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Review of Piping Inspection Programs at the Valdez Marine Terminal (5590.14.01)

Prince William Sound Regional Citizens' Advisory Council
3707 Spenard Road, Suite 100
Anchorage, AK 99503

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Prepared by:

Dynamic Risk Assessment Systems, Inc.

Suite 208, 1324 – 17th Avenue S.W.
Calgary, Alberta, Canada
T2T 5S8
Phone: (403) 547-8638

Waterway Plaza Two, Suite 250
10001 Woodloch Forest Drive
The Woodlands, TX 77380
Phone: (832) 482-0606

www.dynamicrisk.net

Review of Piping Inspection at the Valdez Marine Terminal

Prepared for:	**Prince William Sound Regional Citizens' Advisory Council** 3707 Spenard Road, Suite 100 Anchorage, AK 99503
Prepared by:	Signature Keith Leewis, PhD, PEng Senior Risk Consultant, Dynamic Risk
Prepared by:	Signature Monica K. Porter, P.E. Engineer, Dynamic Risk, USA, Inc.
Reviewed by:	Signature Phillip G. Nidd Vice President, Operations, Dynamic Risk, USA, Inc.

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Executive Summary

Background

Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) has retained Dynamic Risk Assessment Systems, Inc. (Dynamic Risk) to perform an assessment of the current and planned Alyeska Pipeline Service Company (Alyeska) inspection programs for crude oil transport piping sections located at the Valdez Marine Terminal (VMT). The objective of this assessment was to evaluate Alyeska inspection programs as they pertain to piping at the VMT and how these programs compare to industry standards and practices, and to enhance PWSRCAC understanding of these programs. While documentation provided to date for this review has not been of sufficient detail to fully realize the objective, the Dynamic Risk project team was able to apply knowledge of technology strengths and limitations, working expertise of appropriate industry standards and engineering experience gained through working with other pipeline operators, to draw conclusions and derive recommendations for this report.

For the purposes of this report, three approaches to pipeline inspection classified as 1) In-line inspection (ILI), 2) Internal inspection, and 3) External inspection were addressed. The focus of this study was to review and assess in-line inspection and other programs being developed by Alyeska to inspect VMT crude oil transport piping. Alyeska has also developed a program, the Piping Integrity Testing (PIT) program, to address annual testing and inspections of above and below ground piping in the VMT. An overview of the current inspection activities, along with commentary on the appropriateness of these inspection activities for each of the VMT pipe segments addressed within this study, is provided in Table 1.

The Alyeska plan is to utilize axial magnetic flux leakage ILI technology to assess the integrity of the 36-inch and 48-inch crude oil transport lines at the VMT from the East Metering Building to the West Metering Building. This technology is considered to be appropriate for evaluating corrosion-caused metal loss within the specified tolerances and operational considerations. The specific ILI vendor has not yet been identified, but Alyeska has indicated that vendors with a proven industry reputation will be selected. The operational differences at the VMT with respect to the Trans Alaska Pipeline System mainline are considerable and warrant development of unique ILI procedures.

Also reviewed and discussed within the report are industry recognized inspection technologies and approaches under consideration by Alyeska for those pipe segments not included within the proposed ILI plan.

The 800-mile TAPS is regulated by 49 CFR Part 195 (Transportation of Hazardous Liquids by Pipeline), however this governance terminates at the East Metering Building[*]. Marine terminals are regulated by the US Coast Guard, and it is reported by Alyeska that the VMT is classified as a facility and is not regulated against 49 CFR Part 195[†]. Such federal requirements along with industry standards as incorporated by reference, should however always be considered as guidance when developing the inspection program for the VMT piping.

49 CFR Part 195 regulations stipulate specific requirements for pipe segments located within a "high consequence area," defined as an area of high population, unusual sensitivity or containing a commercially navigable waterway. In consideration of these requirements and the findings of external corrosion in 2012 on girth welds on Berths 4 and 5 piping, the pipe segments over Port of Valdez waters should continue to be prioritized by Alyeska for corrosion assessment within the VMT piping inspection program.

Susceptibility to corrosion is being assessed by Alyeska on VMT piping and meets industry standards for facility piping assessment, (external inspections, corrosion coupons), however no information or data provided was sufficient to clearly establish the condition of the pipe in the crude oil transport lines in the VMT. The corrosion condition and the remaining wall thickness for a majority of the piping has not been confirmed.

The corrosion monitoring activities for non-ILI pipe segments, inclusive of pressure testing, electro-magnetic acoustic transducer, guided wave testing, and ultrasonic testing, are all acceptable technologies for evaluation of pipeline corrosion within industry standards subject to each technology's restrictions for detection and/or assessment of corrosion-caused metal loss. However, these activities are acceptable only if performed in appropriate combinations and subject to procedures that account for industry accepted practice, technology application and accuracy tolerance limitations. Operational, safety, environmental, and risk management considerations are also an integral part of selection and use of each technology.

The content and findings contained within this report are based upon information and data available at the time of the report writing. Alyeska representatives had the opportunity to review and provide input on this report but had no comments regarding its content.

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[*] The 36-inch relief piping located immediately downstream of the East Metering Building is reported by Alyeska as being subject to 49 CFR Part 195 and is a pipe section that is designated for ILI assessment.

[†] Heidersbach, Corrosion Survey of Valdez Marine Terminal, PWSRCAC Contract 559.12.01, December 20, 2012 plus confirmatory email from Barry Roberts, Alyeska Aug 29, 2014. "The VMT is classified as a facility and in this case Alyeska reported that it adheres to specific provisions of the Grant and Lease as administered by the Bureau of Land Management and the Alaska Department of Environmental Conservation, respectively, with respect to all other facilities including piping at the VMT. Therefore, as indicated by Alyeska, it satisfies the requirements of 49 CFR 195 in a variety of ways depending on the regulator having cognizance".

Findings

1. Documentation provided to date for review by the Dynamic Risk project team has not been of sufficient detail to conduct a full and complete industry standard or "best industry practice[‡]" procedure review and comparison.
2. It is reported by Alyeska that the VMT is classified as a facility and is not regulated against 49 CFR Part 195. The 36-inch relief piping located near the East Metering Building is, however, reported by Alyeska as being subject to 49 CFR Part 195 regulations. This pipe section is designated for ILI assessment.
3. It is reported by Alyeska that a static head product pressure test (per 33 CFR 156.70) of the piping from the East Tank Farm to the ends of Berths 4 and 5 piping is performed on an annual basis. A static head of the highest tank level is applied to achieve test pressure; pressure is held for three hours, and the pipe section is metered at both ends to verify no loss of crude oil. The reported Alyeska pressure test practice is not in alignment with accepted industry standards for pipeline pressure testing, relative to pressure and test duration. Consideration should be given to the undertaking of additional assessment measures (49CFR195 Subpart E). Alyeska reports however, that test leaks have not occurred during any of the pressure tests that have been conducted to date.
4. The VMT has been in operation since 1977, and the majority of the crude oil transport lines have not been fully assessed for external or internal corrosion. This duration of time exceeds accepted industry timelines for pipe inspections as required for effective assessment of industry recognized pipeline threats, i.e., external and internal corrosion.
5. No information or data provided was sufficient to establish the current condition of the pipe wall in the crude oil transport lines in the VMT. The corrosion condition and the remaining wall thickness for a majority of the piping has not been confirmed.
6. Alyeska expects that by the end of 2014, portions of insulation will be permanently removed from piping over water and all girth welds on piping over water will have been subjected to external inspection (UT, EMAT and/or GWT). Once this plan is carried out, and all girth weld regions have been externally inspected, this plan will appropriately address the girth weld corrosion threat that has been documented on this piping segment.
7. The current corrosion assessment activities for non-ILI pipe segments, inclusive of pressure testing, EMAT, GWT and UT, are all acceptable inspection technologies for evaluation of pipeline corrosion in application with industry standards and subject to each technology's restrictions for detection and/or assessment of corrosion-caused metal loss. However, these activities are acceptable only if performed in a standard integrity assessment methodology using appropriate combinations and subject to procedures that account for technology application and accuracy tolerance limitations.
8. An ILI program at the VMT is being developed for the 36-inch and 48-inch piping from the East Metering Building to the West Metering Building.

[‡] The processes, practices, systems and techniques used by organizations that are widely recognized as driving exceptional efficiency and safety performance while meeting compliance objectives and moving towards the goal of zero incidents.

9. It is proposed by Alyeska that service supply vendors and MFL ILI tools similar to those used to inspect the TAPS mainline will also be used to detect and size corrosion-caused metal loss for selected piping segments at the VMT, including the 36-inch and 48-inch header systems. Supply vendors and MFL technologies proposed by Alyeska are considered acceptable for an ILI program on VMT piping.
10. The extensive Alyeska ILI experience on the TAPS mainline lends credibility to their capability to conduct a successful ILI integrity assessment program on the VMT piping. The current TAPS ILI Practice meets industry standard guidelines and will provide a strong protocol basis for ILI of the VMT piping.
11. The ILI integrity assessment program at the VMT, if executed as described for those pipe segments being considered, will accommodate periodic maintenance and inspection needs and will improve the identification of corrosion threats for purposes of assessment and mitigation. The addition of ILI to the current VMT facility corrosion control programs will also provide a strong corrosion knowledge basis to enhance and improve corrosion detection and monitoring on the entire VMT piping system.
12. The 48-inch piping downstream of the West Metering Building to Berths 4 and 5 is not included in the proposed ILI program at the VMT and limited information relating to confirmed inspection plans and approaches for this segment was provided for review.
13. The following elements of the proposed VMT ILI program are being addressed in a manner consistent with recognized industry practice, as defined within the industry standards referenced within this report: technology selection, vendor selection, procedure for validating results, reporting.

Acknowledgements

Dynamic Risk would like to recognize the contributions and support provided by Alyeska and PWSRCAC employees. Specifically, we would like to thank Tom Kuckertz (PWSRCAC Project Manager) and Barry Roberts (Alyeska Community Liaison/Advisor Operations) for their support and cooperation.

List of Acronyms

ADEC Alaska Department of Environmental Conservation
AG Above ground
AK Alaska
ANSI American National Standards Institute
API American Petroleum Institute

- API 570 Piping Inspection Code: In-Service Inspection, Rating, Repair, and Alteration of Piping Systems
- API 580 Risk-Based Inspection
- API 581 Risk Based Inspection Guidance
- API 1160 Managing System Integrity for Hazardous Liquid Pipelines
- API 1163 In-Line Inspection Systems Qualification Standard
- API Specification 5L "Specification for Line Pipe"
- API Specification 6D "Specification for Pipeline Valves (Gate, Plug, Ball, and Check Valves)"

ASME American Society of Mechanical Engineers

- B31Q Pipeline Personnel Qualification
- B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
- B31.8 Pressure Piping, Gas Transmission and Distribution Piping Systems
- B31.8S Managing System Integrity of Gas Pipelines
- PCC-3 Inspection Planning Using Risk-Based Methods
- Boiler and Pressure Vessel Code

ASNT American Society for Non-destructive Testing

- ILI-PQ – In-Line Inspection Personnel Qualification And Certification Standard

BG Below ground
BLM Bureau of Land Management
CEO Chief Executive Officer
CEPA Canadian Energy Pipeline Association

- Facilities Integrity Management Program Recommended Practice

CFR Code of Federal Regulations
CUI Corrosion under insulation
DOT (US) Department of Transportation
ILI In-line inspection
ECDA External corrosion direct assessment
EMAT Electro-Magnetic Acoustic Transducer
EMB East metering building
EO Executive order
ETF East tank farm
FEL Front-end loading
FERC Federal Energy Regulatory Commission
GWT Guided Wave Testing
HCA High consequence area
HHC Highly hazardous chemicals
HR High resolution

ID	Inside diameter
IFC	Issued for construction
IFR	Issued for review
ISO	International Organization for Standardization
MFL	Magnetic flux leakage
MP	Maintenance procedure
NACE	National Association of Corrosion Engineers • NACE SP 0102 In-Line Inspection of Pipelines • NACE RP 0104 The Use of Coupons for Cathodic Protection Monitoring Applications • NACE SP 0169 Standard Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems • NACE SP 0502 Pipeline External Corrosion Direct Assessment Methodology • NACE SP 0208 Internal Corrosion Direct Assessment Methodology for Liquid Petroleum Pipelines • NACE SP 0313 Guided Wave Technology for Piping Applications • NACE TM 0109 Aboveground Survey Techniques for the Evaluation of Underground Pipeline Coating Condition
NDE	Non-destructive examination
NEB	National Energy Board
OD	Outside diameter
OSHA	Occupational Health and Safety Administration
PE	Professional Engineer, USA
PEng	Professional Engineer, Canada
PhD	Doctor of Philosophy
PHMSA	Pipeline and Hazardous Materials Safety Administration
PSM	Process Safety Management
PIT	Piping Integrity Testing
POD	Probability of detection
POI	Probability of Identification
PPT	PowerPoint presentation
PQ	Personnel qualification
PWR	Project work request
PWSRCAC	Prince William Sound Regional Citizens' Advisory Council
RFP	Request for proposal
SME	Subject matter expertise
SPCO	State [of Alaska] Pipeline Coordinator's Office
SR	Standard resolution
SS	Stainless steel
TAPS	Trans Alaska Pipeline System
USA	United States of America
UT	Ultrasonic testing
VMT	Valdez Marine Terminal
WMB	West metering building

1. Introduction

Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) has retained Dynamic Risk Assessment Systems, Inc. (Dynamic Risk) to perform an assessment of the current and planned inspection programs for crude oil transport piping sections located at the Valdez Marine Terminal (VMT). The project details are outlined in RFP 5590.14.01 – Inspectability of Piping at Valdez Marine Terminal issued by PWSRCAC and further described in Dynamic Risk's proposal P-PWSRCAC-20140115.

Dynamic Risk is an industry leader in providing pipeline integrity and risk management expertise to support operational decision making to improve pipeline reliability. In addition, Dynamic Risk has specific experience in Alaska pipeline operations including the Trans Alaska Pipeline Systems (TAPS) and North Slope operations.

Findings from this project have been summarized in this final report; this final report supersedes previous Dynamic Risk interim report submissions to PWSRCAC for this project.

2. Background

The VMT is the terminus for TAPS and is the facility where the Alaskan North Slope oil production is received, stored in above ground storage tanks, and loaded onto petroleum tankers for subsequent marine transport. The VMT facilities in service include approximately 3.5 miles of crude oil transport piping, 14 storage tanks, metering facilities to measure the incoming oil and two functional loading berths. The VMT has been in operation since 1977, and the majority of the crude oil transport lines have not been fully assessed for external or internal corrosion.

PWSRCAC was chartered as a non-profit corporation by the State of Alaska on December 26, 1989. PWSRCAC is funded under a contract with Alyeska, and is certified as the alternative voluntary advisory group for Prince William Sound under the Oil Pollution Act of 1990 to maintain constant vigilance needed to promote environmentally safe operation of the VMT and the petroleum tankers that use it. PWSRCAC is aware that a considerable portion of the crude oil transport piping at the VMT has not been subjected to internal inspection to validate piping integrity since construction and seeks to verify that all corrosion issues potentially affecting piping integrity are being identified, characterized and resolved in a timely fashion.

The piping system at the VMT consists of deeply buried sections and elevated sections of pipe, all of which are inherently susceptible to corrosion. Corrosion, both internal and external, is a time dependent threat that leads to progressive wall thinning and in extreme cases, loss of containment incidents. The decision to perform inspections is based upon information, either direct or inferred. In executing any inspections, operational, safety, environmental, and risk management considerations are also an integral part of the decision process.

The content and findings contained within this report are based upon information and data available at the time of the writing of this report. Finalized inspection plans and new information may in future, influence or change the findings contained within this report.

Alyeska representatives had the opportunity to review and provide input on this report but had no comments regarding its content.

3. Objective

The objective of this assessment was to evaluate Alyeska current and planned inspection programs as they pertain to piping at the VMT and how these programs compare to industry standards and practices, and to enhance the Council's understanding of current and developing regulatory trends for pipe inspection and applicable inspection technologies.

4. Approach

Dynamic Risk was selected by PWSRCAC as the contractor qualified to understand in technical detail the inspection program at the VMT. The project team was comprised of members from Dynamic Risk as follows:

Name	Company Title / Project Role	Company
Phillip G. Nidd	Vice President, Operations Project Executive Sponsor	Dynamic Risk USA, Inc.
Keith Leewis, PhD, PEng	Senior Risk Consultant	Dynamic Risk
Monica K. Porter, P.E.	Engineer	Dynamic Risk USA, Inc.

The three core members of the Dynamic Risk project team have 75 years of combined subject matter expertise (SME) in pipeline integrity and operations.

The Dynamic Risk protocol for document security and transmittal; "Document Control and Flow of Information" is provided as Appendix A. Publicly available documents together with documents received from Alyeska in response to a Dynamic Risk information request were reviewed against industry standards API 1163 ("*In-Line Inspection Systems Qualification Standard*")[§], ASME B31.8S ("*Managing System Integrity of Gas Pipelines*")[**] and other appropriate industry standards as a general basis for comparison. A complete alignment of the industry standards applied as a basis for the general comparison was not part of this project scope.

[§] API 1163 is a standard for establishing the performance and validation of an ILI tool that also serves as an umbrella document to be used with complement companion standards: NACE SP 0102 "*In-Line Inspections of Pipelines*," and ASNT ILI PQ "*In-Line Inspection Personnel Qualification & Certification Standard*" to enable pipeline operators to conduct safe, repeatable and rigorous processes in the ILI industry.

[**] ASME B31.8S "*Managing System Integrity of Gas Pipelines*" was designed to supplement ASME B31.8, "*Pressure Piping, Gas Transmission and Distribution Piping Systems*." The intent of this Standard is to provide a systematic, comprehensive, and integrated approach to managing the safety and integrity of pipeline systems; it can apply as a technical and industry practice guideline for both liquid and gas pipeline systems.

Representatives of the Dynamic Risk project team attended meetings with PWSRCAC and Alyeska personnel on May 6 and 8, 2014 in Anchorage, AK. A site visit to the VMT occurred on May 7, 2014 to observe facility operation and discuss proposed plans for VMT piping inspection. Informal interviews and/or discussions involving several Alyeska personnel were undertaken to provide additional clarification. Preliminary results of the team's observations were presented to PWSRCAC on May 29, 2014 and subsequently provided to the Terminal Operations & Environmental Monitoring committee on June 16, 2014.

Significant technological advancements in the past several decades have been made on technologies for detection and remediation of corrosion, including in-line inspection (ILI) technologies. When applied in combination with sound engineering judgment, these advancements have allowed the pipeline industry to achieve a level of confidence in the operating integrity of even the most complex piping systems.

Dynamic Risk has reviewed the proposed ILI program for VMT piping and has also provided SME commentary on inspections for corrosion control and integrity programs now in use or being considered where application of ILI technology is not currently under consideration. This additional insight provides PWSRCAC with further understanding of the methodologies for monitoring and mitigation of corrosion for those VMT pipe segments where ILI may not be an immediate option.

Lastly, as part of this project, PWSRCAC queries related to basic knowledge aspects of VMT operations, pipeline integrity, and inspection technologies have been discussed during the monthly teleconferences. While Dynamic Risk appreciates the benefit of this additional knowledge to PWSRCAC representatives, it is not possible to describe all of this knowledge or respond to all such queries in detail within this report. A supplemental PowerPoint presentation has been prepared for reference on these subject matters (See Appendix B).

5. Constraints

The objectives of this evaluation could not be fully realized due to the preliminary planning status of Alyeska inspection programs resulting in a lack of detail relating to program technologies, application and execution. In order to satisfy the objectives of this project, it was required that the project team have access to documented VMT ILI plans and related program protocols. Specific details on the Alyeska proposed VMT ILI program were not available, including (a) technology and vendor selection (b) pipe characteristics and corrosion history of piping to be inspected, (c) operational aspects of conducting the ILI survey and (d) the procedure for validating ILI results and reporting.

Documentation provided to date for review by the Dynamic Risk project team has not been of sufficient detail to conduct a full and complete industry standard or "best industry practice"[††] procedure review and comparison.

[††] The processes, practices, systems and techniques used by organizations that are widely recognized as driving exceptional efficiency and safety performance while meeting compliance objectives and moving towards the goal of zero incidents.

As of the date of this report, complete design documents and associated Alyeska project planning gate documents (e.g., FEL-1, FEL-2, FEL-3) have not been provided. (Refer to Appendix C for a description of the Alyeska project planning process.) While lacking access to formal inspection planning documentation for the VMT piping limited this analysis, the Dynamic Risk project team was able to apply knowledge of technology strengths and limitations, working expertise of appropriate industry standards and engineering experience gained through working with other pipeline operators, to draw conclusions and derive recommendations for this report.

6. Analysis

For the purposes of this report, three (3) approaches to pipeline inspection are classified as follows:

1. In-line inspection (ILI),
2. Internal inspection, and
3. External inspection.

ILI refers to an inspection of a pipeline from the interior of the pipe using an instrumented tool ("smart pig") that is launched, propelled within the pipeline by the product stream and then extracted, all without stopping the flow of the product.

Different than ILI, **internal inspection** refers to an inspection of a pipeline from the interior of the pipe using a mechanically propelled sensor carrying tool, whether robotic or tethered, possibly self-propelled and/or bi-directional. The line pipe must be exposed as required at each end of the target pipe segment for purposes of inserting and extracting the inspection tool. The target pipe segment is, in most cases, isolated from product flow for purposes of the inspection; the tool is rarely surrounded by product.

External inspection refers to an inspection of a pipeline from the exterior of the pipe with hand held tools or more sophisticated technologies designed to detect specific defects. Ultrasonic Testing (UT), Laser Scan or Guided Wave Testing (GWT) are examples of external inspection technologies used to assess the remaining wall thickness to assess the integrity of line pipe.

6.1 Current Inspection Activities at the VMT

The facility piping inspection program at the VMT is modeled after API 570 *Piping Inspection Code: In-service Inspection, Repair, and Alteration of Piping Systems*. Currently implemented is the VMT Piping Integrity Testing (PIT) program [P05][‡‡] that is responsible for annual testing and inspections of above and below ground piping in the VMT. An overview of the current piping inspection activities for all VMT pipe segments considered to be within the scope of this study, is provided in Table 1.

[‡‡] Documents and references were compiled as part of the "Protocol for Document Control and Flow of Information" (See Appendix A). These references are also listed in Section 9 of this report.

Table 1: Current Piping Inspection Activities at the VMT

Asset Name	Activity	Status	Dynamic Risk Commentary
EMB to East Tank Farm (ETF)(near tanks 1 & 3)	Pipe is inspected every time it is exposed.	Cathodic protection records/ coupon measurements not available. No record of pipe exposure and inspection.	• Detailed review of historical coupon and cathodic protection records should be conducted. • Planned for ILI- Specific ILI procedures required.
ETF Headers A & B	Annual 3-hr static head pressure test. Pipe is inspected every time it is exposed.	Cathodic protection records/ coupon measurements not available. No record of pipe exposure and inspection. Pressure test records not available.	• Detailed review of historical coupon and cathodic protection records should be conducted. • Planned for ILI- Specific ILI procedures required. • Pressure testing being performed of pipe body not to recognized industry practice.
ETF to West Metering Building (WMB)	Annual 3-hr static head pressure test. Pipe is inspected every time it is exposed.	Cathodic protection records/ coupon measurements not available. No record of pipe exposure and inspection. Pressure test records not available.	• Detailed review of historical coupon and cathodic protection records should be conducted. • Planned for ILI- Specific ILI procedures required. • Pressure testing being performed of pipe not to recognized industry practice.
WMB to near shore line	Annual 3-hr static head pressure test. Pipe is inspected every time it is exposed.	Cathodic protection records/ coupon measurements not available. No record of pipe exposure and inspection. Pressure test records not available.	• Detailed review of historical coupon and cathodic protection records should be conducted. • Pressure testing being performed of pipe not to recognized industry practice. • Additional supplementary inspections between all girth welds should be considered. • Should be considered for ILI program to achieve operating confidence.
Over water piping to Berths 4 & 5	Annual 3-hr static head pressure test. By the end of 2014, 100% of the girth welds will be externally inspected, portions of insulation will be permanently removed, and girth welds will be inspected by Visual, UT, EMAT and/or GWT technologies.	Pressure test records not available. External Inspection program is In progress.	• Girth weld inspection technology is appropriate and acceptable. • Pressure testing being performed of pipe is not to recognized industry practice. • Additional supplementary inspections between all girth welds should be considered. • Should be considered for ILI program to achieve operating confidence.

It is reported by Alyeska that when the insulation and anti-corrosion coating are removed to expose the pipe surface for visual inspection, other techniques such as GWT, UT, or EMAT are used to evaluate the integrity [P10 and P19]. An explanation of the individual inspection techniques is found in the glossary.

It is reported by Alyeska that a static head pressure test (per 33 CFR 156.70) of the piping from the East Tank Farm to the ends of Berths 4 and 5 is performed on an annual basis. A static head of the highest tank level is applied to achieve test pressure; pressure is held for three hours, and the pipe section is metered at both ends to verify no loss of crude oil.

While there is limited direct examination data for the buried pipe sections at the VMT, a program is in place on several segments (as identified in Table 1) to monitor the susceptibility for external corrosion and internal corrosion. To mitigate external corrosion, a cathodic protection system is maintained on all below ground pipe segments to protect buried piping in the VMT. Weekly monitoring and bi-monthly rectifier readings are performed at the VMT in accordance with Alyeska's procedure *MP 166-2-3.23 Facilities Cathodic Protection System* [P08].

Corrosion coupons are utilized on several segments at the VMT [P10, P19] to monitor for internal corrosion susceptibility. Corrosion coupons are machined strips of line pipe material that are inserted into the pipeline at the 6 o'clock orientation and are exposed to the pipe contents. After a period of time, coupons are temporarily removed from the pipeline for assessment, and the change in the weight of the coupon is used to estimate a corrosion rate. The results of this monitoring are used to evaluate the effectiveness of the chemical corrosion inhibitor treatment program, and changes are made when necessary. Corrosion coupons at the VMT are assessed twice annually (63 coupons in May 2013, 50 coupons in November 2013).

While corrosion susceptibility is being monitored, actual direct inspection of crude oil transport piping at the VMT facility for the presence of corrosion is performed on only a limited basis. The VMT pipelines have been in service since 1977, and the majority of the crude oil transport lines have not been directly assessed for external or internal corrosion; the remaining wall thickness of the majority of the piping has not been confirmed. This duration of time exceeds accepted industry timelines for pipe inspections as required by 49CFR195 for effective assessment of industry recognized pipeline threats, i.e., external and internal corrosion.

Inspection of piping at Berths 4 and 5 was undertaken in 2012 and "*…extensive corrosion underneath thermal insulation was detected. …corrosion was greater than 70% on Berth 4 and greater than 60% on Berth 5.*"[§§] As a result of this discovery, a follow-up program is being planned, as described in the following section.

6.2 Planned Inspection Activities at the VMT

As a follow-up to the 2012 inspection and finding of corrosion on piping at Berths 4 and 5, by the end of 2014, portions of insulation will be permanently removed from the piping over water, and all girth welds over water will be inspected by UT, EMAT and/or GWT technologies. The current corrosion assessment activities and planning for non-ILI pipe segments, inclusive of pressure testing, EMAT, GWT, UT are all acceptable technologies for evaluation of pipeline corrosion within industry standards, however only if performed in appropriate combinations and subject to procedures that account for technology limitations. Such technologies are best applied in combination with ILI as tools to validate ILI results and supplement knowledge of the pipeline condition.

[§§] Report- Corrosion Survey of Valdez Marine Terminal, Submitted by R.Heidersbach, Dr. Rust, Inc., December 20, 2012. [D08]

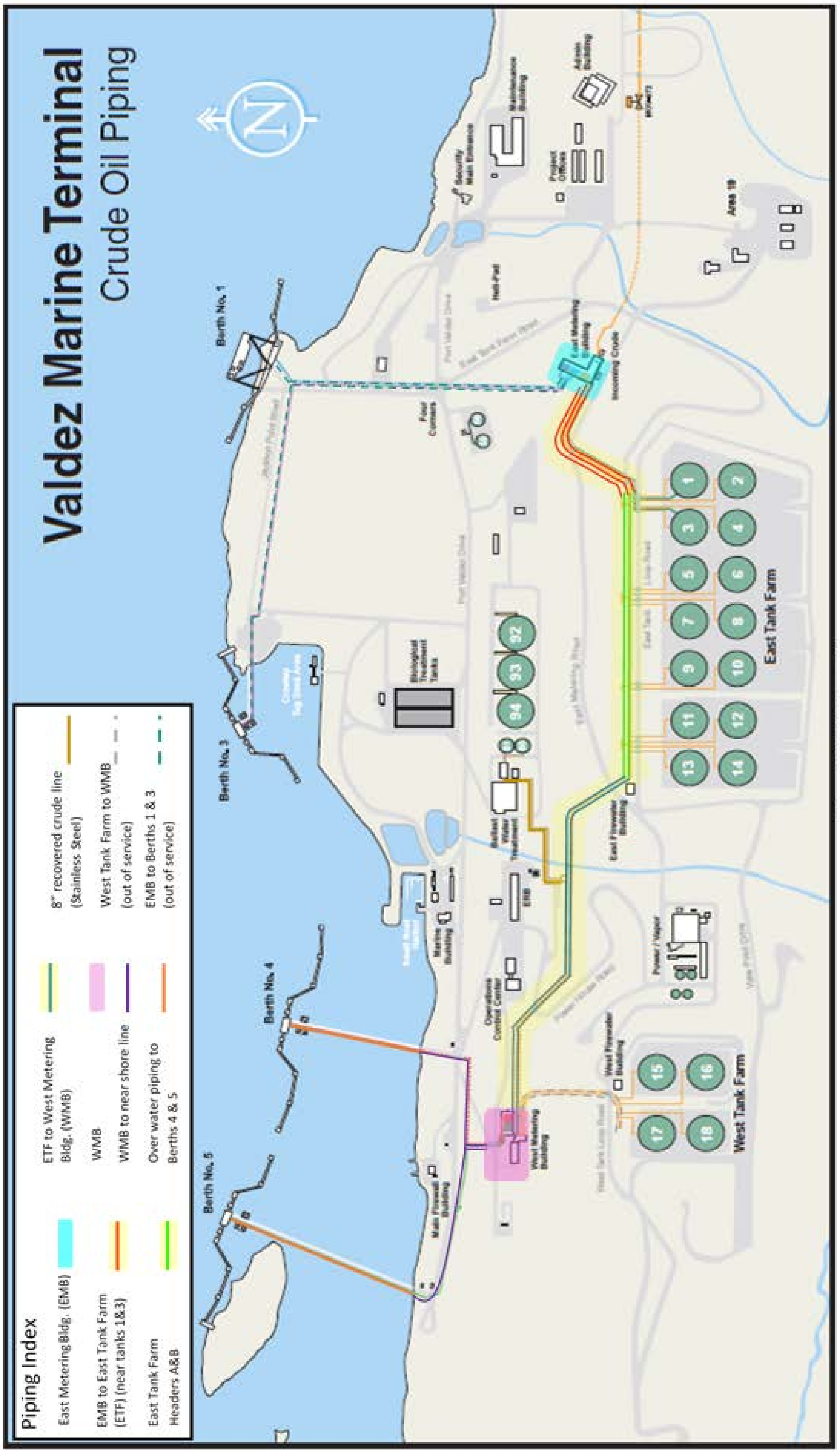
The planned inspection activities for VMT piping, Project Z716, "Valdez Marine Terminal (VMT) Below Ground Crude Oil Piping," will include the installation of permanent fittings and facilities whenever possible to create efficiencies for the implementation of a periodic ILI program. The draft plan of Project Z716 as presented to the Dynamic Risk project team (in the form of email correspondence) by Alyeska along with Dynamic Risk considerations is outlined in Table 2. A schematic diagram of the VMT assets is presented in Map 1.

Table 2: Draft Plan of Inspection Activities at the VMT

Asset Name	Relief Piping (36")	Process Piping (24")	Process Piping (48")	Notes	Schedule Estimate*	Dynamic Risk Commentary
East Metering Bldg (EMB)	455'	425'		Abandon below ground piping Install above ground piping	FEL 1: 9/2013 FEL 2: 12/2014 FEL 3: 7/2015 IFR: 11/2015 IFC: 12/2015 Implementation: 4/2015-10/2017	• Review procedures for piping abandonment- ensure compliance with best industry practice and evaluate for long term issues. • Review procedures for ILI.
EMB to East Tank Farm (ETF)(near tanks 1 & 3)	1,100'		2 x 1,100'	Install (3) pig launchers Modify (2) valves Install (1) 36" pig receiver		
East Tank Farm Headers A & B			2 x 2,135'			
ETF to West Metering Building (WMB)			2 x 2,900'	Install (2) pig receivers		
WMB to near shore line			~1,300' ~1,000'	(information not available to Dynamic Risk)		• Review pressure test procedure. Consider conducting hydrostatic test program to industry standards[***]. • Review configuration of piping for ILI of this segment.
Over water piping to Berths 4 & 5 (girth welds and saddles)			1,000' 1,500'	100% girth weld inspection, annual spot inspections, annual 3-hour leak test at service pressure, EMAT, GWT and/or UT[**]	Expect completion end of 2014	• Review pressure test procedure. Consider conducting hydrostatic test program to industry standards. • Review girth weld inspection results. • Ensure inspection activities account for technology limitations. • Review piping configuration for ILI/ internal inspection program acceptability.

*Schedule estimate pending final design and project approval. FEL: Front-end Loading; IFR: Issued for Review; IFC: Issued for Construction. (Refer to Appendix C for a description of Alyeska's project planning process.)
** Electro-Magnetic Acoustic Transducer, Guided Wave Testing and Ultrasonic Testing

[***] Pressure testing to 49CFR195 Subpart E



Map courtesy of PWSRCAC

Map 1. VMT Asset Lines
Assets highlighted in yellow are planned for ILI.

6.3 Proposed In-Line Inspection Program at the VMT

The ability to utilize ILI technologies and establish a high reliability in the results is dependent upon many factors including physical constraints, operational limits, and threats to be assessed. In the case of the VMT, extreme elevation changes and space limitations in proximity to the launchers and receivers require a complex engineering design. Alyeska plans to use existing spool pieces[†††], valves and fittings, wherever possible, and this will help with system modifications and provide efficient implementation of an ILI program.

As provided by Alyeska representatives, the development and implementation of an ILI program at the VMT from the East Metering Building to the West Metering Building is summarized in Table 3. The specific VMT piping segments that are candidates for ILI are identified.

Table 3: In-Line Inspection Program at the VMT

<table>
<tr><th>Asset Name</th><th>Activity</th><th>Program Development Status</th><th>Implementation Status</th><th>Dynamic Risk Commentary</th></tr>
<tr><td>East Metering Bldg to East Tank Farm (ETF) (near tanks 1 & 3)</td><td>Install above ground 36” piping to replace 36” below ground piping. 36” relief header and (2) 48” headers are planned for ILI</td><td>Engineering Design</td><td>Pipe replacement in progress.</td><td rowspan="3">• Initial approach is acceptable; Plan needs to account for piping configuration, flow velocities and validation of results.
• Consider supplementary inspections during interim period leading up to ILI program.</td></tr>
<tr><td>ETF Headers A & B</td><td>(2) 48” headers planned for ILI</td><td>Engineering Design</td><td rowspan="2"></td></tr>
<tr><td>ETF to West Metering Building (WMB)</td><td>(2) 48” headers planned for ILI</td><td>Engineering Design</td></tr>
</table>

Alyeska intends to utilize MFL ILI technology to assess the 36-inch and 48-inch crude oil transport lines at the VMT. This technology is appropriate for evaluating corrosion-caused metal loss within the specified tolerances. The specific ILI vendor has not been identified, but Alyeska has indicated that vendors with a proven reputation will be selected. The most widely used ILI vendors that provide this ILI technology, or similar, include Baker Hughes, GE/PII, TD Williamson, and Rosen.

[†††] A spool piece is a removable length of pipe sufficiently long to house an ILI tool, attached to the VMT piping by bolted flanges at each end. (See the upper figure on page 28 of Appendix B.)

6.4 Assessment of Proposed In-line Inspection Program (36-inch and 48-inch diameter lines) at the VMT

Alyeska's extensive ILI experience on the TAPS mainline lends credibility to their capability to conduct a successful ILI program on the VMT piping. Alyeska intends to apply the TAPS ILI practice [P16] as the basis for development of a VMT ILI standard practice. The current TAPS ILI Practice meets industry standard guidelines and will provide a strong protocol basis for ILI of the VMT piping. While the anomaly assessment and response is expected to be the same, operational differences at the VMT with respect to the TAPS mainline are considerable, and the development of a VMT-specific ILI practice document will be required.

The VMT has relatively short pipe segments and extreme elevation changes when compared to ILI programs undertaken by most pipeline operators. Management of the ILI tool velocity is critical to produce quality data from the ILI tool and is a particular challenge at the VMT facility. Each ILI vendor specifies an optimal velocity at which ILI tool detection capabilities are maximized. ILI tool velocity outside of the specified velocity limits reduces the axial resolution and increases the uncertainty in the corrosion-caused metal loss sizing. Typically during an ILI survey, pumps and valves are used to regulate the product and ILI tool velocity.

The ILI program at the VMT, if executed as described for those pipe segments being considered, will accommodate future maintenance and inspection needs and will improve the identification of corrosion threats for the purpose of assessment and mitigation. The addition of ILI to the current VMT facility corrosion control programs will also provide a strong corrosion knowledge basis to enhance and improve corrosion detection and monitoring on the entire VMT piping system.

6.5 Piping Segments at the VMT that are not Included in the ILI Program

Table 4 provides a summary of the pipe segments that are not included in the proposed ILI program at the VMT. The evaluation of the remaining wall thickness of these assets may be considered for application of internal or external inspection technologies.

Table 4: VMT assets not included in the proposed ILI program

Asset Name	Activity	Status	Dynamic Risk Commentary
West Metering Bldg to Berths 4 & 5	Considered a possible candidate for an ILI. Modifications to piping required. (Discussion only)	Unknown	
Over water piping to Berths 4 & 5	By the end of 2014, 100% of the over-water girth welds will be externally inspected, portions of insulation will be permanently removed, and girth welds will be inspected by Visual, UT, EMAT and/or GWT technologies. Considered a possible candidate for an internal crawler inspection tool. (Discussion only)	In progress	• Review external piping inspection findings relative to GWT, EMAT and UT limitations.

For those pipe sections that are not planned for assessment using ILI technologies, there are other industry accepted pipeline assessment methods that can be applied where appropriate as follows:

- External Corrosion Direct Assessment (ECDA) - A four-step process that combines pre-assessment, indirect inspection, direct examination, and post assessment to evaluate the threat of external corrosion to the integrity of a pipeline. The ECDA concept involves application of several integrated data inspection sets; i.e. cathodic protection, external coating surveys, soil resistivity surveys in combination with pipeline historical leak records to locate, evaluate, predict, excavate, inspect and repair faults in regions where external metal loss through corrosion is most likely to have occurred. ECDA is recognized by PHMSA (49CFR195.588) as an alternative to ILI as an integrity assessment methodology for corrosion.
- Hydrostatic Testing - A strength and tightness test of a closed pressure vessel by water pressure; a test using non-compressible liquid under pressure at a level equal to or greater than the maximum pressure that will be utilized when in use. A typical pipeline industry hydrostatic test involves purging all natural product out of the pipeline, cleaning the inside of the pipeline, filling the pipe segment with water, and pressurizing the pipeline to a pressure higher than the normal operating pressure, and "holding" that pressure for a predetermined time duration. Under normal soil and climate conditions, when a hydrostatic test leak occurs, there is an immediate drop in pressure, and water is released. The pipeline segment where the leak occurred is excavated; repairs are made, and the pipeline segment is retested. This process is repeated until a successful test result is achieved. Hydrostatic testing will remove wall loss and crack defects that have critical dimensions at the pressure test level of the pipeline segment (49CFR192 Subpart E and API 1110).

Additional recommended practices and limitations for using ECDA and Hydrostatic testing are provided in Appendix B. As mentioned previously, pressure testing, UT, EMAT, GWT are all acceptable technologies for direct assessment of pipeline corrosion, however, only if performed in appropriate combinations using an accepted standard integrity assessment methodology. Operational, safety, environmental, and risk management considerations are also an integral part of selection and use of each technology.

6.6 Industry Inspection Standards and Recommended Practices

All stakeholders involved in the pipeline industry continuously work to improve the safety and reliability of pipeline systems and operations through the development and implementation of industry standards[‡‡‡] and recommended practices[§§§]. Standards and/or recommended practices are typically developed though industry organizations such as the National Association of Corrosion Engineers (NACE), American Petroleum Institute (API), American Society of Mechanical Engineers (ASME),

‡‡‡ A Standard is defined as "any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity…" (International Civil Aviation)

§§§ A Recommended Practice is defined as "any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency…" (International Civil Aviation)

American National Standards Institute (ANSI) and the American Society of Nondestructive Testing (ASNT). In many cases, specific portions of industry standards and/or recommended practices are incorporated by reference within pipeline regulations. Pipeline operators are obligated to identify pipeline segments and establish which jurisdictional requirements are applicable for compliance.

The primary industry standards and recommended practices that may apply to the VMT are as follows:

- ASME/ANSI B31.4 "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids"
- API Specification 5L - Specification for Line Pipe
- API Specification 6D - Specification for Pipeline Valves (Gate, Plug, Ball, and Check Valves)
- ASME Boiler and Pressure Vessel Code, Section VIII, Division 2 "Alternate Rules for Construction for Pressure Vessels"
- ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 "Rules for Construction of Pressure Vessels"
- ASME Boiler and Pressure vessel Code, Section IX "Welding and Brazing Qualifications"
- API 1110 "Pressure Testing of Steel Pipelines for the Transportation of Gas, Hazardous Liquids or Carbon Dioxides"
- API 1160 "Managing System Integrity for Hazardous Liquid Pipelines "
- API RP 1163 "In-Line Inspection Systems Qualification Standard "
- ANSI/ASNT ILI-PQ "In-line Inspection Personnel Qualification and Certification Standard"
- ASME B31.8S "Managing System Integrity of Gas Pipelines"
- ASME/ANSI B31G "Manual for Determining the Remaining Strength of Corroded Pipelines"
- AGA Pipeline Research Committee, Project PR-3-805 "A Modified Criterion for Evaluating the Remaining Strength of Corroded Pipe" (RSTRENG, December 22, 1989). The RSTRENG program may be used for calculating remaining strength.

The following industry standards provide general program guidance for ILI tool selection and performance specifications, qualification of ILI data, reporting on threats, threat mitigation, and personnel qualifications and are the primary focus of this review as it relates to the undertaking of an ILI program on the VMT crude oil transport piping:

- API RP 1163 "In-Line Inspection Systems Qualification Standard"
- NACE SP-0102 "In-line Inspection of Pipelines"
- ANSI/ASNT ILI-PQ "In-line Inspection Personnel Qualification and Certification Standard"

A pipeline operator's ILI standard operating practice, such as the "*Integrity Management Monitoring Program Procedures"* [P16] ('TAPS ILI Practice'), is intended to further interpret and build upon the above guidance documents and define pipeline-specific performance requirements including those for ILI systems, tool prequalification, cleaning and inspection procedures, personnel qualifications, equipment, and associated software.

The TAPS ILI Practice [P16] is a document that contains the ILI guidelines specifically for the TAPS mainline. The review of this document resulted in the following conclusions:

- Meets the requirements of API 1163;
- Qualifies the tool and certainty in the results (e.g. does the tool provide the resolution and accuracy that the vendor claimed);
- Applies NACE SP-0102 guidelines for safe and reliable pigging operations; addresses personnel safety and ILI tool operation requirements;
- Applies ASNT ILI-PQ guidelines to qualify ILI data analysis personnel and reporting of results within acceptable statistical qualifiers.

The following elements of the proposed VMT ILI program are being addressed in a manner consistent with recognized industry practice, as defined within the industry standards referenced within this report as follows:

- Technology Selection – At the VMT, the targeted pipeline threats are external and internal corrosion. Alyeska has proposed to use MFL ILI technology for VMT piping, an equivalent technology to that used on the TAPS mainline. This MFL technology is considered to be well suited to detect and monitor the targeted corrosion threats.

- Vendor Selection- Two ILI vendors were referenced by Alyeska representatives for the provision of ILI services within the VMT; Baker-Hughes and the Rosen Group. Both vendors are industry recognized and have the appropriate MFL-ILI tools and technology to identify, locate and size internal and external pipeline corrosion on VMT piping.

- Procedure for Validating Results- The procedure written for validating results of an ILI survey at the VMT is expected to be analogous to the validation procedure contained within the TAPS ILI Practice [P16], which is considered to meet recognized industry practice.

- Reporting- The reporting requirements for the VMT ILI program are expected to be analogous to the ILI reporting requirements contained within the TAPS ILI Practice [P16], which is considered to meet recognized industry practice.

6.7 Current and Developing Regulatory Trends for Pipe Inspection as Such Pertains to the VMT

49 CFR Part 195 (*Transportation of Hazardous Liquids by Pipeline*) is the US DOT PHMSA regulation that governs pipelines based upon specific criteria (e.g., interstate commerce). The 800-mile TAPS is regulated against 49 CFR Part 195, however this governance terminates at the East Metering Building. However, 49 CFR Part 195 regulations stipulate specific requirements for pipe segments located within a "high consequence area" (HCA), which is defined as an area of high population, unusual sensitivity or containing a commercially navigable waterway. In consideration of this requirement and the findings of external corrosion in 2012 on girth welds on Berths 4 and 5, the pipe segments over Port of Valdez waters should continue to be prioritized for corrosion assessment within the VMT piping inspection program and should also be considered for application within the ILI or internal inspection programs.

The 36-inch relief piping (1,100 feet in length) within the VMT is reported by Alyeska as subject to 49 CFR Part 195 and is a pipeline segment that Alyeska has targeted for an ILI survey. It is recognized that PHMSA issued a Consent Agreement that indicated that *Alyeska will replace or remove any hazardous liquid pipeline along TAPS which cannot be assessed using in-line inspection tools (or other suitable assessment methods approved by the Director) and which would compromise the safe operation of TAPS upon failure*.[****]

The current regulatory environment requires the use of risk-based inspection to assure the integrity of pipeline facilities. Alyeska manages the integrity of the VMT following the recommended practices in API 570 (*Piping Inspection Code: In-service Inspection, Repair, and Alteration of Piping Systems*). Specifically, Alyeska has a developed a procedure (MP-166-3.03-1) that outlines the VMT PIT program [P05]. These programs were described in detail as part of prior work performed and reported to PWSRCAC [D08].

The current trend in the USA and Canada is to expand regulations to require Safety and Loss Management Systems in addition to the current operator integrity management programs. The Canadians have updated CSA Z662 to include Annex A (informative) Safety and loss management system. Liquid operators in Canada have been audited for progress in adopting these principles aimed at Board level responsibility. The same regulator expectation within the United States has produced the draft of API 1173, Pipeline Safety Management System Requirements due for affirmation this year. These standards all focus on the CEO level principles and responsibilities and similar expectations are found in recently issued ISO 55000 Asset Management System Standards:

- ISO 55000 – overview of asset management, principles and terminology
- ISO 55001 – requirements specification for an integrated, effective management system
- ISO 55002 – guidelines for the implementation of an effective management system

Recently both PHMSA and the NEB have conducted public workshops to outline regulatory expectations and possible outcomes. Increased inspectability of the VMT piping by Alyeska will demonstrate future regulatory awareness and help to establish a level of progress relating to these new regulatory expectations.

Regulatory oversight, jurisdiction, and the involvement of many stakeholders is unique to operations in Alaska when compared to the rest of the pipeline industry. Establishing a comprehensive understanding of all stakeholders, boundaries, and responsibilities of each stakeholder was outside the scope of this effort. Stakeholders that may have some jurisdiction across portions of the VMT include the following:

[****] Consent Agreement, U.S. Department Of Transportation, Pipeline And Hazardous Materials Safety Administration, Office Of Pipeline Safety, Washington, DC 20590, In the Matter of CPF No. 5-2011-5001S: Alyeska Pipeline Service Company, Respondent, August 12, 2011. [D11]

- US Coast Guard regulates Marine terminals. The Coast Guard's jurisdiction extends from the first isolation valve inside the secondary containment of the marine terminal to the vessel.
- Occupational Health and Safety Administration (OSHA) assures safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance.
- Alaska Department of Environmental Conservation (ADEC) is primarily responsible for spill prevention and response.
- Bureau of Land Management oversees and monitors activities related to the 800-mile TAPS, and works with other federal agencies to monitor environmental protection, pipeline system integrity, public and worker safety, and to ensure regulatory compliance.
- State-Federal Joint Pipeline Office was created to partner State and Federal agencies in monitoring and overseeing TAPS and work proactively with Alaska's oil and gas industry to safely operate, protect the environment, and continue transporting oil and gas in compliance with legal requirements.

6.8 Comparison of the VMT ILI program against industry practices and selected set of ILI technologies.

API 1163, *In-Line Inspection Systems Qualification Standard* in conjunction with NACE SP0102, *In-Line Inspection of Pipelines* provide guidance for pipeline operators to perform tool selection based upon the targeted anomaly type, the product being transported, and operational issues anticipated on the pipeline system. "Table 1. Types of ILI Tools and Inspection Purposes" within NACE SP0102 identifies types of ILI tools matched to their inspection purposes and a portion of this table is provided below as Figure 1:

Anomaly	Imperfection/ Defect/Feature	Metal Loss Tools			Crack Detection Tools		Deformation Tools
		Magnetic Flux Leakage (MFL)		Ultrasonic Compression Wave[M]	Ultrasonic Shear Wave[M]	Transverse MFL	
		Standard Resolution (SR)	High Resolution (HR)				
Metal Loss							
	External Corrosion	Detection,[A] Sizing[B] No ID/outer diameter (OD) discrimination	Detection,[A] Sizing[B]	Detection,[A] Sizing[B]	Detection,[A] Sizing[B]	Detection,[A] Sizing[B]	No Detection
	Internal Corrosion						
	Gouging						

(A) Limited by the detectable depth, length, and width of the indication.
(B) Defined by the sizing accuracy of the tool.

Figure 1. Excerpt from NACE SP0102

As seen in Figure 1, magnetic flux leakage (MFL) and ultrasonic technology (UT) ILI tools are both suitable for identifying, locating and sizing corrosion-caused metal loss in pipelines. In cases where line cleanliness and/or paraffin are identified (as in the TAPS mainline due to low flows and cool temperatures), UT ILI tools may have additional challenges (coupling disruption, sensor sensitivity loss) and may not be able to achieve adequate performance.

API 1163 also requires that the ILI vendors qualify their data analysts responsible for the interpretation of the ILI data (ASNT ILI-PQ *In-Line Inspection Personnel Qualification and Certification*) to ensure the quality of the evaluations.

Most high resolution MFL tools are capable of detecting metal loss greater than 10% of the wall thickness with 80% confidence. MFL tools from ILI vendors such as Baker Hughes, GE/PII, TD Williamson, and Rosen generally meet or exceed minimum technical specifications to perform this inspection. While these tools are capable of detecting corrosion-caused metal loss less than 10%, the tool specifications are typically focused on an optimum corrosion reporting threshold of greater than 10% of the wall thickness and a length-to-width ratio greater than three times the wall thickness (3t), where an 80% confidence interval can be achieved. Table 5, taken from API 1163, is an example of the expected characterization of detection thresholds and probabilities of detection.

Table 5: Reference Anomalies*

Reference Anomaly (length by width) as a function of wall thickness (t)	Detection Threshold	Probability of Detection (POD)	Qualifiers and Limitations
5t by 5t	10%	90%	Extended metal loss Length and width > 3t
2t by 2t	15%	90%	Pits t < Length and width < 3t
5t by 1t	35%	90%	Axial Grooves Width < t, length > 3t

*Please see API 1163 for additional explanation and detail regarding reference anomalies.

7. Findings

Documentation provided to date for review by the Dynamic Risk project team has not been of sufficient detail to conduct a full and complete industry standard or "best industry practice[††††]" procedure review and comparison.

It is reported by Alyeska that the VMT is classified as a facility and is not regulated against 49 CFR Part 195. The 36-inch relief piping located near the East Metering Building is, however, reported by Alyeska as being subject to 49 CFR Part 195 regulations. This pipe section is designated for ILI assessment.

It is reported by Alyeska that a static head product pressure test (per 33 CFR 156.70) of the piping from the East Tank Farm to the ends of Berths 4 and 5 piping is performed on an annual basis. A static head of the highest tank level is applied to achieve test pressure; pressure is held for three hours, and the pipe section is metered at both ends to verify no loss of crude oil. The reported Alyeska pressure test

[††††] The processes, practices, systems and techniques used by organizations that are widely recognized as driving exceptional efficiency and safety performance while meeting compliance objectives and moving towards the goal of zero incidents.

practice is not in alignment with accepted industry standards for pipeline pressure testing, relative to pressure and test duration. Consideration should be given to the undertaking of additional assessment measures (49CFR195 Subpart E). Alyeska reports however, that test leaks have not occurred during any of the pressure tests that have been conducted to date.

The VMT has been in operation since 1977, and the majority of the crude oil transport lines have not been fully assessed for external or internal corrosion. This duration of time exceeds accepted industry timelines for pipe inspections as required for effective assessment of industry recognized pipeline threats, i.e., external and internal corrosion.

No information or data provided was sufficient to establish the current condition of the pipe wall in the crude oil transport lines in the VMT. The corrosion condition and the remaining wall thickness for a majority of the piping has not been confirmed.

Alyeska expects that by the end of 2014, portions of insulation will be permanently removed from piping over water and all girth welds on piping over water will have been subjected to external inspection (UT, EMAT and/or GWT). Once this plan is carried out, and all girth weld regions have been externally inspected, this plan will appropriately address the girth weld corrosion threat that has been documented on this piping segment.

The current corrosion assessment activities for non-ILI pipe segments, inclusive of pressure testing, EMAT, GWT and UT, are all acceptable inspection technologies for evaluation of pipeline corrosion in application with industry standards and subject to each technology's restrictions for detection and/or assessment of corrosion-caused metal loss. However, these activities are acceptable only if performed using appropriate combinations and subject to procedures and industry standards[‡‡‡‡] that account for technology application and accuracy tolerance limitations.

An ILI program at the VMT is being developed for the 36-inch and 48-inch piping from the East Metering Building to the West Metering Building.

It is proposed by Alyeska that service supply vendors and MFL ILI tools similar to those used to inspect the TAPS mainline will also be used to detect and size corrosion-caused metal loss for selected piping segments at the VMT, including the 36-inch and 48-inch header systems. Supply vendors and MFL technologies proposed by Alyeska are considered acceptable for an ILI program on VMT piping.

The extensive Alyeska ILI experience on the TAPS mainline lends credibility to their capability to conduct a successful ILI integrity assessment program on the VMT piping. The current TAPS ILI Practice meets industry standard guidelines and will provide a strong protocol basis for ILI of the VMT piping.

[‡‡‡‡] Such as API 570, API 580, API 1160, ASME B31.8S that require inspection standards for the individual techniques from ASNT and ASTM or the recent NACE SP0313 Guided Wave Technology for Piping Applications.

The ILI integrity assessment program at the VMT, if executed as described for those pipe segments being considered, will accommodate periodic maintenance and inspection needs and will improve the identification of corrosion threats for purposes of assessment and mitigation. The addition of ILI to the current VMT facility corrosion control programs will also provide a strong corrosion knowledge basis to enhance and improve corrosion detection and monitoring on the entire VMT piping system.

The 48-inch piping downstream of the West Metering Building to Berths 4 and 5 is not included in the proposed ILI program at the VMT and limited information relating to confirmed inspection plans and approaches for this segment was provided for review.

The following elements of the proposed VMT ILI program are being addressed in a manner consistent with recognized industry practice, as defined within the industry standards referenced within this report: technology selection, vendor selection, procedure for validating results, reporting.

8. Recommendations

Due to a lack of detailed data in regards to historical piping evaluations and the present status of the planned Alyeska ILI and related corrosion assessment programs, specific and qualified recommendations could not be included within this report. The following general ILI and pipeline inspection program recommendations are provided for the awareness of PWSRCAC. The recommendations are intended to assist in forming the basis for PWSRCAC monitoring of future Alyeska reporting on VMT piping corrosion conditions and to aid in benchmarking the effectiveness of Alyeska corrosion assessment programs as such programs evolve to completion.

VMT Inspection Program

- Consider 49 CFR Part 195 regulations along with industry standards as incorporated by reference, as guidance when developing the inspection program for the VMT piping.
- 49 CFR Part 195 regulations stipulate specific requirements for pipe segments located within a "high consequence area," defined as an area of high population, unusual sensitivity or containing a commercially navigable waterway. In consideration of this guidance requirement and the findings of external corrosion in 2012 on girth welds on Berths 4 and 5 piping, continue to prioritize pipe segments over Port of Valdez waters for corrosion assessment within the VMT piping inspection program.
- The 36-inch relief piping located near the East Metering Building is a VMT pipeline reported by Alyeska as being subject to 49 CFR Part 195 regulations. Review the status of this pipeline relative to applicable requirements; i.e., threat assessment, risk management, integrity management plan development, to establish compliance within the future inspection planning process.
- Continue to undertake assessment measures for the piping over water; i.e. removal of pipe coating as required to allow for external corrosion assessment and ultrasonic examination of selected pipe segments for the presence of internal corrosion. In lieu of an ILI program being planned for these pipe segments, this approach, if undertaken subject to appropriate procedures and periodicity requirements, combined with the planned external assessment of

girth welds, will provide a degree of confidence in pipeline operating integrity for the piping over the water.

- In order to provide increased operating confidence, undertake piping configuration modifications necessary to perform an ILI of the pipe segments downstream of the West Metering Building and/or to perform a hydrostatic test program to pressures that will exceed normal operating pressure, as per guidelines based upon 49 CFR Part 195 requirements.
- Determine piping system ILI and supplementary inspection periodicity requirements through assessment of ILI and other inspection results that can be combined with predicted corrosion growth rate calculations. Periodicity requirements, as developed, should be applied within future inspection program planning.
- Review 2014 inspection results of girth welds over water to determine if girth weld integrity is an issue that needs to be addressed within the VMT facility inspection planning. Ensure that piping over water (or other piping) inspection activity (EMAT, GWT and/or UT) procedures and reporting account for personnel qualifications and technology limitations.
- API 1163 and Alyeska TAPS experience can be applied as guidelines when developing ILI procedures for the VMT; however, challenges specific to the VMT (short distances, extreme elevation changes and absence of pumps to control tool speed) will challenge the ability to keep the ILI tool within a required velocity threshold and will need to be addressed. Development of a VMT-specific ILI practice document is required of Alyeska.
    - Ensure that ILI reporting is validated through direct pipe examinations, where practical, and conducted by certified NDE personnel. The results should be clearly documented and communicated to the correct departments
    - Ensure that validation results are compared to ILI technology stated accuracy, detection and identification tolerances and that discrepancies, if any, are noted and addressed
    - Ensure that the selected ILI technology POD, POI and accuracy tolerances are accounted for within any subsequent excavation and repair programs
    - Ensure that the evaluation methodology determines the interval between subsequent ILI integrity assessments and is based upon analysis of ILI data and factors of safety
- Investigate methods and technology for application of supplementary inspections on pipe segments designated for inclusion within the proposed ILI program. Results can provide continued operating confidence during the interim time period leading up to initiation of the ILI program and receipt of final reporting, which may take up to 6 months following completion of the pipe segment inspection.
- Review the facility specific risk and integrity assessment methodologies outlined in API 1160, and supported by CEPA recommended practice for Facilities Integrity Management when next updating the MP-166 series of integrity documents to include ILI as a new integrity assessment methodology.

<u>VMT Inspection Program Monitoring</u>

- Continue to assess and maintain awareness of ILI industry and inspection improvements and new developments as a means of monitoring the continuing effectiveness of the proposed VMT ILI program.

- Continue to monitor the VMT ILI integrity assessment program and practice developments with specific focus on the ILI vendor selection process, applied ILI technologies, ILI data validation procedures and the corrosion assessment and reporting process subject to the following Best Practice ILI program criteria:
    - Ensure that the correct technology tool is utilized for the anticipated target pipeline risk.
    - Ensure that pipeline is prepared and internally cleaned.
    - Ensure that the product flows are adequate.
    - Ensure that the pipeline operator ILI contract agreement:
        - Summarizes all pipeline operating parameters and characteristics, including pipe steel grades, wall thickness, diameters, product flows, product temperatures and pipeline geographic characteristics
        - States expectations relative to final reporting and deliverables
        - States the requirement to validate all stated POD and POI tolerances for all involved pipe diameters and wall thicknesses
        - Allows for auditing of data by a pipeline operator representative throughout the program
        - Provides a well-defined criteria and signature approval process for field acceptance of ILI data.
        - Summarizes signal response interpretation and reporting requirements that are in application with repair criteria guidelines and inline inspection tool reporting tolerances.
- Maintain an awareness and understanding that the VMT is a complex facility and that operational, safety, environmental, and risk management considerations are an integral of every decision.

9. References

Document Reference Number	Document Title
Received from Alyeska:	
P01	MP-166-1.00 Integrity Management Programs Process
P02	MP-166-3.01 Corrosion Inhibitors – Pump Stations, North Pole Metering & VMT
P03	MP-166-3.02 Internal Corrosion Investigation and Monitoring Program
P04	MP-166-3.03 Facility Corrosion Integrity Monitoring
P05	MP-166-3.03-01 Facility Corrosion Integrity Monitoring Engineering and Implementation
P06	MP-166-3.03-02 Facility Atmospheric Corrosion Control Plan
P07	MP-166-3.07 Bimonthly Inspection – Rectifiers and Other Devices
P08	MP-166-3.23 Facilities Cathodic Protection Systems
P09	Trans Alaska Pipeline Systems (TAPS) 2012 Annual Report - Cathodic Protection Monitoring
P10	Trans Alaska Pipeline System (TAPS) 2012 Annual Report – Pipeline and Valdez Marine Terminal Facilities Corrosion Monitoring
P11	B-511 Pump Station and Terminal Pipe Investigation Specification
P12	SUR-10. Surveillance/Repair Procedure, Belowground Piping (2)
P13	PPT 2014 Dynamic Risk.SI VMT Piping Inspection Overview Draft A_050214
P14	PPT Presentation to RCAC-Dynamic Risk 4-24-14
P15	MP-166-3.22_Pipeline Cathodic Protection Systems
P16	* MP-166-3.04 Integrity Management Monitoring Program Procedures
P17	Scope of Work for Project Z716 (email, 16 July 2014)
P18	*(5) Drawings to support Project Z716
P19	Trans Alaska Pipeline System (TAPS) 2013 Annual Report – Pipeline and Valdez Marine Terminal Facilities Corrosion Monitoring
Publicly available documents:	
D01	18 AAC 75.080 Alaska Administrative Code
D02	Alaska Risk Assessment of Oil & Gas Infrastructure
D03	Valdez Marine Terminal Non-Tank Corrosion Abatement Study 2005, Coffman
D04	Review of the Valdez Marine Terminal Maintenance Program 2007, Petrotech Alaska
D05	Comprehensive Evaluation and Risk Assessment of Alaska's Oil and Gas Infrastructure 2009, DoyonEmerald, ABS Consulting
D06	Valdez Marine Terminal Maintenance Assessment Advisory Audit 2011, PWSRCAC
D07	Assessment of the TAPS, Maintenance Prioritization 2011, SPCO
D08	Corrosion Survey of Valdez Marine Terminal, 2012, Dr. Rust
D09	FACTS Trans Alaska Pipeline System, 2013, APSC
D10	Trans Alaska Pipeline System Right-of-Way Lease ADL 63574 Assessment Report: 11-SPCO-A-001, August 2011, SPCO
D11	US DOT PHMSA Consent Agreement In the Matter of CPF No. 5-2011-5001S: Alyeska Pipeline Service Company, Respondent, August 12, 2011.

10. Definitions

API American Petroleum Institute- a national trade association that represents all aspects of the oil and gas industry in the US.

ASME American Society of Mechanical Engineers - A not-for-profit membership organization that enables collaboration, knowledge sharing, career enrichment, and skills development across all engineering disciplines, toward a goal of helping the global engineering community develop solutions to benefit lives and livelihoods.

CATHODIC PROTECTION a procedure by which an underground metallic pipe is protected against corrosion. A direct current is impressed onto the pipe by means of a sacrificial anode or a rectifier. Corrosion will be reduced where sufficient current flows onto the pipe.

DIRECT ASSESSMENT an integrity assessment method that utilizes a process to evaluate certain threats (i.e., external corrosion and internal corrosion) to a covered pipeline segment's integrity. The process includes the gathering and integration of risk factor data, analysis to identify areas of suspected corrosion, direct examination of the pipeline in these areas, and post assessment evaluation.

EMAT Electro-Magnetic Acoustic Transducer – an ILI tool that uses a magnetic field coupling to bridge gaps between the sensor head and the pipe wall and provide an ultrasonic inspection of wall thickness or crack detection

FEL Front-end loading and refers to gate documents that are part of Alyeska’s project planning process

FERC Federal Energy Regulatory Commission—an independent agency that regulates the interstate transmission of electricity, natural gas and oil

GWT Guided Wave Testing – an externally applied ultrasonic inspection technique that uses Full wall width sound waves to screen pipe for wall loss; it cannot distinguish between Internal or external corrosion nor detect the size of an anomaly

ILI In-line inspection is the inspection of a pipeline from the interior of the pipe using an instrumented tool (“smart pig”) that is launched, propelled within the pipeline by the product stream and then extracted, all without stopping the flow of the product.

MFL Magnetic flux leakage – often describes an ILI tool used to detect and size corrosion- caused metal loss anomalies (length, width and depth)

NACE National Association of Corrosion Engineers is an industry association whose mission is to protect people, assets and the environment from corrosion; world-wide corrosion authority; recognized globally as the premier authority for corrosion control solutions.

NDE Non-destructive examination: most commonly visual inspection, radiography (x-ray) inspection and ultrasonic inspection.

NEB National Energy Board - pipeline regulator in Canada with regulatory functions

PHMSA	Pipeline and Hazardous Materials Safety Administration - the federal pipeline regulatory agency that falls under the United States (US) Department of Transportation (DOT).
PIT	Piping Integrity Testing and specifically references Alyeska's Risk-Based Inspection program
UT	Ultrasonic testing – generally refers to an external inspection technique that uses piezoelectric transducers to send and receive high frequency sound to measure wall thickness (loss) or to detect geometric changes such as laminations or cracks

Appendix A

Protocol for Document Control and Flow of Information for PWSRCAC

Inspectability of Piping at the Valdez Marine Terminal

Document Number:	DR-DOC-v0.0
Author:	Monica Porter
Date:	April 01, 2014
Status:	Production

INTRODUCTION

In order to ensure the traceability and security of information produced through various mechanisms (document production, interviews, references, etc.), this procedure provides the necessary guidelines and protocols that should be followed.

INFORMATION EXCHANGE BARRIER

Verbal or written communications regarding the status or any other aspect of the 'Project' is restricted to the 'Project Team' and support staff.

- Project: PWSRCAC Inspectability of Piping at the Valdez Marine Terminal
- Project Team: all personnel who are involved in the project details where there is a need to know the details:

Person	Title	Company
Phillip G. Nidd	Vice-President	Dynamic Risk USA, Inc.
Keith Leewis	Senior Advisor, Project Lead	Dynamic Risk
Monica Porter	Engineer, DCM	Dynamic Risk USA, Inc.
Tom Kuckertz / Austin Love	Council Project Manager	PWSRCAC
Barry Roberts		Alyeska

- Project Lead: the person in charge of the project who is ultimately responsible for the implementation and execution of this procedure.
- Document Control Manager: the person who is responsible for the managing all of the information requests, cataloging, compilation and storage of materials, controls of documents, etc.

TREATMENT OF PROJECT DOCUMENTS

- Documents will be requested in a controlled manner through use of a number referenced "Information Request Form" (Exhibit A).
- Once received, documents will be recorded in a controlled manner such that each document will be assigned a unique, corresponding document reference number pursuant to a naming convention that identifies the type of document (I-Interview, P-received from Alyeska, O-Observation, D-publicly available documents, DR-Dynamic Risk).
- Receipt of all hard copy or electronic documents will be confirmed by the document control manager through issuance of a signed information transmittal. (Exhibit B)
- A project master log record will be maintained of all documents, drawings and data received. (Exhibit C)
- Once received and recorded, project documents received will be made available to Project Team members by the Document Control Manager. All project team members will be assigned necessary passwords and will have access to a repository for temporary storage of documents. The intent is to utilize to the maximum degree possible, the restricted access and security of all project electronic documents.
- Document transmittal as an attachment to email is to be avoided.

- To the extent that portable media is ever involved to store project documents and/or work products (e.g., laptops, external hard drives, tablet, etc.), access to the device is to be password protected.
- All Project Team produced work product documents to bear a header: DYNAMIC RISK PROJECT TEAM WORK PRODUCT

TREATMENT OF DYNAMIC RISK-PRODUCED DOCUMENTS AND WORK PRODUCT

- Hard copy documents produced by the Project Team relative to research and work product shall be stored within properly labeled binders or file folders. All work products are considered to be 'working drafts' and will be subject to change as additional information is made available.
- Documents produced by the Project Team shall be stored electronically on the server and such documents will be made accessible to all Project Team members on a read, print or download basis, subject to Project Information Barrier restrictions.

EMAIL COMMUNICATIONS / TELEPHONE COMMUNICATIONS

Email communications are subject to the following restrictions:

- All project related email subject lines shall initiate with the Project Title followed by the subject matter; i.e. "Inspectability of Piping at the Valdez Marine Terminal – meeting notes 1 April 2014".
- All project team members are expected to issue and respond to project email communications in a manner that will withstand future scrutiny by engineers, attorneys and other third parties.
- Only factual information shall be produced in any written communications except in the Final Report where conclusions will be established based upon thorough review of all available information.

RETENTION OF DOCUMENTS

- Project Team draft work product documents shall be retained for a duration of time as required to validate subsequent work product versions and once deemed to be redundant, shall be deleted from all storage servers, local laptop computers, external hard drives or desktop work stations.
- Project Team draft reports shall be retained for a duration of time as required to validate subsequent reports and once deemed to be redundant, are to be deleted from all storage servers, local laptop computers, external hard drives or desktop work stations.
- Interview notes and observations or material observations are to be recorded either within electronic format or within a project designated hard cover record book and retained in the original format inclusive of corrections and or modifications. Logging of activities to be recorded in a consistent format that includes the date and time, the name of the Project Team member recording the data, a description of the activity and specific comments.
- Hand logging of field observation activities are to be recorded either within electronic format or weather resistant, hard cover, record books and retained in the original format inclusive of corrections and or modifications. Logging of activities to be recorded in a consistent format that includes the date and time, the name of the Project Team member recording the data, a description of the activity and specific comments.

- Following the conclusion of the project, the respective Project Team members and representatives will confer about document retention and disposition, including the retention and disposition of electronic documents, photographs, electronic back up, and the handling (including potential return or destruction) of hard copy documents.

Exhibit A

Inspectability of Piping at the Valdez Marine Terminal
Information Request #1
April 11, 2014

This initial information request seeks readily available summaries and documents and is therefore fairly broad and encompassing.

1. Valdez Marine Terminal (VMT) assets:
   - Specific VMT facilities targeted for ILI
     - Physical parameters (lengths, diameter, location, etc.)
     - Expected operating pressures and flow conditions
     - Notable physical and operating constraints
   - VMT facilities that are not targeted for ILI (with explanation)
   - Schematic drawings of these systems
2. Current corrosion assessment program for assets described above
   - Corrosion detection (known corrosion), assessment, repairs, status, and monitoring (summary reports that may have been produced to Coast Guard or others)
   - VMT corrosion management strategy
3. Corrosion Program Development:
   - Program details related to the ILI program considered for VMT
     - ILI technologies (vendors and specific tools) considered
     - Ideas for assessing sections of the VMT system that are currently unpiggable
   - Anticipated Capital investment required and over what length of time by year
   - Program constraints (financial, physical or operational)
4. Corrosion Procedures that would be relied upon as part of this effort
   - Procedures for NDE and ILI
   - Procedures for validation
   - Record keeping / database applications

CONFIDENTIAL / DYNAMIC RISK PROJECT TEAM WORK PRODUCT

Exhibit B

Information Transmittal #1

Project Name: **Inspectability of Pipe at the Valdez Marine Terminal**

Attention: **Barry Roberts, Tom Kuckertz**

Date of Transmittal: **25 April 2014**

Date Documents Received: **25 April 2014**

Dynamic Risk Project Team acknowledges the receipt of the following documents:

Document Reference Number	Document Title
P01	MP-166-1.00 Integrity Management Programs Process
P02	MP-166-3.01 Corrosion Inhibitors – Pump Stations, North Pole Metering & VMT
P03	MP-166-3.02 Internal Corrosion Investigation and Monitoring Program
P04	MP-166-3.03 Facility Corrosion Integrity Monitoring
P05	MP-166-3.03-01 Facility Corrosion Integrity Monitoring Engineering and Implementation
P06	MP-166-3.03-02 Facility Atmospheric Corrosion Control Plan
P07	MP-166-3.07 Bimonthly Inspection – Rectifiers and Other Devices
P08	MP-166-3.23 Facilities Cathodic Protection Systems

Project Manager or Designate: Monica Porta

Exhibit C – List of References

Document Reference Number	Document Title
Received from Alyeska:	
P01	MP-166-1.00 Integrity Management Programs Process
P02	MP-166-3.01 Corrosion Inhibitors – Pump Stations, North Pole Metering & VMT
P03	MP-166-3.02 Internal Corrosion Investigation and Monitoring Program
P04	MP-166-3.03 Facility Corrosion Integrity Monitoring
P05	MP-166-3.03-01 Facility Corrosion Integrity Monitoring Engineering and Implementation
P06	MP-166-3.03-02 Facility Atmospheric Corrosion Control Plan
P07	MP-166-3.07 Bimonthly Inspection – Rectifiers and Other Devices
P08	MP-166-3.23 Facilities Cathodic Protection Systems
P09	Trans Alaska Pipeline Systems (TAPS) 2012 Annual Report - Cathodic Protection Monitoring
P10	Trans Alaska Pipeline System (TAPS) 2012 Annual Report – Pipeline and Valdez Marine Terminal Facilities Corrosion Monitoring
P11	B-511 Pump Station and Terminal Pipe Investigation Specification
P12	SUR-10. Surveillance/Repair Procedure, Belowground Piping (2)
P13	PPT 2014 Dynamic Risk.SI VMT Piping Inspection Overview Draft A_050214
P14	PPT Presentation to RCAC-Dynamic Risk 4-24-14
P15	MP-166-3.22_Pipeline Cathodic Protection Systems
P16	* MP-166-3.04 Integrity Management Monitoring Program Procedures
P17	Scope of Work for Project Z716 (email, 16 July 2014)
P18	*(5) Drawings to support Project Z716
P19	Trans Alaska Pipeline System (TAPS) 2013 Annual Report – Pipeline and Valdez Marine Terminal Facilities Corrosion Monitoring
Publicly available documents:	
D01	18 AAC 75.080 Alaska Administrative Code
D02	Alaska Risk Assessment of Oil & Gas Infrastructure
D03	Valdez Marine Terminal Non-Tank Corrosion Abatement Study 2005, Coffman
D04	Review of the Valdez Marine Terminal Maintenance Program 2007, Petrotech Alaska
D05	Comprehensive Evaluation and Risk Assessment of Alaska's Oil and Gas Infrastructure 2009, DoyonEmerald, ABS Consulting
D06	Valdez Marine Terminal Maintenance Assessment Advisory Audit 2011, PWSRCAC
D07	Assessment of the TAPS, Maintenance Prioritization 2011, SPCO
D08	Corrosion Survey of Valdez Marine Terminal, 2012, Dr. Rust
D09	FACTS Trans Alaska Pipeline System, 2013, APSC
D10	Trans Alaska Pipeline System Right-of-Way Lease ADL 63574 Assessment Report: 11-SPCO-A-001, August 2011, SPCO
D11	US DOT PHMSA Consent Agreement In the Matter of CPF No. 5-2011-5001S: Alyeska Pipeline Service Company, Respondent, August 12, 2011.

Appendix B

Basic Knowledge Aspects of VMT Operations and Inspection Technologies

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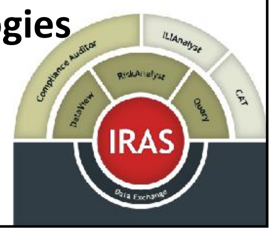
Basic Knowledge Aspects of VMT Operations and Inspection Technologies (Supplemental to Final Report)



8/20/2014

For PWSRCAC

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Project Z716 VMT Below Ground Crude Oil Piping

* This slide is adapted from Alyeska's presentation to Dynamic Risk May 7, 2014.

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Alyeska's Project Z716 Scope*

Project Scope Proposed Elements

1. Modify East Metering Building piping to eliminate below ground pipe *(PHMSA Consent Agreement)*
2. Install pig launcher spools at East Metering Building
3. Modify piping and replace (2) valves to enable pigging
4. Install pig receiver in 36" relief header near Tank 3
5. Install pig receivers at West Metering

* This slide is adapted from Alyeska's presentation to Dynamic Risk May 7, 2014.

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Pig Receiver inside East Metering Building

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East Metering Upstream of Spool

East Metering – Existing Spool & Tee (Stopples as Alternative to Valves)

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Steep Slope
East Metering Building to East Tank Farm

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◊ Concrete, slurry-encased then up to 35’ deep

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Across the Tank Farm

- ◊ 48” Valves
- ◊ Lines to tanks
- ◊ In front of berm

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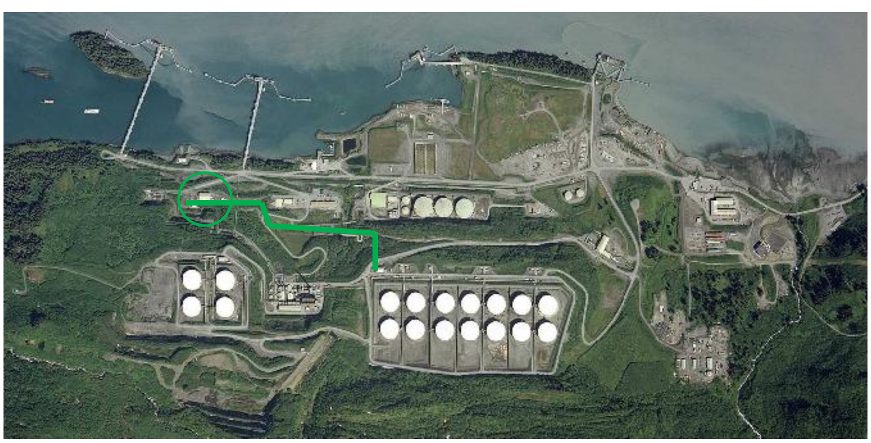
West Metering is half-way down the hill



East Tank Farm to West Metering Building

◊ Exposed Expansion Loop and Creek Crossing

West of West Metering
(possible location of spools for pigs from east metering)

Looking south (uphill)

Looking east

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West Metering to Tankers

- ◊ Conceptual
  - ➢ Not to launch/receive over water = bidirectional or Piping Integrity Testing (PIT)?
  - ➢ ILI when buried

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VMT Current PIT Program

- ◊ Remove insulation and inspect using automated and hand Ultrasonic Techniques, X-ray, and Guided Wave
- ◊ Needed for down stream of crude oil expansion loop under control rooms on outboard ends of berths 4 & 5
- ◊ Over water

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Insulation Removal for PIT

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In-Line Inspection Tools

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Types of ILI Tools

- Magnetic flux leakage (MFL) – Internal/External Wall Loss
  - Axial
  - Circumferential (TFI or transverse flux inspection)
- Geometry – Bore diameter, dents, ovality, buckles
  - Gauge plate
  - Mechanical Caliper
- Ultrasonic – Internal/External Wall Loss, cracking
  - Normal beam (wall thickness)
  - Angle beam (cracks)
  - Electromagnetic acoustic transducer (EMAT)

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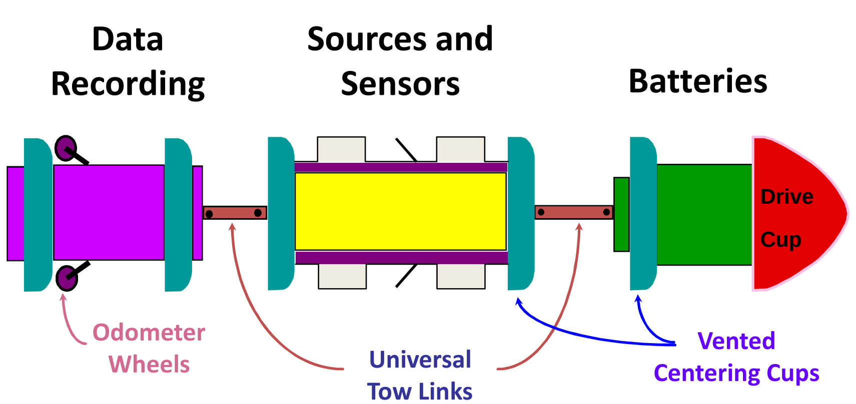
Schematic of an ILI Tool



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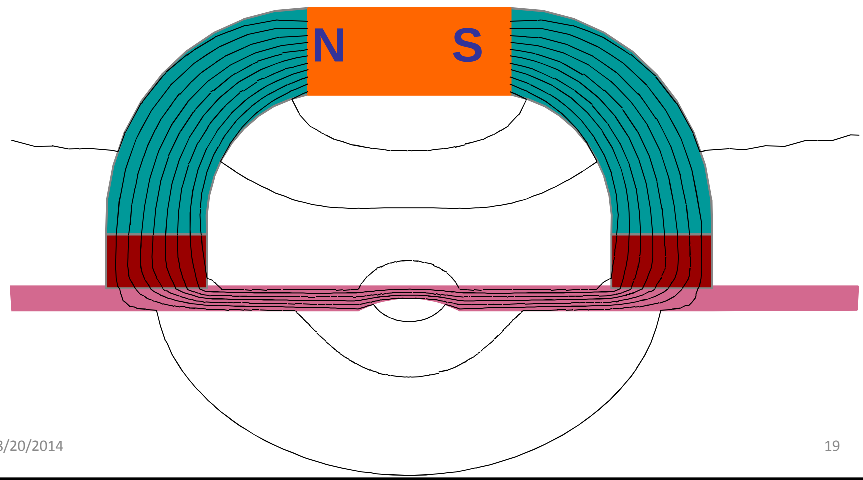
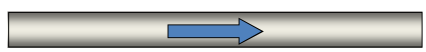
Basics of Flux Leakage (MFL)

◊ Defects, such as corrosion, cause the magnetic flux to be diverted outside the pipe wall.



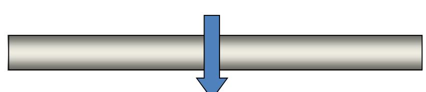
Two Types of MFL – Field Direction

◊ Axial



- Magnetize in the axial direction

◊ Circumferential



- Magnetize in the hoop direction
- Referred to as:
  - Transverse
  - Circumferential

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MFL Pig at East Metering Building

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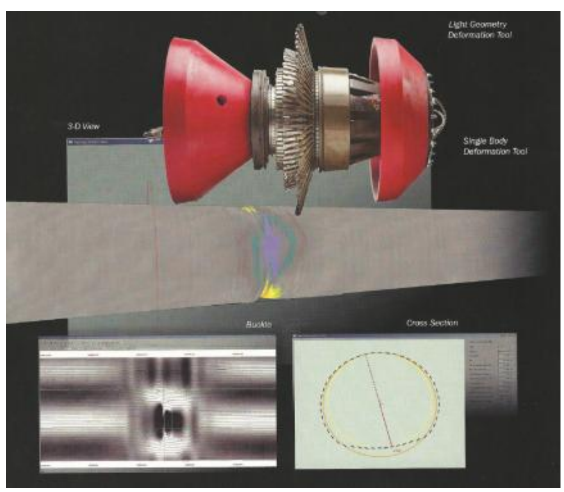
TD Williamson - Deformation Tool

- ◊ Bore Diameter
- ◊ Out of Round
- ◊ Wrinkle/ Buckle
- ◊ Dent



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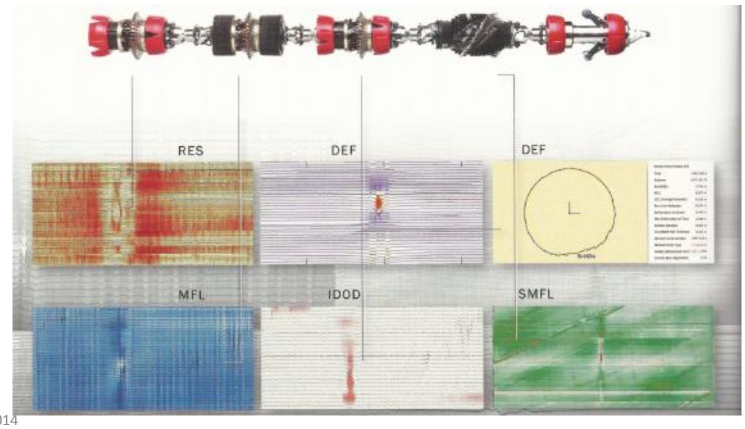
TD Williamson Multiple Data Set

◊ External/Internal, Axial MFL, Deformation, Spiral MFL, X-Y-Z



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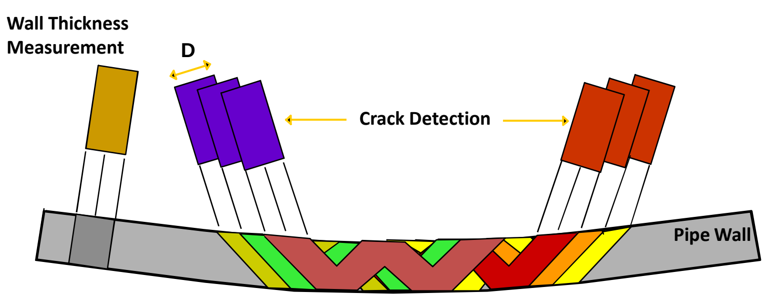
Ultrasonic Tools (Liquid Coupled)



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NDT Systems & Services
Ultrasonic Metal Loss Tool

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Pig Launch & Receive Components

For PWSRCAC

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Typical Components

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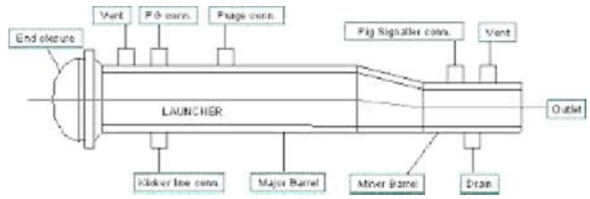
A typical pig trap is comprised of the following components:

- Major barrel
- Minor barrel
- End closure
- Pig signaller
- Kicker line connection
- Pressure gauge connection
- Vent and drain connection
- Utility connections



Typical Design

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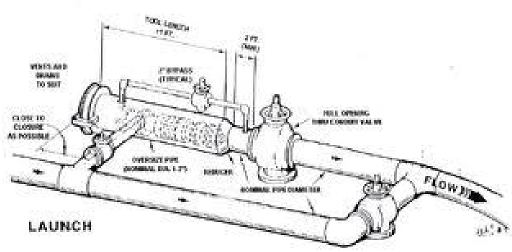
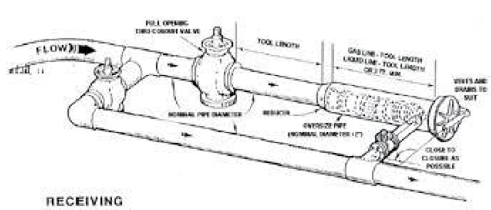
Simple Operations

- Insert pig
- Close all valves
- Pressurize launcher
- Open exit valve
- Open kicker branch valve
- Use kicker bypass for speed
- Use branch valve on receiver for speed



- Receive pig, stops in larger diameter
- Close all valves
- Open bypass for product
- Depressurize trap and drain liquids
- Open trap when no internal pressure



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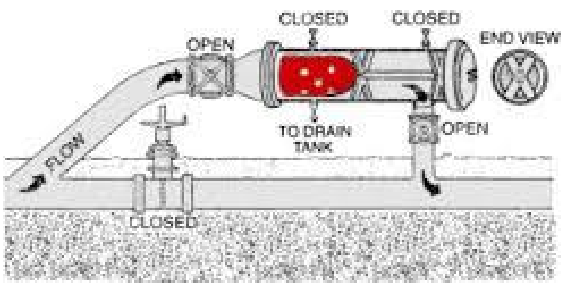
Receive

Pig flows into trap and larger diameter breaks the driving seal



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Cleaning Pig

Displayed at Fairbanks TAPS visitor center

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Non-destructive Examination (NDE) Overview

For PWSRCAC

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NDE Tools

- Pit gauge
- PipeScan
- Guided Wave UT
- UT Pen probe
- Laser Scan
- Mapscan
- T.O.F.D.

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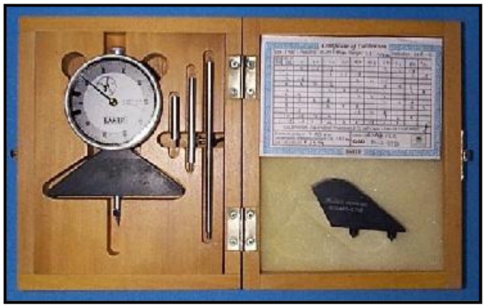
NDE

Starret/Pit Gauge – External Inspection

- ◊ Measures Pit Depths
- ◊ Manual Grid System
- ◊ Tip Size /.025



NDE

U.T. Pen Probes

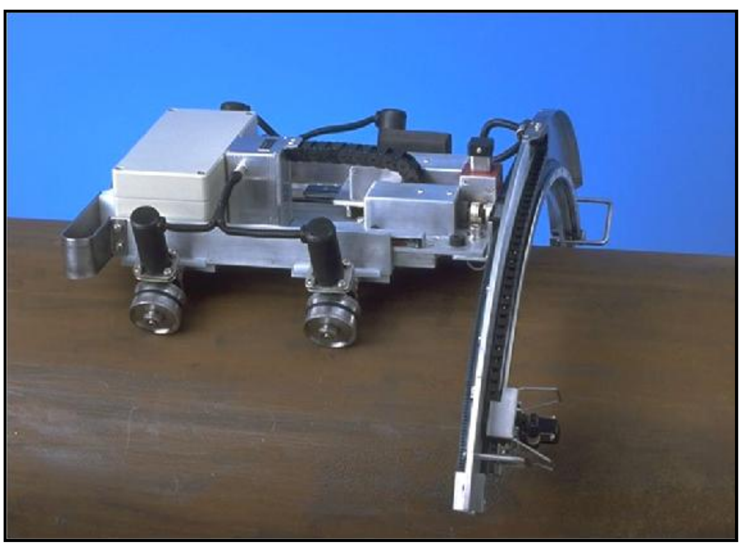
- ◊ Measures Remaining Wall (accurate)
- ◊ Grid System
- ◊ Tip Size /0.060

NDE

PipeScan – Internal/External Inspection

NDE

Laser scanning – External Inspection



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NDE - Guided Wave UT (Internal & External Inspection)

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NDE

Internal Corrosion – MAPSCAN

NDE

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Actual Corrosion

NDE

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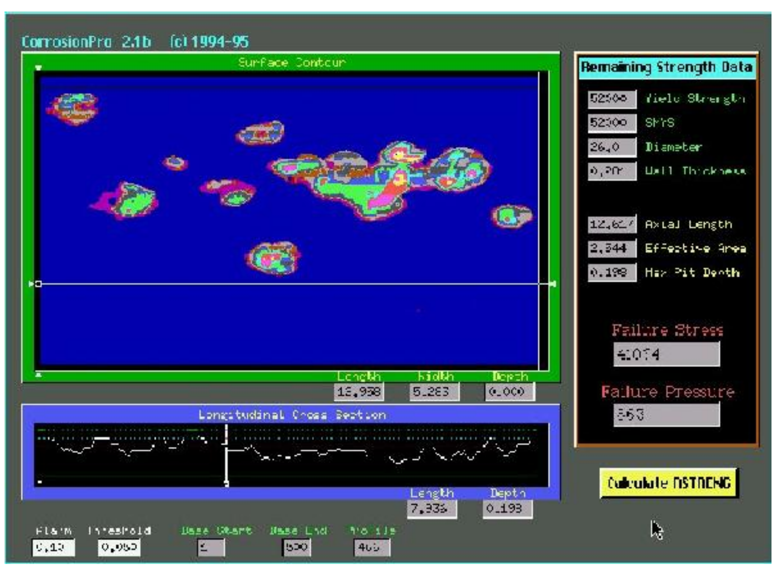
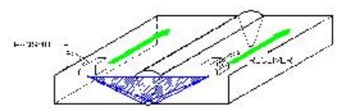
Screen Image - MAPSCAN

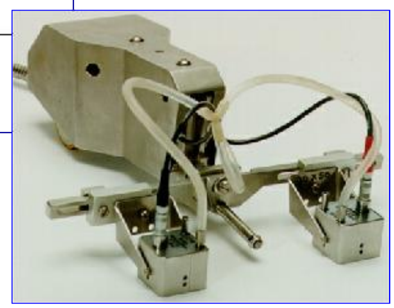


NDE

Advanced Crack Sizing
T.O.F.D. – Time of Flight Diffraction (UT)



TOFD probe arrangement

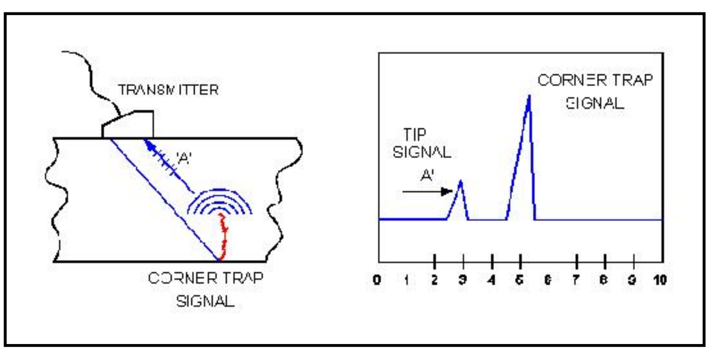


NDE

Tip Diffraction – Two Techniques

◊ Time of Flight Diffraction (TOF):

- The arrival time of the diffracted signal, from the tip of the flaw



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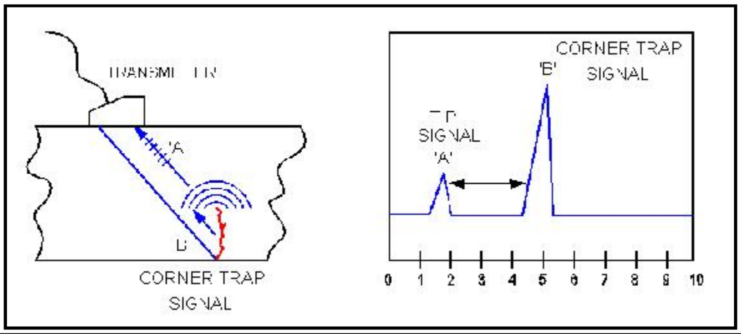
NDE

Tip Diffraction – Two Techniques

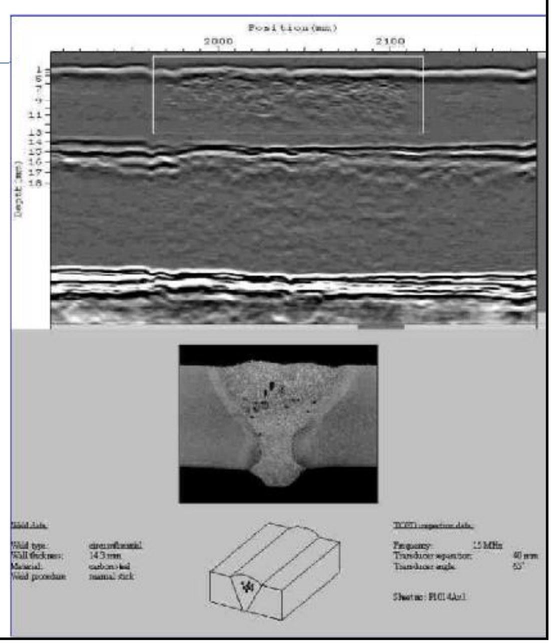
◊ Delta TOF:

- The separation in time of the diffracted signal from the tip of the flaw and the reflected or “corner trap” signal from the base of the flaw



Dynamic Risk

T.O.F.D. Image



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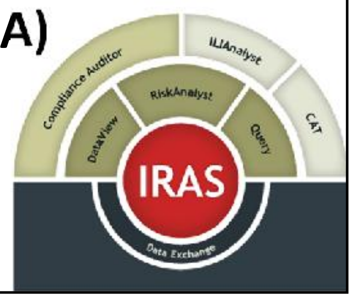
Hydrostatic Testing and Direct Assessment (ECDA)

For PWSRCAC



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Pipeline Assessment- Hydrostatic Testing and ECDA

Dynamic Risk

- ◊ Industry acceptable methods to assess the integrity condition of a pipeline segment through means other than ILI:
  - ➢ External Corrosion Direct Assessment (ECDA) - ECDA is a four-step process that combines pre-assessment, indirect inspection, direct examination, and post assessment to evaluate the threat of external corrosion to the integrity of a pipeline.
  - ➢ Hydrostatic Testing - A strength and tightness test of a closed pressure vessel by water pressure; a test using non-compressible liquid under pressure at a level equal to or greater than the maximum pressure that will be utilized when in use.

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ECDA Overview

◊ The ECDA concept is involves utilization of several integrated data sets; i.e. cathodic protection, external coating surveys, soil resistivity surveys in combination with pipeline historical leak records to locate, evaluate, predict and excavate, inspect and repair faults in regions where external metal loss through corrosion is most likely to have occurred.

◊ ECDA as a concept has been applied in various forms by pipeline companies for many years, however it has now become a USA regulatory recognized assessment technique for those pipelines that cannot be reasonably inspected utilizing ILI tools.

◊ Objective is to identify problematic areas or sections along the pipeline where corrosion is more likely to be occurring than elsewhere.

Dynamic Risk

ECDA Program Limitations

◊ Technical limitations in regards to quantification of pipeline defects other than external corrosion; i.e. construction dents, mechanical damage, internal corrosion, cracks.

◊ Inconsistency of reliable, comprehensive data about a pipeline and the inherently subjective nature of the analysis process

◊ The land through which a pipeline runs and the pipeline itself is always changing:
  - Soil conductivity can fluctuate due to climate changes and elevation variables.
  - The replacement of pipe sections over the years, other repairs or changes to the pipe.
  - Multiple foreign pipeline crossings, underground mining operations, and other energy sources can exponentially multiply the variables influencing a pipeline.
  - Human encroachment and changes to the pipeline's surrounding environment also can be difficult to factor.
  - Micro-bacterial changes to the soil in discrete portions of a line can be difficult to ascertain.

ECDA – Recommended Approach

Dynamic Risk

- ◊ As a prerequisite, establish and document solid technical justification for not using other more objective assessment techniques to assess the pipeline section
- ◊ Establish a data management approach that ensures security of data and allows for seamless data integration and manipulation
- ◊ Ensure that all data sets provide sufficient long term data for acceptable statistical conclusions and that all data sets contain results that are accurate within acceptable industry tolerances
- ◊ Establish and document solid engineering criteria for selection of excavation sites and examination of excavated pipe
- ◊ Ensure that all involved personnel are trained and qualified and that all certifications are documented
- ◊ Ensure that the program evolves to a conclusion in a timely manner
- ◊ Ensure that a backup plan for pipeline integrity assessment is in place that can be implemented quickly if required
- ◊ Ensure that the IMP recognizes and fully addresses the limitations of the ECDA program in regards to quantification of pipeline defects other than corrosion

Pipeline Hydrostatic Testing Overview

Dynamic Risk

- ◊ A typical industry hydrostatic test involves purging all natural product out of the pipeline; cleaning the inside of the pipeline, filling the pipe segment with water and pressurizing the pipeline to a pressure higher than the normal operating pressure and "holding" that pressure for a predetermined time duration
- ◊ The test is designed to locate defects in the pipeline that cannot tolerate the higher pressure. Under normal soil and climate conditions, when a hydrostatic test leak occurs, there is an immediate drop in pressure and water is released. The pipeline segment where the leak occurred is excavated, repairs are made and the pipeline segment is retested. This process is repeated as many times that are necessary, in order to obtain a successful test result
- ◊ Periodic hydrostatic testing is an acceptable method to ensure the integrity of pipelines. Hydrostatic testing will remove material wall loss defects and crack defects, regardless of geometry or orientation, that have critical dimensions at the pressure test level of the pipeline segment

Pipeline Hydrostatic Testing Program Limitations

Dynamic Risk

- It is not always practical to take a pipeline segment out of service.
- No information is gained regarding the presence or absence of sub-critical flaws and in some cases (crack defects) hydrostatic testing may actually result in defect growth.
- If water is not completely removed from the pipeline, internal corrosion can initiate within low elevation pipe sections.
- Water disposal following the hydrostatic test program can be a major environment concern.
- It is difficult to predict and plan for the number of hydrostatic leaks and the type of pipeline defects that will be exposed.

Pipeline Hydrostatic Testing Recommended Approach

Dynamic Risk

- Ensure that the hydrostatic test program follows strict engineering protocols and that accurate records of the test program are maintained for the life of the pipeline
- Ensure that the engineering approach to the hydrostatic testing program is based upon the type of defect anticipated; i.e. corrosion wall loss may require implementation of a simple hydrostatic test pressuring approach; pipe wall cracking may require implementation of a "spike" test at a higher maximum pressure for a short period.
- Ensure that the time duration between hydrostatic testing programs is based upon solid demonstrable critical assessment studies in regards to the operating condition of the pipeline and the category of pipeline defects involved.

Dynamic Risk Assessment Systems, Inc.

Your Integrity Management Partner

From wellhead to burner tip, Dynamic Risk's integrity management solutions provide you the information to make effective decisions for your entire asset base.

Hot Tap and Related Information

For PWSRCAC

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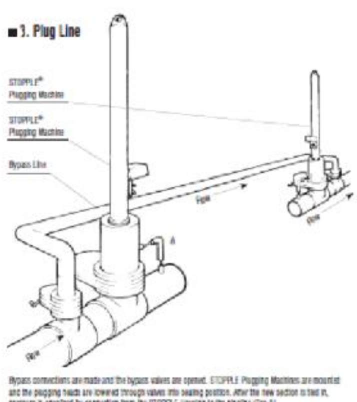
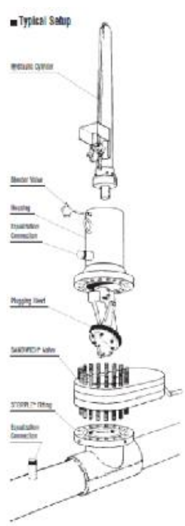
Dynamic Risk

TDW Stopple

◊ Mechanical plug which can be installed without taking the line out of service

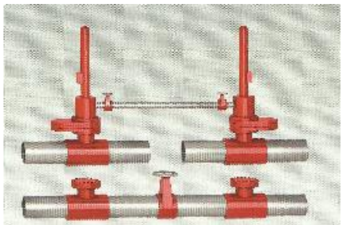




Dynamic Risk

Overview for Simple Spool Installation

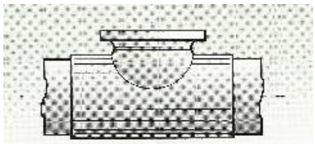
- ◊ Two 48” hot taps
- ◊ Two large valves
- ◊ Two small bypass valves
- ◊ Add stopples = stop flow
- ◊ Drain & remove pipe
- ◊ Insert flanges and ILI launch/receive spool


Double STOPPLE® Plugging using housing-to housing temporary by-pass

Dynamic Risk

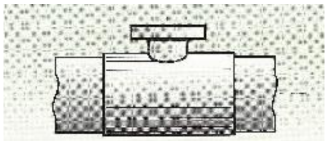
Add Welded Split “T” Sleeves

- ◊ 48” to 48” size on size


Size on Size Fitting

- ◊ Folding Seal

- ◊ Smaller bore 24” to 48”


Reduced-Branch Fitting

Dynamic Risk

Weld Split "T" onto Live Pipe

Weld Long Seam and then Girth Seam

Dynamic Risk

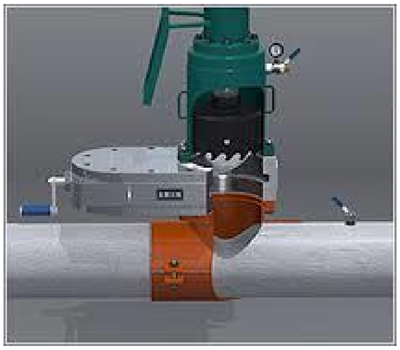
Add Valve then Cut

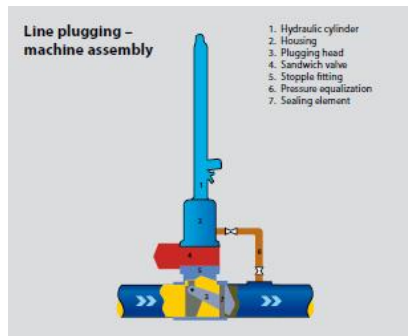
- ◊ After welding the split "T"
- ◊ Add isolation valve
- ◊ Add cutter tool
- ◊ Open valve
- ◊ Pressurize cutting chamber
- ◊ Saw out coupon
- ◊ Raise saw & coupon
- ◊ Close valve
- ◊ Depressurize
- ◊ Remove cutting tool

Dynamic Risk

Remove Coupon and Stop the Flow

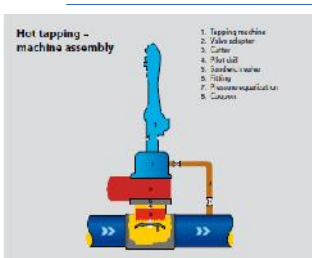
- ◊ Gate valve
  - Allows access for the tools
  - Isolates the pressure chamber

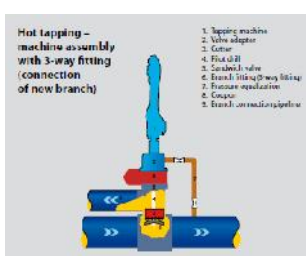




Dynamic Risk

Hot Tap and Setting Stopple

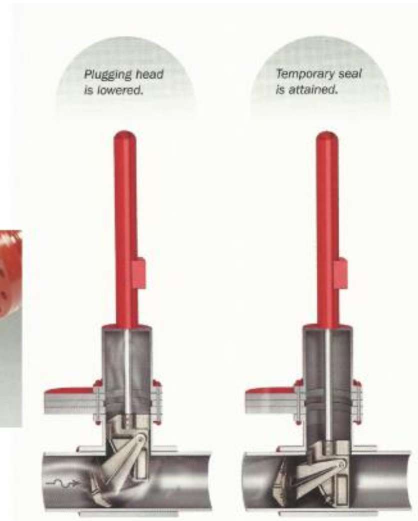




Dynamic Risk

Stopple Operation

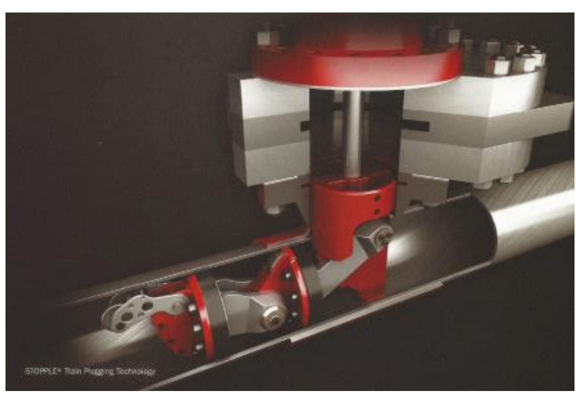
- ◊ Lower into flow
- ◊ Complete seal for flow
- ◊ Small, single and double



Dynamic Risk

Double Stopple Train

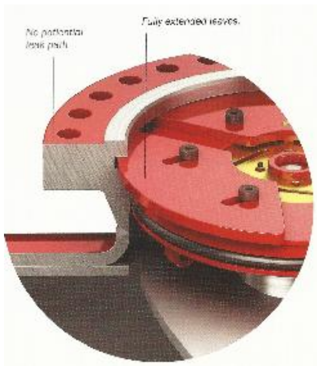
Extra margin of safety to prevent flow



Dynamic Risk

Sealed Hot Tap

- ◊ Disk has mechanical lock and "O" ring seal
- ◊ Tool is inserted through the isolation valve



Dynamic Risk

Flange Sealing for Future Access

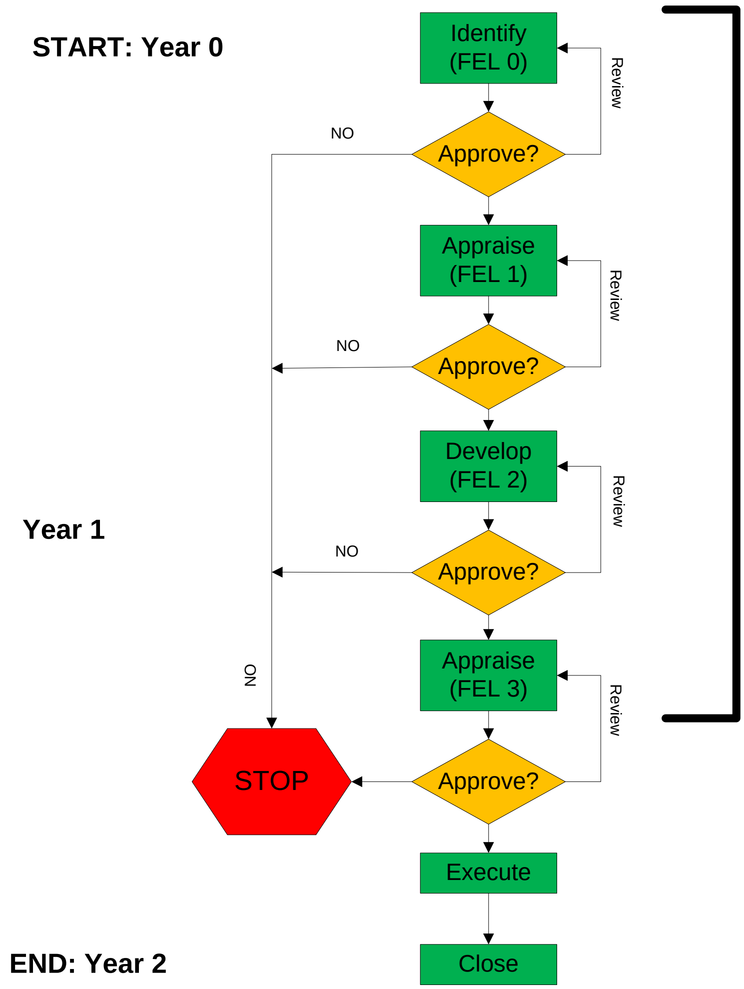
- ◊ Weld on Split "T"
- ◊ Add isolation valve
- ◊ Bolt on cutter
- ◊ Remove cutter and coupon
- ◊ Insert disk through valve
- ◊ Lock & set mechanically
- ◊ Remove insertion tool
- ◊ Remove valve
- ◊ Bolt on flange face

Dynamic Risk

Thanks to TD Williamson, GE, RTD for providing images.

Appendix C

Alyeska Pipeline Project Management Process



FEL: Front End Loading is a formalized process to develop communicate and reach stakeholder alignment for a definitive project scope to improve the efficiency and reliability of project delivery.

GATE: An approval process after each FEL step to reduce the number of changes in later project stages.

STOP: Each gate in the process allows for the project to be cancelled or shelved.

2 Years: The Project Management Process is implemented in 2 year cycles

IFR: Issue for Review
IFC: Issue for Construction