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Kinder Morgan Heartland ULC
Platte Pipeline
Trans Mountain Pipeline L.P.
Trans Mountain Pipeline (Puget Sound) LLC
Kinder Morgan Cochin ULC

June 1, 2012

Mr. Chris Hoidal
Director, Western Region
Pipeline and Hazardous Materials Safety Administration

Re: Notice of Amendment CPF 5-2012-6003M

Dear Mr. Hoidal,

In response to the above referenced Notice of Amendment Kinder Morgan Canada has made a number of revisions to Standards and Procedures to ensure compliance with the noted regulatory requirements. A summary of these amendments are included in the attached table. Copies of the amended procedures and standards are attached.

We trust that this response fully addresses the requirements of the Notice of Amendment and is sufficient to bring this matter to a close. Please contact the undersigned if anything further is required on this issue.

Sincerely,

P Huddleston

Paul Huddleston, P.Eng.
Director, Technical Services
Kinder Morgan Canada Inc.

Enclosures:
Summary of Program Amendments
Integrity Procedure 3.3 Lowering In-Service Pipelines
Safety Standard 534 Signage and Marking
Standard GC1000 Coating Selection and Specification
Standard GC3102 External Coating of Buried Piping
Procedure 3.3.3 Evaluating the Condition of Exposed Pipe
Coating Evaluation Form
Standard GC2000 Cathodic Protection
Integrity Procedure 3.4 Internal Surface Inspection of Pipeline Cutouts
GIS Standard – Pipeline Data Management

cc: Hugh Harden
Bruce Jamer
Patrick Davis
Jessica Toll

Summary of Program Amendments – CPF 5-2012-6003M

PHMSA Ref	WUTC Audit Finding w/ relevant section of CFR 49 Part 195	KMC Actions to clarify the O&M procedures to assure compliance with the referenced regulation
1	195.424 Pipe movement The requirement of section (a) to lower the internal pressure to at least 50% of MOP is not included in KM's current manual but was part of their legacy manual.	KMC developed Integrity Procedure 3.3 Lowering In-Service Pipelines which stipulates that the internal pressure must be lowered to a maximum of 50% of MOP.
2	195.434 Signs The standards for signs at facilities such as pumping stations and breakout tank farms are not in compliance. The requirement to have the name of the operator and emergency contact telephone number should be included in the procedure/manual for signs.	KMC revised the Safety Standard 534 Signage and Marking to clarify that the name of the operator and the emergency contact telephone number shall be included on signs at pumping stations, breakout tank farms and other facilities.
3	195.559 What coating material may I use for external corrosion control? The requirements for coating material properties should be included in KM's manual.	KMC updated standard GC1000 Coating Selection and Specification to clarify that coating materials for external corrosion control must: • Be designed to mitigate corrosion of the buried or submerged pipeline; • Have sufficient adhesion to the metal surface to prevent under film migration of moisture; • Be sufficiently ductile to resist cracking; • Have enough strength to resist damage due to handling and soil stress; • Support any supplemental cathodic protection; and • If the coating is an insulating type, have low moisture absorption and provide high electrical resistance. KMC also updated standard GC3102 External Coating of Buried Piping to include

PHMSA Ref	WUTC Audit Finding w/ relevant section of CFR 49 Part 195	KMC Actions to clarify the O&M procedures to assure compliance with the referenced regulation
		recently approved coatings for use on KMC pipelines.
4	195.561 When must I inspect pipe coating used for external corrosion control? The requirement of (b) you must repair any coating damage discovered, is not included in KM's current manual but was part of their legacy manual.	KMC developed Pipeline Maintenance Procedure 3.3.3 Evaluating the Condition of Exposed Pipe that stipulates that any coating damage discovered must be repaired.
5	195.563 Which pipelines must have cathodic protection? The requirement of CP to be in operation not later than one year after pipeline is constructed, relocated, replaced, or otherwise changed is not in KM's manual.	KMC developed GC2000 Cathodic Protection Standard which stipulates that cathodic protection is required to be in operation no later than 1 year after a pipeline has been constructed, relocated, replaced or otherwise changed.
6	195.569 Do I have to examine exposed portions of buried pipelines? Examining coating condition and recording it whenever the pipe is exposed is not always in KM's manual. KM is currently using the ROW Proximity form and Anomaly Report form to document coating condition along pipeline ROW. A procedure and a new exposed pipe condition report should be created.	KMC developed Pipeline Maintenance Procedure 3.3.3 Evaluating the Condition of Exposed Pipe and a complementary Coating Evaluation Report form which are to be used anytime buried pipe is exposed. The procedure also applies to the inspection of pipeline spans.
7	195.579(c) What must I do to mitigate internal corrosion? The requirement of section (c) inspecting the internal surface whenever you remove pipe from a pipeline is not included in KM's current manual but was part of their legacy manual.	KMC developed Integrity Management Procedure 3.4 Internal Surface Inspection of Pipeline Cutouts to clarify the requirement to inspect accessible internal surfaces of pipe for the presence of internal corrosion during pipeline cutouts.
8	195.583 What must I do to monitor atmospheric corrosion control? The requirement of section (b) during inspection you must give particular attention to spans over waters, is not included in KM's current manual, but was part of their legacy manual.	KMC developed Pipeline Maintenance Procedure 3.3.3 Evaluating the Condition of Exposed Pipe which requires that particular attention shall be made to the external coating condition of spans over watercourses.

PHMSA Ref	WUTC Audit Finding w/ relevant section of CFR 49 Part 195	KMC Actions to clarify the O&M procedures to assure compliance with the referenced regulation
9	<u>195.589 What corrosion control information do I have to maintain?</u> The corrosion control records retention should be included in KM's manual.	KMC developed GC2000 Cathodic Protection Standard which stipulates which corrosion control records need to be retained. The record retention period is described in the GIS – Pipeline Data Management Standard.

3.3 LOWERING IN-SERVICE PIPELINES

1.0 INTRODUCTION

1.1 Purpose

1.1.1 This procedure describes mandatory requirements for the planning and execution of line lowering projects.

1.2 Authorization

1.2.1 Line lowering shall only be performed under the supervision of a qualified Engineer.

1.2.2 An approved Facility Modification Request is required prior to lowering a pipeline.

1.3 Applicability

1.3.1 This procedure applies to the following (checked) systems:

- ☑ Trans Mountain
- ☑ Puget Sound
- ☑ Jet Fuel
- ☐ Express Canada
- ☐ North 40 Terminal

1.4 Background

1.4.1 Where areas of low depth of cover are determined to present a hazard one option for addressing the problem is by line lowering.

1.4.2 Proper execution of this procedure meets the requirements of CFR 195 and *CSA Z662*:

1.5 Responsibilities

1.5.1 **Project Engineer** – Responsible for managing all facets of the project including obtaining required approvals, completing engineering assessments, detailed design, identification and arrangement of resources, planning and execution of the line lowering project.

1.5.2 **District Supervisors** – Ensure that field personnel performing work in relation to this procedure are properly qualified.

1.5.3 **Operations Coordinator** – will assist with scheduling down time for completion of the lowering project.

1.6 Documentation

1.6.1 A completed engineering assessment is required that documents the calculations supporting the design.

1.6.2 A detailed design drawing is required.

1.6.3 A job plan is required.

2.0 DEFINITIONS

2.1 **Line Lowering** – The controlled movement of a portion of a pipeline downward resulting in a new permanent profile of the section without requiring cutting of the pipe.

3.0 EQUIPMENT

3.1 Equipment Required

3.1.1 The equipment for the line lowering will be determined by the Project Engineer and defined in the Job Plan.

3.2 Documents Required

3.2.1 Detailed Design drawings showing the planned lowered alignment of the pipeline in plan and profile shall be available at the job site.

3.2.2 The Job Plan shall be available at the job site.

4.0 SAFETY PRECAUTIONS

4.1 General Safety Considerations

4.1.1 Line lowering of a pipe section shall not be undertaken unless the section has been taken out of service, isolated and the pressure reduced to the lowest level possible. The pressure during lowering shall not be greater than 50 percent of the qualified maximum allowable operating pressure.

4.1.2 Consideration shall be given to purging or draining the section prior to lowering but purging or draining the section to be lowered is not a mandatory requirement.

4.2 Lockout/Tagout

4.2.1 The job plan shall identify requirements for isolation and shall include a table for the logging of valve movements during the execution of the line lowering.

4.3 Personal Protective Equipment (PPE)

4.3.1 PPE requirements shall be in accordance with the Safety Standards manual.

4.4 Field Hazard Assessment

4.4.1 A detailed hazard assessment shall be conducted based on the job plan prior to the start of the lowering operation. For each hazard identified, control measures shall be identified to demonstrate how the risk from the hazard is being controlled.

4.5 Other Protective/Safety Equipment

None identified

5.0 PROCEDURE

5.1 Engineering Assessment

5.1.1 An engineering assessment shall be completed in accordance with Integrity Procedure 2.1, Engineering Assessments, which demonstrates that the planned lowering can be completed safely and without imposing net strains which may affect the integrity of the pipeline section. The Engineering Assessment shall consider the following Items in the section to be lowered:

- Survey of the existing plan and profile and the desired plan and profile;
- Recommended practices described in API 1117, Movement of In-Service pipelines;
- Pipe material properties of the section to be lowered

- ILI data shall be reviewed in detail to determine the presence of any anomalies
- Presence of mechanical couplings
- Presence of bends
- Failure history
- Presence of mainline valves which will require lowering

5.2 Design

5.2.1 Detailed engineering design of the line lowering shall be completed in consideration of the Engineering Assessment.

5.2.2 Drawings shall be prepared to show the extents of the excavations including plan profile and details.

5.2.3 Work areas shall be indicated on the design drawings including the location of spoil piles and locations for required equipment such as for dewatering where necessary.

5.2.4 A schematic diagram showing the location of isolation valves and stating the maximum allowable pressure in the lowering section and how it shall be measured shall be provided.

5.3 Planning

5.3.1 Consult with potentially affected landowners, residents or groups and notify in advance of the work.

5.3.2 Make arrangements for required temporary work space.

5.3.3 Obtain any necessary environmental permits

5.3.4 Conduct one calls and complete any necessary ground disturbance or proximity permits

5.3.5 Develop a detailed Job Plan including:

- Responsibilities, and contact information.
- Weight of pipe per unit length
- List of equipment and resources
- Schedule
- Excavation plan
- Anomaly inspection requirements
- Maximum equipment spacing for safe lifting

- Communication plan
- Isolation and draining plan as required
- Flooding plan as required
- Contingency plan

5.4 Execution.

5.4.1 The on-site supervisor responsible for the line lowering shall follow the detailed design and job plan requirements. Any variation from the plan shall require advance written approval from the Project Engineer.

5.4.2 The pipeline shall be excavated in accordance with the KMC Ground Disturbance Pipeline Protection Requirements.

5.4.3 Excavate the pipeline and leave it on a shelf of stable soil or supported by other means at the required spacing. Next to this shelf, excavate a ditch matching the design profile.

If the exposed pipeline will be left on a shelf with an adjacent open excavation, consideration shall be given to maintaining ditch plugs at max acceptable spacing in case the pipe were to fall off the shelf.

5.4.4 Visually inspect the exposed coating surfaces of the pipeline. If any disbonded coating or damaged pipe is discovered, inspect, evaluate, repair and recoat the pipe before lowering the line. Any required assessments and repairs shall be completed in accordance with the KMC Anomaly Assessment and Repair Standard.

5.4.5 Excavate bell holes at all locations required for inspection of anomalies, repair of coating or installation of sling or airbag to facilitate lifting of the pipe.

5.4.6 Ensure that maximum allowable unsupported lengths as outlined in the detailed design are not exceeded.

5.4.7 Ensure that there is adequate select fill base for the new location of the pipe and that the base is continuous, smooth, and sufficiently compacted according to the design requirements.

5.4.8 Prior to lowering, communicate with the Control Centre to shutdown the pipeline. Execute the purge plan if required in consultation with the Control Centre. Confirm and log required valve movements to isolate the lowering segment according to the job plan. Confirm the pressure in the pipeline is below 50% of MOP and log the measured pressure on the job plan log.

5.4.9 When ready, begin lowering the pipe in a gradual, controlled manner while maintaining support at the required spacing indicated in the plan.

5.4.10 After lowering is completed, the line shall be fully supported along the entire trench bottom. A survey shall be completed to document the post lowering plan and profile.

5.4.11 Conduct an inspection of the lowered line to ensure that no coating or other damage occurred during the lowering operation. After any necessary repairs backfill the pipeline in accordance with the design requirements.

5.4.12 Restore the site to its original condition.

5.5 Records

5.5.1 Prepare as-built drawings and forward copies to Manager of drafting and GIS. The as-built should also include sub-meter GPS readings at tip of pipe for each girthweld.

5.5.2 Submit any anomaly reports completed on the lowered segment to Tech Services.

6.0 ABNORMAL OPERATING CONDITIONS (AOC)

6.1 General Abnormal Operating Conditions

A list of the recognition of and response to general abnormal operating conditions that may be encountered when performing this procedure is found in General Operating Procedure *3.2 Recognizing and Responding to Abnormal Operating Conditions*.

6.2 Task-Specific Abnormal Operating Conditions

6.2.1 Damage to Pipeline or Underground Utility

RECOGNIZE: The pipeline or underground utility has possibly become damaged during excavation activities.

REACT: The Technician or Inspector shall contact the CCO and have the pipeline shutdown to reduce pressure in the work area until an evaluation of damage can be determined.

RECOGNIZE: When digging for pipeline anomalies and a defect is detected which, in the opinion of the Technician, is severe enough to cause immediate concern.

REACT: The Technician or Inspector can contact the CCO and have the mainline shutdown until an evaluation of the damage can be evaluated.

6.2.2 Unexpected Hazardous Liquids

RECOGNIZE: Be aware by sight, sound, odour or the activation of hazardous atmosphere testing equipment.

REACT: Immediately evacuate the area and notify your Supervisor and/or the Control Center for possible system shutdown and isolation. Secure the area to prevent unauthorized entry. Assess the situation and isolate if safe to do so.

7.0 REFERENCES

7.1 *Industry Standards and Regulations*

- CSA Standard Z662
- National Energy Board Onshore Pipeline Regulations, SOR/99-294
- 49 CFR 195

7.2 *KMC Health and Safety Standards Manual*

- 401 Hazard Identification/Assessment & Control Program
- 527 Personal Protective Equipment
- 702 Lockout/Tagout (LO/TO)

7.3 General Operations Procedures

- *3.2 Recognizing and Responding to Abnormal Operating Conditions*

7.4 Integrity Standards and Procedures

- 3.1 Anomaly Assessment and Repair Standard
- 2.1 Engineering Assessments

534 SIGNAGE & MARKERS

1. Preamble

1.1 Accident prevention signs are widely used to ensure that personnel are aware of potentially hazardous situations.

1.2 Red and yellow ribbon or barricade tape may be used alone or with signage to limit access to a facility or piece of equipment.

1.3 Tags are temporary signs typically attached to a piece of equipment to warn of existing or immediate hazards. Tags in use by the Company include DO NOT OPERATE and DO NOT USE.

1.4 Signs, barricade tape and tags may be ordered from Stores.

1.5 Safety signs are divided into the following categories:

Danger	Used to indicate where an immediate hazard exists (e.g., **OVERHEAD HAZARD**, or **RESTRICTED AREA – AUTHORIZED PERSONNEL ONLY)**. Red oval in top panel with black or red lettering in lower panel.
Caution	Lesser hazards, (e.g., **CAUTION SLIPPERY SURFACE).** Yellow background colour.
General Safety	Provide safety instructions and suggestions, (e.g., **BE CAREFUL**). Green background on upper panel with black or green lettering on lower panel.
Fire & Emergency	Indicate direction of travel for emergency evacuation, (e.g., **EMERGENCY EXIT**). White letters on a red background or red letters on a white background.

2. Standard

2.1 Existing signs must be replaced for any of following reasons:

- the sign does not conform to standards
- the sign contains misleading information
- the sign is damaged to the extent that it cannot be easily read

2.2 Signs must have blunt or rounded corners and be free from sharp edges, splinters, burrs or other sharp projections. Fastening devices must not be located in such a way that they constitute a hazard.

2.3 Pump Station, Breakout Tank Farm, Delivery Facility, Remote Valves and Facility Perimeter Signs; require the name of the operating company (for example, "Kinder Morgan Canada Inc.") and emergency notification information, including an emergency telephone number with area code.

2.4 DO NOT OPERATE tags must be used in accordance with company lockout/ tagout procedures.

2.5 Ensure that defective tools and equipment are tagged as a temporary means to alert others.

3. References

3.1 British Columbia Occupational Health and Safety Regulation, Part 12 “Tools, Machinery and Equipment” Section 12.13-12.14.

3.2 Canada OHS Regulation, Part VII Section 7.8(1) “Warning Signs”.

3.3 Washington Administrative Code 296-155 Part E “Signalling and Flaggers”.

KINDER MORGAN CANADA INC.
ENGINEERING STANDARDS AND PRACTICES

COATING SELECTION AND SPECIFICATION

GC1000, Revision 1, April 2012

TABLE OF CONTENTS

1.0 SCOPE

This standard is a guide for the selection and application of coating systems for station and mainline applications. This standard is not a comprehensive reference on the subject of coating and coating application but it includes mandatory requirements for the selection and specification of coatings.

The performance of any coating system depends on four main components: the specification, the quality of the materials, the qualifications of the contractor and the effectiveness of the inspection. The objective of this standard is to provide some understanding of how the major elements of Kinder Morgan Canada Inc.'s coating standards address these four basic components.

2.0 REFERENCED PUBLICATIONS

Kinder Morgan Canada Inc.'s coating standards are based on the following industry standards:

API 2027 Ignition Hazards Involved in Abrasive Blasting of Atmospheric Storage Tanks in Hydrocarbon Service

NACE RP0188 Fabrication Details, Surface Finish Requirements, and proper Design Considerations for Tanks and Vessels to be lined for Immersion Service

Steel Structures Painting Council (SSPC)

PS Guide 12.00 Guide to Zinc Rich Coatings
Paint 30 Weld-Through Inorganic Zinc Primer
SP 1 Solvent Cleaning
SP 2 Hand Tool Cleaning
SP 3 Power Tool Cleaning
SP 5 White Metal Blast Cleaning
SP 6 Commercial Blast Cleaning
SP 7 Brush-Off Blast Cleaning
SP 8 Pickling
SP 10 Near-White Blast Cleaning

Steel Structures Painting Manual

Volume I Good Painting Practice
Volume I Systems and Practices

3.0 DEFINITIONS

3.1 Binder

Nonvolatile portion of the liquid vehicle of a coating. It binds or cements the pigment particles together and the paint film as a whole to the material to which it is applied. The amount of binder needed to completely wet a pigment is determined primarily by the particle size, degree of polymerization and wetting properties of the binder.

3.2 Chalking

Formation of a friable powder on the surface of a paint film caused by the disintegration of the binding medium due to disruptive factors during weathering. The chalking of a paint film can be considerably affected by the choice and concentration of the pigment or the binding medium.

3.3 Diluent

A volatile liquid which, while not a solvent for the non-volatile constituents of a coating, may yet be used in conjunction with the true solvent, without causing precipitation.

3.4 Drying

The process by which coatings change from the liquid to the solid state, due to oxidation, evaporation of the solvent or chemical reactions of the binding medium, or a combination of these causes.

3.5 High-Build Coating

Coatings that are applied in thickness' (minimum 5 mils) greater than those normally associated with paint films and thinner than those normally applied with a trowel.

3.6 Holidays

Application defect whereby small areas are left uncoated.

3.7 Resin

General term applied to a wide variety of more or less transparent and fusible products, which may be natural or synthetic. In a broad sense, the term is used to designate any polymer that is a basic material for coating.

3.8 100% Solids Coating

Also known as solventless coatings, these coatings contain no solvents and dry by chemical reaction rather than solvent evaporation.

3.9 Solids

The nonvolatile matter in a coating composition. This includes the ingredients of a coating composition that, after drying, are left behind and constitute the dry film. Also called ***nonvolatile matter***.

3.10 Solvent

The liquid, usually volatile, that is used in the manufacture of paint to dissolve or disperse the film-forming constituents. The solvent evaporates during drying and therefore does not become a part of the dried film. Solvents are used to control the consistency and character of the finish and to regulate application properties.

3.11 Substrate

Any surface to which a coating is applied.

3.12 Surface Profile

Also referred to as ***surface roughness*** or ***anchor pattern***, this is the degree of roughness of a surface to be coated. Surface profiles are measured in mils or µm (microns or micrometers) and this dimension indicates the average height, from peak to trough of a blast cleaned surface.

3.13 Stripe Coating

The pre-coating of edges and corners, prior to full coating, to provide added thickness in these vulnerable areas.

3.14 Thinner

The portion of a paint or related product that volatilizes during the during process. Any volatile liquid used for reducing the viscosity of coating compositions or components. It may consist of a simple solvent, a diluent, or a mixture of solvents and diluents.

3.15 Vehicle

The liquid portion of the paint in which the pigment is dispersed. It is normally composed of the binder and a thinner.

3.16 Wicking

The infiltration of contaminates through penetrations in coating systems provided by incompletely covered fill material, reinforcing material or other inclusions.

4.0 SPECIFICATION ORGANIZATION

Coating specifications can be broken into two major categories, shop and field applied coatings. Specifications for each coating system consist of five major sections. These include:

a) general information;
b) coating systems;
c) surface preparation;
d) application; and
e) inspection and quality control;

This organization attempts to follow the sequence of events for a typical coating application.

5.0 GENERAL INFORMATION

This section covers minimum technical requirements for coating projects. Field coating specifications that are conducted on Kinder Morgan Canada Inc's property should include:

a) minimum requirements for the supply, receipt, storage and disposal of materials;
b) minimum requirements for labour and supervision; and
c) limiting atmospheric conditions.

Items a) and b) are touched on in the contracts general conditions, but this section reinforces the technical significance. Limiting atmospheric conditions such as maximum relative humidity and minimum ambient air temperatures are included in this section indicating that no coating work should take place outside the specified conditions.

Coating material for external corrosion control must:

a) Be designed to mitigate corrosion of the buried or submerged pipeline;
b) Have sufficient adhesion to the metal surface to prevent under film migration of moisture;
c) Be sufficiently ductile to resist cracking;
d) Have enough strength to resist damage due to handling and soil stress;
e) Support any supplemental cathodic protection; and
f) If the coating is an insulating type, have low moisture absorption and provide high electrical resistance.

6.0 COATING SYSTEMS

This section stipulates the approved coating systems and the colour scheme if required. This is the main distinguishing feature of each coating standard. There are seven coating standards as listed in Table 6.0.A.

TABLE 6.0.A -- COATING STANDARDS

Standard	Application	Material	
GC3101	external, exposed	Pipe and fittings	Epoxy primer/polyurethane top coat
GC3102	external, buried	Pipe and fittings	100% solids epoxy
GC3202	external, buried	Line Pipe	polypropylene/fusion bonded epoxy
GC3401	external, exposed	Tankage	epoxy primer/polyurethane top coat
GC3501	internal	Tank Lining	polyester reinforced plastic
GC3502	internal	Tank Lining	vinyl ester reinforced plastic
GC3503	internal	Tank Lining	epoxy phenolic

6.1 GC3101

This system is the general purpose, external coating for most piping, fitting and structural steel applications. The system consists of a polyamide epoxy primer and a high build aliphatic urethane top coat. The epoxy provides excellent adhesion and the urethane provides good solvent resistance and UV protection *(epoxies characteristically chalk with exposure to UV light).* This is a high performance coating and it requires attention to detail during application. In particular, the urethane top coat has a limited window for effective overcoating the epoxy primer. The standard requires that the urethane be applied within 72 hours of the primer application. Experience has shown that if the epoxy is allowed to weather prior to application of the urethane, a poor bond will result between the two coatings. There are three recommended strategies for the application of this coating system:

a) complete all surface preparation and coating insitu; or
b) do all surface preparation and coating in the shop and touch-up on site; or
c) do the surface preparation and prime with an inorganic zinc primer in the shop and epoxy prime and shop coat in the field.

It is generally advisable to shop coat pipe and fittings and then touch-up any scratches and abrasions after final assembly. The main advantage of this approach, over in-situ coating, is that the surface preparation can be completed away from the operating environment, greatly reducing the potential for introduction of spent abrasive into piping and equipment.

The next best alternative is to complete the surface preparation in the shop and prime with 1.0 to 1.5 mdft of an inorganic zinc primer. The zinc primer will provide adequate protection for the surface preparation and at these thicknesses and is also considered weldable. The work will have to be epoxy primed in the field, but is more economical than epoxy priming the work in the shop and then epoxy priming the work a second time in the field prior to application of the urethane top coat. If more than a few weeks pass prior to coating the inorganic zinc primer, it should be high-pressure water washed prior to coating. If exposed to the elements for any length of time, zinc corrosion products will form inhibiting the adhesion of the epoxy primer.

6.2 GC3102

This is a 100% solids epoxy coating intended for coating of buried pipe and fittings. Although epoxies suffer from UV degradation when exposed to the elements, they provide excellent protection in buried or immersion applications.

This type of coating is ideally suited for shop or field coating of small quantities of pipe and fittings or piping that has been modified by thermal bending processes. Larger quantities or sizes of pipe should be pre-coated with polyethylene or fusion bonded epoxy as indicated in Appendix A of MP1110.

6.3 GC3201

This is a two coat system consisting of a fusion bonded epoxy primer and an extruded polypropylene outer sheath. The polypropylene is extruded over the epoxy immediately after its application and before it gels. The epoxy provides a strong interface between the pipe and the polypropylene, and the polypropylene is a stronger and denser coating than polyethylene.

This is a shop coating system and is therefore limited to large orders of pipe for main line applications. This type of system would not be appropriate for station drain line applications.

6.4 GC3401

This system is simply a customized version of GC3101. The urethane coatings specified for the top coat in GC3101 were specifically selected for tank coating applications. These are high build urethanes whose formulations make them amenable to either roller or spray application. This is particularly important for tank painting. Urethanes are notoriously slow drying coatings, so any overspray can be carried some distance before landing on some object that does not need coating *(ie. cars or other structures).*

Painting tank shells with rollers is less weather dependant than spray application *(windy conditions can halt spray operations*) and it eliminates overspray problems. The urethanes specified have also proven effective for over-coating existing alkyd coatings with only a high pressure water wash to remove chalked paint. There is only one urethane coating qualified for use on Burnaby tankage because Devoe is the only manufacturer that will provide a low gloss version of the urethane for the tank shell. **Note: the tank green colour specified is darker and has a lower gloss than the regular green used for valve bodies in piping systems.**

6.5 GC3501

This type of coating has been in use for over twenty years. It is a fibre-glass reinforced plastic (FRP) tank lining system. The coating consists of alternating layers of polyester resin and fibre-glass mat. The fibre-glass acts as a reinforcement for the coating, providing a strong abrasion resistant coating. This coating system is much thicker than the previously mentioned paint based systems *(50 to 65 mils versus 7 to 10 for paints).*

Polyester resins do not bond well to steel. Originally a thin vinyl primer was used to coat the steel prior to FRP application. The primer prevented the abrasive blasted steel from rusting prior to coating and was thin enough to preserve the surface profile *(surface roughness created by the abrasive blast)*. In the late 1980s this was changed to an epoxy primer specially formulated to interface between the steel and the polyester resin.

The original system relied on a mechanical bond between the steel and the resin. The newer system provides a stronger chemical bond. As a result, large sections of the older style system can disbond if the substrate is disturbed, such as when a tank encounters significant settlement.

6.6 GC3502

This coating system is identical to GC3501 except a vinyl ester resin is used in place of the polyester resin. This vinyl ester has greater chemical resistance but the installed cost can be as much as double that of the polyester. The use of this system is therefore limited to tanks used for the storage of more aggressive solvents such as MTBE.

This coating is also the preferred system for overcoating of existing polyester linings. When a change in service is required for a tank with an existing polyester lining, the lining has to be removed or overcoated. Overcoating is preferred, as removal can be costly. To overcoat, the top layer of resin or the "seal coat" is removed by abrasive blasting because it contains wax *(the wax is used as a thickening agent and it will inhibit adhesion)*. Depending on the quality of the initial installation, some hydrocarbon may have *"wicked"* into the polyester lining and it can resurface after removal of the seal coat. Some of the hydrocarbon can be removed by solvent cleaning, but the vinyl ester lining system has proven more effective at coating or *"bridging"* this type of substrate contamination than a 100% solids epoxy paint system.

6.7 GC3503

This is a phenolic epoxy that can be used for lining small vessels or tanks in water or refined products service. This system is also used on other equipment requiring an internal coating such as provers. The lining is recommended for water, crude oil and refined products, but the manufacturers specifications should be checked for compatibility with other solvents such as MTBE.

For more information on coatings see chapter 3.2 on Paint Materials, Steel Structures Painting Manual, Volume 1, Good Painting Practices.

7.0 SURFACE PREPARATION

7.1 General

The primary functions of surface preparation are to clean the surface of material that will induce premature failure and to provide a surface that can be easily wetted for good coating adhesion. The subject of surface preparation can be broken down into three areas. These are:

a) surface and fabrication defects;
b) surface cleanliness; and
c) surface roughness.

7.2 Surface and Fabrication Defects

Coatings tend to pull away from sharp edges and projections, leaving little or no coating to protect the underlying steel. Sharp edges and fillets should be ground to a smooth radius of at least 3 mm (c in.) and preferably 6 mm (3 in.). Grinding should be completed prior to abrasive blasting as grinding can make surfaces too smooth for proper adhesion of some coatings.

Most coating specifications have a clause on *"surface irregularities"* which requires that all rough surfaces, such as *weld spatter, flux slag, laminations, burred edges and sharp projections* be ground off. While this is a good general requirement it does not cover all contingencies.

a) Most coating contactors will only perform a very minor amount of grinding, so **it is important to include requirements in the fabrication specifications to cover the removal of surface irregularities** on piping and vessels. One source of recommendations for the treatment of surface defects is included in NACE Standard RP0188-91, *Fabrication Details, Surface Finish Requirements, and Proper Design Consideration for Tanks and Vessels to be lined for Immersion Service*. This standard has been attached for reference.
b) The extent of grinding should be reviewed. While atmospheric storage tanks can accept a fair amount of grinding, limits have to be

   maintained on pressure piping, pressure vessels and any welds on pressure containing enclosures. **All grinding operations should be examined by the coating inspector.**

7.3 Surface Cleanliness

Most organic coatings adhere to a surface by polar adhesion which is helped or reinforced by mechanical adhesion. Polar adhesion occurs when the coating molecules act like weak magnets and their north and south poles attract opposite groups on the substrate. This attraction is only effective at molecular distances from the substrate and films of dirt, oil and water can impair adhesion. Preparation of all surfaces usually requires some or all of the following procedures:

a) removal of any loose material such as rust or flaking paint;
b) removal of material which is tightly adhering initially but which will fail in service such as mill scale;

c) removal of inorganic soluble salts such as sodium chloride or zinc oxides;
d) removal of oils, greases and other organic materials;
e) chemical or physical modification of the substrate.

Items a) and b) will require mechanical methods of preparation, item c) will require a water wash and item d) will require a solvent wash, hot detergent or steam cleaning. Often a combination of methods is required to obtain the best results. **Oil and grease residues should always be removed before mechanical or abrasive blast cleaning since these operations are likely to spread the contamination over a wider area.**

The required degree of cleanliness is usually specified by use of a NACE or SSPC surface preparation specification. Hand and power tool specifications apply only where localized surface preparation is required, as in the removal of loose paint, loose rust or other localized surface defects. Blast cleaning specifications usually cover applications where the entire surface is to be prepared to a defined degree of cleanliness. Basic industry surface preparation standards include:

SSPC-SP 1 Solvent Cleaning
SSPC-SP 2 Hand Tool Cleaning
SSPC-SP 3 Power Tool Cleaning
SSPC-SP 5/NACE 1 White Metal Blast Cleaning
SSPC-SP 6/NACE 2 Commercial Blast Cleaning
SSPC-SP 7/NACE 4 Brush-Off Blast Cleaning
SSPC-SP 8 Pickling
SSPC-SP 10/NACE 2 Near-White Blast Cleaning

7.4 Surface Roughness

Mechanical adhesion is assisted by roughening the surface and thereby increasing the surface area on which the coating can bond. Abrasive blasting can increase the surface area two to three times that of the unblasted surface. Some coatings, such as the polyester resin used in tank linings, develop excessive shrinkage on curing and require a high surface profile *(the term used to denote the height from peak to trough of a blast cleaned surface)*. The majority of organic coatings can obtain adequate adhesion on surface profiles in excess of 25 µm (1 mil).

Another important factor of mechanical adhesion is the firmness or stability of the substrate *(unstable substrates would include mill scale, rust scale, old paint and friable, powdery layers of dirt or rust)*. Modern, fast drying, high build, high-cohesive strength coatings such as epoxies applied by spray, put greater stress on the adhesive bond during drying and curing than older brush applied, slow drying, highly penetrating materials.

8.0 APPLICATION

Although there are several methods of application, the three most common are brush, roller and spray.

8.1 Brush Application

Application of paint by brush is most commonly used for maintenance painting (to avoid overspray) or small areas of new construction. The brush acts as the means of transfer from the storage container to the work and as the actual method of application. The main disadvantage is the slow rate of application. However, taking into account the time saved on masking, cleaning, etc. the overall rate of application is much better. Brush coating is generally used for "stripe coats" along edges or corners.

8.2 Roller Application

Roller application is particularly suited to coating large flat surfaces such as tank shells. Rollers can provide application rates up to four time faster than those achieved by brush. Rollers are not generally recommended for high build coatings because it is difficult to control film thickness with this method. In spite of this short coming it is the preferred method for the application of urethanes on tank shells as it eliminates the overspray problems.

8.3 Spray Application

8.3.1 Airspray Application

Their are two basic methods of spray application, airspray and airless. Airspray was the first type of spray equipment developed to provide speedier application of paints. With airspray application, also referred to as *"conventional"* spray application, compressed air is used both to atomize the paint and carry it to the surface to be painted. The volume of air required to atomize a given volume of paint is considerable. This feature makes airspray less efficient because of the large volumes of air needed and the high degree of overspray that occurs. Airspraying can be efficiently used in automatic plants and in properly designed spray booths, but it is less efficient for field applications.

8.3.2 *Airless Application*

In airless spraying, the paint is forced through a small jet so that it reaches the velocity required for atomization and a spray of droplets is produced. As there is no expanding compressed air to disperse the fluid particles, most of the paint adheres to the work surface, greatly reducing paint overspray. This results in a faster rate of application than conventional methods *(up to twice that of air spraying)*.

An airless spray gun looks similar to that used for air spraying, except it does not have a paint reservoir or a connection for compressed air. The gun is connected by a hose to a pump which forces the paint to the tip at pressures from 12,500 to 35,000 kPa. Since the airless system does not require compressed air to atomize and deliver the paint, the potential for water and oil contamination from the compressed air system is eliminated. Although airless spray application is preferred, the high pressures involved present a safely hazard. The main advantages of airless over airspray are:

a) higher output;
b) less paint fog, or rebound;
c) ability to apply thick films in a single pass;
d) coatings often require no thinning before application;
e) an operator can place the feed pump at a remote location and only a single line is required for connection to the gun.

The main disadvantages of airless over airspray are:

a) higher equipment costs;
b) greater safety hazard;
c) it cannot be used for all types of paint;
d) inorganic zinc-rich primers and other highly abrasive paints are not generally suitable for airless spray application;

TABLE 8.3.A -- SUMMARY OF PAINT APPLICATION METHODS		
Application	**Method**	**Coverage (m_2/day)**
small areas	Brush	100
large flat areas	Roller	200 - 400
large areas	airspray	400 - 800
large areas	airless	800 - 1200

Source: ***Steelwork Corrosion Control,*** D.A. Byliss & K.A. Chandler

8.4 Tank linings

The application of fiber-glass reinforced plastic (FRP) linings is considerably more involved than paint type coatings. The application portion of these standards consists of the following sections:

a) priming;
b) putty application;
c) lay-up of resin and mat; and
d) sealing coat.

8.4.1 Priming

This section covers the application of the primer and includes requirements for the removal of all dust from abrasive cleaning and to reblast if the cleaned steel starts to rust.

8.4.2 Putty Application

Due to the relatively high rate of shrinkage encountered with FRP coatings care must be taken to eliminate stress concentrations at sharp edges. Protruding edges should be ground and lap joints, and inside corners should have a minimum radius of at least 3 mm (1 in.). Lap joints, pits and inside corners are filled with a polyester or epoxy putty to provide the appropriate profile.

8.4.3 Lay-up of Resin and Mat

This section delineates the extent of liner application, the treatment of the striker plates, defect repair and the methodology for application of the laminate. The laminate consists of:

a) a sprayed layer of catalyzed resin;
b) a layer of fiber-glass mat;
c) more catalyzed resin to fully wet the mat;
d) a layer of surfacing veil (a finer mat used to seal the coarse layer);
e) a final layer of catalyzed resin;

8.4.4 Sealing Coat

After the laminate has cured such that intermediate holiday testing can be conducted and any repairs completed, a final seal coat of 10 to 15 mils of resin containing 2% wax is applied. Any repairs made after this application will require the removal of the seal coat layer to ensure proper adhesion.

9.0 INSPECTION

9.1 Function of the Inspector

The main objective of the inspector is to ensure that the work is carried out in accordance with the specification. The inspector does this by witnessing and documenting the coating work in a formal fashion. Aside from specification enforcement, a thorough coatings inspector provides job documentation including a commentary on: the type and adequacy of equipment at the jobsite; the rate of work progression; ambient conditions and verification that the surface preparation, coating application, coating thickness and curing are as required.

9.2 Methods of Inspection

Most coating specifications contain "hold points" or steps beyond which no further work can proceed until the approval of the inspector has been obtained. These inspection points can include some or all of the following:

a) Surface Preparation
   i. pre-surface preparation inspection;
   ii. determination of surface preparation cleanliness; and
   iii. determination of surface profile.

b) Application
   i. measurement of paint film thickness;
   ii. evaluation of surface cleanliness between coats;
   iii. detection of discontinuities; and
   iv. evaluating cure.

Aside from inspection hold points the inspector should also inspect, monitor, witness and document the following:

a) the ambient weather conditions;
b) the substrate temperature;
c) evaluation of compressor air cleanliness;
d) evaluation of abrasive media;
e) inspection of application equipment;
f) mixing of coatings; and
g) coating application.

For more information on these and other inspection points see chapter 6 on Inspection, Steel Structures Painting Manual, Volume 1, Good Painting Practice.

KINDER MORGAN CANADA INC.
ENGINEERING STANDARDS AND PRACTICES

EXTERNAL COATING OF BURIED PIPING

GC3102, Revision 3, April 9, 2012

1.0 SCOPE

This standard describes the requirements for surface preparation and application of coating materials to external surfaces on buried piping and fittings. Aluminium, stainless steel, and galvanized fittings are to be left uncoated unless specified.

2.0 REFERENCE PUBLICATIONS

The following codes and standards (latest issue) shall form part of this standard.

SSPC-PA-1	Shop, Field and Maintenance Painting
SSPC-SP-1	Solvent Cleaning
SSPC-SP-7	Brush-off Blast Cleaning
SSPC-SP-10	Near White Metal Blast Cleaning

The Manufacturer's recommendations for the use of their coatings shall be considered a part of this standard. The Contractor may intermix manufactured products but must use a specified coating system approved by Kinder Morgan Canada Inc. The Contractor shall use the materials specified in Section 5.0 of this standard.

3.0 DEFINITIONS

3.1 Contractor

Contractor shall mean the coating applicator.

3.2 Holiday

A discontinuity that exhibits electrical conductivity when exposed to a specific voltage.

3.3 Manufacturer

Manufacturer shall mean the coating manufacturer or supplier.

3.4 mdft

Units of measure for coating applications - **mils dry film thickness** (0.001 inches).

3.5 SSPC

SSPC stands for the Society of Protective Coatings.

4.0 GENERAL

4.1 Supervision

The Contractor shall have a full-time supervisor on site at all times during the course of the coating work. The on-site supervisor is expected to be completely familiar with conditions and constraints existing in the work area and shall insure that all of the Contractor's personnel are aware of potential hazards.

4.2 Materials

4.2.1 General

The Contractor shall supply all thinners, cleaning, and coating materials in sufficient quantities to complete the Work. The Contractor shall be responsible for receiving and unloading these materials. The Contractor shall keep a strict account of all materials used during the course of the Work.

4.2.2 Storage

The Contractor shall ensure that all containers are suitably stored to prevent damage to or rusting of the containers, and to preserve all identifying labels and markings. Paint, thinners, and abrasive materials in damaged or leaking containers shall be rejected and shall be the responsibility of the Contractor.

4.3 Clean-Up and Disposal

4.3.1 General

The Contractor shall store, transport, and dispose of all waste materials in accordance with all applicable Federal, State and Provincial regulations.

The Contractor shall disclose, in writing, the proposed methods of waste storage, transport, and disposal to Kinder Morgan Canada Inc.'s Designated Representative, not less than one (1) week prior to the completion of the coating work.

The Contractor shall provide written confirmation that the methods used were in accordance with the requirements listed above (including copies of manifests and disposal facility receipts), to Kinder Morgan Canada Inc.'s Designated Representative not more than one (1) week after the waste transport and disposal.

4.3.2 Abrasive Blast Materials

The Contractor shall sweep-up, collect, and place all abrasive blast materials used into appropriate disposal containers.

4.3.3 Coating Containers and Waste Materials

The Contractor shall place all waste materials into appropriate disposal containers at the end of each working day.

4.3.2 Final Clean-Up

Upon completion of the coating work, the Contractor shall ensure that the work area is in its original clean state and that all equipment and materials have been removed from Kinder Morgan Canada Inc.'s property.

4.4 Labour

All surface preparation and application shall be carried out by tradesmen skilled in the application of corrosion-resistant protective coatings.

4.5 Limiting Atmospheric Conditions

Surfaces shall not be coated when:

- The relative humidity is greater than 80%,
- The surface temperature is less than 3°C below the dew point,
- The ambient air temperature is lower than the minimum specified by the coating manufacturer
- There is a possibility that the blasted surface will be subject to wetting before the primer can be applied.

4.6 Coating Repairs

Coating repairs shall be divided into two (2) classifications. These shall be defined as major and minor repairs. A minor repair shall be an area 10 cm^2 or less and a major repair is an area greater than 10 cm^2.

5.0 COATING SYSTEM

5.1 Approved Manufacturers

The specified coating systems are listed in Table 5.1.A. Deviations are not allowed without prior approval in writing from Kinder Morgan Canada Inc. The Contractor shall specify, at the tender stage, all pre-cleaning, blasting, and coating material to be used.

TABLE 5.1.A -- COATING SYSTEMS

Coating Application	Pipe Temperature	Approved Manufacturer	Approved Product	Surface Profile, mils	Application Type	Coating Thickness (mdft)	
						Minimum	Maximum
Girth Welds, Minor/Major Repairs and Other Field Installed Components	Above 10°C	Denso North American Inc.	Protal 7200 Epoxy	2.5 to 5.0	Brush or Spray Grade	25	50
	Above 10°C	Specialty Polymer Coating	SP2888 RG Epoxy Urethane	2.5 to 5.0	Brush or Spray Grade	25	50
Valves, Valve Bodies, Irregular Shapes and Branch Connections	0°C to 25°C	Denso North American Inc.	Paste, LT Petrolatum Tape, Glass Outerwrap	N/A	Petrolatum	N/A	N/A
	15°C to 25°C	Canusa	Wrapid Bond, Wrapid Coat PVC Tape Outerwrap	N/A	Petrolatum	N/A	N/A
	0°C to 25°C	Amcorr ViscoTac	ViscoWrap ST, ViscoTaq Polyethelene Outerwrap	N/A	Visco-Elastic	N/A	N/A
Minor repairs, less than 10 cm^2	Above 7°C	Polyguard	600 Liquid Adhesive, RD-6 Tape	N/A	Textile Backed Tape	N/A	N/A

5.2 Coating Materials

Coating material for girth welds or coating repairs shall be brush or spray grade and shall be applied in accordance to Section 6.0, Surface Preparation, and Section 7.0 Application, of this standard.

6.0 SURFACE PREPARATION

6.1 Surface Irregularities

Before commencing blast cleaning, all weld spatter, flux, slag, laminations, burred edges, and sharp projections shall be ground off. Rough hand welds shall be ground to minimum 3 mm radius or to the acceptance of Kinder Morgan Canada Inc.

6.2 Pre-Blast Cleaning

All oil, grease, and other deleterious matter shall be removed by chemical cleaning with biodegradable water-based degreasers per SSPC-SP-1 prior to any preparation and / or coating application.

6.3 Blast Cleaning

All surfaces to be coated shall receive a Near White Metal Blast Cleaning in accordance with SSPC-SP-10, unless otherwise specified.

6.4 Blasting Equipment Grounding

All blasting equipment, including the nozzle, shall be electrically grounded to the work prior to the commencement of blasting. As a minimum, 12 AWG insulated flexible conductor wire shall be employed for grounding. Grounding connections shall be inspected whenever the blasting equipment is repositioned.

6.5 Blast Cleaning Abrasive

Abrasive used for blast cleaning shall be new, unused, dry, neutral PH, hard material of angular configuration, and free of dust, clay, or other foreign particles. Particle size shall range from approximately 20 to 40 mesh with a maximum of 5% retained on No. 20 U.S. Standard Sieve.

6.6 Masking

Care shall be exercised in blast cleaning to avoid damage to flange faces, nameplates, gauges, instruments, electrical controls, and coated conduit. Unless otherwise specified by Kinder Morgan Canada Inc., these surfaces shall not be painted.

6.7 Surface Contamination

Freshly blasted surfaces shall not be contaminated by workers' hands or feet.

6.8 Incomplete Blasting Prior to Coating

A 300 mm wide strip of uncoated surface shall be left between blasted and unblasted surfaces. When additional blasting is done, the 300 mm strip of previously blasted surface shall receive a light brush blast in order to remove any rust. Such cleaning shall be accomplished by holding the nozzle in a direction away from the painted surface.

6.9 Coating Contamination

Special care shall be taken to ensure that blasting abrasive or dust is not allowed to contaminate freshly applied coating. All dust and foreign matter, including insects, shall be completely removed from an existing coat before application of a new coat. Any contaminated coating shall be removed and replaced at Contractor's expense.

6.10 Re-Blasting

No more surface shall be blasted than can be coated before visible or detrimental re-rusting occurs. Blasted surfaces shall be coated by the end of the same workday or before any rust bloom occurs.

6.11 Dead Man Control

Abrasive blast nozzles must be equipped with a fully operational "Dead Man Control".

6.12 Girth Welds

Surface preparation for coating of girth welds shall be by means of blast cleaning.

6.13 Cleaning Methods for Coating Repairs

Edges of the existing coating shall be roughened to a distance of 75 mm minimum using the following methods:

- Power Brushing.
- Sweep Blasting.
- Sand Paper (60 to 80 grit).

7.0 APPLICATION

7.1 Rust Blooming

Where rusting or blooming occurs, the metal surfaces shall be reblasted to remove all rust and blooming. Surfaces must be blown free of blasting abrasives before the surface is coated.

7.2 Spray Grade – Spray Equipment

Spray equipment suitable for the intended purpose shall be used. It shall be capable of properly atomizing the coating to be applied and shall be equipped with suitable pressure regulators and gauges in good working order. The air caps, nozzles, and needles shall be those recommended by the spray equipment Manufacturer for the coating being applied.

7.3 Brush Grade (and Two Part Tube Loaded Cold Cure Liquid Epoxy)

The coating is a two-component system (activator and resin) that shall be mixed and applied in accordance with Manufacturer's application specification.

7.4 Film Continuity

All coatings shall be uniformly applied with adequate overlap, minimum 75 mm, and be free of runs, sags, holidays, pinholes, voids, mud-cracking, and other anomalies.

7.5 Compressed Air Quality

Traps or separators shall be provided to remove oil and condensed water from the air. They must be of adequate size and be drained periodically during application. The air from the spray gun impinging against the surface shall show no signs of condensed water or oil.

7.6 Air Pressure

The atomizing air pressure at the gun shall be high enough to properly atomize the coating, but not so high as to cause excessive fogging, loss of solvent, or overspray.

7.7 Film Thickness

The Contractor shall provide the tradesmen applying coating materials with wet film thickness gauges to ensure the application will result in the correct final dry film thickness.

7.8 Coating Contamination

If, in the judgement of Kinder Morgan Canada Inc., a coating's performance has been jeopardized by contact with rain, moisture, condensation, dust, or other foreign elements it shall be removed and replaced.

7.9 Overspray

Any surfaces contaminated by the Contractor with overspray or otherwise displaced coating shall be cleaned or recoated to Kinder Morgan Canada Inc.'s satisfaction.

7.10 Handling or Backfilling

No handling or backfilling shall be allowed until the coating has completely cured; cure tests shall be completed by the Contractor and accepted by Kinder Morgan Canada Inc.

8.0 INSPECTION

8.1 Contractor's On-Site Supervisor, Quality Control

For the duration of the job, the Contractor's on-site supervisor shall complete the Daily Coating / Inspection Report included within this specification or on a similar form pre-approved by Kinder Morgan Canada Inc. Ambient conditions shall be recorded a minimum of four (4) times per day or as requested by Kinder Morgan Canada Inc.

8.2 Contractor's Inspection Equipment

The Contractor must have the following inspection equipment on site: surface thermometer, psychrometer, dewpoint chart, wet mil gauge, dry film thickness gauge, cure test equipment and holiday tester.

8.3 Inspection Hold Points

The work shall be subject to inspection and acceptance of Kinder Morgan Canada Inc. before proceeding at the following hold points; these hold points shall be identified on the Contractor’s Inspection Test Plan (ITP):

- Pre-job meeting
- After blast cleaning and prior to the application of the coating
- After the application of the coating
- Final Inspection. This shall include holiday testing, cure test, and a visual examination for anomalies and film thickness measurements

9.0 SAFETY DATA SHEETS

All material brought on site shall be clearly labelled with batch numbers and other pertinent data. MSDS sheets, as required by WHMIS, are to be provided for all materials to be used on Kinder Morgan Canada Inc.’s property.

COATING / INSPECTION DAILY REPORT

SITE DESCRIPTION

Inspector:		Date:	
Customer:		Job Number:	
Area:			
Notes:			

SURFACE PREPARATION

Pre Inspection Comments	
Defects Corrected	
Pre Cleaning Method	
Equipment Used	
Comments:	

BLASTING ABRASIVE

Type/Grade of Abrasive		Spec. Standard	
Abrasive Check for: Cleanliness		Abrasive Check for: pH	

AMBIENT CONDITIONS

Condition		Time	Time	Time	Time	Time	Time
Air Temp	°C (°F)						
Wet Bulb Temp	°C (°F)						
Relative Humidity	°C (°F)						
Steel Temp	°C (°F)						
Dew Point	°C (°F)						
Wind Direction							
Wind Speed	Km/HR (mi/HR)						

ANCHOR PROFILE MEASUREMENTS

Min.		Max.		Mean		Hrs. Left Uncoated		Comments:

COATINGS

Coat	Paint Manufacturer Name & Description	Description	Batch Number	Application Method	Color	MDFT Before This Coat	W.F.T.	
							Min	Max
1.								
2.								
3.								

Coat	MDFT		Mixing	Thinning	Storage	Holidays	Defects/Comments:
	Min	Max					
1.							
2.							

3.3.3 EVALUATING THE CONDITION OF EXPOSED PIPE

1.0 INTRODUCTION

1.1 Purpose

1.1.1 The purpose of this procedure is to provide guidance in evaluating and documenting the condition of coatings on exposed sections of pipe.

1.2 Authorization

1.2.1 KMC Technicians who have been qualified by successfully completing the *Evaluating Pipe Condition (Pipeline Maintenance 2)* Skill Packet of the KMC KEEP Canada training program or have been approved by Kinder Morgan Canada based on equivalent training or experience are authorized to perform this procedure.

1.3 Applicability

1.3.1 This procedure applies to the following (checked) systems:

- ☑ Trans Mountain
- ☑ Puget Sound
- ☑ Jet Fuel
- ☑ Express Canada
- ☑ North 40 Terminal

1.4 Responsibilities

1.4.1 **District Supervisors**

- Ensure that personnel performing work in relation to this procedure are properly qualified

1.4.2 **Technician**

- Complete coating evaluation per the requirements outlined in this procedure.

1.5 Definitions

None

2.0 PROCEDURE SPECIFIC INFORMATION AND REQUIREMENTS

2.1 Requirements

2.1.1 The pipe coating condition must be examined whenever the pipeline is exposed.

2.1.2 Particular attention shall be made to the external coating condition of spans over watercourses.

2.2 Coating Inspection Guidelines

2.2.1 This section establishes the guidelines for evaluating and grading the condition of exposed piping for signs of coating failure.

Three grading scales are used to describe the condition of the coating: **Good**, **Fair**, and **Poor**.

Coating Type	Good Condition	Fair Condition	Poor Condition
Coal Tar	• Outerwrap is in good condition with no tears or breaks.	• Outerwrap shows isolated minor tears or breaks; and • No area of pipe surface is visible.	• Outerwrap has large tears or breaks; or • Any amount of pipe surface is visible.
Fusion Bonded Epoxy (FBE) or **Epoxy Urethane**	• A coating system that is well bonded and intact; or • Topcoat degradation that is limited to "chalking."	• Deterioration of the coating system where small regions of the coating show cracking, flaking, or peeling. • No regions of pipe surface are visible.	• Any amount of pipe surface is visible.

Coating Type	Good Condition	Fair Condition	Poor Condition
Tape	• Tape is in good condition with no tears or breaks.		• Tape has tears, breaks or wrinkles of any size; or • Any other signs of deterioration or disbonding; or • Any amount of pipe surface is visible.

Note

Because any flaws in tape coating can compromise its effectiveness, tape coating shall be evaluated as either good condition (meaning no detectable deterioration) or poor condition (meaning any degree of deterioration).

2.3 Documentation to be Completed

2.3.1 When evaluating the coating as part of an Anomaly Investigation, record the coating type and condition on the *Anomaly Investigation Report*.

2.3.2 When evaluating the coating as part of installing a test station, record the coating type and condition on the *Test Station Installation and Repair Report*.

2.3.3 When evaluating the coating as part of any other excavation or inspection, record the coating type and condition on the *Coating Evaluation Report*.

3.0 REQUIRED EQUIPMENT AND DOCUMENTS

3.1 Equipment Required

3.1.1 Digital camera

3.2 Documents Required

3.2.1 *Anomaly Investigation Report*, *Coating Evaluation Report*, or *Test Station Installation and Repair Report* as applicable.

4.0 HEALTH, SAFETY, AND ENVIRONMENTAL PRECAUTIONS

4.1 General Safety Considerations

4.1.1 Safety consciousness must be at the forefront of all thinking relative to all activities. Safe work procedures and processes are the first and highest priority.

4.2 Lockout/Tagout

Not required

4.3 Personal Protective Equipment (PPE)

4.3.1 Use approved PPE as required. This may include:

- Steel-toed safety footwear
- Fire retardant outerwear
- Hard hat
- Gloves
- Eye protection (available to be worn)
- Hearing protection (available to be worn)

4.3.2 Additional PPE may be required depending on the hazards anticipated.

Refer to the Safe Work Practice in KMC Health and Safety Standards Manual, Sections *527 Personal Protective Equipment* and *703 Respiratory Protective Equipment* for additional information and guidance.

4.4 Field Hazard Assessment

4.4.1 Technicians travelling to field locations must be aware of potential hazards that may be present, especially if there is potential pipeline damage. These hazards may include, but not be limited to, the following:

- Toxic/flammable vapours
- Tripping, slipping, and falling
- Traffic and heavy equipment

4.4.2 Check the work area for hazards that may cause personal injury. Correct any hazardous situations before work begins.

Additional information and guidance regarding hazard recognition and control can be found in the KMC Health and Safety Standards Manual, Section *401 Hazard Identification/ Assessment & Control Program*.

4.5 Gas Monitoring

4.5.1 Continuous gas monitoring must be done while performing this procedure.

CAUTION

If hazardous vapours are detected in the work area, proceed with extra caution following a hazard assessment approach and the guidance provided in the KMC Health and Safety Standards Manual, Section *502 Action Levels*.

4.6 Other Protective/Safety Equipment

None identified

4.7 Environmental Considerations

4.7.1 Ensure all other wastes generated by inspection and maintenance activities have been properly disposed of.

- Contact a Kinder Morgan EHS Representative with questions or concerns.

5.0 PROCEDURE

This procedure is performed on exposed pipeline, before the coating is removed or disturbed.

Refer to Pipeline Maintenance Procedure *2.3.1 Excavation*.

5.1 Evaluating Coating

5.1.1 Evaluate the condition of the coating per the criteria in section 2.2.

5.1.2 Take one or more photographs to properly record the coating condition.

For anomaly investigations:

5.1.3 Record the condition on the *Anomaly Investigation Report*.

5.1.4 Copy the digital photographs and a scanned copy of the *Anomaly Investigation Report* to the appropriate site folder.

- The site folder is located in *E:\Project\Anomaly_Reports* for Trans Mountain, Puget Sound, Jet Fuel, and North 40.
- The site folder is located in *E:\Project\Digs* for Express Canada.

For test station installations and repairs:

5.1.5 Record the condition on the *Test Station Installation and Repair Report*.

5.1.6 Email the *Test Station Installation and Repair Report*, along with accompanying digital photographs, to Technical Services.

For other inspections and excavations:

5.1.7 Record the condition on the *Coating Evaluation Report*.

5.1.8 Email the *Coating Evaluation Report*, along with accompanying digital photographs, to Technical Services.

For all excavations:

5.1.9 Any coating damage discovered must be repaired.

- Coating repairs shall be completed in accordance with Corrosion Protection Standard GC3101 for exposed piping or GC3102 for buried piping. If the repair is not completed immediately a corrective work order shall be generated for the required repair.

6.0 ABNORMAL OPERATING CONDITIONS (AOC)

6.1 Abnormal Operating Conditions

A list of the recognition of and response to non task-specific abnormal operating conditions that may be encountered when performing this procedure is found in General Operating Procedure *3.2 Recognizing and Responding to Abnormal Operating Conditions*.

6.2 Task-Specific Abnormal Operating Conditions

6.2.1 Damage to Pipeline or Underground Utility

RECOGNIZE: The pipeline may have been damaged during excavation activities.

REACT: The Technician or Inspector shall contact the CCO and have the pipeline shutdown to reduce pressure in the work area until an evaluation of damage can be determined.

RECOGNIZE: When excavating, a defect is detected which, in the opinion of the Technician, is severe enough to cause immediate concern.

REACT: The Technician or Inspector can contact the CCO and have the mainline shutdown until an evaluation of the damage can be evaluated.

6.2.2 Unexpected Hazardous Liquids

RECOGNIZE: Be aware by sight, sound, odour or the activation of hazardous atmosphere testing equipment.

REACT: Immediately evacuate the area and notify your Supervisor and/or the Control Center for possible system shutdown and isolation. Secure the area to prevent unauthorized entry. Assess the situation and isolate if safe to do so.

7.0 REFERENCES

7.1 *KMC Health and Safety Standards Manual*

- 401 Hazard Identification/Assessment & Control Program
- 502 Action Levels
- 527 Personal Protective Equipment
- 703 Respiratory Protective Equipment

7.2 General Operations Procedures

- *3.2 Recognizing and Responding to Abnormal Operating Conditions*

KINDER MORGAN CANADA

COATING EVALUATION REPORT

Date:	Technician's Name:

Location

Chainage:		km / mi.	
GPS Coordinates	Northing:		Latitude:
	Easting:		Longitude:

Description of Coating

Refer to Pipeline Maintenance Procedure *3.3.3 Evaluating the Coating of Exposed Pipe* for evaluation criteria.

Existing coating type:	
Condition of Existing Coating (As Found)	Comments:
Good ☐	
Fair ☐	
Poor * ☐	

* Contact Technical Services to provide details

Recoating type applied (if applicable):

Additional Notes:

1.0 INTRODUCTION

1.1 Scope

1.1.1 This standard is a mandatory guide on the application of cathodic protection for mainline and station applications.

1.1.2 A buried or submerged pipeline that has been constructed, relocated, replaced, or otherwise changed must have cathodic protection. The cathodic protection must be in operation no later than one year after the pipeline is constructed, relocated, replaced, or otherwise changed.

1.1.3 An above ground storage tank that has been constructed must have cathodic protection in operation no later than one year after construction.

1.2 Applicability

1.2.1 This document is applicable to the following (checked) KMC operated systems/facilities:

- ☑ Trans Mountain System
- ☑ Puget Sound System
- ☑ Jet Fuel System
- ☑ North 40 Terminal
- ☐ Express Canada

1.3 Definitions

1.3.1 **Stray Current** – Electrical current flowing in the earth from some source other than those associated with the structure being cathodically protected.

1.3.2 **Metallic Shorted Casing** – A casing that is in direct metal contact with the carrier pipe. The difference between the "ON" and "OFF" potential readings of a metallically shorted casing and carrier pipe are generally 100 mV or less.

1.3.3 **Electrolytic Shorted Casing** – A casing that is shorted to the carrier pipe through electrolyte (fluid) within the annulus of the casing. The difference between the "ON" and "OFF" readings of an electrolytically shorted casing and carrier pipe are generally 100 mV or more. However, due to the fluid within the annulus of the casing, potential shifts on the pipe also shift the casing potentials (ie. they are not electrically isolated).

1.3.4 **Portable Reference Cell** – often referred to as a half cell, is a device composed of a pure metal in a saturated solution of its own ions. It is placed above or near a structure and is used in conjunction with a multimeter or hand-held data collector to obtain a structure to electrolyte voltage reading.

1.3.5 **Copper/copper Sulphate Reference Cell** – is composed of a copper rod in a saturated copper sulphate solution and is the industry standard reference cell for recording structure to electrolyte voltage readings in soils and fresh water.

1.3.6 **Silver/silver Chloride Reference Cell** – is composed of a silver rod in a saturated sodium chloride solution and is the industry standard reference cell for recording structure to electrolyte voltage readings in sea and brackish water.

1.3.7 **Permanent Reference Cell** – is pre-packaged and designed to be placed in the electrolyte for the purpose of long term monitoring of structure/electrolyte voltage readings in areas where accessibility precludes or limits the use of a portable reference cell.

1.3.8 **Interrupters** – devices used to interrupt cathodic protection current sources, for the purpose of obtaining "Instant Off" readings, or to evaluate foreign structure interference problems.

1.3.9 **Insulating Flange Tester** – device used to check the dielectric status of insulated pipe flanges, unions, collars, etc.

1.3.10 **Dielectric Isolating Devices** – are used to separate DC current that is dedicated to a "company" structure from a "foreign" structure (e.g., insulated flanges and unions)

1.3.11 **Close Interval Survey** – involves the recording of structure to electrolyte potentials at intervals of predetermined distances over the pipeline—typically 1 to 10 metres (3 to 30 feet)

1.3.12 **Rectifiers** – convert AC to DC and power impressed current cathodic protection systems.

1.3.13 **Insulated Collars** – are steel collars lined with a dielectric material. Insulated collars are used to isolate pipe sections.

1.3.14 **Casing Insulators** – are dielectric spacers used to maintain electrical separation between the carrier pipe and the casing.

1.3.15 **Insulating Unions** – have a dielectric material covering the face of one side of the union, thus eliminating the electrical path between each side. Insulating unions are used to isolate pipe sections.

1.3.16 **Insulating Flange** – a bolted joint isolated by using a gasket made of dielectric material with dielectric sleeves and washers. Such flanges are used to isolate pipe sections or valves.

1.3.17 **Monolithic Insulating Joint** – a prefabricated pipe "pup" with dielectric insulation which may be used instead of insulating flanges and requires no maintenance once installed.

1.3.18 **Pipe Support Insulators** – are dielectric spacers used to maintain electrical separation between the carrier pipe and the supporting structure.

1.3.19 **Galvanic Anode System** – an electrochemical reaction between dissimilar metals in metallic contact in a common electrolyte, resulting in a potential difference whereby the anode will corrode sacrificially and discharge current to protect the structure.

2.0 REQUIREMENTS FOR EQUIPMENT AND MATERIALS

2.1 Reference Electrodes (Reference Cells)

2.1.1 Reference electrodes are used to obtain structure to electrolyte voltage readings.

- Saturated copper/copper sulphate reference electrodes shall be used only in soils and fresh water.
- Saturated silver/silver chloride reference electrodes shall be used only in brackish water or seawater.

2.1.2 Reference electrodes shall be maintained as follows:

- The solution shall be replaced when it becomes contaminated or dirty.

- The solution shall contain a manufacturer's recommended anti-freeze in areas where freezing temperatures are possible;
- The metal rod shall be cleaned with fine, non-metallic sandpaper when it becomes dirty, tarnished, or build-up occurs;
- The porous plug shall be kept clean and shall be replaced if it becomes contaminated with crude oil, petroleum products, chemicals, etc.

2.1.3 For long term monitoring of structure/electrolyte voltage readings in areas where accessibility precludes or limits the use of a portable reference cell, permanent copper/copper sulphate reference cells can be placed at line crossings, near underground storage tanks, and under above ground storage tanks.

2.1.4 Permanent reference electrodes shall typically be placed 30 cm – 60 cm (12" – 24") to the side or under the structure to be evaluated. However, some design considerations, such as placement of permanent reference electrodes at some pipeline crossings, between new and old tank bottoms, within secondary containment, and possibly other situations may require a closer placement.

2.2 Dataloggers / Multimeters / Current Interrupters

2.2.1 High impedance (10 mega ohms or greater) digital multimeters (such as Fluke, Beckman and MC Miller) are used to obtain structure to electrolyte voltage readings, rectifier AC and DC volts, amperage (using shunts), pipeline IR drops, resistance, diode checks, and continuity testing.

2.2.2 High impedance data loggers with an input impedance of 10 mega ohms or greater are used to record all potential readings.

2.2.3 AC/DC Ammeters such as the Fluke Y-8300 may be used to inductively measure current without the need for a shunt.

2.2.4 GPS synchronized current interrupters may be used on rectifiers that do not have remote monitoring units installed.

2.2.5 All meters shall be maintained in accordance with the manufacturers' recommendations and specifications as set forth in the owner's manual.

2.3 Test Leads (Test Stations)

2.3.1 Test leads are used for corrosion control testing and are installed at intervals frequent enough to indicate the adequacy of cathodic protection. The recommended maximum distance between test leads is 3 km.

2.3.2 Test leads are typically installed at, but not limited to, road crossings, railroad crossings, block valves, major water crossings, insulating flanges, foreign line crossings, and property lines.

2.4 Soil Resistivity Test Equipment

The following test equipment may be used for determining soil resistivity:

2.4.1 **Single Rod Resistance Probe** ("Shepherd Cane" or "Jacob's Rod") – a probe with two electrically separated electrodes connected to wires inside the shaft and then to a resistance measuring circuit. With this equipment, direct current flows form a constant voltage battery and this current indicates the conductance of the circuit from which the instrument may be calibrated to read resistivity in ohm-cm directly. When using this equipment, the measured resistivity is the average resistivity over a volume of approximately one cubic foot. Other similar single, or walking-stick probes, use AC measuring devices.

2.4.2 The **4 Pin** or **Wenner Test Instrument** – uses a method of measuring soil resistivity involving the setting of four steel pins in a straight line, at equal distance from each other. The pins are connected to an AC resistance test instrument, which applies a measured amount of current to the two outer pins, and measures the resistance between the inner two pins. For any pin spacing, the soil resistivity is determined by the following formula: Resistivity = 191.5 x d x R. Where: d = pin spacing in feet and R = is the measured resistance between the inner two pins. The spacing of the pins represents the depth at which the soil resistivity is being measured. Caution: the pins should not be placed close to a paralleling pipeline or other metallic structure, as part of the test current could travel along the metal causing the resistance and subsequently the soil resistivity reading to be in error. If it is necessary to conduct the test close to a metal structure, the pins should be placed perpendicular to the structure.

2.4.3 **Soil Box** – A small rectangular shaped box composed of plastic or other insulated material with two metal ends and two metal pin electrodes in one side. Generally the cross sectional area of the box (in sq. cm.) equals the length between the two pin electrodes (in cm.). The resistance (in ohms), calculated from Ohms Law (E = IR or R = E/I), is equal to the resistivity (ohm cm). When using the Ohms Law formula, E (potential drop) is recorded in volts, I (current flow) is recorded in amps, and R (resistance) is recorded in ohms. The soil box is filled with a compacted soil or water sample then a voltage is applied across the two metal ends causing a measured current to flow between the two metal ends. A soil box is typically used to measure the resistivity of soil samples taken from excavations or augured holes.

2.5 Rectifiers

2.5.1 Rectifier selection must consider current and voltage requirements including future additions/expansions. Other features to consider include constant current/potential measurements, remote monitoring, and type of enclosure.

2.5.2 Security measures may include lights, AC warning signs and padlocks on lids/doors, AC safety switches, and remote monitoring of door switches.

2.5.3 An explosion proof rectifier may be required in designated hazardous atmosphere areas. Oil immersed rectifiers are typically used for intrinsically safe and/or explosion proof applications.

2.5.4 Where AC power is not available, alternate sources of electrical power may be required. Some options include solar panels or thermo-electric generation. However these options are expensive and provide limited DC voltage.

2.5.5 The rectifier area may need a fence or other enclosure to keep farm animals or unauthorized personnel at a safe distance.

2.5.6 Consideration shall be given to using zinc-grounding rods at rectifier installations to minimize interference to the AC grounding system.

2.6 Dielectric Isolation Devices

2.6.1 Dielectric isolation devices are used to electrically isolate metallic structures. Whenever an isolation device is installed, a resistance bond or shunt may be installed across the isolation device to provide a method to monitor current flow. Care shall be taken when installing these devices to ensure the dielectric material is not damaged. Once installed, the insulator should be checked with an insulated flange tester or another approved test method (i.e., potential difference across the insulator). AC polarization cells (e.g. Kirk Cells) are sometimes used to provide a path for AC fault current across a DC dielectric isolation device.

2.6.2 Dielectric isolation devices may be installed at the following locations:

- Station Sites (block valves, flanges, unions and pressure tubing).
- Storage Tanks (suction and discharge flanges).
- Change of Ownership (flanges, unions, valves and meters).
- Lateral Tie in Points (flanges and valves).
- Cased Roads, Railroads, and Other Locations.

2.6.3 The location of isolating devices shall be chosen with consideration of future placement of tubing, conduit, or other metallic structures, which might bypass the device.

2.6.4 Care shall be taken to avoid shorting out the isolating device by the installation of tubing, conduit, or other metallic structures, creating a current path around the device.

2.6.5 All underground insulating devices shall be properly coated and tested for electrical isolation prior to backfilling.

3.0 PERSONNEL REQUIREMENTS

3.1 Personnel that perform survey work (annual test lead survey / close interval survey / depolarized survey) are required to have a minimum NACE CP Level I certification.

3.2 Personnel that perform diagnostic testing work are required to have a minimum NACE CP Level II certification.

3.3 Personnel that complete the annual rectifier inspections or complete any work on a rectifier are required to have the following qualifications:

Canada	US
• Minimum NACE CP Level 1 certification • Journeyman electrician OR other personnel having completed the Electrical Cathodic Protection Work for Non-Electricians course • KMC Rectifier Inspection and Maintenance Qualification • Have a working knowledge of each rectifier component and its intended use. • Knowledge of KMC Lock Out Tag Out Procedures	• Minimum NACE CP Level 1 certification • Trained to B31Q Operator Qualifications • KMC Rectifier Inspection and Maintenance Qualification • Have a working knowledge of each rectifier component and its intended use. • Knowledge of KMC Lock Out Tag Out Procedures

3.4 Personnel that perform interference testing are required to be a qualified engineer with a minimum NACE CP Level III certification.

3.5 Personnel that complete cathodic protection groundbed designs are required to be a qualified engineer with a minimum NACE CP Level III certification.

4.0 CATHODIC PROTECTION CRITERIA

4.1 "Interrupted Current" or "Instant Off" surveys are conducted with current interrupters in place to intermittently halt the flow of current from designated rectifiers and/or bonds. Two potential readings are recorded; the most negative "On" potential and the potential just after the current source(s) is interrupted ("Instant Off").

4.2 The criteria for carbon steel pipelines or structures in contact with soil or fresh water is as follows:

4.2.1 CP potential readings are considered "high" if "Instant Off" potentials (relative to a copper/copper sulphate reference electrode) are more negative than –1200 mV.

4.2.2 CP potential readings are considered "low" if "Instant Off" potentials (relative to a copper/copper sulphate reference electrode) are less negative than –850 mV AND 100mV depolarization of pipe is not met.

4.3 The criteria for carbon steel pipelines or structures in contact with brackish water or sea water is as follows:

4.3.1 CP potential readings are considered "high" if "Instant Off" potentials (relative to a silver/silver chloride reference electrode) are more negative than –1200 mV.

4.3.2 CP potential readings are considered "low" if "Instant Off" potentials (relative to a silver/silver chloride reference electrode) are less negative than –850 mV AND 100mV depolarization of pipe is not met.

4.4 To verify if the 100 mV polarization criteria have been met, a comparison is made between the depolarized pipe-to-soil potential and the "interrupted" (i.e. current off) pipe-to-soil potential. If the "Instant Off" potential is a minimum 100 mV more negative than the depolarized potential, the pipe is considered polarized and protected by cathodic protection.

4.5 Both "high" and "low" readings are considered cathodic protection deficiencies unless as otherwise determined by the Technical Services department.

4.6 Above Ground Storage Tanks

4.6.1 Above Ground Storage Tanks without permanent reference electrodes or reference electrode test tubes buried under the tank, that are equipped with an impressed current cathodic protection system installed remote from the tank bottom (e.g., anodes ringing the perimeter or deep anode ground beds), shall have a minimum "Instant Off" potential of –1000 mV at the closest point to the perimeter of the tank.

4.6.2 Tanks without permanent reference electrodes or reference electrode test tubes buried under the tank, that are equipped with impressed current anodes installed directly under the tank bottom, shall have a minimum "Instant Off" potential of –850 mV at the perimeter of the tank.

4.6.3 When permanent reference electrodes or reference electrode test tubes are placed under the tank floor, in conjunction with an impressed current system, a minimum polarized potential of –850 mV shall be the criteria.

5.0 SURVEYS AND TESTING PRACTICES

5.1 Monthly Rectifier Readings

5.1.1 Rectifier voltage and current measurements are taken monthly to verify the continued adequate and proper operation of the impressed current system.

5.1.2 The rectifier voltage and current measurements are compared to past readings to identify groundbeds that are depleting or to indicate where groundbed cable breaks may have occurred.

5.1.3 All reverse current switches, diodes and critical bonds, whose failure would jeopardize the protection of any structure, shall be inspected monthly and not exceeding 2.5 months, but at least 6 times each calendar year.

5.2 Annual Test Lead Survey

5.2.1 Annual Test Lead Surveys are used to indicate that cathodic protection has been established according to applicable criteria and that each part of the cathodic protection system is operating properly. Surveys shall be conducted at intervals not exceeding 15 months, but at least once each calendar year. They should be performed as close as possible to the same time each year in order to have similar soil conditions that make comparisons from year to year more meaningful.

5.2.2 The readings shall be On / Instant Off.

5.2.3 Minor repairs that do not require excavation work are to be made to the test leads during the Annual Test Lead Survey. Repairs that require excavation shall be documented in the Annual Test Lead Survey Report and will be repaired in a separate program.

5.2.4 The readings shall be compared to previous readings to look for significant changes that might indicate:

- Degradation of the CP system.
- New CP systems on foreign structures that might interfere with the structure being surveyed.
- New foreign structures that may be subject to interference.

5.2.5 Pipe-to-soil and casing-to-soil potentials shall be obtained at each location where casings are located.

- Technical Services will prioritize the remediation of any casings that are determined to be either mechanically shorted to the carrier pipe or electrolytically shorted.

5.2.6 Foreign structure to electrolyte measurements are obtained to verify that the potential of the foreign structure has not changed from the previous readings. Changes in potentials could indicate:

- Change in the foreign structure's CP system.
- Change in the effect of KMC's CP systems on the foreign structure.
- That an interference bond, or other interference mitigation method, is no longer functioning as designed.

5.2.7 Interference bond currents, as well as bond drains, are measured to verify that the desired magnitude and direction of current is maintained. Changes in interference bond current might indicate changes in the CP system of either the KMC or of the foreign structure.

5.2.8 For above ground storage tanks, potential readings shall be taken at points on the tank that can be readily identified, such as at manhole entries, piping locations, standard compass point locations, or any other "landmark" (avoid taking readings in the vicinity of ground rods).

5.2.9 The effectiveness of isolating devices may be verified by using an insulated flange tester. Visual inspection may indicate problems with the isolating device or kit. Under no circumstances shall a welding machine be used to test isolation, as it may arc across the device creating a permanent short.

5.3 Close Interval Survey (CIS)

5.3.1 The determination to undertake a Close Interval Survey will be made by the Technical Services Department.

5.3.2 Close Interval Surveys may be conducted to:

- Assess the effectiveness of the cathodic protection system.
- Provide baseline operating data.
- Locate areas of inadequate levels of protection.
- Identify locations likely to be adversely affected by construction, stray currents, or other unusual environmental conditions.
- Select areas to be monitored more frequently.
- Investigate the cause of extensive external corrosion in specific areas.

5.3.3 The readings shall be On / instant Off.

5.3.4 The typical spacing between readings shall be 3 metres.

5.3.5 While travelling from test lead to test lead, the wire used for the Close Interval Survey must be retrieved immediately after hooking up to the downstream test lead. Under no circumstances shall wire be left overnight and it is imperative that all wire be collected in a timely manner.

5.4 Depolarized Surveys

5.4.1 Depolarized surveys are conducted to obtain natural/static (i.e. non-cathodically protected) pipe-to-soil readings. This survey may be conducted on:

- Structures prior to the energizing of the cathodic protection system (native potentials).
- Systems that are cathodically protected, after all influencing rectifiers have been turned off and the structure has been allowed to depolarize for at least 6 hours.

5.4.2 Depolarized surveys can be conducted at test leads (to verify annual test lead readings) or at 3m intervals (to verify close interval survey readings).

5.5 Diagnostic Testing

5.5.1 Diagnostic Testing is completed at locations where either "high" CP readings or "low" CP readings are obtained from the Annual Test Lead Survey or the Close Interval Survey.

5.5.2 Diagnostic Testing consists of the following steps:

- Investigate bonds in areas of "high" and "low" readings to determine if the removal or alteration of the bonds corrects the readings.
- Adjust rectifiers down in areas of "high" readings so that potential readings are less negative than –1200 mV OFF. This may require several iterations of adjustment and resurveying.
- Resurvey where required to verify areas of "low" readings. Use paint to mark the ground in the location of "low" readings.
- Adjust the closest influencing rectifier(s) accordingly to attempt to have all readings within the criteria range.
- If "low" readings are still present, then determine current required at low spots to adjust the pipe potential to meet criteria. The required current may be modelled by applying current from a temporary groundbed or by projecting the test current to the current needed to attain the desired level of cathodic protection.
- Complete soil resistivity testing in areas where new groundbeds may be required.

5.6 Annual Rectifier Maintenance

5.6.1 All rectifiers are visited annually by the Corrosion Technologist to complete the following tasks:

- Clean the rectifier and keep area free of brush and high weeds.
- Visually inspect the rectifier components for physical damage.
- Air-cooled units are to be inspected for proper ventilation.
- Check and repair vandalism and other damage as needed.
- Check the operation of the gauges (if available)
- Adjust rectifier tap settings and circuit resistor settings as required.
- Complete minor repairs to the rectifiers as required.
- Ensure rectifier and remote monitoring unit is operating as designed.

- Inspect associated groundbed right-of-ways for evidence of construction activity or other signs of problems, such as erosion.
- Inspect vent pipe openings on deep groundbed systems to ensure they are clear of obstructions.
- Inspect junction boxes. Junction boxes shall be kept clean and (if applicable) painted. Cable terminations and shunts shall be kept clean of corrosion and other build-up (i.e. ant and wasp nests). Identification of all terminal connections shall be maintained.

5.6.2 Any damaged rectifiers and/or broken components shall be repaired as soon as practical.

5.6.3 Basic rectifier components and trouble shooting information are as follows:

- Fuses are used for circuit protection and may be tested by removing the fuse from the circuit and using a DVM to check for electrical continuity.
- Transformers are used in the AC side of the circuit to step down the AC voltage to be used by the rectifier. After removing it from the rectifier circuit, the transformer may be checked by using a digital voltmeter to verify continuity between the taps in both the primary and the secondary sides. There should not be electrical continuity between the primary and secondary side or to the case.
- Diodes and silicon stacks are used to block AC current flow in one direction. After isolating each section, they may be tested by using the "Diode" setting (setting which supplies a trigger voltage) on the digital voltmeter. Electrical continuity should only be observed in one direction, with the other direction showing an infinite measure of resistance.
- Surge suppressors (voltraps) are used to filter out voltage surges. Isolate the voltrap and use a digital voltmeter to test for electrical continuity in only one direction.
- Lightning arrestors are designed to protect the rectifier from voltage surges by directing them to ground. Current will only flow across the contacts in the arrestor if there is a voltage surge (i.e. from lightning) to produce a potential difference, large enough in magnitude to allow current to flow across the device. Usually this component will fail in an open condition and will not hinder the operation of the rectifier, although it does leave the rectifier in an

unprotected state. The lightning arrestor can be tested using a digital voltmeter to ensure the contacts do not have electric continuity, but visual inspection is normally adequate to determine the condition of the component.

5.7 Current Mapping

5.7.1 Direct Current Voltage Gradient (DCVG) surveys can be used to determine locations of poor coating on the pipeline.

5.7.2 In-line inspection tools that can measure the current direction and flow on the pipeline can also be used to determine locations of bonds on the pipe and areas of inadequate CP current.

5.7.3 Current Mapping would be a supplement to the Annual Test Lead Survey and Close Interval Survey programs.

6.0 REQUIREMENTS FOR GROUNDBED SYSTEMS

6.1 Galvanic Anode Systems

6.1.1 Galvanic anodes may be used in the following applications:

- In short sections of well-coated pipe where relatively small amounts of current are required.
- To mitigate stray impressed current interference problems at pipeline crossings.
- In areas where supplemental cathodic protection is required.

6.1.2 Anode leads shall be routed into a test station for monitoring purposes and attached to the structure it is protecting by thermite welding.

6.1.3 The anodes are typically placed a minimum of three feet from the structure.

6.1.4 Where several anodes are installed at a single location, the anode leads may be connected to a common header wire. This wire shall be routed into a test station for monitoring purposes.

6.1.5 When a test station is used at an anode location, a wire designated for the purpose of obtaining structure to soil measurements is also typically installed.

6.1.6 Galvanic anode cathodic protection systems shall be inspected once every calendar year, not to exceed 15 months including the following:

- Pipe to soil measurements and current flow to the anode where test leads are available.
- Current output shall be calculated from the shunt reading using the following formula: Current = DC voltage drop (mV) across the shunt divided by the shunt resistance (ohms).
- Any inconsistencies shall be reported to the Technical Services Department.

6.1.7 Magnesium is the most commonly used material. It is available in various forms, weights, and alloys. High potential alloy magnesium anodes have a nominal potential of 1750 mV referenced to copper/copper sulphate. Low potential alloy magnesium anodes have a nominal potential of 1550 mV referenced to copper/copper sulphate.

6.1.8 Zinc anodes are 99.99% pure. If lesser purity zinc is used, the anode may go passive and cease to discharge sufficient amounts of protective currents. Zinc anodes have a nominal potential of 1100 mV. The use of zinc in high temperature applications (typically considered to be at operating temperatures above 100°F) is not recommended. Under heat transfer conditions, zinc exhibits inter-granular corrosion causing a reduction in anode life. Also, the anode potential is affected and an erratic corrosion potential is obtained. High purity zinc alloys have, to a limited extent, overcome these difficulties at intermediate temperatures but for high temperature conditions zinc anode alloys must be regarded as unsuitable.

6.1.9 Aluminum anodes are used mainly for salt-water applications and are not preferred for soil applications. Aluminum anodes have a nominal potential of 1100 mV.

6.2 Impressed Anode Systems

6.2.1 Impressed current cathodic protection systems are used when a galvanic system can not be used due to high soil resistivities, high current requirements, insufficient design life, practicality of installation, or economics. Impressed systems are powered by a rectifier. They may be composed of a variety of anode materials. Commercially available anode materials that are most often utilized are high silicon cast iron, graphite, various inert materials (such as platinum, niobium, titanium, conductive polymer, mixed metal oxides and abandoned steel structures). The anodes may be arranged in two different ground bed configurations: surface and deep anode. Surface ground beds can be separated into two design varieties, remote and distributed. Deep anode ground beds may vary in depth from 50 to several hundred feet and require a drilling rig to install. Both surface and deep anode ground beds are used to provide cathodic protection current to pipelines, facilities, and aboveground storage tanks.

6.2.2 When designing an impressed current cathodic protection system, the following should be considered:

- Right-of-way easement availability and future right-of-way or facility/structure development should be considered. In addition, the location selected for installation shall be chosen to minimize stray current interference with foreign structures. Investigations with all affected parties shall be conducted to determine mutually satisfactory solution(s) of all interference problems.
- Power availability (i.e. location and availability of adequate power source).
- Design parameters such as soil resistivity, current requirement, and anticipated design life.
- Cost of installation, operation, and maintenance.
- The groundbed circuit resistance ideally should be near one ohm or less. If necessary, the total resistance may be decreased by increasing the number of anodes and/or increasing the cable size. If the resistance cannot be sufficiently reduced, the rectifier can be sized to accommodate the higher total ground bed resistance.
- The rectifier DC output should be oversized by approximately 50% of the calculated voltage and amperage. The over sizing allows for changing conditions or future current increase that may be needed for facility expansion.

6.2.3 The selection and specification of materials and installation practices shall ensure dependable and economical operations throughout the intended design life. A variety of materials may be used for an impressed anode groundbed. However, typically the following materials are used:

- High silicon cast iron, graphite, and mixed metal oxide for surface and deep groundbeds.
- Mixed Metal Oxide anode systems for under tank floors.

6.2.4 Surface (Conventional) groundbeds have the following characteristics:

- High anode potential gradients over each individual anode;
- Current distribution is typically confined to the area adjacent to the distributed ground bed;
- Limited water table environmental concerns;
- Can be made along existing right-of-way and/or within company property.
- Geographic, topographic and right-of-way easement problems may be an issue.
- Are susceptible to accidental damage that may occur during excavation or land cultivation.
- May be affected by seasonal moisture variations and freezing.
- In areas where annual rainfall is extremely low, periodic watering of surface ground beds may be necessary to maintain an adequate current output. In such cases, the groundbed design may need to include provisions for adding water to the ground bed.

6.2.5 Remote groundbeds (i.e. deep groundbed systems) have the following characteristics:

- Low anodic potential gradient.
- Current spread typically covers a large area.
- Requires minimal surface area, which allows it to be located in congested areas.
- Less susceptible to construction/outside related damage than surface ground beds.
- Less affected by seasonal moisture variations and not subject to freezing.
- Typically more expensive to install than surface ground beds.
- Inspection, replacement, or repair of ground bed anodes and cable is very difficult and usually not practical.
- Often requires venting to prevent gas blockage within the ground bed. (Improperly installed vent pipe may provide a path for possible contamination down the deep anode hole.)

- Compaction of backfill material around the anode may be difficult to achieve. Poor compaction or absence of backfill can cause accelerated deterioration of the anode. The use of high-density backfill material along with pumping the backfill as slurry can improve compaction.
- Environmental concerns, involving potential mixing of multiple aquifers and possible exposure to surface contaminants, require appropriate sealing procedures.
- Due to current spread characteristics, interference problems may be more likely than in surface bed installations.

6.2.6 Ground bed repairs shall be made in accordance with the original construction specifications.

6.3 Above Ground Storage Tanks

6.3.1 Design of cathodic protection systems for above ground storage tanks shall be in accordance with API Recommended Practice 651.

6.3.2 Current requirements shall be based on the surface area of the tank bottom and any piping that is electrically continuous with the tank. Current requirement will be reduced by coating on the tank bottom and/or the associated piping and may also be affected by the type of tank pad. As a generally accepted rule of thumb one to two ma/square foot is used as a minimum requirement for cathodic protection of ambient temperature tanks and five or more ma/square foot for high temperature (asphalt) tanks.

6.3.3 The following anode types may be used:

- Deep anode
- Distributed, ribbon-style placed under tank
- Mixed metal oxide placed under tank
- Grid-style placed under tank
- Horizontal/angle-drilled near tank bottom

6.3.4 Typically for new above ground storage tank construction, the ground bed should be directly under the tank bottom in a uniform electrolyte.

7.0 INTERFERENCE / STRAY CURRENTS

7.1 Pitting damage is the detrimental effect of interference current, which occurs at a location where the current transfers between the affected structure and the electrolyte. Those locations where the stray current leaves the structure to re-enter the earth are the areas where pitting may occur. The severity of corrosion damage depends upon the duration and magnitude of the stray current discharge and the size of the discharge area.

7.2 AC shock hazards may occur where pipelines parallel high voltage AC power lines. AC voltage can be induced onto pipelines and can cause an electrical shock hazard on pipelines under construction or in service. This hazard is generally most severe during pipeline construction and when connecting to test stations to obtain CP potentials. An AC potential of 15 V, or as may be recommended by NACE in RP0177-95 (or current revision), is considered to be a "trigger" requiring mitigation.

7.3 Coatings may become disbonded at areas where stray current is collected or discharged onto the affected structure. This disbondment at the "collection point" is caused by the accumulation of hydrogen gas. The disbondment may also occur at the discharge point due to the buildup of corrosion byproducts. Because of this disbondment, the metal at both locations may be shielded from cathodic protection current causing additional corrosion problems to occur at these areas. Over time, this coating damage may create a greater demand for cathodic protection current.

7.4 The following are possible sources of DC interference currents:

- Foreign cathodic protection systems
- High voltage direct current transmission systems
- DC operated rail systems
- DC operated underground mines
- Other grounded sources such as welding machines

7.5 The following are possible sources of AC interference currents:

- High voltage AC power systems
- AC operated rail systems

7.6 During Annual Test Lead Surveys or Close Interval Surveys, a significant shift (positive or negative) in structure-to-electrolyte potentials at or near foreign line crossings or rectifier ground beds may indicate interference.

7.7 The identification and mitigation of interference problems requires careful and thorough analysis. Each interference problem is unique and mitigation shall be conducted in consultation with the Technical Services Department.

7.8 The following methods may be considered to resolve interference problems:

- Adjustment of the current output from cathodic protection rectifiers
- Relocation of the ground bed and rectifier can reduce or eliminate the pick-up of interference current by decreasing the current density in the current "pick-up area"
- Galvanic anodes can be installed on the affected structure at those locations where the interfering current is being discharged. There will still be current discharge but it will now be from the anodes rather than the previously affected structure. These galvanic anodes should be placed between the affected structures and as near to the interfering structure as possible. A test point should be installed, where possible, to facilitate the measuring of anode current output and to monitor the structure-to-electrolyte potentials.
- A solid bond between the two affected structures, drains interference current from an affected structure to the interfering structure and/or current source. Bonds shall only be installed in consultation with the Technical Services Department.
- Resistance may be added to the bond circuit to control the flow of current from an affected structure to the interfering structure and/or current source. Typically, the resistance is adjusted to restore the potential to the level prior to the interference.
- If fluctuating currents are present, unidirectional control devices such as diodes or reverse current switches may be required in conjunction with electrical bonds. These devices block current flow reversal.

8.0 TELLURIC CURRENTS

8.1 Telluric currents are magnetically induced currents that flow in the ground associated with disturbances in the earth's magnetic field. Such disturbances have been found most active during periods of severe sun spot activity. Telluric current effects on pipelines are seldom of long duration and are not localized at specific pick-up points or discharge areas for any length of time. Normally, corrective measures are not required due to the short duration of their existence.

8.2 Telluric currents adversely effect cathodic protection measurements by erratically changing the potentials and current flow along the pipeline. When this condition occurs, cathodic protection testing may need to be suspended until this phenomenon no longer exists. The telluric current phenomenon is more widely observed on well coated, north to south oriented pipelines.

9.0 RECORD KEEPING

9.1 Technical Services will be responsible for the collection and quality control of all KMC cathodic protection related records.

9.2 Validated records shall be stored and retained in accordance with the GIS Standard Pipeline Data Management.

9.3 The Corrosion Technologist shall review the Annual Test Lead Survey and Close Interval Survey data and prepare a report to identify deficiencies noted during the surveys and identify required corrective actions.

9.4 The Corrosion Technologist maintains a shorted casing list/spreadsheet. This list shall be considered an administrative record and may be maintained for reference for as long as necessary. The Corrosion Technologist will make recommendations, as necessary or as requested, concerning the disposition of shorted casings.

9.5 Cathodic Protection project records shall be filed in accordance with the KMC records management program. Drawings shall be developed and maintained to fully describe cathodic protection installations. CP drawings shall be stored in the meridian database.

10.0 CP SYSTEM EFFECTIVENESS

10.1 The effectiveness of a CP system may be confirmed by:

10.1.1 Comparing the cathodic protection history with physical evidence from the pipeline or structure to determine whether active corrosion has occurred. "Old" inactive corrosion (which occurred prior to the application of CP) or other corrosion deemed as not preventable by the application of cathodic protection (such as atmospheric corrosion, internal corrosion, corrosion under disbonded coating, etc.) shall be exempted from consideration in determining the historical effectiveness of a CP system. The cathodic protection history may be compared to one, or combinations, of the following: leak history, excavation examinations, or high resolution metal loss ILI tool data.

10.1.2 Evaluating the physical and electrical characteristics of the structure and its environment (i.e. electrolyte resistivity and/or coating condition).

11.0 REFERENCES

11.1 Reference Publications

- CSA Z662-11
- CGA OCC-1-2005
- 49 CFR 195
- NACE Standard Recommended Practice RP0I69 *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*
- NACE Standard Recommended Practice RP0502 *Pipeline External Corrosion Direct Assessment Methodology*

11.2 Pipeline Maintenance (Cathodic Protection) Procedures

- 2.3.6 AC Voltage Check
- 3.1.1 Cathodic Protection Potential Readings
- 3.1.2 Thermite Welding
- 3.1.3 Test Station Maintenance and Installation
- 3.1.4 Installation of Impressed Current Anode Beds

3.4 INTERNAL SURFACE INSPECTION OF PIPELINE CUT-OUTS

1.0 INTRODUCTION

1.1 Purpose

The purpose of this procedure is to define requirements to inspect the internal surfaces of pipe exposed whenever a cut-out is performed for evidence of internal corrosion (as per Code of Federal Regulations (CFR) 195.579 (c)).

1.2 Authorization

Only personnel qualified to perform anomaly investigations in accordance with the KMC training program are authorized to complete this procedure.

1.3 Applicability

1.3.1 This procedure applies whenever the pipe is removed and applies to the following (checked) systems:

- ☑ Trans Mountain
- ☑ Puget Sound
- ☑ Jet Fuel
- ☐ Express Canada
- ☐ North 40 Terminal

1.4 Background

1.4.1 This procedure defines the internal corrosion investigation and data gathering process and provides instructions using proven industry practices and processes.

1.4.2 Proper execution of this procedure meets the requirements of CSA Z662-11 and CFR 195.579 (c).

1.5 Responsibilities

Project Engineer – Ensure the requirement for completing this procedure is part of the cut-out job plan.

District Supervisors – Ensure that personnel performing work in relation to this procedure are properly qualified.

Pipeline Maintenance Technician – Responsible for performance of this procedure.

1.6 Documentation

KMC Cut-out Job Plan

2.0 DEFINITIONS

- **Corrosion**: The deterioration of a metal by reaction with its environment.
- **Detailed Examination**: The examination of the pipe wall at a specific location to determine whether metal loss from internal corrosion has occurred. This may be performed using any industry-accepted technology, such as visual, ultrasonic, and radiographic means.
- **Microbiologically Influenced Corrosion (MIC):** Corrosion that is caused by environmental changes brought about by microbiological activity on or near the metal surface.

3.0 EQUIPMENT

3.1 Equipment and Resources Required

Pit gauges, camera, pens for marking pipe

Sampling kit for internal deposits (for MIC testing)

Qualified NDE UT Technician with equipment

3.2 Documents Required

Anomaly Investigation Report

NDE Report

4.0 SAFETY PRECAUTIONS

4.1 General Safety Considerations

- Corrosion investigators often need to collect samples as soon as possible after a pipeline is cut open; therefore, exposure to hazardous liquids and vapours could be an issue.
- Personnel conducting investigation must be trained in safe practices for working around excavations.

5.0 PROCEDURE

5.1 Preparation and Planning

- The requirement for internal inspection of the pipe should be included in the job plan and preparation for the cut-out project.

5.2 Internal Surface Inspection Of Pipeline Cut-Outs

- Whenever any pipeline section is removed for any reason, the accessible internal pipe surfaces must be inspected for evidence of corrosion.
- Visual inspection and direct measurement using callipers or UT shall be used to determine the presence of internal corrosion as described in NACE SP0208-2008; Paragraph 5.2.5:

    a) Internal corrosion metal loss is considered present if the wall thickness is less than minimum specified nominal wall thickness (compensation for metal loss from external corrosion can be made).

- If internal corrosion is determined to be present, an anomaly investigation shall be completed in accordance with the Anomaly Investigation Standard.
- Samples shall be collected of internal corrosion deposits where present to check for the occurrence of MIC.
- An appropriate repair shall be completed when necessary in accordance with the requirements of Pipeline Maintenance Procedure 4.1.6, Assessing Corrosion and Metal Loss.
- For Trans Mountain, Puget Sound, and Jet Fuel, the MIC samples and the completed anomaly report documentation shall be forwarded to Tech Services. For Express and Platte, samples and documentation shall be forwarded to the Regional Corrosion Specialist.

6.0 ABNORMAL OPERATING CONDITIONS (AOC)

No task-specific abnormal operating conditions have been identified.

7.0 REFERENCES

7.1 CSA Standard Z662-11

7.2 DOT Regulations (CFR 195.579 (c))

7.3 NACE SP0208-2008 Internal Corrosion Direct Assessment Methodology for Liquid Petroleum Pipelines

REVISION HISTORY

REV	DESCRIPTION	DATE	BY
0	Created Draft Document	Jul 25 2011	MH
1	Reformatted Document	Aug 25 2011	MH

1 INTRODUCTION

1.1 SCOPE

The scope of this standard is to itemize all of the data warehoused in KMC's enterprise GIS and identify the following data management criteria:

A. The database the data is warehoused in

B. The database tables that the data is stored in

C. The source group that the data is developed and maintained by.

D. The source of the data

E. The review and update frequency

F. The document retention period.

1.2 DEFINITION OF TERMS

DATABASE:
GIS data is warehoused in KMC's Sequel Server APDM SDE database. Aerial Photography is stored in an ArcGIS Imager Server Database.

SOURCE GROUP:
The group who creates, maintains and owns the data. This is the group with the subject matter expertise and qualifications to manage the data. Example: The Source Group for the Cathodic Protection data is the Tech Services Group.

SOURCE DATASET:
The origin of the data. Data can be purchased, created by a consultant, created in-house or created through a combition of the three.

REVIEW AND UPDATE FREQUENCY:
The period by which data is audited, reviewed and updated. Triggers for data updates can be a regular time interval and/or can be triggered by the update and review of other datasets.

2 DATA MATRIX

2.1 PIPELINE DATA

Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended.

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	ARCHIVE GROUP	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
PIPELINE CENTERLINES	MAJOR PROJECTS OR TECH SERVICES	PROJECT ENGINEER OR INTEGRITY ENGINEER	E:\PROJECTS OR E:\DEPT\TECH SERVICES\XXX	UPDATES TRIGGERED BY PROJECT TURNOVER OF SURVEY OR INLINE INSPECTION GEOPIG DATA	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
INSTALLATION DATE	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
MANUFACTURER	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
DIAMETER	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
WALL THICKNESS	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
GRADE	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
MATERIAL	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
GIRTH WELDS	PIPELINE INTEGRITY	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
LONG SEAM TYPE	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
GIRTH WELD TYPE	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
CASINGS	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
MAXIMUMOPERATING PRESSURE	PIPELINE INTEGRITY		E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
PIPE COATING	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
WIRTH WELD COATING	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
TEES	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
VENTS	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
RIVER/SWAMP WEIGHTS	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
VALVES	OPERATIONS, PROJECTS, MAJOR PROJECTS	PROJECT ENGINEER, OPERATIONS ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
FACILITIES	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS.	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US

2.2 PIPELINE RIGHT-OF-WAY DATA

Right of Way data is associated with items positioned in the right of way, excluding cathodic protection data
Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	ARCHIVE GROUP	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
RIGHT OF WAY BOUNDARIES	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
CROSSINGS	MAJOR PROJECTS/PIPELINE PROTECTION	MAJOR PROJECTS/PIPELINE PROTECTION	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
ROW VEGETATION	OPERATIONS ENGINEERING	PROJECT ENGINEER/PIPELINE MAINTENANCE	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
KILOMETER/MILE POSTS	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
AERIAL MARKERS	MAJOR PROJECTS	PROJECT ENGINEER	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
EXPOSURES	OPERATIONS /PIPELINE MAINTENANCE	PROJECT ENGINEER/PIPELINE MAINTENANCE	E:\PROJECTS	UPDATES TRIGGERED BY PROJECT TURNOVER OR OPERATIONAL SYSTEM MODIFICATIONS	GIS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US

2.3 PIPELINE EXCAVATION AND REPAIR DATA

Excavation and repair data is associated with the dig program and associated excavation and repairs.
Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
EXCAVAIONS	TECH SERVICES	INTEGRITY ENGINEER	E:\DEPT\TECH SERVICES	ANNUALLY UPON SIGN OFF OF DIG REPORTS	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
REPAIRS	TECH SERVICES	INTEGRITY ENGINEER	E:\DEPT\TECH SERVICES	ANNUALLY UPON SIGN OFF OF DIG REPORTS.	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US

2.4 INLINE INSPECTION DATA

Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
ILI TALLY DATA	TECH SERVICES	INTEGRITY ENGINEER	E:\DEPT\TECH SERVICES	UPON COMPLETION OF TALLY VERIFICATION	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US

2.5 CATHODIC PROTECTION DATA

All CP infrastructure and readings outside of facility fences.
Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
TEST TAPS AND READINGS	TECH SERVICES	CP SPECIALIST	E:\DEPT\TECH SERVICES	UPON COMPLETION OF ANNUAL SURVEY	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
RECTIFIERS AND READINGS	TECH SERVICES	CP SPECIALIST	E:\DEPT\TECH SERVICES	UPON COMPLETION OF ANNUAL SURVEY	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
CLOSE INTERVAL SURVEY DATA	TECH SERVICES	CP SPECIALIST	E:\DEPT\TECH SERVICES	EVERY FIVE YEARS ON COLPLETION OF SURVEY	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US
DEPTH OF COVER DATA	TECH SERVICES	CP SPECIALIST	E:\DEPT\TECH SERVICES	EVERY FIVE YEARS ON COLPLETION OF SURVEY	GIS ANALYST	SDE	UPTIME_CN OR UPTIME_US

2.6 AERIAL PHOTOGRAPHY

All purchased hi resolution aerial photography.
Retention Period: Three years after the procurement of updated aerial photography

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
AERIAL PHOTOGRAPHY URBAN AND HIGH CONSEQUENCE AREAS	GIS GROUP OR MAJOR PROJECTS	GIS ANALYST	K\DATA\IMAGE SERVER	EVERY TWO YEARS	GIS ANALYST	IMAGE SERVER	K\DATA\IMAGE SERVER
AERIAL PHOTOGRAPHY RURAL AND LOW CONSEQUENCE AREAS	GIS GROUP OR MAJOR PROJECTS	GIS ANALYST	K\DATA\IMAGE SERVER	EVERY FIVE YEARS	GIS ANALYST	IMAGE SERVER	K\DATA\IMAGE SERVER

2.7 HCA DATA CANADA

High Consequence data is used to identify areas of above average risk associated with pipeline operations, emergency response and risk management.
Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
POPULATED AREAS	GIS	GIS	K:\GIS-GROUP\GIS-DATA\	ANNUALLY	GIS ANALYST	SDE	ENVIRO
DRINKING WATER	GIS	GIS	K:\GIS-GROUP\GIS-DATA	ANNUALLY	GIS ANALYST	SDE	ENVIRO
ECOLOGICAL AREAS	GIS	GIS	K:\GIS-GROUP\GIS-DATA\	ANNUALLY	GIS ANALYST	SDE	ENVIRO

2.8 HCA DATA USA

High Consequence data is used to identify areas of above average risk associated with pipeline operations, emergency response and risk management.
Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
POPULATED AREAS	NPMS	NPMS	NPMS	ANNUALLY	GIS ANALYST	SDE	ENVIRO
DRINKING WATER	NPMS	NPMS	NPMS	ANNUALLY	GIS ANALYST	SDE	ENVIRO
ECOLOGICAL AREAS	NPMS	NPMS	NPMS	ANNUALLY	GIS ANALYST	SDE	ENVIRO
NAVIGABLE WATER	NPMS	NPMS	NPMS	ANNUALLY	GIS ANALYST	SDE	ENVIRO

2.9 TERRAIN FLOW AND STREAM TRACING DATA

Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
CANADIAN SPILL POLYGONS	GIS	GIS	K:\GIS-GROUP\GIS-DATA\	UPDATES TRIGGERED BY CHANGE IN HCA, HYDROLOGICAL OR OPERATING CONDITIONS.	GIS ANALYST	SDE	ENVIRO
US SPILL POLYGONS	GIS	GIS	K:\GIS-GROUP\GIS-DATA	UPDATES TRIGGERED BY CHANGE IN HCA, HYDROLOGICAL OR OPERATING CONDITIONS.	GIS ANALYST	SDE	ENVIRO
CANADIAN STREAM TRACING DATA	GIS	GIS	K:\GIS-GROUP\GIS-DATA\	UPDATES TRIGGERED BY CHANGE IN HCA, HYDROLOGICAL OR OPERATING CONDITIONS.	GIS ANALYST	SDE	ENVIRO
US STREAM TRACING DATA	GIS	GIS	K:\GIS-GROUP\GIS-DATA\	UPDATES TRIGGERED BY CHANGE IN HCA, HYDROLOGICAL OR OPERATING CONDITIONS.	GIS ANALYST	SDE	ENVIRO

2.10 HCA ANALYSIS DATA

Retention Period: Life of Asset, Three years after asset has been sold or it's life has ended

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
CANADIAN HCA ANALYSIS	GIS	GIS	K:\GIS-GROUP\GIS-DATA\	UPDATES TRIGGERED BY CHANGE IN HCA, HYDROLOGICAL OR OPERATING CONDITIONS.	GIS ANALYST	MERIDIAN /E:\MANUALS	SEQUAL SERVER MERIDIAN DATABASE
CANADIAN HCA MAPS	GIS	GIS	K:\GIS-GROUP\GIS-DATA	UPDATES TRIGGERED BY CHANGE IN HCA, HYDROLOGICAL OR OPERATING CONDITIONS.	GIS ANALYST	SDE MERIDIAN /E:\MANUALS	SEQUAL SERVER MERIDIAN DATABASE
US HCA DATA	GIS	GIS	K:\GIS-GROUP\GIS-DATA\	UPDATES TRIGGERED BY CHANGE IN HCA, HYDROLOGICAL OR OPERATING CONDITIONS.	GIS ANALYST	SDE MERIDIAN /E:\MANUALS	SEQUAL SERVER MERIDIAN DATABASE
US HCA MAPS	GIS	GIS	K:\GIS-GROUP\GIS-DATA\	UPDATES TRIGGERED BY CHANGE IN HCA, HYDROLOGICAL OR OPERATING CONDITIONS.	GIS ANALYST	SDE MERIDIAN /E:\MANUALS	SEQUAL SERVER MERIDIAN DATABASE

2.11 CADASTRAL DATA CANADA

Cadastral data is comprised of datasets that identify legal boundaries.
Retention Period: Three years after the procurement/update of existing data

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
LAND PARCELS	LAND TITLE CADASTRE DATA PROVIDED BY PROVINCES, AND MUNICIPALITIES. MAJOR WAREHOUSES ARE ALTALIS AND ICIS	DATA RESELLER OR PROVIDER	DATA RESELLER OR PROVIDER	ANNUALLY	GIS ANALYST	SDE	BASE
LEGAL FABRIC	ALTALIS AND ICIS	DATA RESELLER OR PROVIDER	DATA RESELLER OR PROVIDER	ANNUALLY	GIS ANALYST	SDE	BASE
MUNICIPAL DISTRICTS	ALTALIS AND ICIS	DATA RESELLER OR PROVIDER	DATA RESELLER OR PROVIDER	ANNUALLY	GIS ANALYST	SDE	BASE

2.12 CADASTRAL DATA USA

Cadastral data is comprised of datasets that identify legal boundaries.
Retention Period: Three years after the procurement/update of existing data

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
LAND PARCELS	LAND TITLE CADASTRE DATA PROVIDED BY USGS, STATE, COUNTIES AND MUNICIPALITIES	DATA RESELLER OR PROVIDER	DATA RESELLER OR PROVIDER	ANNUALLY	GIS ANALYST	SDE	BASE
LEGAL FABRIC	LAND TITLE CADASTRE DATA PROVIDED BY USGS, STATE, COUNTIES AND MUNICIPALITIES	DATA RESELLER OR PROVIDER	DATA RESELLER OR PROVIDER	ANNUALLY	GIS ANALYST	SDE	BASE
MUNICIPAL DISTRICTS	LAND TITLE CADASTRE DATA PROVIDED BY USGS, STATE, COUNTIES AND MUNICIPALITIES	DATA RESELLER OR PROVIDER	DATA RESELLER OR PROVIDER	ANNUALLY	GIS ANALYST	SDE	BASE

2.13 ROAD/RAIL AND POI DATA

All roads, rail and points of interest data (POI). POI data includes emergency responder locations, hospitals, schools etc.
Retention Period: Three years after the procurement/update of existing data

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
ROAD/RAIL AND POINTS OF INTEREST CANADA	DMTI	DMTI	DMTI	ANNUALLY	GIS ANALYST	SDE	BASE
ROAD/RAIL AND POINTS OF INTEREST UNITED STATES	WHITESTAR	WHITESTAR	WHITESTAR	ANNUALLY	GIS ANALYST	SDE	BASE

2.14 HYDROLOGICAL DATA

Includes rivers, creeks, costal waters, lakes, and irrigation canals.
Retention Period: Three years after the procurement/update of existing data

DATASET	SOURCE GROUP	QC DESIGNATE (SOURCE)	SOURCE LOCATION	UPDATE TRIGGERS/FREQUENCY	QC DESIGNATE (ARCHIVE)	FINAL DATA ARCHIVE LOCATION	SPECIFIC ARCHIVE DATABASE
USA HYDROLOGY	USGS	USGS	USGS	EVERY FIVE YEARS	GIS ANALYST	SDE	BASE
CANADA HYDROLOGY	NRCAN	NRCAN	NRCAN	EVERY FIVE YEARS	GIS ANALYST	SDE	BASE