper pipe/transition pups install'd as necessary?	☐ Y ☐ N ☐ N/A		
All equipment, rods, etc. meet specifications?	☐ Y ☐ N ☐ N/A		
All rejected welds documented?	☐ Y ☐ N ☐ N/A	**Safety**	
Any serious welding non-conformances today?	☐ Y ☐ N ☐ N/A	Personnel alert to welding/hoisted load hazards?	☐ Y ☐ N ☐ N/A
		Minimum personal protective equip/apparrel plus full face shield for Welder Helpers?	☐ Y ☐ N ☐ N/A
		General safety rules followed?	☐ Y ☐ N ☐ N/A
		Any safety hazards/incidents today?	☐ Y ☐ N ☐ N/A

CATEGORY	☐ Yes ☐ No	REMARKS

Start Welding Time	End Welding Time	

Name (print)	Signature	Date	Hours Worked

It is recommended that the owners/operators meet with construction contractor's key management personnel to demonstrate the owner/operators commitment to comply with project specifications and procedures. Another objective of this meeting is to ensure that when procedures are applied collectively they will achieve the specification's requirements. This includes a commitment that changes or variations to specifications and procedures will only be undertaken using the terms of change management, variances, and change orders specified in the contract. It is recommended that documents reviewed during this meeting should be managed under document control, with version/revision, and be dated, including drawings. The work products of the meeting should be revisions that reflect agreements made and committed to in the meeting. Parties should check the revisions and confirm that they are in agreement.

It is recommended that the owners/ operators should define personnel responsible for interactions with US Department of Transportation, Pipelines and Hazardous Materials Safety Administration (PHMSA) personnel as well as local and state officials. The PHMSA Regional Director appreciates notification of a project, an overview schedule, and project updates to allow them to plan for inspections. It is advisable to

invite PHMSA personnel to qualification of welding procedures and qualification of welders and provide periodic updates.

6.2 Construction Initiation

This subsection provides "how-to" guidance for use during the commencement of construction. The owner/operator should communicate to the contractor the specifications and procedures applicable to the project. This information should be communicated through written documents but also may be communicated through meetings so that the contractor may ask clarifications and the owner/operator may assess the contractor's understanding.

There are two key steps:

- A first step is for the owner/operator and contractor to conduct an on-site meeting prior to commencement of construction with key project personnel of the construction contractor to reconfirm commitment to comply with contract specifications and procedures approved for the contract, and that changes or variations to specifications and procedures will only be undertaken using the terms of change management, variances, and change orders specified in the contract. With this and all other suggested meetings, it is recommended that a record of attendance be kept.
- A second step entails having this same type of meeting with the contractor, subcontractors, the chief inspector and lead inspectors. The purpose of the meeting is to review key aspects of the specifications and procedures to ensure that everyone has a common understanding. It is not intended that this be for the purposes of training. This meeting can include ensuring that contractor employees whose primary language is Spanish have access and understand project requirements.

Contractor is responsible for ensuring that job requirements are communicated to subcontractors. Job books are put in the hands of personnel conducting the work.

This is an important meeting because it provides the opportunity to reinforce critical elements of project execution, application of procedures, inspection and testing. It is important to recognize that contractors, subcontractors and inspection personnel may have recently come from another job where the specifications, procedures or both may have differed, for valid reasons. This particular meeting provides an opportunity for personnel to raise questions and ensure that they understand the key elements of the specifications and procedures that relate to the work they will be doing. A contractor should discuss and reinforce the process it has defined for raising issues and problems identified by construction personnel and inspectors, and the process for resolution.

Depending upon the size of the job, there may be value in a third set of meetings led by subject-matter experts (SMEs) from or working on behalf of the owner/operator. Topics that may warrant meetings to provide project-specific training include:

- Welding
- Tie-Ins
- Coating, including repairs of mill-applied coating
- Lowering-in, including limits to ensure conformance with conditions development of alternate acceptance criteria for mechanized welding, among others.

In this third meeting, the SME reviews pertinent contract specifications and the key steps in the applicable procedures. Examples can include:

- Use of pre-heating for welding and how one demonstrates that the desired temperature has been achieved (what the procedure allows and examples of what it does not allow),
- Specification on how much of a first pass must be completed before internal clamps can be removed,
- Specifics on when post-weld heat treatment is required and how that can be undertaken (e.g.- blanketing),
- Specification of surface preparation and pre-heating for girth weld coating application, and
- Specification of allowable coatings to be used for repairs, including conditions for use of each, where there are multiple coatings.

This also provides an opportunity to reinforce the management and storage of consumables such as coatings, welding rods, flux and other materials. There is value in reinforcing that inspectors will be observing management and storage practices for conformance with manufacturer and owner/operator specifications, as applicable.

An SME may choose to have a manufacturer's representative involved in meetings. This has been found to be invaluable on jobs where conditions may change during a day or over the course of construction. It provides inspectors and contractors the opportunity to ask questions that relate to the fundamentals of the work and reinforce critical steps and application of materials by the manufacturer.

Depending on the size job and the number of inspectors and contractors, the owner/operator may elect to conduct a separate meeting with inspectors prior to a meeting with inspectors and contractors. The owner/operator may elect to hold a separate meeting with inspectors for other reasons as well, especially if it is the first time an inspector has worked with this owner/operator. The owner/operator should stress that the inspector's job is to ensure conformance with each step of the procedure.

6.3 Oversight during Initial Construction

This subsection provides "how-to" guidance for use during initial construction. During the initial work in each stage of construction, the owner/operator or contractor assigns SMEs to observe work conducted. The purpose of observation during initial construction is to observe inspection as well as work being conducted to ensure that procedures are being properly implemented.

On large projects, SMEs also are available as a resource for inspectors and contractors as questions or issues arise. It also serves as an opportunity to reinforce key steps in procedures. Examples include:

- Ensuring that spoil does not spill over onto landowners property outside of the temporary right-of-way,
- Ensuring that line pipe is handled properly during stringing and lowered in carefully to preclude damage to coating,
- Placing emphasis on the importance of pre-heating for welding,
- Ensuring that the required anchor profile is achieved by grit blasting prior to applying field coatings, among others.

SMEs also should review daily reports produced by inspectors to verify completeness and identify possible problems and non-conformances as they arise. SMEs can work directly with an inspector and contractor to address problems and ensure that they are promptly addressed, precluding their proliferation on the project.

Examples of the kinds of problems being identified include use of non-conforming consumables in welding, non-conforming repair coatings such as use of patch stick when it is not specified in procedures.

An SME also should observe storage and management of consumables, checking items such as specified material conformance with specification, expiration dates and storage of consumables to maintain their integrity.

6.4 On-going Oversight during Construction

This subsection provides "how-to" guidance for use during ongoing construction. Inspectors on a construction project provide a constant means of monitoring quality, in effect, quality control. Periodic oversight, including unannounced visits, provides a means of assuring quality. The purpose of periodic observation is to observe inspection as well as work being conducted to ensure that procedures continue to be implemented per specifications and procedures. There is an additional benefit that the SME is available as a resource for inspectors and contractors as questions or issues arise. It also serves as another opportunity to reinforce key steps in procedures.

In addition, when away from construction, or a portion of the construction, SMEs can review daily reports and reports of construction performance (refer to Section 4, Performance Evaluation and Continuous Improvement) to identify non-conformances or potentially adverse trends in performance. Examples include:

- Increase in weld reject rates, and the cause or set of causes for the weld rejects, and,
- Indications of challenges in applying procedures or difficulties in conducting work as reflected in daily reports.

Maintaining close contact through use of daily reports and performance reporting enables problems and adverse trends to be addressed and corrective action taken as they arise. The owner/operator may wish to deploy an SME to directly address problems or adverse trends, depending upon their severity, and even prevalence.

6.5 Oversight near Project Breaks and Restarts

This subsection provides "how-to" guidance for use in those instances where a construction project approaches a break; e.g., a holiday weekend or spring break. Experience indicates that people may let their attention waiver and potentially lose focus. The owner/operator or contractor may want to apply additional vigilance as the break approaches. Examples include:

- Deployment of SME or other personnel to meet with the chief inspector and senior inspectors to emphasize the importance of maintaining vigilance, including personnel safety as the break approaches.
- Deployment of SMEs to observe inspection and work on all or selected steps being executed.
- Rechecking of settings and calibration of equipment and changes in conditions that may require modifications.

Time on site during construction prior to a break provides an additional benefit that the SME is available as a resource for inspectors and contractors as questions or issues arise. It also serves as another opportunity to reinforce key steps in procedures.

When inspectors and crews return to begin construction, the owner/operator may conduct an initial meeting to review progress and work to be conducted with the restart. The purpose of the meeting is to review key aspects of the specifications and procedures for remaining portions of construction to ensure that everyone has a common understanding. This is an important meeting because it provides the opportunity to reinforce and reemphasize critical elements of project execution, application of procedures, inspection and testing. This particular meeting provides an opportunity for:

- Personnel to raise questions and ensure that they understand the key elements of the specifications and procedures that relate to the work they will be doing.
- A commitment that changes or variations to specifications and procedures will only be undertaken using the terms of change management, variances, and change orders specified in the contract.
- The contractor to discuss and reinforce the process it has defined for raising issues and problems identified by construction personnel and inspectors, and the process for resolution.

6.6 Construction Close Out

This subsection provides "how-to" guidance for use in the project close out. Owner/operators should consider the use of a project closeout checklist. This is a practice in use by many INGAA Foundation owner/operators. The checklist ensures that all items specified in the contract are completed and important records, such as as-built drawings and critical records, such as hydrostatic test records, are retained. An exemplary practice is to require completion of the checklist and sign-off by a project manager designated by the owner/operator. Great care must be taken to perform QA/QC of project completion documents. They should be checked and verified as part of the closeout process to ensure that checklists become the end in and of themselves.

6.7 Special Considerations for EPC/Turn Key Contracts

This section provides "how-to" guidance for use in those instances where a construction project is done under an EPC contract or is done turnkey. In general, the prime contractor takes on the responsibilities for oversight described above. The owner/operator may specify a different approach and in that case, the owner/operator should clearly define roles and responsibilities for both inspection and oversight. It is important that the owner/operator convey responsibility and accountability to the prime contractor and clearly define the expectations of inspection, testing and oversight. The owner/operator may consider use of a variation of Appendix C in the contract to ensure its expectations are clearly defined. The owner/operator may then review the specific terms of the contract and its version of Appendix C in a meeting in awarding the contract, and possibly again, at a project kick-off meeting.

With EPC contracts, the owner/operator typically places greater reliance on progress performance reports and on establishing specific observable KPIs. The content and frequency of reporting should be specified in the contract. The content should include specific measures to be used and the basis for performance in accordance with the contract as well as mechanisms for identifying adverse trends and their mitigation.

7.0 Audit, Performance Evaluation and Continuous Improvement

This section addresses performance evaluation, auditing and continuous improvement. Auditing within a management system is an evaluation of conformance with processes, and in this instance, the governing documents for the project. Performance evaluation is evaluation of the quality of the execution of processes, and in this instance, execution of work using the governing documents. They both provide a basis to improve the quality of the project as well as the C-QMS. The findings and corrective actions defined from audits and performance evaluation serve as a basis for continuous improvement.

7.1 Audit and Evaluation

An audit is the examination of conformity with the C-QMS, including governing project documents, such as owner/operator specifications, drawings, references to company standards and international consensus standards, and owner/operator-specific procedures. An evaluation looks beyond conformance and is an assessment of the effectiveness C-QMS in meeting quality objectives. The outcome of an audit or evaluation is findings and recommendations, and corrective actions to address the findings.

Consideration should be given to conducting audits and evaluations during the course of a project. There may be value in conducting an audit early in construction to ensure that adequate controls have been defined and implemented. Activities selected for audit can be based on importance with respect to the construction of the scope of work. Project performance can be a factor in defining if and when to conduct audits and evaluations. The size and duration of the project are other factors to be considered. The prevalence of non-conformances should be considered in defining the need for an audit or evaluation. An audit should be conducted upon the completion of a project.

Audits and evaluations can be conducted in a tiered fashion, as follows:

1. Evaluating procedures, processes and work practices being used on the project, i.e., "*what the owner/operator or contractor expects to be done.*"
2. A second tier entails interviews and observations of inspectors and personnel conducting work, i.e., "*what is actually being done*," and
3. A third tier entails review and evaluation of completed documentation, i.e., "*what you can show that you do.*"

Audits can be performed using checklists developed from the governing documents, such as applicable procedures and technical and quality requirements.

An audit is performed by external professionals or internal personnel not involved in the construction project. Evaluations rely on a formal process and are typically performed by management and subject matter experts within the owner/operator's organization, the engineering contractor for the project, as applicable, or an independent firm with expertise in construction. Project partners or investors may wish to conduct an audit.

Audit findings and corrective actions are part of periodic management reviews of the C-QMS. The review of the C-QMS should involve identifying response times for addressing identified findings and defining corrective as well as preventive actions. The management responsible for the area being audited or evaluated should ensure that corrective actions are implemented. The results of internal audits and the status of corrective actions should be reported in the management review. Records of audits and evaluations should be maintained as specified in the owner/operator's specifications. The cost of audits should be defined and built into the overall project cost.

NOTE: ISO 19011 provides additional guidance on performing management system audits.[14]

7.2 Performance Evaluation

Performance evaluation involves measurement (collection), analysis, and assessment. Performance measures, sometimes referred to as indicators or KPIs, provide the means to measure. There should be KPIs defined for each step in the construction process. It is recommended that the owner/operator consult with the contractors, the Chief Inspector and lead inspectors of particular trades on target levels of KPIs.

The thoughts of W. Edwards Deming provide a starting point for selecting measures, i.e., "You can't manage, what you can't measure." The purpose of having measures is to manage and to improve. Quality impacts may be latent, and so KPIs should include those that reflect a commitment to preventing non-conformances and eliminating rework. However, there should be KPIs that address non-conformances to facilitate corrective actions. KPIs like weld repair rate above a certain level, require corrective action and in some instances evaluation of derivative measures such as the cause of the repair, i.e., lack of fusion, porosity, etc. KPIs need to reflect changing circumstances, such as work on slopes and changes in weather, including temperature changes/fluctuations and precipitation.

The owner/operator should define the frequency of measurement for each of the KPIs according to their determined specifications. Likewise, the frequency of analysis and assessment should be defined. The owner/operator should employ trend measurements by comparing daily, weekly and monthly trends against target levels.

KPI's for the overall performance of the project (budget, schedule, compliance of contractual obligations and of general owner/operator requirements) are good quality practices for project management and control. As an example, Project Management Dashboards are a recommended quality practice to ensure that all aspects of a project are measured and corrective action taken by project managers early on, before deviations can have a major impact on project results. Furthermore, cumulative project results can be tallied for top management to assess and have a clear measure "real-time" of project performance from the business and contractual management viewpoints.

Case Study – Performance Measurement – Quality Incident Reporting

The practice entails establishing an environment where reporting is encouraged. The process includes project-level reporting of incidents and semi-weekly calls to communicate and discuss incident, trending, and corrective and preventive measures. This owner/operator adapted a process developed for personnel safety.

The use of control charts may be of value for large projects and those of a relatively long duration (e.g., greater than three months). Control charts provide a means to identify adverse trends before they become critical.

[14] Guidelines for auditing management systems. International Organization for Standardization. http://www.iso.org/iso/catalogue_detail?csnumber=50675

The objective of assessment is to identify adverse trends and deviations or exceedances of target values. The owner/operator or contractor should define a frequency of measures assessment. The frequency is often a function of the nature of change in measures; measures that change frequently should be evaluated frequently, as much as daily depending on the circumstances. Measures that change infrequently can be assessed with a longer interval between assessments.

Case Study – Performance Evaluation

The construction contractor has personnel (subcontractor) assigned to manage control of documents used to provide input to performance measurement, e.g., welding log, coating inspection forms. A leading practice is to have the personnel manage document control, review documents, to collect and aggregate data, conduct analyses and compare data to target values. The job of simply receiving and electronically filing documents is expanded to evaluate quality and identify non-conformances, raising them to the Chief Inspector.

Case Study – Nonconformance Reporting

Consistent and centralized nonconformance reporting (NCR) is a key procedure to ensure all formal requirements are consistently met, identify trends across the company and understand the root causes of such issues, to determine appropriate preventive and corrective actions and systematically implement them across the organization (proactively rather than reactively), and to enable continual improvement in project management processes and procedures. As well, an effective method of capturing NCRs needs to be established.

One additional consideration is the value of capturing and recording all non-conformances, including those corrected during construction. There may be situations where the data are skewed because corrected non-conformances are not reported; yet a non-conformance still happened. They can be coded differently i.e. NCRFC for NCR field corrected. Having the data to track NCR's is important. An example of a NCRFC is coating of a girth weld improperly applied, recognized through inspection, and repaired.

Deviations or exceedances of target values are reported to the Chief Inspector so that the underlying cause can be identified and corrective action taken.

7.3 Management of Change

In order to ensure quality, construction projects should include a procedure for management of change (MOC). For MOC, the owner/operator or contractor shall identify the potential risks associated with the change and any required approvals prior to the introduction of such changes.

Management of change should address:

1. technical,
2. physical,
3. procedural, and
4. organizational changes to the system, as well as
5. corrective action resulting from audit

Whether permanent or temporary, the process should incorporate planning for each of these situations and consider the unique circumstances of each.

An MOC process includes the following:

1. Reason for change
2. Authority for approving changes
3. Analysis of implications
4. Acquisition of required work permits
5. Documentation
6. Communication of change to affected parties
7. Time limitations
8. Qualification and training of staff

Application of the MOC process should be documented and communicated. The utilization of checklists and forms for proper following of change procedures is a recommended quality practice in construction projects.

7.4 Continuous Improvement

Continuous improvement of a C-QMS includes the use of quality planning (policy, objectives), audit and inspection results, analysis of data, corrective and preventive actions and management review. Collecting, processing and sharing lessons learned also are a recommended practice.

The PDCA cycle is a commonly recommended continuous improvement quality tool for an organization to utilize to ensure the QMS, and all aspects involved in the quality processes, that ultimately have an impact in the bottom line of a business enterprise (as a consequence of the cumulative results of all construction projects it has completed) are managed in perfect alignment with the company's business plan, objectives and customer requirements.

Figure 2 provides an illustration of such the PDCA cycle as applied to the continuous improvement of a Quality Management System.

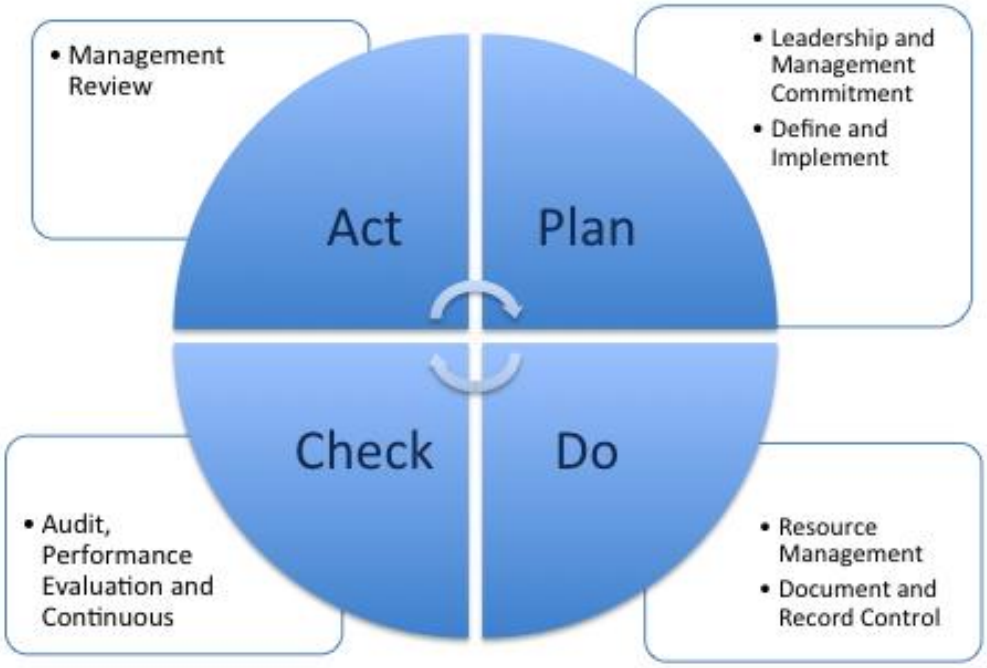

Figure 2 – Construction Quality Management System Applied To Plan, Do, Check, Act

Corrective actions from audits and performance evaluation provide a basis for continuous improvement. Corrective actions ultimately should become preventive actions, reducing, and ultimately, precluding non-conformances. The owner/operator or contractor should look beyond the immediate remedy and evaluate what can be changed in the process to improve it. Changes can be viewed in the way MOC is addressed.

8.0 Document and Record Control

Documentation and recordkeeping are an essential part of a C-QMS. The sections that follow define control of documents and records. Documentation and record keeping is a vital part of ensuring quality during all phases of the project. This is critically important as they are often viewed as adjunct functions that fulfill an obligation of a management system.

Documentation is a key component of a successful project. Examples include:

- Inspectors Daily Reports,
- Records of training and qualification,
- Hydrostatic test documentation,
- Equipment calibration logs, and
- Project diaries, among others.

Documentation should be reviewed for adequacy of content and completeness.

The owner/operator working with the construction contractor should assign responsibility for quality of as-received material as an integral step in reviewing as-received documents and creating records. First, materials received for the project should be accompanied by documents serving as a record of their conformance with the specifications. Documents that accompany materials should be reviewed to confirm their conformance with the project specifications.

Case Study – Review of As-Received Documents

The construction contractor has personnel (subcontractor) assigned to manage control of as-received documents. A leading practice is to have personnel managing document control also review them to confirm conformance with specifications. The job of simply receiving and electronically filing documents is expanded to evaluate quality and identify non-conformances, raising them to the Chief Inspector. For example, when valves are received the bill of lading is reviewed to ensure that the number of valves and serial numbers is correct. Material test reports (MTRs), typically scanned and stored in an electronic filing system, are compared with the project specifications for valves. The ANSI rating on the valve is compared to the ANSI rating specified. For special class valves, accompanying documents are reviewed to ensure that they state the valve is special class that the additional requirements of special class valves such as hydrostatic testing are present. For factory bends, documents are reviewed to ensure that an MTR is present. The MTR is then reviewed to ensure that all of the parameters in the owner/operator's specification are present on the MTR and meet the requirements of the specification. In this way, personnel responsible for document control are identifying non-conformances before they are moved to the project and installed.

8.1 Management and Control of Documents

Project documents should be managed and maintained in conformance with the owner/operator's specifications, and as applicable, the owner/operator's procedures. Documents should be:

- Identifiable and locatable
- Controlled (in a system, with version number, date and signatures, as applicable
- Distributed as specified

- Legible and complete
- Undergo periodic review
- Accessible when needed
- Maintained in accordance with the owner/operator's specifications and removed from use when obsolete, and marked as such if retained for legal or other reasons.

Approval and change of documents should be done in conformance with the owner/operator's or contractor's specifications. Documents should be reviewed for adequacy prior to issue and use.

8.2 Control of Records

The owner/operation should provide a definition of the records to be provided. Records should be controlled in conformance with the owner/operator's specifications and as applicable, the owner/operator's procedures. Controls and responsibilities should be defined for:

- identification,
- collection,
- storage,
- protection,
- retrieval,
- retention time, and
- disposition of records.

Records should be established and controlled to provide evidence of conformity to requirements and the pipeline operator's pipeline safety management system.

Case Studies – Control of Records

A leading practice developed by a Foundation member is use of project close out checklist. Records from the project are delivered to the manager of records. The manager reviews the records provided, and ensures that compliance with specifications and project requirements. A construction project cannot be closed until records manager confirms that all records have been delivered.

Another member provided a build on this practice by having project records transferred to records personnel project records so that records can be reviewed as they are developed. This should enable completion of project closeout checklist in a timely manner.

Records should be managed so they remain:

- legible,
- identifiable, and
- retrievable.

Records should be retained in accordance with the operator's specifications, operating procedures and applicable regulatory requirements.

9.0 Summary

This document provides practical, "how-to" guidance for pipeline construction projects. It utilizes the structure of the Foundation white paper, entitled Overview of Quality Management Systems - Principles and Practices for Pipeline Construction, May 2012. Specifically, it provides guidance for the elements defined in the referenced white paper. The elements are:

- Leadership and management commitment
- Resource management
- Defining and implementing a C-QMS Audit, performance evaluation and continuous improvement
- Document and record control

As is the case with all guidance developed by the INGAA Foundation, members are encouraged to review and evaluate the guidance, and adapt and incorporate it as is appropriate for their needs. Each owner/operator, construction contractor or subcontractor will need to review and evaluate these guidelines and adapt them to their own C-QMS. Then these systems must be coordinated on individual projects as needed.

Appendix A
Process Used To Develop the Guidelines for Implementing a Construction Quality Management System

The Foundation developed these Guidelines for C-QMS through a series of steps. The first step entailed a review of the similar quality management processes and procedures contained within other management systems (e.g., Operations, Health Safety & Environment and Integrity Management programs), as well as current standards, guidelines, and company practices from other sectors of the oil and gas industry (e.g., refining, exploration and production). P-PIC searched for similar types of programs and documents available through consensus standards organizations, research organizations and regulatory guidelines or standards. Foundation Members were asked for model quality management practices and processes to help develop a set of leading practices. P-PIC developed a summary of the findings of the research and they are reflected in case studies throughout these guidelines.

A second step involved a "workgroup session." The workshop session was facilitated by P-PIC and included presentations and discussions by the steering team and Foundation members. The goal of the first session was to identify key processes and procedures for implementing the core elements of a CQMS along with any practices and experiences that will help develop a more complete understanding of the strengths, weaknesses, and challenges of current practices. Practical examples were shared, discussed, and included in the Guidelines. Based on the collective expertise of the participants gleaned through the initial workshop session, P-PIC created and distributed a draft of proposed guidelines.

The third step involved the collection, sorting and organizing of the leading practices and experiences found in the document search and expressed in the first workshop, which are reflected as case studies in this document.

The fourth step involved a second "workgroup session." The second workshop was facilitated by P-PIC and was focused on a review of draft guidelines, as well as a discussion of issues raised by steering team members. In addition, the workshop session devoted time to identifying any additional relevant practices, processes and procedures as well as measuring support for those previously identified items.

The final step was compilation of the Guidelines. The members of the INGAA Foundation as well as the INGAA Pipeline Construction, INGAA Foundation Safety and the INGAA Pipeline Safety Committees reviewed the draft.

Appendix B
Design and Engineering
(Per ISO 9001:2008)

As stated in the Introduction, the scope of this guidance addresses the steps involved in construction of a pipeline, as this is where many of the quality-related problems occurred. There is no question that design, development of specifications, engineering, constructability reviews and permitting are critical to a projects' success. While design and engineering are not addressed within these guidelines, this appendix provides the process established within ISO 9001 for consideration.

Design Control

Contractor/Owner/operator shall follow the following process to ensure quality in Design Control:

- Design Planning:
- Definition of the design stages
- Review, validation and verification of the design
- Definition of responsibilities and authorities for the design

Communication:
Contractor/owner/operator shall ensure smooth communication occurs among the parties and groups involved in the design. Owner/operator shall make sure contractor and its subcontractors are given sufficient time in advance to analyze design drawings to ensure constructability is verified with sufficient time in case changes are necessary. Subcontractors, such as, but not limited to HDD contractors shall also have the possibility to review and verify design drawings and calculations with sufficient time so as to ensure no delays occur due to changes needed in the engineering and design of the project.

The inputs of project design shall include:

- Functional and performance requirements
- Regulatory requirements
- Information derived from previous designs
- Any other essential requirements

The above-mentioned inputs shall be reviewed for adequacy and documented.
The outputs of project design shall comply with the following requirements:

- Meet the input requirements
- Provide information for purchasing and all aspects of constructions
- Contain acceptance criteria
- Shall be approved prior to be issued for use
- Shall be documented
- Shall be verified against the original design

Design Review

The goal of the design review stage shall be to assess the results of the design meet requirements of the project. Ideally, record of this design review stage should be kept.

Design Verification

The design shall be checked to verify that it meets the input requirements, and records of the verification process should be kept.

Design Validation
Validation of the design shall be performed to ensure its constructability, for all different scopes of the project. Records of validation should ideally be kept.

Control of design revisions and changes
Revisions shall be identified, documented and recorded. Changes shall be reviewed, verified and approved prior to issue for use. Assessment of changes shall include, but not limited to the impact of such changes on the project.

Appendix C: Quality Control in Construction of Natural Gas Transmission Pipelines

Construction Step	Description	Applicable Consensus Standard	Applicable Regulations	Training/ Qualification	Inspection Frequency	Inspection Type
Preconstruction Planning and Design	Including Corridor Analyses, Initial Surveys and Route Selection	INGAA Foundation Guidelines for Parallel Construction of Pipelines, Rev 1	18 CFR 380.15; FERC's Wetland and Waterbody Construction and Mitigation Procedures (Procedures) and the FERC's Upland Erosion Control, Revegetation and Maintenance Plan (Plan).	Personnel trained and work using procedures	Plans reviewed and approved by FERC	Hold
			49 CFR 192 Subpart G - General Construction Requirements			
Design of Line Pipe and Appurtenances	Design of line pipe, valves, fittings, etc.	Design as per API 5L, 6D. ASME B31.8, MSS-SP-75	49 CFR 192 Subpart C - Pipeline Design	Design bases approved by registered professional engineer	Design basis and documentation subject to review during design and construction and ultimately, PHMSA audit	Review, Witness and Audit Available to FERC and PHMSA staff
	Transport of pipe	Transportation as per API 5L1, 5LW and Company procedures by truck (API 5L is developing RP for truck transport)		Personnel trained and work using procedures	Inspection of loading and unloading on large orders	
	Protection From AC Interference during construction	IEEE Standard 80		Design bases approved by registered professional engineer		
Clearing and Grading of Right-of Way, and Erosion Control		Common Ground Alliance Best Practices	Applicable State One Call Regulations	Locators that also perform O&M tasks are Operator Qualified	Continuously or as needed during clearing and grading; industry leading practice is to have an inspector observing all ground disturbances	Witness, work stoppage when unsafe conditions are deemed to exist
		INGAA Foundation Guidelines for Parallel Construction				

Appendix C (Continued): Quality Control in Construction of Natural Gas Transmission Pipelines

		API 1166 - Recommended Practice on Excavation Observation				
Construction Step	**Description**	**Applicable Consensus Standard**	**Applicable Regulations**	**Training/ Qualification**	**Inspection Frequency**	**Inspection Type**
Trenching			OSHA 1926.651 - Trenching Requirements	Personnel trained and work using procedures	Continuously or as needed during clearing and grading; industry leading practice is to have an inspector observing all trenching	Witness, work stoppage when unsafe conditions are deemed to exist
			OSHA 1926 Subpart P, Appendix B - Sloping and Benching			
Stringing		ASME B31.8, Section 841.251	49 CFR 192.307 - Inspection of materials and 49 CFR 192.309 - Repair of steel pipe	Personnel trained and work using procedures	Continuously or as needed	Witness, work stoppage when unsafe conditions are deemed to exist
Pipe Bending		ASME B31.8, Section 841.23 and other constraints defined within B31.8	49 CFR 192.313 Bends and elbows	Personnel trained and work using procedures	Continuously or as needed	Witness, work stoppage when unsafe conditions are deemed to exist
Welding	General	API 1104	49 CFR 192.225 - Welding Procedures including Qualification of Procedures; 49 CFR 192.227 - Qualification of Welders	49 CFR 192.227 - Qualification of Welders	Industry leading practice is 100 percent of welds. Regulations require NDE on 10 percent of welds in Class 1, 15 percent in Class 2 and 100 percent in Class 3 and 4, and crossings unless impractical and then 90 percent is minimum.	Hold
	Manual	API 1104				
	Mechanized	API 1104 including Appendix A				
Coating	Corrosion coating of girth welds, and abrasive resistant overlay (ARO) for crossings	Company Coating Specification including min., nom., and maximum	49 CFR 192.461 - external corrosion control; protective coating;	Personnel trained in applying FBE and industrial coatings; given site specific training on job	All coating including girth welds is inspected by jeeping at the end of lowering into trench	Hold
		NACE RP-0394-94				
	Surface cleaning and anchor pattern	NACE No. 1/SSPC-SP 5 or No. 2/SSPC-SP10				

Appendix C (Continued): Quality Control in Construction of Natural Gas Transmission Pipelines

Construction Step	Description	Applicable Consensus Standard	Applicable Regulations	Training/ Qualification	Inspection Frequency	Inspection Type
Lowering Pipe In Trench	Inspection of coating and pipe prior to and during lowering	ASME B31.8, Section 841.252	49 CFR 192.325 - Underground clearance; 49 CFR 192.461(c) with respect to coating	Personnel trained and work using procedures	Continuously or as needed	Witness, work stoppage when unsafe conditions are deemed to exist
	Inspection of ditch bottom and contour to make sure no stress on pipe	ASME B31.8	192.319(a) to ensure the pipe is protected and minimize stresses			
Tie-Ins	Making welds connecting line pipe to crossings or interconnects to other pipelines	API 1104		49 CFR 192.227 - Qualification of Welders		Hold
Padding	Ensure that padding is provided to prevent damage to pipe from resident rocks and other materials	ASME B31.8	192.319 (a) and (b)	Personnel trained and work using procedures	Continuously or as needed	Witness
Backfilling	Ensuring that coating is not damaged during backfilling and regrading	ASME B31.8	49 CFR 192.319(b) for backfilling requirements and 49 CFR 192.461(c) with respect to protecting coating during backfilling	Personnel trained and work using procedures	Continuously or as needed	Witness
	Provide sufficient cover over the pipeline	ASME B31.8	49 CFR 192.327			
Testing	Pressure testing of the pipeline system	ASME B31.8, and Appendix N	49 CFR 192 Subpart J	Personnel trained and work using procedures	All line pipe is pressure tested	Hold, test failure requires removal of pipe
Cleanup and Restoration			FERC's Upland Erosion Control, Revegetation and Maintenance Plan (Plan)	Personnel trained and work using procedures	As specified in company approved plans	Witness
Environmental Mitigation Monitoring	Ongoing environmental mitigation and monitoring	18 CFR 380.16 - Environmental reports for Section 216 Federal Power Act Permits	FERC's Wetland and Waterbody Construction and Mitigation Procedures (Procedures) and the FERC's Upland Erosion Control, Revegetation and Maintenance Plan (Plan).	Personnel trained and work using procedures	As specified in company approved plans	Witness
Cathodic Protection	Install appropriate number of test stations, design and install CP system	ASME B31.8	49 CFR 192.455	Personnel Operator Qualified and work using procedures	As needed	Witness

Post-Construction ILI and Above Ground Surveys	In-line inspection of pipeline for dents and metal loss, and above ground surveys (such as CIS and DCVG) to identify low potentials and coating damage.	API 1163, NACE RPs define methods and how to implement		Personnel trained and work using procedures	At the completion of construction. Anomalies identified addressed by construction contract can be remediated under cost of contract.	Witness