APPENDIX B
Corrosion Management System Framework and Guidance

B.1 INTRODUCTION

A framework for a Corrosion Management System (CMS) for assets is described in this Appendix. The CMS developed shall include and document the following, which are discussed in more details throughout this framework:

- Defined asset corrosion management objectives and personnel accountabilities.

- Processes to establish and maintain the appropriate asset organizational structure.

- Processes to establish and maintain the appropriate competency of internal and contracted personnel.

- Processes to facilitate and verify corrosion management throughout the asset life cycle.

- Processes to prevent, detect, mitigate, and eliminate near-misses and non-compliances with corrosion management procedures, specifications, regulations, and referenced standards.

- Assessment of the achievement of corrosion management objectives throughout the asset life cycle.

- Methods to measure each process's effectiveness and enact continual improvement of the CMS.

Guidance

This framework can be utilized to develop a stand-alone CMS or to integrate corrosion management into an organization's existing management system. Additionally, some processes covered in this framework may already be implemented by an organization, for example, MOC. Existing processes may be modified to address the corrosion concerns identified in this framework.

B.2 SCOPE

This framework is applicable to organizations that manage assets affected by the risk of corrosion. The framework should be used to aid in the development of an organization-specific CMS.

B.3 TERMS AND DEFINITIONS

The following terms and associated definitions are utilized throughout this framework document.

1. Audit - a systematic, independent and documented process for obtaining records or information and evaluating it objectively to determine the extent to which a set of policies, procedures, or requirements are fulfilled.

2. Corrective Measure – an action taken to respond to the corrosion situation thereby limiting adverse consequences (i.e., actions taken to rectify an existing situation).

3. Inspection - an evaluation for conformity by observation and judgment accompanied, as appropriate, by testing and/or measurement.

4. Monitoring - a continuous, albeit not necessarily constant and complete, observation of parameters of a process. The intent of monitoring is to allow personnel, such as an inspector, to observe the activity or request performance data as needed.

5. Preventive Measure – an action taken to eliminate the causes of a potential corrosion issue in order to prevent occurrence (i.e., actions taken to prevent a situation from occurring. For instance, actions arising from a risk assessment or near miss).

6. Qualification - an activity or process carried out to demonstrate that a procedure, material, or technology is able to fulfil specified requirements. This is typically associated with an extended volume and modified scope of testing, as compared to normal production.

7. Near Miss – an event where the asset was not affected, but had the potential to be affected. An example of a near miss is an inspector stopping an improper backfilling task as the machinery operator is about to commence. A near miss is often a situation or event that may not be known to others outside the activity or project. If not attended to at an early stage, near misses can develop into actual corrosion issues.

8. Nonconformance – failure to follow a standard, specification, procedure, plan, etc., or non-fulfillment of a requirement contained in such document.

9. Audit Finding - a nonconformance, observation, or improvement opportunity identified during either internal audits or external audits conducted by third parties or auditors.

10. Incident – an undesired event that adversely affects integrity. These could include damages or failures, failures to meet corrosion management standards in the absence of damage, complaints that were caused by conformance to substandard procedures or specifications, or failures to comply with appropriate procedures or specifications.

11. Improvement Proposal – an action identified by the organization or suggested by an employee or contractor that may lead to an improvement in the organization's corrosion management standards, performance, or effectiveness of the CMS.

12. Corrosion Management System – A systematic approach designed to manage an organization's objectives, policies, procedures, and processes with regards to corrosion.

13. Supervise - to observe and direct the execution of a process, activity, or task.

14. Verification - an examination to confirm that an activity, product, service, or document is in accordance with specified requirements.

15. Witnessing - the presence at and observation of a defined and specified event or test. Work shall not proceed until the inspector is available to witness the event. This is equivalent to a "hold point" in the production. The inspector may, however, in advance inform in writing or through a formal minute of meeting that his/her presence is not required.

B.4   ABBREVIATIONS

CMS   Corrosion management system

MOC   Management of change

NACE   NACE International, formerly National Association of Corrosion Engineers

B.5   GENERAL

B.5.1   Corrosion Management System

A CMS shall be developed, implemented, maintained, and continually improved by the company in accordance with this framework document. An organization's CMS shall include requirements for suppliers, contractors, and subcontractors to verify that corrosion management requirements are met over the life cycle of the asset, as applicable.

B.5.2   Approach

The development, implementation, maintenance, and continual improvement of a CMS shall be achieved using a "process approach" by performing and documenting the following:

1. Identification of the asset processes and activities that require management over the life cycle of the asset.

2. Identification of the interactions between various asset processes and activities.

3. Determination of the criteria and methods required for the effective execution and monitoring of these processes.

4. Determination of the resources required to execute and monitor the CMS processes, as well as the assurance of the availability of necessary resources.

5. Measurement, monitoring, inspection, and analysis of these processes and activities.

6. Implementation of the activities required to achieve continual improvement.

7. Additional information regarding CMS implementation is presented in Section B.8, below.

B.5.3   Documents and Records

Guidance

For the purpose of this framework, a "document" contains plans or instructions for what actions will be performed. Documents can be continually improved and examples include the CMS manual, specifications, procedures, and inspection forms. Alternately, a "record" shows proof of compliance with a document's requirements at a single point in time. Examples of records include meeting minutes, training records, and inspection reports.

B.5.3.1   General

The organization shall assemble, manage, and maintain the following major types of documentation and records:

1. Documented requirements for the ways in which the organization expects each element of the management system to be met. These requirements may be included in a document such as a CMS manual or written management system and should include the following:

    a. CMS policy and objectives.

    b. Roles and responsibilities.

    c. Requirements of each CMS element outlined in this framework.

    d. Any additional organization-specific requirements, as applicable.

2. Supporting documentation and records to demonstrate conformance with the CMS requirements, including:

    a. Procedures.

    b. Planning, operation, and process control documents.

    c. Records.

The organization should perform a needs analysis to determine which records and documents should be retained, both for regulatory or legislative reasons, as well as to conform to organization requirements. In addition to maintaining records and documents, the organization shall store the information in an appropriate manner, i.e., in a format that allows usability, reliability, authenticity, and preservation.

Guidance

Suggestions for the minimum required documentation and records are contained in Table B-1 for a selection of the CMS and asset-level processes. This table is not all-inclusive.

Table B-1. Minimum Considerations for Documentation and Records Requirements

Element	Requirement
CMS Scope	• Document the applicability of the Corrosion Management System as it pertains to the organization and its assets. Include the types of assets that do fall under this scope as well as any exclusions that may not. • Identify links to other programs that connect to or incorporate pieces of the CMS.
CMS Policy and Objectives	• Document the organization's policy on managing corrosion risks during asset life cycle and the objectives the organization strives to achieve through the CMS.
CMS Records and Documents	• Document the methods used for managing CMS records and documents. • Maintain an index of the records and documents that contain information that is relevant to, or used in conjunction with, the CMS. • Identify the person or role responsible for maintaining and approving documents and records related to the CMS and its associated activities. • Establish and document the review process to confirm that the documentation/records meet those requirements and are complete and reliable.
Management of Change	• Develop and implement a management of change process for changes that have the potential to affect corrosion of assets or the ability of the organization to manage corrosion. • Verify the MOC process procedures are in place to address and document corrosion-related changes. • Define and implement performance indicators for management of change. • Document risks associated with changes that are managed through the MOC process and the ways in which they could potentially affect the organization.
Management Responsibility	• Document management's responsibilities and accountabilities related to maintaining and supporting the CMS as well as activities associated with verifying corrosion management.
Contractor and Supplier Responsibility	• Document the responsibilities of contractors and suppliers as they relate to producing and providing services, products and equipment. • Define the organization's expectations of contractors and suppliers as they relate to corrosion management activities. Verify a process is in place to communicate the expectations in a written agreement.

**Table B-1.   Minimum Considerations for Documentation and
Records Requirements (continued)**

Continual Improvement	• *CMS Audits:* • *Document the requirements for how, where, and how long CMS audit reports should be kept.* • *Maintain CMS audit reports in a manner that allows for efficient retrieval and access by authorized personnel.* • *Verify there is a way to demonstrate that the results of audits are communicated to, and agreed with, those who were audited, communicated to management, included in the management review process, and followed-up through to completion.*
	• *Findings and Recommendations:* • *Document the method(s) for tracking findings and recommendations, their associated corrective actions, and the process for closure of the items.* • *Maintain records of recommendations and closure of recommendations* • *Document the process for consulting with and informing appropriate personnel about corrosion issues and findings from audits and management reviews.*

	Learning from Events:
	
	• *Establish procedures for investigating and reporting incidents as well as near misses.*
	
	• *Document the feedback loops and methods for communication to potentially affected organization and contractor personnel.*
	
	• *Document the requirements for what should be included in incident and near miss reports, such as, but not limited to, the following:*
	
	   ○ *A description of what occurred*
	
	   ○ *Initial actions taken*
	
	   ○ *An evaluation of potential severity and probable frequency of recurrence*
	
	   ○ *Identification of root cause(s)*
	
	   ○ *Need to notify regulatory authorities*
	
	• *Recommended corrective and/or preventive actions to prevent recurrence*

	Monitoring and Measurement: • *Define, document, and track performance indicators for the written CMS and associated critical activities.*

B.5.3.2   Control of CMS Documents

The organization shall establish procedures for the control and dissemination of CMS documents, including:

• Identification of documents that are required for the effective implementation of the CMS.

• Identification and review of documents that require access control and/or distribution control.

• Approval of documents, including assurances of legibility and accessibility.

• Identification of the current revision of each document, including procedures for removal of obsolete/invalid documents from circulation and use.

- Maintenance of documents, including back-up and archival of critical or obsolete documents.

Guidance

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

B.5.3.3   Control of Records

The organization shall establish procedures for the control of records that demonstrate compliance with and the effectiveness of their CMS. Such records are generated as part of the CMS process and a system should be created to identify, organize, and retain these records.

Guidance

Examples of applicable records include:

- *Management review records.*

- *Contracts and contract review records.*

- *Correspondence and meeting minutes.*

- *Design review, verification, and validation records for new and acquired assets.*

- *MOC records.*

- *Descriptions of approved suppliers and contractors.*

- *Engineering/technical inquiries and associated responses.*

- *Traceability records, including equipment tag numbers and lists.*

- *Qualified processes, equipment, and personnel.*

- *Training records.*

- *Inspection and test records.*

- *Asset drawings.*

- *Nonconformance reports and records of subsequent actions.*

- *Internal and external audit reports.*

- *Records for monitoring and measurement activities.*

- *Standard formats and templates.*

B.5.4　Management of Change

The CMS shall include a MOC process to control, evaluate, verify, and validate technical and administrative (non-technical) changes to the design, contracting, procurement, manufacturing, fabrication, construction, operation, maintenance, or upgrade of assets, as well as changes to the CMS itself. Each MOC request must be approved prior to implementation. The review of such changes shall include evaluation of the effect each change or suite of changes can potentially have on corrosion management.

Guidance

The MOC process should identify the types of changes to be managed, provide a means of verifying the process is consistently utilized, and include metrics to determine if changes are being evaluated as intended by the CMS. Each change should be evaluated based on the significance of the change, the need, technical basis, and expert evaluation of the risk associated with the change. Utilizing this information, authorization to proceed with the change should be determined.

It is critical that the MOC is effectively communicated to all impacted parties to facilitate effectiveness. Additionally, records of MOC reviews and any necessary actions should be maintained as part of the MOC process. Any action items should be addressed as outlined in Section B.9, below, and tracked to closure.

Management of technical changes associated with the asset should be conducted to verify engineering regulations, codes, and standards are being met and to take into account ways in which the change can affect the corrosion risks and management. Appropriate subject matter experts should evaluate whether the risks associated with the change have been identified and understood by parties who can affect the risk or be affected by it and whether the risks have been mitigated or addressed appropriately.

B.5.4.1　Managing Administrative Changes

Changes to the written CMS document, as well as other associated administrative processes, procedures, and requirements shall be managed to determine the effects they may have on asset integrity.

When managing changes to the written CMS, the requirements for Continual Improvement, discussed in Section B.9, below, shall be followed as outlined in the CMS document. In addition, the effect the change may have on the organization's risk profile, risk tolerance, corrosion philosophy, and other corporate standards shall be evaluated with the change.

Guidance

The organization should verify the MOC process manages changes that can affect the following, at a minimum:

1. *Approved supplier, contractor, and vendor lists.*

2. *Supplier, contractor, and vendor agreements and contract terms.*

3. *Procurement practices and requirements.*

4. *Contractor management practices and contractor oversight requirements.*

5. Engineering standards.

6. Material and design specifications.

7. Operational plans.

8. Supplier/contractor requirements.

9. Construction and installation practices and procedures.

10. Safe work practices.

11. Inspection, mitigation, and maintenance procedures.

12. Spare parts requirements.

13. Modifications to operating philosophy or procedures.

14. Changes in the designation of key personnel responsible for specific work scope items, decision making, or communication requirements.

B.5.4.2 Managing Temporary Changes and Exceptions

The CMS shall include requirements for managing temporary changes to construction, inspection, mitigation, operation, or maintenance plans and procedures, temporary exceptions to the CMS requirements, and exceptions to specifications. Although temporary in nature, these changes shall be evaluated to determine if they present a risk to asset integrity, operation, personnel safety, or environmental safety.

Guidance

The following listing provides examples of temporary changes; however, it is not intended to be a complete listing:

1. *A temporary change to an operational plan due to maintenance activities.*

2. *An exception to a material specification resulting from a shortage of the material.*

3. *A local exception to the procurement requirements resulting from limited choices in vendors.*

B.5.4.3 Learning from Events

Following continuous improvement activities, such as external complaints, incident investigations, near misses, non-conformances, audits, improvement proposals, or planned assessments, the organization may suggest changes to improve the CMS or corrosion management processes. Prior to the implementation of suggested changes on currently on-going projects, the MOC process, as described in Section B.5.4, shall be utilized to minimize the likelihood that the change will adversely affect the asset integrity.

Guidance

Suggested changes may come from either internal or external events. For example, an organization may choose to improve their CMS following a public corrosion incident experienced by another organization.

B.6 MANAGEMENT RESPONSIBILITY

The organization is responsible for:

- Conformance to regulations.

- Conformance to standards of the industry.

- Conformance to organization specifications.

- The ability of the asset to perform the intended function on a sustained basis in a safe and environmentally sound manner.

When utilizing contractor services, the organization shall verify the CMS and associated project specifications/requirements are followed by the contractor.

Guidance

The corrosion management should be consistent with the espoused principles. Therefore the organization has the responsibility to put into place a CMS with sufficient definition to manage corrosion over the life cycle of assets. The organization must verify:

- *Employees and contractors have the ability to design, procure, build, commission, acquire, operate, maintain, update, and decommission assets safely within their scope.*

- *Suppliers provide materials and equipment that meet requirements.*

- *Construction, operation, and maintenance meets or exceeds commonly accepted industry standards as supplemented by organization or project specifications.*

- *Control of the asset is maintained through competent asset management.*

- *The installed asset meets the standards and specifications through inspection and testing.*

B.6.1   Management Commitment

Management shall commit to developing, implementing, and continually improving the effectiveness of the CMS. This is achieved by:

- Establishing the corrosion management policy and its objectives.

- Communicating to the entire organization the importance of meeting all statutory, regulatory, and organization requirements.

- Having a written statement describing the management's approval and support of the CMS.

- Conducting management reviews.

- Confirming the availability of resources.

- Preventing conflicts between budget and asset integrity.

- Identifying and documenting organization requirements in applicable orders, contracts, and specifications.

Guidance

Implementing and utilizing a fully-functional CMS will require additional up-front costs and staffing. However, these additional costs will promote integrity and may reduce operational and repair costs over the life of the asset. Management should be committed to providing the required resources.

B.6.2 Policy

The organization shall establish a corrosion management policy. This policy describes the organization's intentions with regards to managing corrosion risks utilizing a CMS; it shall:

- Be appropriate for the purpose of the organization and aligned with the organization values.

- Provide for a framework for establishing and reviewing corrosion management objectives.

- Be managed through a management review process.

- Be communicated and understood within the organization.

- Be reviewed on a regular basis for continuing suitability.

B.6.3 Communication

Communication processes must be established which facilitate awareness, understanding, and acceptance of the CMS and associated processes and procedures throughout the organization, as well as by contractors and other external stakeholders. Critical communications that require action should be tracked through completion.

Guidance

Channels should exist to allow communication to flow from management to asset/field personnel and vice versa.

B.6.3.1 Internal Communication

Internal communication links management, employees, and other internal stakeholders. The attainment of the corrosion management goals depends on successful communication. The communication process should allow for employees to give feedback and provide possible solutions to issues. Key communication processes include:

- Establishment, communication of, and adherence to best practice.

- Learning opportunities from ongoing activities, near-misses, and incidents.

- Effective MOC communications.

- Clear communication of roles, authorities, and responsibilities.

B.6.3.2 External Communication

The external communication process shall include:

- Sharing of organization requirements and expectations.

- Sharing of best practice.

- Learning opportunities from ongoing activities, near-misses, and incidents.

- Key contacts and elevation plans for technical and non-technical inquiries.

- Approval processes for subcontracting or other contractual changes.

B.6.4   Organization

B.6.4.1   Responsibilities and Authorities

The responsibilities and authority of each role in the organization with respect to the CMS or construction project shall be defined and documented. The responsibilities and authorities for each role shall be communicated throughout the organization to promote awareness.

Guidance

In addition to the defining of responsibility and authorities, minimum training and competency requirements should be established for all roles and should include criteria that must be met in order to hold a given role. Competency and training requirements should include assessments that verify that individuals have the knowledge and experience needed to perform the required tasks and make informed decisions. Additional information on training and competency can be found in Section 1.1B.7.2.1, below.

B.6.4.2   CMS Management Representatives

A management representative shall be appointed within each appropriate organizational unit to:

- Promote the establishment, implementation, and maintenance of processes needed for the CMS.

- Apply lessons learned from similar activities or assets.

- Communicate to management regarding the performance of the CMS and need for improvement with regard to their organizational unit.

- Facilitate the promotion of awareness within the organization as a whole.

B.6.5 Management Review of CMS

B.6.5.1 General

A management review shall be defined and carried out at the frequency necessary to promote the continuing effectiveness of the CMS, examine current issues, and assess opportunities for improvement. Additionally, continual improvement activities, conducted by individual or cross-functional groups, should be reviewed. Management reviews shall be documented.

B.6.5.2 Review Input

The management review input shall include information relative to the performance of the CMS and detection, mitigation, and resolution of corrosion risks or issues. In addition, the review shall consider the potential effect of external influences on corrosion management requirements.

Guidance

The management review input information should include but may not be limited to the following:

- *Nonconformances.*

- *Status of preventive and corrective actions.*

- *Follow-up actions from previous management reviews.*

- *Changes in the organization's operational environment that could affect the CMS including the requirements for additional or revised resources.*

- *Audit results.*

- *Overall performance of the CMS and opportunities for improvement.*

- *Changes in applicable regulatory requirements or applicable industry consensus standards.*

B.6.5.3 Review Output

The output from the management review shall include any actions related to:

- Corrective and preventative measures taken or planned.

- Reallocation or supplementing of resources.

- Redefinition of responsibilities or changing organizational details.

- Changes to procedures and/or documentation practices to meet changes in organization specifications and/or regulatory requirements.

- Changes to policy.

- Setting new objectives and initiating actions to improve the CMS, processes, and procedures.

Guidance

The format of the review output should be determined by the organization. Additionally, a process should be implemented to track the completion of any required actions.

B.7 RESOURCE MANAGEMENT

B.7.1   Provision of Resources

The organization shall determine the resources required to develop, document, implement, manage, supervise the application of, and continually improve the CMS.

Guidance

Those resource requirements may be met by providing a combination of organization staff and contracted, supplemental staffing.

B.7.2   Human Resources

B.7.2.1   Training and Competency

The organization is responsible for developing, documenting, implementing, managing, supervising, and continuously improving a program that trains personnel to meet the requirements of the CMS and other applicable organization standards, specifications, and regulations in a safe and environmentally responsible manner. Applicable training and competency requirements shall be applied to both organization personnel and contractor/supplier personnel responsible for the CMS system and for all life cycle stages with corrosion management activities, including design, procurement, manufacturing, fabrication, construction, operation, maintenance, or upgrade of assets. The training and results of competency testing shall be documented and retained according to organization or regulatory requirements.

Guidance

Competency may be measured by organization-administered testing and/or job demonstration, external certification programs, or a combination of both. Consideration should be given to periodic retesting or re-certification.

Training and competency verification programs should be defined for the personnel performing work, which may be employed by the organization, contractor, or supplier, and should include:

- *Determining the competency needs for critical job activities.*

- *Determining the best mechanism for developing the competency, for example a combination of classroom training, practice on mock-ups, and specified amount of on-the-job training under the supervision of a qualified individual.*

- *Determining the most effective method of evaluating the competency and an acceptable assessment metric.*

- *Determining a re-training and evaluation protocol for those who don't demonstrate adequate competence or who later demonstrate unacceptable work quality after having been judged to be competent.*

- *Setting appropriate levels of differentiation between training and evaluation requirements for experienced employees and contractors compared to the needs of new employees with developing skills or employees in new positions.*

- *Identifying mechanisms for supplemental or revised training and evaluation to address changes in existing procedures or addition of new procedures.*

- *Measuring the effectiveness of the training by comparing work performance to competency evaluation results.*

- *Determining the need for periodic evaluation or auditing of work performance.*

- *Setting training, evaluation, and auditing result documentation formats and requirements.*

Competence evaluations can take many forms; examples include written examinations, oral examinations, demonstrations of competence, previous job experience, on the job evaluations by an "expert" in the task, the results of previous evaluations, or a combination thereof.

B.7.2.2   Contractor Services

The organization shall develop, document, apply, and refine processes at specified intervals to verify that contractor services meet or exceed the requirements of the CMS. The same considerations should be applied to the qualification of any subcontractors used by the contractor. The contractor shall be responsible for verifying the subcontractor meets the requirements of the CMS.

The organization shall define and document performance standards and communicate those to the contractor. The contractor and organization shall jointly define a suitable method and frequency of audits and performance monitoring and the manner in which the contractor will support the monitoring and assessment of contractor performance.

B.7.3   Infrastructure

The organization shall identify, provide, and maintain the infrastructure required to support the effective implementation of the CMS.

Guidance

The infrastructure, which is either provided directly by the organization or a contractor, should include:

- *Access to required power and water resources.*

- *Project management, supervision, and supporting services workspaces including related office technology.*

- *Construction, testing, and inspection equipment and technology.*

- *Space or facilities for other supporting services, if applicable, including temporary housing, food services, employee parking, etc.*

B.7.4   Work Environment

The organization shall identify and manage the environmental, human, organizational, and security factors of the project working conditions that could inhibit the ability to meet the requirements of the CMS.

Guidance

Examples of pertinent factors include, but may not be limited to:

- *Work schedules, including consideration of likely commuting distances and availability of local food and housing resources.*

- *Weather conditions (temperature, wind, and precipitation).*

- *Naturally occurring environmental hazards (unstable slopes, susceptibility to flooding, poisonous vegetation, dangerous animals, etc.).*

- *Restrictive limitations on work activities a result of endangered species, contentious landowners, or other considerations.*

- *Labor/management and reporting relationships.*

- *Relationships between inspectors or auditors and the production supervision.*

- *Ease of access to additional resources, including subject matter experts or other technical support, additional or replacement equipment, or additional labor.*

- *Access to emergency response resources (medical, fire, hazardous material release, etc.).*

- *Security of asset, materials, and equipment against theft and damage.*

B.8 CMS ASSET IMPLEMENTATION

Section B.8 describes the activities that directly support effective implementation of the CMS for an organization's assets. The processes and procedures for the implementation of the corrosion management plans and activities shall:

- Be consistent with the corrosion management policy, strategy, and asset objectives.

- Ensure that costs, risks and asset performance are controlled across the asset life cycle phases.

B.8.1 Life Cycle Considerations

The organization shall establish, implement, and maintain processes and procedures for the implementation of its corrosion management plans and activities across the life cycle of the asset, including:

- Design, procurement, building, and commissioning.

- Acquisition of existing assets.

- Operation, maintenance, and update of assets.

- Decommissioning and/or disposal.

B.8.2 Legal and Regulatory Requirements

The organization shall establish, implement and maintain processes or procedures for identifying, complying with, and communicating the legal, regulatory, statutory and other applicable corrosion management requirements.

B.8.3 Corrosion Risk Management

The organization shall identify the corrosion risks, or probability of events and their consequence, over the life cycle of each asset. Risks should be managed through monitoring, controlling, or minimizing the probability and/or consequences. Effective corrosion risk management relies upon the ability to identify potential sources of deviations or deficiencies and then to develop strategies to prevent or mitigate each.

B.8.3.1 Implementation of Corrosion Management Activities

Formal processes and procedures applicable to corrosion management activities include consideration of the following topics:

- Description of the objective.

- Identification of the responsible and accountable organizational element.

- Identification of resource requirements including training, qualification, or certification requirements for organization staff, contractors, manufacturers, or suppliers, where applicable.

- Documentation and record keeping.

- Management of change.

- Review and validation practices to verify consistency with applicable regulations, standards, and organization policy and procedures.

- Objective performance measurement targets and measurement methods.

- Scope and frequency of inspections and audits to verify that the objectives are being met, with feedback to a continuous improvement process.

Guidance

The information provided below includes an example of a corrosion management activity: cathodic protection (CP) system installation for an onshore pipeline. This information should not be considered all-inclusive, however the table provided below may be used to assist the organization to develop a corrosion management plan for this activity. The table includes the following information:

- *Potential corrosion management risks that may be encountered during the activity.*

- *Recommendations for improved corrosion management.*

- *Training and competency requirements for personnel performing the activity.*

- *Inspection requirements.*

- *Training and competency requirements for the personnel performing the inspection.*

- *Applicable records.*

Additional plans should be in place for the other life cycle stages of the CP system, including operation, maintenance, upgrading, and decommissioning.

Table B-2. Considerations for the Development of a Corrosion Management Plan for Cathodic Protection (CP) System Installation for an Onshore Pipeline

Potential Corrosion Management Risks	• *Creation of undesirable microstructures in the pipe at the site of local attachments* • *Burn-through of thin-wall pipe when using an exothermic welding process* • *Poor electrical and or mechanical attachment* • *Detachment of leads during backfilling* • *Failure to effectively coat the connection* • *Improper installation of impressed current anode ground beds* • *Installation of CP cables with damaged electrical insulation* • *Creation of stray current interference due to improper anode ground bed site selection* • *Reversed electrical connections between the pipeline and rectifier* • *Condition changes between design and installation leading to insufficient CP*

Recommendations for Improved Corrosion Management	• *Establish and properly qualify a written joining procedure for leads, which documents the following:*
	
	  o *Surface preparation requirements*
	
	  o *Minimum wall thickness and maximum carbon equivalent of the pipe at attachment sites*
	
	  o *Measurement of attachment site wall thickness*
	
	  o *Minimum distances from other welds, adjacent lead attachment or unsuccessful attempts to attach lead*
	
	  o *Specification of exothermic charge size range, as applicable*
	
	• *Provide slack and be aware of wire placement to minimize stress on the lead during backfilling*
	
	• *Use an approved coating and coating application procedure*
	
	• *Inspect compaction of carbonaceous backfill around anodes*
	
	• *Visually inspect and test the area where the anode bed will be installed to identify potential buried structures susceptible to stray current.*
	
	• *Perform a CP survey to identify potential stray current after installing the pipeline and the CP system*
	
	• *Verify that the rectifier is properly connected*

Table B-2. Considerations for the Development of a Corrosion Management Plan for Cathodic Protection (CP) System Installation for an Onshore Pipeline (continued)

Inspection Requirements	• *Confirmation of electrical continuity* • *Confirmation of mechanical security of attached lead wires* • *Confirmation of field coating at attachment sites*
Training/Competency of Personnel	• *Trained on organization attachment procedures for CP and corrosion monitoring systems, as well as protective coating procedures* • *Ability to take required measurements* • *Trained to perform Cathodic protection surveys to identify potential stray current interference* • *Operator Qualified to perform the task, as applicable*
Records Requirements	• *Pipe attachment report, which includes:* 　○ *Precise location of each attachment for correlation with in-line inspection (ILI) reports* 　○ *Total number of unsuccessful/successful attempts to attach the lead to the pipe* • *Coating inspection reports, including documentation of coating type, manufacturer, lot numbers, etc.*

B.9   CONTINUAL IMPROVEMENT

B.9.1   General

Organizations shall plan, manage and take appropriate measures to enable the continual improvement of the CMS as well as associated procedures and processes. Both the effectiveness of the CMS and its continued relevance to the company's organizational goals and objectives should be evaluated through this process. Improvements may take the form of changes to the overall policy, the organization objectives for corrosion management, as well as the individual elements of the CMS and their associated processes and procedures.

Guidance

The continual improvement process is an integral part of CMS, and should include management's commitment to monitor and evaluate performance measures.

The continual improvement process should follow the Plan-Do-Check-Act (PDCA) model. This continuous process of identifying and analyzing the CMS (Plan), developing ways to address issues (Do), measuring the effectiveness of actions (Check), and implementing solutions (Act) should be utilized to verify the CMS remains relevant to the business, is achieving its goal of promoting integrity, and is being improved and enhanced as needed.

The most effective way to continuously improve the CMS is to use a combination of both formal and informal processes to systematically review the existing CMS. This information can then be used to measure performance against the requirements of the management system.

The following types of processes and activities will have an impact on the ability to continually improve the CMS:

1. *Management Review and CMS Audits.*

2. *Control of Nonconformance.*

3. *Learning from Events.*

4. *Management of Change.*

5. *Monitoring and Measurement.*

B.9.2 Management Review and CMS Audits

The effectiveness of the CMS shall be continually reviewed and improved through systematic management reviews and audits of the CMS. The processes to be used for each of these activities shall be documented as part of the CMS, along with requirements for re-assessment intervals.

B.9.2.1 Management Review

Management Reviews sha/l be undertaken as set out in Section 0 of this document and should be carried out in a way that will verify the following:

1. The corrosion management policy still reflects the organization's position on maintaining integrity over the life cycle of assets.

2. The corrosion management objectives continue to support the overall organizational objectives.

3. The CMS reflects current regulatory requirements and recognized and generally accepted good industry practices.

4. Management supports the CMS.

5. Management reviews are conducted at a defined frequency, and actions are undertaken to address findings.

6. Data are analyzed in a way that will identify trends and facilitate an appropriate response to corrosion issues.

7. Previous CMS audit action items have been closed or are in the process of being addressed.

8. The organization is in conformance with the CMS.

9. The effectiveness of the CMS is being evaluated.

10. Management Review minutes are circulated to appropriate personnel.

11. The MOC process is used to facilitate the appropriate management of changes to the CMS.

B.9.2.2 CMS Audit

An audit process shall be in place to verify that the organization is evaluating the performance of the CMS. For each CMS audit, a written plan or document should include the scope of the audit, people or positions to be interviewed, checklists or listing of documents to be reviewed, and other relevant

information that will enable the auditor/audit team and audit organizer to have a common understanding of the audit's purpose. This information may be stated in a "terms of reference" (TOR) document, proposal, audit protocol, or similar and should be fit for purpose, as determined by the scope and scale of the audit.

Guidance

Careful consideration should be given to the type of audit conducted and the intended outputs of each audit. Audits of the CMS can be conducted by an internal audit function (such as a self-assessment or corporate audit) or by a third party auditor or consultant.

The CMS can also be evaluated in its entirety or by element; however, during each audit cycle, the CMS audits should determine, at a minimum, if the following are occurring:

1. The corrosion management policy is understood throughout the organization.

2. Staff understand their role in achieving the corrosion management objectives.

3. The written CMS is comprehensive and relevant to the organization's business and assets.

4. The requirements of the CMS are being met as intended.

5. Inspections are conducted on a regular basis, and actions are undertaken to address findings.

6. Preventive actions are taken to minimize the likelihood of foreseeable corrosion issues.

7. Corrective actions are taken to minimize the likelihood of a similar corrosion issue being repeated.

8. Corrosion issues are being addressed in a timely manner.

9. Lessons learned and corrosion management concerns are circulated to appropriate personnel.

10. Appropriate training is being done to enable conformance to the CMS.

11. The MOC process is used to facilitate appropriate management of changes to the CMS.

B.9.2.3   Review and Audit Reports

The CMS shall require findings or results of audits and management reviews to be reported in an appropriate form and communicated to appropriate personnel. Requirements for document control and retention time are addressed in Section B.5.3, above.

B.9.3   Addressing Findings and Recommended Actions

Documented procedures shall be established and maintained as part of the CMS to address non-conformances in an appropriate manner. Organizations should verify that procedures address the following:

1. Identifying and investigating non-conformances.

2. Determining causes of non-conformances.

3. Determining which type(s) of action(s) should be implemented – corrective or preventive.

4. Preventing recurrence of non-conformances.

5. Documenting preventive and corrective actions to be taken.

6. Implementing actions.

7. Promoting appropriate communication.

8. Reviewing the effectiveness of actions following implementation.

Both corrective and preventive actions may be used, as appropriate.

Guidance

Corrective actions should be taken to address findings such as those resulting from incident investigations, audits and management review activities. Preventive actions should be taken in response to proactive activities, such as risk assessments and near misses. Both corrective and preventive actions may take the form of, for example, revisions to procedures, development of new procedures, additional oversight, etc., all of which should be implemented as appropriate following the MOC requirements.

B.9.4   Learning from Events

Learning from events is critical to the continual improvement of the CMS. Formal, consistent, standard processes, such as incident investigations, shall be used to verify that a continuous improvement loop is in place to learn from events. In addition to formal processes, informal opportunities, such as employee concerns and impromptu feedback, should be utilized in an appropriate manner to improve the CMS.

Guidance

The ultimate goal of learning from events should be to identify necessary improvements to the CMS and associated processes and procedures. Examples of documents or activities that may be impacted include:

*   *The written CMS document(s).*

*   *Materials specifications and requirements.*

*   *Personnel qualifications, competence, and oversight.*

*   *Organization procedures for construction, installation, testing, and inspection.*

*   *Inspection and preventive maintenance schedules.*

*   *Operating philosophy and operating procedures.*

In all cases, when changes are made to the CMS, those changes shall be managed in accordance with the MOC requirements.

B.9.4.1   Reactive Learnings

The CMS shall include a process for evaluating incidents and events related to corrosion in a manner that will promote determination of the root cause of the event, incorporation of the findings into the CMS, and communication of important information to employees to maximize the likelihood that corrosion issues are not repeated.

If the root cause of a failure of an asset is determined to be corrosion, actions should be taken to determine if a similar situation could occur given the existing CMS and its associated processes and procedures. All efforts should be taken to improve the CMS, as well as related procedures and processes.

B.9.4.2   Proactive Learnings

Proactive activities, such as near miss investigations, utilize information to predict possible corrosion problems and correct them in a proactive manner. Proactive activities can be utilized to identify potential corrosion management concerns before an event occurs.

B.9.4.3   Informal Opportunities for Learning

Informal activities should also be considered as a means for capturing improvements to the CMS. Such activities may include, but are not limited to:

- Personnel concerns and suggestions.

- On-the-job observations.

- Potential improvements identified by employees or contractors through the regular use of the CMS and related procedures or documents.

B.9.5   Management of Change

The MOC process shall be utilized when making changes to the CMS as a result of any continual improvement or other activity. Changes should be communicated appropriately to personnel who could potentially be affected by the change, and any necessary training should be conducted. See Section B.5.4 above for details regarding the requirements for MOC.

B.9.6   Monitoring and Measurement

Appropriate performance metrics shall be in place to provide information that will help the organization improve the CMS and communicate pertinent information. A combination of leading and lagging metrics should be considered in an effort to provide the most effective improvement.

Guidance

Lagging metrics are derived from events that have occurred in the past, such as corrosion-related incidents, nonconformances, citations, etc. Leading indicators are those which look forward and indicate potential problems that could occur if corrective action is not taken.

Metrics should allow the organization to determine the following, at a minimum:

1. *Are appropriate controls are in place to manage corrosion risks?*

2. *How well is the organization conforming to the CMS requirements?*

3. *Are procedures that affect corrosion being followed as intended?*

4. *Is training being carried out in an appropriate manner and at appropriate intervals?*

5. *Are action items from management reviews and audits being addressed, tracked, and closed as required by the CMS?*

In addition to defining performance metrics, the organization should develop and document plans or procedures for collecting, processing, and validating the metrics, which include:

- *Organizational responsibility for collection of metric data.*

- *Required qualifications of personnel gathering and processing the metric data.*

- *Acceptable data sources.*

- *Timing limits for the collection and processing of metric data.*

- *Review and validation process for the collected and processed data to identify potential errors, and uncertainties.*

- *Required formats/systems for raw metric data retention, retrieval, and analysis, as well findings from the metrics.*