ASSET INTEGRITY MANAGEMENT PLAN

Rev 4 – May 2009

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Foreword

This document is a revision to *Pipeline System Integrity Management Program – Guiding Document* that was produced in March 2004. While the operating philosophy of Plains Marketing Canada, L.P. and its subsidiaries (PLAINS) is consistent across pipeline systems and jurisdictional boundaries, the content of the original document was specifically focused on pipeline systems regulated by the National Energy Board, which is responsible only for inter-provincial and international energy matters.

Since 2004, PLAINS has acquired new assets (including underground storage caverns in the U.S.) and expanded on its existing asset base in North America. At the same time, there have been some organizational changes within PLAINS and regulatory changes affecting integrity management of various assets (e.g., the Energy Resources Conservation Board's adoption of Annex N of the *CSA Z662* standard addressing Pipeline Integrity Management Program). As a result, this new document is produced to reflect those changes.

When further changes occur from within the company or from external sources that have the potential to affect asset integrity, the contents captured in this "living" document will be reviewed again and revised, as required, to reflect such changes. This review will be performed at least once within a calendar year with applicable stakeholders.

Introduction

PLAINS is engaged in crude oil transportation, gathering, marketing, terminalling and storage, as well as the marketing and storage of liquefied petroleum gas (LPG) and other natural gas related petroleum products in Canada and in the United States (U.S.). PLAINS' existing assets in Canada fall under provincial and federal jurisdictions, while LPG facilities in the U.S. fall under various jurisdictional authorities in different States.

Appendix 1 contains two maps showing the assets operated by PLAINS in Canada and the U.S. **Table 1** and **Table 2** provide a brief summary of crude oil and LPG assets, respectively, and highlight unique hazards/risks associated with the assets. Details of the assets are captured in various tables in **Appendices 3, 9, 10** and **11.**

Table 1: Summary of Crude Oil Assets Operated by Plains Marketing Canada, L.P. and Plains Midstream Canada ULC

Asset	Location	Jurisdiction[1]	Year[2]	Description[3]	Major Hazards/Risks
Manito (from Murphy Oil Company Ltd.)	SK	SIR	2001	162km of parallel crude and condensate mainline and gathering lines	1970's tape coated pipe susceptible to SCC
North Sask (from Murphy Oil Company Ltd.)	SK	SIR	2001	55km of parallel crude and condensate lines	North Sask River crossing
Cactus Lake/Bodo[4] (from Murphy Oil Company Ltd.)	AB/SK	ERCB/NEB/SIR	2001	88km of parallel crude and condensate lines	
Wascana (from Murphy Oil Company Ltd.)	SK	NEB	2001	173km of 12" inactive pipeline	1970's tape coated pipe susceptible to SCC
Milk River (from Murphy Oil Company Ltd.)	AB	NEB	2001	17km of 6", 10" (and a partial loop) and 12" and 36000 bbl tank	6" mainline – 1960's tape coated pipe susceptible to SCC

				storage	
Slave Lake Atlantis (from CANPET Energy Group, Inc.)	AB	ERCB	2001	130000 bbl tank	
Rimbey (from CANPET Energy Group, Inc.)	AB	ERCB	2001	Crude oil handling and treating	H2S; community sensitive to odour
Wapella (from private investors)	SK/MB	SIR/NEB/MPUB	2002	Includes 21500 bbl tank storage	
South Saskatchewan P/L (from IOL)	SK	SIR	2003	253km of 16" mainline and 325km of 3" to 12" gathering lines and 170000 bbl tank storage	Pre-1970's ERW pipe with coating that is susceptible for SCC
Cal Ven (from Unocal Canada Limited)	AB	ERCB	2004	312km of mainly 8" and 10" gathering and mainline and 5000 bbl tank	Muskeg terrain; sensitive watercourse crossings
Joarcam (from Joarcam Pipeline, LLC and SES Equities, Ltd.)	AB	ERCB	2005	58km of 6" mainline and several km of gathering lines	High-consequence area (pipeline alley into Edmonton)
Rangeland (from Pacific Energy)	AB	ERCB	2006		HVP (butane), sensitive watercourse crossings
Aurora (from Pacific Energy)	AB	NEB	2006	750m of 8" and 12" pipelines	HVP (butane)
Rainbow P/L (from IOL)	AB	ERCB	2008	768km of mainline, 224km of	Muskeg terrain; sensitive watercourse

				gathering lines, 570000 bbl of tank storage	crossings; SCC issue on 24" mainline
Valley P/L (from IPF)	AB	ERCB	2009		1938 pipeline (6" Turner Valley to Priddis Junction), sensitive watercourse crossings

Notes:

1. SIR = Saskatchewan Industry and Resources; NEB = National Energy Board; ERCB = Energy Resources Conservation Board; MPUB = Manitoba Public Utilities Board
2. The year in which the asset was acquired or constructed
3. The asset at the time of the acquisition
4. The remaining 85% working interest in the Cactus Lake system was acquired in 2006

Table 2: Summary of LPG Assets Operated by Plains LPG Services, L.P.

Asset	Location	Jurisdiction	Year[1]	Description[2]	Major Hazards/Risks
Arlington	Washington		2002		HVP (propane)
Washougal	Washington		2002		HVP (propane)
Kincheloe	Michigan		2002		HVP (propane)
Alto (from Ohio-Northwest Development Inc.)	Michigan		2003	106MM salt cavern storage, 38 MM USG pressure vessel storage	HVP (propane and butane)
Fort Madison	Wisconsin		2003		HVP (propane)
Cordova	Illinois		2004		HVP (Natural Gasoline)
Schaefferstown (from Koch Hydrocarbon, L.P.)	Pennsylvania		2004	2 X 215000 bbl cryogenic tanks; 570000 USG pressure vessel storage	HVP (propane)
Claremont (from Rymes	New Hampshire		2004	720000 USG pressure	HVP (propane)

Heating Oils, Inc.)				vessel storage	
Tulsa (from Koch Hydrocarbon, L.P. and Koch Pipeline Company, L.P.)	Oklahoma		2005	810000 USG pressure vessel storage; 130-mile C3 pipeline[3]	HVP (propane); high-consequence area
Shafter (from Andrews Petroleum, Inc.)	California		2006	8.4MM USG pressure vessel storage	HVP (mainly butane)
Bumstead (from AmeriGas Propane, L.P.)	Arizona	EPA (caverns)	2007	133MM USG salt cavern storage; 180000 USG pressure vessel storage; 6” C3 pipeline[3]	HVP (propane)
Tirzah (from Suburban Propane, L.P. and Suburban Pipeline LLC)	York County, South Carolina	State of South Carolina (caverns)	2007	57.5MM USG granite cavern, 360000 USG pressure vessel storage, 62-mile C3 pipeline[3]	HVP (propane)
San Pedro	California		2008		

Notes:

1. The year in which the asset was acquired or constructed
2. The asset at the time of the acquisition
3. Propane pipelines will be operated by the parent company (PAALP) effective 2008

Program Scope

PLAINS’ asset integrity management program (IMP) encompasses piping (buried, submerged, and aboveground), aboveground storage tanks, underground storage tanks, pressure equipment (vessels and piping), and underground storage caverns.

Under the U.S. Occupational Safety and Health Administration’s Process Safety Management (PSM) Regulations, mechanical integrity includes items such as pump and pressure safety valve inspection and maintenance. Similarly, pressure equipment regulations, such as those promulgated by ABSA, mandate that a company's integrity program address pressure relief and control systems. Within PLAINS' IMP, the inspection and maintenance of such items fall under the responsibility of Field Operations.

Policy and Objectives

As stated in the corporate Health, Safety and Environment policy, PLAINS is committed to conducting its operations in a manner that protects employees, contractors, communities, the public, and the environment. PLAINS' overall operating philosophy is loss prevention.

The three-fold aim of the IMP is as follows:

- Asset life extension,
- Incident-free operations, and
- Maximum reliability

Organizational Responsibilities

At PLAINS, asset integrity management falls under the accountability of the Director, Asset Integrity who reports to the Vice President, Crude Operations. With LPG assets, field staff ultimately reports to the Managing Director, LPG Operations who, along with the other Vice Presidents, reports to the President. **Appendix 2** contains a portion of the organizational chart that shows the interactions of other departments with the Asset Integrity department.

The Director, Asset Integrity is responsible for the development of the IMP. This includes recommending an annual budget for the IMP to the Executive Team (President and Vice Presidents) for approval. Individuals within the Asset Integrity department implement the various activities that form PLAINS' IMP, with support from Field Operations, the Land department and/or the Engineering department. Dependent on the nature of the activity, the Asset Integrity department also consults Corporate Development and Transportation Services and Facilities (Marketing) prior to proceeding with the work.

The Asset Integrity department carries out the following activities, including drafting approvals for expenditures (AFE's) and appropriate Job Orders and Purchase Orders:

- Schedule and coordinate in-line inspection (ILI) and dig program:
    - Analyze ILI results to determine which anomalies need to be exposed in the field for further assessment
    - Determine and notify the Land department of dig locations
    - Determine repair method based on field results

    - Perform corrosion growth projection analysis to determine future digs and ILI interval
- Schedule and coordinate aboveground and underground storage tank and pressure equipment (vessels and piping) inspections and review results of such inspections
- Review results of underground storage cavern inspections
- Coordinate inspection and any required repair of watercourse crossings (e.g., shallow or exposed crossings)
- Review monthly and annual cathodic protection (CP) results and recommend any corrective actions
- Review internal corrosion monitoring results (corrosion rate, bacterial activity) and recommend any corrective actions (e.g., more frequent pigging, different biocide and/or chemical inhibitor type, dosage, and frequency)
- Coordinate leak/rupture repair and investigation of causes
- Implement and track program for discontinued/abandoned lines
- Advise and provide recommendations during acquisition due diligence process
- Review and recommend new technology that support IMP (e.g., geographical information system, leak detection, risk assessment)
- Provide expert advice to other departments (e.g., design of new facilities or pipelines, pipeline reactivation, and licence amendments)
- Provide regular integrity presentations to the Executive Team

While many of the activities are performed by approved contractors under the supervision of PLAINS' onsite inspectors, several integrity-related activities are carried out by Field Operations. These include pipeline patrols, monthly CP monitoring, pigging, biocide/chemical inhibitor injection, day-to-day visual inspections of equipment, and approval of third-party crossing applications.

Personnel Competency

To date, for all PLAINS employees, the predominant and most effective method of training and competency assessment is through supervised work experiences and on-the-job mentoring, supplemented by attendance at relevant vendor-sponsored training and technical courses, seminars, and conferences. Specifically, individuals within the Asset Integrity department have taken out-of-office training that has included attendance at *CSA Z662* and API courses (e.g., *API 653* and *API 579*), ILI and SmartBall technology seminars, International Pipeline Conferences, NACE seminars, Banff Pipeline Integrity Workshops, and ABSA seminars.

Contractor and Consultant Qualifications

At PLAINS, most products and third-party services are acquired through a competitive bid process. However, these bids are sought only from vendors and service providers that have been pre-qualified and approved and which have earned a reputation for their quality, experience, and expertise. PLAINS also considers safety performance history and the location where the materials or services are required in the selection of appropriate contractors or consultants. All vendors and contractors are required to register with ISNetworld, an online contractor/supplier management database.

PLAINS' Purchasing department maintains a list of approved vendors and service providers, including applicable master service agreements and engineering service agreements.

Documentation Management System

PLAINS has developed a system to organize paper and electronic data and information related to its assets. The head office houses engineering and construction projects by pipeline systems, as well as operations and maintenance (O&M) and integrity-related reports such as cathodic protection (CP) surveys, in-line inspection (ILI) data, and excavation results. Much of the data and information printed on paper can also be accessed through a department-shared drive which is backed up every evening.

PLAINS' Maintenance Planner (MP2) is currently used to house inventory and equipment records. It also generates electrical and mechanical preventive maintenance (PM) work orders and PM costs associated with equipment.

Effective July 1, 2008, PLAINS has implemented the Dynamics AX (Enterprise Resource Planning) system to improve corporate business processes and manage related documentation. As a next phase of the project, PLAINS will be evaluating an Enterprise Asset Management (EAM) and Maintenance/Repair/Operations (MRO) module to determine if it can be used for integrity data management.

In addition, PLAINS is exploring geographical information systems (GIS) for broad applications across the company's business units. In 2008, PLAINS contracted Dynamic Risk to pilot a project on a portion of the Rangeland mainline in order to demonstrate the ability of its Integrated Risk Assessment System (IRAS) software application to overlay and align different integrity-related information based on a common centerline reference. PLAINS has budgeted funds in 2009 and subsequent years to build on the 2008 pilot project. Eventually, integrity data and information of all existing and new pipeline systems will be stored and accessed electronically through a GIS platform.

Operating and Maintenance Manuals

PLAINS has developed the "Safe Operating Policies, Procedures, and Practices Manual" to assist Field Operations personnel and approved contractors to perform work safely and in compliance with regulatory requirements. Some of the documents are still work in progress and have not been approved for use. Others are currently being reviewed and revised. A process is in place for the review and revision of these polices, procedures, and practices.

While the Manual contains some procedures associated with integrity (e.g., aerial patrols and pigging), it does not contain specific procedures for the assessment and mitigation of integrity threats. These currently reside with the Asset Integrity department.

The Manual does not contain procedures for maintenance welding, which is performed by approved contractors. PLAINS requires contractors to have approved documented procedures for tasks that are not being performed by PLAINS employees. In the case of maintenance welding, PLAINS' quality assurance program encompasses the following aspects in order to ensure weld integrity: a) Verify that the contractors' welding procedure specifications (WPS) meet the most recent applicable welding standards (e.g., *CSA Z662*) supported by acceptable procedure qualification records, b) confirm that welders on site have successfully qualified to the specific WPS (checked by PLAINS' onsite supervisors), and c) perform appropriate non-destructive examination of all welds.

In most cases, PLAINS' preferred method of pipeline repairs is the installation of fiberglass or steel compression reinforcement or pressure-containment sleeves. PLAINS' Manual also does not contain procedures for sleeve installations. Usually, qualified personnel would follow procedure specified by the manufacturer or their company's welding procedure for the sleeve installations.

Initial Risk Assessment

Based on ILI data, past field excavation results, O&M monitoring data, and incident reports, PLAINS' pipelines and piping are susceptible to the following failure mechanisms: external corrosion, internal corrosion, environmentally assisted cracking (in particular, stress corrosion cracking), lack of fusion, and mechanical damage by third-party activities. Poor construction practices such as the use of improper backfill materials have also resulted in deformation damage (dents) to pipelines.

Pipeline Risk Management

To detect and monitor the growth of these failure mechanisms on its pipelines, PLAINS has used various ILI technology offered by a number of vendors. PLAINS is of the view that ILI technology provides the best snapshot of the condition of pipelines. As such, ILI is performed on newly acquired pipelines within one year following the closing date to establish their conditions. Most of PLAINS' pipelines have been inspected at least once in their operating life. **Appendix 3** provides a summary of existing pipelines and their ILI history and inspection schedule.

Based on ILI data, the severity of different anomalies that can lead to pipeline failures is assessed, investigated, and mitigated according to PLAINS' acceptance criteria (which meet or exceed regulatory requirements) and industry standards.

Corrosion Assessment, Investigation, and Mitigation

The first and best defence against external corrosion is the use of a high performance coating supplemented by an impressed CP system (to account for coating deterioration over the operating life of pipelines). However, despite meeting the industry-accepted criterion of -850mV "instant off" potential, as measured against a saturated copper-copper sulfate electrode, external corrosion has still been found on pipelines.

To reduce the likelihood and severity of internal corrosion, pipelines are regularly cleaned with utility pigs. Depending on the line conditions and season, they can be pigged at a frequency that ranges from twice per week to once per month. The purposes are to remove any solids, liquids, and/or bacteria that can affect the integrity of pipelines and their flow efficiency. To detect the presence of corrosion (iron-related) products, corrosion-inducing species such as chloride ions, and harmful bacteria such as sulphate-reducing bacteria and acid-producing bacteria, PLAINS sends pigging samples to a laboratory for chemical analysis. In addition, PLAINS has placed coupons at strategic locations on certain pipelines to provide information related to the extent of internal corrosion on those lines. The coupons are pulled once or twice per year for analysis by the same firm that performs the laboratory analysis.

Pig & Dig Program

Recognizing that no coating and CP system are perfect to protect against external corrosion and that corrosion coupon and chemical analysis of pig yield samples provide limited information on the location and severity of internal corrosion, PLAINS has implemented an ILI program to better monitor the conditions of pipelines.

Since 2001, PLAINS has established a program to perform a baseline inspection of all of its piggable pipelines by 2009. While several lines were re-inspected in 2006 and a number of smaller gathering lines have not yet been inspected, PLAINS' ILI program has shifted from a baseline inspection to a risk-based re-inspection program beginning in 2007. Based on historical excavation information and operating history, PLAINS has determined that an inspection interval ranging from five to seven years is not unreasonable for budget planning purposes. However, the likelihood of failure (i.e., corrosion growth rate) and the consequence of such failure for any particular line are factored into the risk assessment and the determination of the next inspection (see **Appendix 4**).

Pipelines that are unpiggable will be integrity assessed via aboveground coating or pipe-to-soil surveys and tools positioned on the external pipe surface (e.g., long-range guided wave ultrasonic testing) supplemented with confirmatory bellhole excavations.

PLAINS has developed a flowchart (**Appendix 5**) that establishes criteria for determining when corrosion anomalies would be excavated based on ILI data and repaired according to Table 10-1 of *CSA Z662*. As permitted by *CSA Z662*, PLAINS is reducing the excess conservatism embedded in *ASME B31G* (previously used) in its corrosion assessment by using the predicted failure/burst pressure as determined by the RSTRENG™ program.

However, PLAINS will opt to deviate from the criteria and be more conservative depending on the nature and location of the anomaly.

Shorted Casings

At a number of road, railway, and watercourse crossings throughout PLAINS' pipeline systems, steel casings are present. A shorted casing (i.e., where a portion of the casing contacts the carrier pipe) may create an environment for external corrosion to occur because CP current bypasses the pipe within a casing. However, field experience has shown that corrosion actually occurs at the edges of the casing.

PLAINS has developed a flowchart to address the monitoring and mitigation of shorted casings (see **Appendix 6**). Once the shorted casing has been confirmed to exist by a CP company, ILI data are used to determine if corrosion anomalies exist on the pipe in the vicinity of and inside the casing. If corrosion is not severe, no mitigation work may be required but monitoring will continue on an annual basis. If corrosion exists, one of several mitigation options will be performed to repair the corrosion and/or to remove the short.

Stress Corrosion Cracking Assessment, Investigation, and Mitigation

Of the different types of environmentally assisted cracking, stress corrosion cracking (SCC) has been found on two of PLAINS' pipeline systems: Rangeland and Rainbow. On the Rangeland system, one case of SCC was found on one 88.9mm O.D. (3”), two 114.3mm O.D. (4”), and one 219.1mm O.D. (8”) pipelines. Except for the 8”, the other three cases of SCC were found in the 1990's when the issue of SCC was just beginning to surface and knowledge and understanding of this mechanism was limited. On the Rainbow system, SCC has been found on the 24” mainline between Utikuma pump station and the Edmonton connection. On that line, two SCC failures occurred in 1993 and one SCC failure occurred in 2006. In all cases, near-neutral pH SCC was identified as the cause.

PLAINS' strategy for addressing SCC follows the approach outlined by the Canadian Energy Pipeline Association (CEPA).

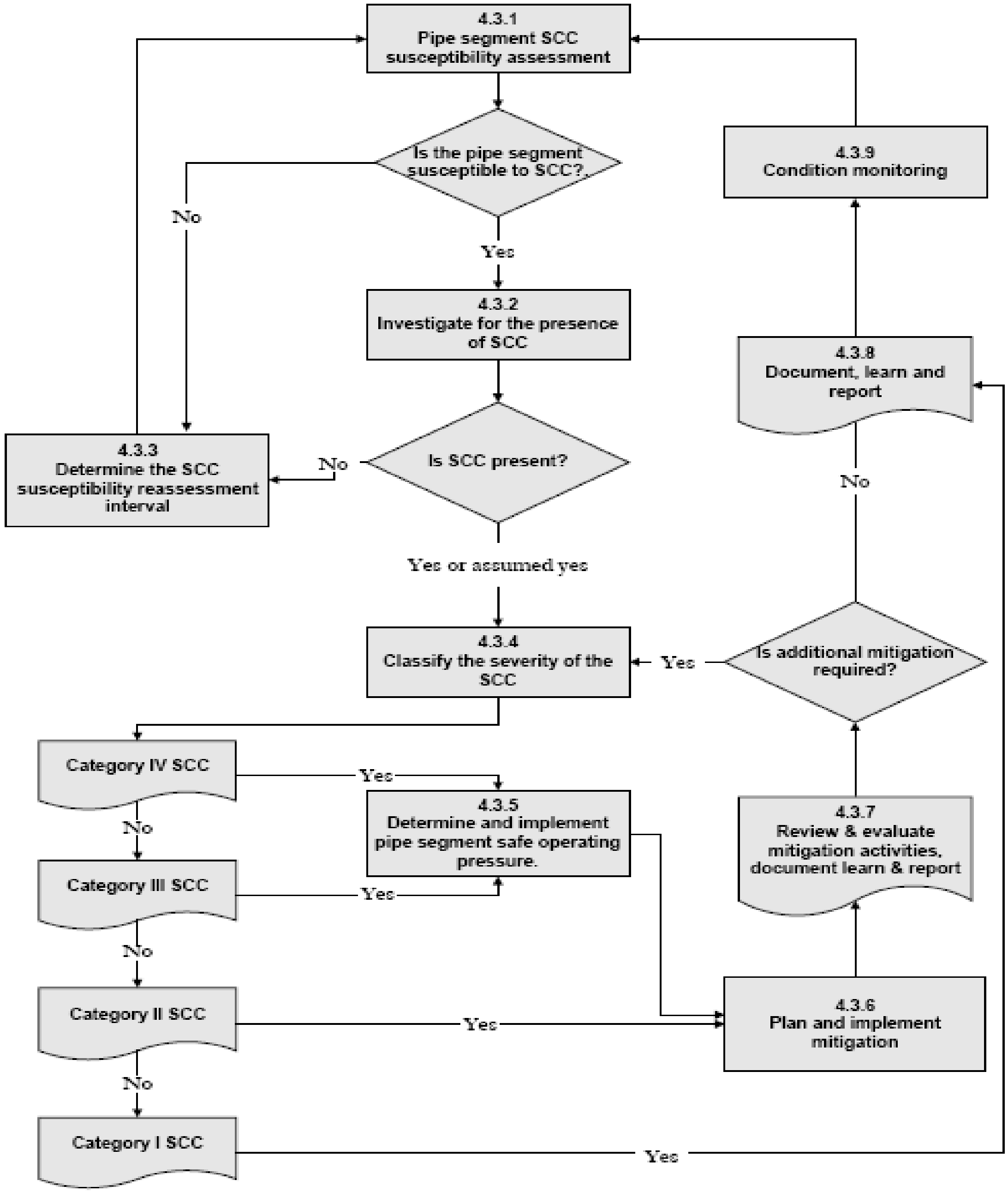

Figure 4.2: The CEPA SCC Management Program

In addition, PLAINS has developed a set of flowcharts (**Appendix 7**) to address different aspects identified on CEPA's flowchart, such as the determination of SCC susceptibility, selection of investigation method, dig prioritization, and determination of reassessment interval.

Based on the criteria established on the flowcharts, pipelines that were originally coated with polyethylene tape, asphalt or coal tar enamel are susceptible to SCC (see **Appendix 3**). However, not all of these lines can be inspected with a crack detection tool since the current best available technology can only accommodate lines 273.1mm O.D. (10") or greater. Where ILI technology is currently not available, PLAINS will perform magnetic particle inspection (MPI) at every dig location on these susceptible lines in order to assess if SCC is present. When SCC is found, the failure pressure will be determined and an appropriate repair, as per *CSA Z662* and CEPA guidelines, will be selected. In most cases, pipe recoating or the installation of a steel compression sleeve will be used as the preferred repair method. Pipe cutout replacement will be performed as required.

Lack of Fusion Assessment, Investigation, and Mitigation

Some of PLAINS' pipelines were manufactured and installed before 1970 and may be susceptible to lack of fusion (LOF) along the low-frequency electric resistance weld (ERW). During all excavations, the presence of LOF is checked. If LOF is identified at one or more sites, PLAINS will use appropriate ILI technology (e.g., transverse magnetic flux leakage), if available, to assess the extent of LOF along a pipeline. Digs will then be performed to mitigate locations where LOF is present.

Deformation Damage Assessment, Investigation, and Mitigation

Most of PLAINS' pipelines traverse agricultural land (*CSA Z662* Class 1 locations). In addition to regular vehicle patrols by Field Operations personnel, PLAINS contracts fixed-wing pilots to perform aerial patrols of its pipeline ROW at the minimum frequency as prescribed in the AEUB's *Pipeline Regulation* (AR91-2005). Any observed third-party activities or encroachment would be documented and reported to the applicable field locations for follow-up.

Pig and Dig Program

If a particular pipeline is suspected to have numerous dents or if a magnetic flux leakage tool had identified dents during a corrosion inspection, PLAINS may decide to perform a deformation tool inspection to locate and size such dents. Where technically feasible, PLAINS will also consider inspecting lines traversing major watercourses with an inertial mapping/geometry tool to assess any pipe deformation or displacement. Any actual dents and/or gouges found on pipelines would be assessed and repaired in accordance with *CSA Z662*. PLAINS has developed flowcharts that outline the process for the assessment and mitigation of dents and gouges (see **Appendix 8**).

Watercourse Crossings

PLAINS' pipeline systems cross numerous watercourses ranging from unnamed creeks to major named rivers. In particular, between the Rangeland and the Rainbow pipeline systems, there are over 500 watercourse crossings alone.

The *Pipeline Regulation* in Alberta requires that an annual inspection of the ROW be performed to inspect for leaks, to evaluate surface conditions, and to identify construction activity or encroachments. In addition to aerial patrols, PLAINS' Field Operations personnel routinely inspect watercourse crossings for conditions that might affect the integrity of these crossings.

The *Pipeline Regulation*, however, does not require a dedicated annual inspection for depth of cover (DOC). The *CSA Z662* standard permits watercourse crossings to have only 0.6m DOC provided that erosion can be demonstrated to be minimal. In the past, DOC of major or sensitive watercourse crossings had been verified on an annual basis. However, with the significant increase in the number of watercourse crossings since the acquisition of the Rangeland and the Rainbow pipeline systems and recognizing that not all watercourse crossings pose the same risk, PLAINS is developing a system to classify different watercourses. Based on the classification, a frequency is assigned for a detailed visual inspection of the crossing along with a DOC survey. The detailed visual inspection will incorporate a geotechnical and hydraulic assessment.

Factors that will be used for the inspection classification of the watercourse crossings include the following:

- Width of the channel
- Depth of water
- Flowrate of the channel
- Bank height
- Bank and substrate composition and stability
- Areas of scour, erosion, and deposition
- Land Use
- Potential for navigation within channel
- Location of other utility corridors, road and railway infrastructure
- Domestic and municipal water supply locations downstream of crossing
- Sensitivity of watercourse for supporting wildlife habitat
- Recreational potential
- Irrigation networks downstream of crossing
- Number of watercourses affected by drainage of target watercourse

A potential crossing inspection classification is described as follows:

> A – Watercourse crossings with this designation are required to have a detailed visual inspection not to exceed two years with a DOC survey not to exceed three years. Crossings with this designation will typically have a large channel width and depth, transport a large volume of water with high flowrates, support a variety of wildlife habitats, and currently support or have a high likelihood of recreational activity.
>
> B - Watercourse crossings with this designation are required to have a detailed visual inspection not to exceed three years with a DOC survey not to exceed five years. Crossings with this designation will typically have a small to moderate channel width and depth, support a limited variety of wildlife habitats, and have a low possibility for recreational activities.

C - Watercourse crossings with this designation are required to have a detailed visual inspection not to exceed five years with a DOC survey not to exceed seven years. Crossings with this designation are likely characterized by small channel widths with a low flowrate, but will usually have flow within the channel throughout the entire year.

D - Watercourse crossings with this designation will be monitored on a routine basis through aerial patrols and informal maintenance and operations activities. Crossings with this designation will typically be ephemeral, have little to no channel development and resemble a vegetated draw.

Over the next year (2008-09), PLAINS will complete a master inventory of all watercourse crossings throughout its pipeline systems. Each crossing will be assigned an initial classification based on data collected through as-built drawings, maintenance records, aerial photographs, available governmental data such as hydrological information, and discussions with Field Operations personnel. Within five years, verification of the initial classification for each watercourse will then be required through visual inspection. Once the visual inspection is complete, the classification will be updated, if required, to reflect the results of the site evaluation.

Aerial Pipeline Crossing

On the Cal Ven pipeline system, there is one aerial crossing over the East Prairie River at SW2-75-16W5M. The crossing is a cable-suspension structure supporting a 273.1mm O.D. (10”) and a 219.1mm O.D. (8”) pipelines with an overall span length (between towers) of 92 meters. There is one tower located on either side of the East Prairie River with each tower measuring 14.6 meters vertically above grade. The pipelines are supported by a hanger and clamp system with a horizontal spacing of 6.1 meters along the pipeline and connected to the main cable spanning the two towers. Wind cable anchoring is located on both sides of the crossing.

With an aerial crossing, potential concerns include corrosion of unprotected steel, fatigue cracking of steel cables, and freeze-thaw deterioration of concrete anchors and footings. The *Pipeline Regulation* in Alberta or *CSA Z662* does not address inspection of bridge stay cable systems. Based on subject matter experience and industry practices, PLAINS will perform annual inspections that will cover the following items:

- Coating examination for deterioration, tears, holes, disbondment, etc. on towers, cables, bolts, and pipelines
- Cable alignment/tension – Check for waviness, or excessive sag
- Pipeline hanger and clamp alignment
- Examination of exposed concrete surfaces for scaling, cracks and other deterioration
- Examination of clamps at the pipeline/clamp interface for visible signs of corrosion (staining)

- Examination of towers and tower support members for visible signs of corrosion
- Survey of tower lean/alignment

The annual visual inspections will be performed by a bridge maintenance contractor in the presence of PLAINS' Field Operations personnel. Every three years, a bridge/structural engineer, or equivalent, experienced in the design and performance of similar structures will be contracted to perform a more detailed inspection. If required, the following maintenance will be performed:

- Check and tension adjustment of the cables – 3 year interval.
- Survey alignment of towers – 3 year interval.
- Coating of the cables - Interval will depend on life of coating used but likely this activity will occur every 7 to 10 years.
- Coating of the towers - Interval will depend on life of coating used but likely this activity will occur every 7 to 10 years.
- Coating of the pipelines - Interval will depend on life of coating used but likely this activity will occur every 7 to 10 years.
- Sealing of concrete surfaces – As required
- Removal of vegetation to prevent potential moisture buildup - Annually
- Realignment of hangers and clamps – As required
- Tower lights (if applicable) – As required
- Replacement of clamp bolts – As required but will likely be done once every 20 to 30 years
- Replacement of neoprene or similar material between clamp and pipeline (if applicable) – As needed
- Draining free water that collects from condensation from both towers – Typically done once by drilling holes into the base of the tower to prevent water buildup within the tower. Spraying of corrosion inhibitor into the tower through the drain hole may be required if the presence of corrosion is detected.

An ILI was performed on both pipelines in 2005 as part of their reactivation. No defects as defined by *CSA Z662* were identified. The 8" line was re-inspected again in 2007 with a combined deformation and MFL tool. No defects were observed.

In 2008, a baseline structural inspection will be performed as described. In subsequent years, annual and tri-annual inspections, supplemented by routine inspections and ILI, will be used to monitor for conditions that may affect the integrity of this aerial crossing.

Facility Risk Management

Aboveground Storage Tanks

CSA Z662 requires aboveground (atmospheric) steel tanks (AST) to be inspected and repaired in accordance with applicable requirements of *API 653*. **Table 3** summarizes the inspection frequencies.

Table 3: Frequency of Various Tank Inspections

Type of Inspection	Frequency
In-service visual inspection from the ground	Minimum once per month
Cathodic protection survey (in conjunction with pipeline surveys)	Once per year
Floating roof and seal inspection	One year after installation; once every 3 years once in service
In-service external inspection	Lesser of 5 years or RCA/4N[1]
In-service ultrasonic thickness inspection	Minimum once every 5 years if corrosion rate is unknown; lesser of 15 years or RCA/2N[1] if corrosion rate is known
Out-of-service internal inspection	Minimum every 10 years if tank bottom corrosion rate is unknown or similar service experience is unavailable; lesser of 20 years or years before bottom plate thickness is less than the minimum thickness (see Note 2) if corrosion rate is known from a previous inspection

Notes:

1. RCA = difference between the measured shell thickness and the minimum required thickness (mils); N = shell corrosion rate (mils/year)
2. Reference: Sections 4.4.7.1, 4.4.7.4, 4.4.8, 6.4.2, and Table 6-1 of *API 653*

In Saskatchewan, new tanks installed after April 1, 2002 must meet the requirements set out in SIR's *SEM Standards S-01* with respect to secondary containment and leak detection. Once the tanks are in operations, they can be inspected in accordance with *API 653*. Similarly, both the 1995 and 2001 editions of the AEUB's *Guide 55* (now *Directive 55*) permit tanks to be inspected in accordance with *API 653*.

Since 2001, PLAINS has taken numerous AST's out-of-service in order to assess and restore their mechanical integrity, to install a leak detection and/or secondary containment, and to install floating roof for preventing vapour losses to the atmosphere. These activities were carried out as part of PLAINS' commitment to safety and environment and to meet provincial regulators' storage tank requirements.

Appendix 9 provides a summary of operating AST's and their past and future inspections.

Underground Storage Tanks

Clause 10 of *CSA Z662* requires that periodic inspection of underground storage tanks (UST) be performed. *Directive 55* in Alberta and *SEM Standards S-01* in Saskatchewan set out specific UST requirements as captured in **Table 4**.

Table 4: Underground Storage Tank Requirements

Province	Existing UST's	New UST's
Alberta	Inspection at least once every 3 years[1] after October 31, 2001 (1995 edition of *Guide 55*)	Double-walled construction after January 1, 2002 with monthly monitoring of interstitial space (2001 edition of *Guide 55*)
Saskatchewan	Inspection once every 3 years after April 1, 2005	Double-walled construction with leak detection system[2] and monitoring of interstitial space at least once per month

Notes:

1. Inspection frequency is dependent on age of tank, type of service, preventive measures, and past inspection results
2. Underground installation (maximum 5 m^3) is by exception and permission of SIR

Between 2001 and 2006, PLAINS replaced many single-walled UST's with double-walled steel aboveground tanks or double-walled fiberglass UST's with a weeping tile leak detection system. At some locations in Saskatchewan, existing UST's were integrity tested due to difficulty in removing them. In subsequent years, all existing UST's in Alberta, Saskatchewan, and Manitoba will follow the minimum three-year inspection frequency or be replaced with double-walled aboveground tanks.

PLAINS is committed to a five-year program, beginning in 2008, to replace all buried single-walled UST with double-walled or aboveground storage tanks.

Appendix 10 provides an inspection schedule of all existing UST's.

Pressure Equipment

Pressure Vessels

PLAINS purchases new pressure vessels from reputable manufacturers that have qualified personnel (e.g., registered professional engineers), proper equipment, and acceptable joining procedures (as part of their internal quality management system). For used pressure vessels, as a condition of purchase, PLAINS contracts certified inspectors (e.g., *API 510*) to perform an integrity assessment to ensure the vessels are fit for intended service.

Once pressure vessels are placed into operations, they are inspected at intervals as specified by appropriate jurisdictional authorities in their regulations (**Table 5**). If not specifically stated by the jurisdictional authority, PLAINS would follow the frequencies (based on established corrosion rates) set out in *API 510*, as per *CSA Z662*. That is, they will be inspected externally at least once every five years and internally (or by an equivalent method) at least once every ten years. **Appendix 11** summarizes the pressure vessels PLAINS owns and/or operates at various facilities in Canada and the U.S.

Table 5: Pressure Vessel Inspection Frequencies

State or Province	PLAINS' Facilities	Boiler (B), Pressure Vessel (PV) or B&PV Law in Place?	API 510 accepted in lieu of NBIC[1]?	State PSM[2]?	PV External Inspection Interval	PV Internal Inspection Interval[3]
Arizona	Bumstead	Boiler Law	Yes (by default)[4]	Yes	Up to 5 years[5]	Up to 10 years[5]
California	Shafter, San Pedro	B&PV Law	Yes	Yes	Up to 5 years[6]	Up to 10 years[6]
Illinois	Cordova	B&PV Law	Yes	No	Up to 5 years[5]	Up to 10 years[5]
South Carolina	Tirzah	Boiler Law	Yes (by default)[4]	Yes	Up to 5 years[5]	Up to 10 years[5]
Iowa	Fort Madison	B&PV Law[7]	No	Yes	Up to 5 years[5]	Up to 10 years[5]
Michigan	Alto, Kincheloe	Boiler Law[7]	Yes (by default)[4]	Yes	Up to 5 years[5]	Up to 10 years[5]
New Hampshire	Claremont	B&PV Law[7]	No	No	Up to 5 years[5]	Up to 10 years[5]
Oklahoma	Tulsa	B&PV Law	Yes	No	Up to 5 years[5]	Up to 10 years[5]
Pennsylvania	Schaefferstown	B&PV Law	No	No	3 years	Discretionary[8]
Washington	Arlington, Washougal	B&PV Law[7]	No	Yes	Up to 5 years[5]	Up to 10 years[5]
Alberta	High Prairie, CATT, Rimbey, Sundre, Pincher Creek, Hardisty	B&PV Law	Partially	Not applicable	2 to 5 years[9]	Up to 10 years[9]
Saskatchewan	Marshall, Unity, Gull Lake, Midale, Red Jacket	B&PV Law	No	Not applicable	5 years	Discretionary[8]

Notes:
1. Supplement 7 under Part 2 of the 2007 National Board Inspection Code (NBIC) states that “LPG vessels are generally considered to be non-corrosive to the interior of the vessel.” Furthermore, “where there is no reason to suspect an unsafe condition of where there are no inspection openings, internal inspections need not be performed.”
2. OSHA’s Process Safety Management (PSM) standard (Part 1910) applies to (i) a process which involves a chemical at or above the specified threshold quantities and (ii) a process which involves flammable liquid or gas on site in one location, in a quantity of 10 000 lb (4535.9 kg) or more. (Liquid propane has a density of approximately 510 kg/m^3 which equates to a volume of 9 m^3 or 2400 USG. This means that none of the U.S. LPG facilities are exempted.) Several States operate their own OSHA-approved safety and health programs but their standard must be identical to, or at least as effective as, the federal standard. Under the PSM standard, mechanical integrity of process equipment, including pressure vessels and piping, must follow recognized and generally accepted good engineering practices (i.e., implicit references to the NBIC or API standards).
3. If a pressure vessel were to meet a number of criteria, *API 510* permits an onstream (thorough external inspection) in lieu of an internal inspection.
4. Since a Boiler Law does not reference *API 510*, *API 510* is accepted by default based on it being implicitly referenced by the PSM standard.
5. The external and internal inspection requirements are stated in *API 510*.
6. If an *API 580* risk-based inspection program were to be accepted by California’s Department of Industrial Relations, the frequency can be extended to 10 years for external and 15 years for internal or onstream inspection.
7. The State’s boiler or boiler and pressure vessel law does not cover LPG vessels.
8. A State/Provincial inspector may require an internal inspection based on age and condition of the pressure vessel. However, a specific frequency is not stated.
9. Inspection frequency depends on type of service (i.e., fired versus unfired process vessel, type of process fluid). Refer to AB-506 (Inspection & Servicing Requirements for Pressure Equipment).

Pressure Piping

PLAINS' IMP encompasses piping connected to aboveground equipment such as storage tanks and pressure vessels. PLAINS has developed a set of flowcharts to lay out a program for inspecting station piping, including deadlegs, based on *API 570* (see **Appendix 12**). The inspection frequency will be risk-based (i.e., based on established corrosion rate under most circumstances). The likelihood of failure from various potential degradation mechanisms (e.g., corrosion, cracks) and the consequences of such failures (e.g., explosion, fire, or toxic release) determine the intervals for various piping circuits.

Beginning in 2008, the Asset Integrity department will begin the review and classification of piping in order to prioritize inspection in subsequent years. At the same time, some inspection will be performed to obtain baseline information.

Underground Storage Caverns

PLAINS currently owns and operates three U.S. LPG facilities that have underground storage caverns. A brief description of these three underground storage caverns is as follows:

- Bumstead, Arizona has a working capacity of 133 million gallons and is under the jurisdiction of the Environmental Protection Agency (EPA). Product is stored with salt formations.
- Tirzah, South Carolina has a storage capacity of 57.5 million gallons and falls under the jurisdiction of the State of South Carolina. Product is stored within granite rock formations.
- Alto, Michigan has a working capacity of 38 million gallons and is under the jurisdiction of the Environmental Protection Agency (EPA). Product is stored within salt formations.

Components in an underground storage operation typically consist of tubing strings/casings, wellhead equipment, brine and fresh water systems, flare systems, piping, pumps, control buildings, liquid separators, and fire protection.

PLAINS has opted to follow the inspection requirements of *CSA Z341* for managing the integrity of these U.S. underground storage caverns and associated piping (tubing) and aboveground equipment. The *CSA Z341* requirements are more stringent and specific than those in the U.S.

Deviations from Inspection Frequencies

The goal of PLAINS' IMP is to achieve the stated objectives in the most cost-effective manner within the appropriate regulatory framework. Inspection optimization is part of this cost-effective solution. While inspection schedules have been proposed for different assets over the next 15 to 20 years (mainly for budgeting purposes), deviations in such schedules will arise due to several factors, including the following:

- Past inspection results (e.g., corrosion or stress corrosion cracking rate determination),
- Changes to operating conditions (e.g., temperature, pressure, product, bacterial growth),
- Changes to physical environment (e.g., erosion, soil chemistry),
- Local regulatory requirements,
- Physical inaccessibility or technological limitations,
- Past or recent failures, and
- Accepted industry practices (e.g., risk-based inspection)

Incident Reporting, Investigation and Follow-up

It is PLAINS' policy and practice that all incidents (including near misses) be documented and reported. Incidents are investigated to determine immediate and underlying/root causes. Appropriate recommendations from such investigations are then implemented and followed up. The "Accident/Incident Reporting and Investigation" procedure is currently undergoing review and revision.

The Asset Integrity department, in consultation with Field Operations and the EH&S department, developed a flowchart for responding to a notification of a potential leak on a pipeline. Once a leak or break has been located, PLAINS has an O&M procedure that outlines what field data need to be documented and how the failed pipe needs to be bagged and sent away for metallurgical analysis. The Asset Integrity department reviews the failure analysis report into the likely degradation mechanism and incorporates the findings into its program for subsequent years.

Management of Change

In the past, management of change (MOC) was done on an ad hoc or informal basis whereby individuals from different groups (e.g., Engineering, Field Operations, EH&S, Business Development) would discuss if proposed changes should proceed and under what conditions. While the process might have been appropriate when PLAINS was smaller in size as a company, it was thought to be inappropriate as PLAINS' asset and human resource base have expanded.

To achieve consistency and ensure clarity in how proposed changes are being documented, tracked, reviewed and approved, PLAINS developed a guideline and has been working with Beyond Compliance since 2007 to create a custom MOC module within its Integrated Compliance Management System (ICMS)™ software application. On April 30, 2008, PLAINS' guideline addressing "Operations Management of Change" became effective. The guideline applies to changes in facility design, operational process, technology, equipment, product specifications, procedures, and regulations. Changes are initiated, reviewed, assessed, approved for implementation, and tracked using Beyond Compliance's MOC module. Except for replacement in kind changes, all other changes need to be channeled through this electronic process. The MOC module will also be used to document changes related to regulatory attributes of assets such as service fluid and operating status.

Program Evaluation

Ultimately, the effectiveness of PLAINS' asset integrity management program is measured by the number of leaks and breaks that occur or by the number of unscheduled shutdowns due to premature equipment failure. By being proactive in its integrity-related activities, PLAINS has been assessing conditions that may lead to failures before they come to pass. As part of the annual evaluation of program effectiveness, PLAINS' Director of Asset Integrity examines several performance metrics that include the following:

- Activities planned versus those actually completed and ramifications of activities not performed,
- Alignment of activities scheduled for the subsequent year(s) in light of any incidents that might have occurred in the current year
- Accuracy of ILI tool measurements (e.g., anomaly location, orientation, depth, and length) as compared with actual results from field excavations and other monitoring methods (e.g., CP surveys and fluid sampling and internal coupon analysis),
- Appropriateness of the corrosion and stress corrosion cracking rates being used and their effects on predicted remaining service life or re-inspection frequency, and
- Quality of project execution (schedule and cost management)

In addition to the annual evaluations and scheduled internal audits by the EH&S department, PLAINS will consider contracting reputable consulting firms to conduct third-party audits of its asset integrity management program every five to seven years. In late 2007/early 2008, CC Technologies was contracted to provide a high level review of PLAINS' asset integrity management program. These external audits, along with any future regulatory audits, will also provide PLAINS with valuable information to feed into its continuous improvement loop.

Appendix 1 – Map of Assets Operated by PLAINS

(separate from this document)

Appendix 2 – Crude and LPG organizational chart

(separate from this document)

Appendix 3 - ILI history and schedule

(separate from this document)

Appendix 4 - Corrosion growth flowcharts

(separate from this document)

Appendix 5 – ILI, dig and repair flowchart (for corrosion)

(separate from this document)

Appendix 6 – Casing short verification

(separate from this document)

Appendix 7 – Stress corrosion cracking flowcharts

(separate from this document)

Appendix 8 – Deformation anomaly assessment and repair flowchart (for gouges, arc burns, and dents)

(separate from this document)

Appendix 9 - Aboveground storage tank inspection history and schedule

(separate from this document)

Appendix 10 - Underground storage tank inspection history and schedule

(separate from this document)

Appendix 11 – Pressure vessel inspection history and schedule

(separate from this document)

Appendix 12 – Facility Piping Assessment and Mitigation

(separate from this document)

Appendix 13 – List of Most Pertinent Regulations, Standards, and Code

The following regulations, standards, and codes are some of the more relevant documents affecting PLAINS' asset integrity management program:

- National Energy Board Act
- National Energy Board's *Onshore Pipeline Regulations, 1999*
- Alberta Pipeline Act
- Alberta Pipeline Regulation (AR 91/2005)
- Energy Resources Conservation Board's *Directive 55*
- Saskatchewan's SEM Standards S-01
- Saskatchewan's *The Pipelines Regulations, 2000*
- Safety Codes Act
- Pressure Equipment Safety Regulation (AR 49/2006)
- CSA B51
- CSA Z662 and CSA 245 Standards
- ASME Boiler and Pressure Vessel Code
- ASME B31 Pressure Piping Codes (B31.1, B31.3, B31.5, B31G)
- National Board Inspection Code
- API 510, 570, 620, 650, 651, 652, 653, 1163, 2610
- API 579-1/ASME FFS-1 2007
- NFPA 58 and 59
- TEMA Standards
- NACE Standards