Recoat vs. Linear Anode vs. Deferred Action

Planning and Executing a Pipeline Remediation Program

2012 Appalachian Underground Corrosion Short Course (AUCSC)

by
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For Consideration…

Discussion Question – Does strict compliance with code ensure that a pipeline or pipeline(s) are safe?

Will code maintain the integrity of the pipeline(s)?

For Example…

Pipeline Company X:

- High Pressure Natural Gas Pipeline made of 30" x 0.344" X-52 Pipe
- Installed in 1955 and pressure tested to over 90% SMYS
- Coated with asphalt enamel
- Cathodic protection applied semi-remote groundbed 600' from location since 1957
- At rectifier the pipe to soil readings taken since 1957 between -1 to -2Vg CSE
- Test station 300 feet North, PS readings taken since 1955 between -1 to -2Vg CSE
- No history of any sort of leaks or ruptures in area over the past 53 years of operation
- Close interval survey run in 2003 showed pipe to soil readings -0.53Vg to -0.69Vg ON
- Remote groundbed installed in 2004 further away from pipeline
- Groundbed installed in original location depleted in 2005
- Follow up readings showed -0.5Vg to -1Vg of polarization outside of the area between rectifier and test station
- Linear groundbed installed in 2007 that polarized pipe to -2Vg to -3Vg between rectifier and test station
- Smart Pig run June 2008, ext ml 20-40% of pipe wt, digs scheduled for October 2008

Discussion Question – Does strict compliance with code ensure a safe pipeline(s)? Will code maintain the integrity of the pipeline(s)?

Decisions…

- Annual Survey, ECDA, and/or ILI
- Groundbeds or Recoat
  - How much pipe is out of compliance
  - How far out of compliance
  - Cost per foot of linear groundbeds $25-40
  - Cost per foot of recoat $125-500
- Deferred Action
  - Passes 100mV de-polarization but pipe to soil readings in the range where SCC is possible
  - Out of compliance but ILI log shows little corrosion and corrosion present predicted to be safe at present

And More Decisions…

- Pipeline Integrity – After 2003
  - For Williams Gas Pipeline – Transco the tool of choice for assessment is the ILI
  - We are able to use ILI for most of our HCAs
  - We believe ILI provides the most accurate picture of the integrity of our pipelines at a point in time by looking directly at the pipe
- Pipeline Integrity - Before 2003
  - For Williams Gas Pipeline – Transco the tool of choice for assessment was primarily CIS and secondarily ILI
  - Used ILI on 100% of the oldest pipeline by 2001
  - CIS not complete on 100% of the system

Today…

All data is collected with corresponding GPS readings so that data can be overlaid making it possible to draw sound conclusions about the integrity of the pipeline. These conclusions allow good decisions to be made about when and what actions are taken to maintain the integrity of the pipeline.

Class Outline

- The Challenge
- Past, Present, and Future…Assessment
- Deciding on a Direction and Counting the Cost
- Compliance with Code
- Management Expectations…Continuing Education
- Safety Expectations
- The Pipeline Integrity Maintenance Toolbox
- Starting the Program
- Benefits
- The Future
- Mistakes and the Hard Lessons Learned
- Practical Advice
- The End Result

The Challenge

Maintain the integrity of the pipeline and comply with regulations while at the same time maximizing shareholder return on investment and maintaining the competitive advantage by being the lowest cost provider.

Assessment - Past

Determine and understand the scope of the facilities involved under your responsibility as well as each piece and how it has been built and maintained, KNOW YOUR SYSTEM:

- Location
- Pipe Specifications
- Manufacturing Practices
- Construction Methods
- Materials Used
- Coatings Used
- Operating History (Pressure & Temperature fluctuations, Liquids, etc.)
- Past Projects (Groundbeds, Recoat, Anomaly Digs, CIS, etc.)
- Past Problems (corrosion, leaks, damage, deficiencies, etc.)

This information will be invaluable in deciding what steps are, or are not, taken. The past cannot be changed, but you can learn from it, in so far as what worked and what didn't. The goal is to keep from repeating past mistakes but continue past successes.

Assessment – Past: Charlottesville Division

- Four States: SC, NC, VA, & MD
- > 1,800 Miles of >10" to 42" diameter pipeline (Mainline & 6 Laterals) installed from 1950-2007, various grades X-50 to X-70 and wall thicknesses 0.250" to 0.750".
- DSAW, ERW, Spiral Wound, etc.
- Steel used from around the world.
- Coal Tar, Asphalt, Mastic, Tapes, Epoxies, etc.
- Pressures fluctuations from 400-900psig.
- Temperature swings of 70-90°F each year.
- 100 miles of Recoat and 50 miles of Replacement.
- Three ruptures ('73, '96, '08) and several minor pinhole leaks.
- Many dry hilltops and wet bottoms, a lot of rock in various areas.

Assessment - Present

Determine and understand the situation today, KNOW YOUR SITUATION:

- Job Responsibilities (yours and others)
- Knowledge of Pipeline Integrity (yours and others)
- Reporting Structure (strengths and weaknesses)
- Current Projects (Groundbeds, Recoat, Anomaly Digs, CIS, etc.)
- Support Available and In Place (company or contract)

Situational awareness is crucial to both present and future success.

Assessment – Present: Charlottesville Division

1999

- Anything and Everything to do with Pipeline Integrity in the Charlottesville Division
- Knowledge of Pipeline Integrity minimal
- Pipeline Integrity Manager with 4 Direct Reports
- $350k for Groundbeds, $1.3MM for Recoat, and 2 Smart Pigs
- Part Time Administrative help

2009

- Anything and Everything to do with Pipeline Integrity in the Charlottesville Division
- Knowledge of Pipeline Integrity expanded, NACE & ASNT certifications, PE Licenses
- Pipeline Integrity Team Lead with 6 Direct Reports (Engineer and Specialists) and 2 Contract Direct Reports (Anomaly documenters)
- $3.3MM for Groundbeds, $4.8MM for Recoat, $800k for CIS, & 10 ILI runs
- Full Time Administrative help

Assessment - Future

Think through and try to answer the following:

- What is the end goal?
- How will the end goal be reached?
- When is the target set to reach the goal?
- What commitments need to be made by the company in resources?
- What commitments need to be made by the company in capital monies?
- How will the overall project be managed and documented?
- Who will provide oversight and on site guidance?

The answers to these questions will shape the future. They will decide what will be done, how long it will take, and who will do it. Be careful not to do more investigation (i.e. CIS or Smart Pig) than can be remediated in any one year.

Assessment – Future: Charlottesville Division

What is the goal of Pipeline Integrity?

Maintain the Safety (Integrity) of the Pipeline: Above or Below ground, Inside or Outside of the pipeline. Focused on Pipeline Integrity (proactive prevention) instead of Corrosion (reactive).

How is this done?

Assessment – Future: Charlottesville Division

How the end goal of Pipeline Integrity is reached:

- Experienced Personnel that posses Training and Certification
- Trained/Experienced personnel in leadership
- Application of Sufficient Cathodic Protection
- Regular Surveys
- Accurate and Easy to Use Graphical Information System (GIS)
- In Line Inspections (ILI): Geometry and Smart Pigs
- Anomaly Investigation and Remediation (Recoat or Repair)
- Historical Analysis of Data (ILI, CIS, and other surveys)
- Interference Testing
- Effective Coating
- Effective/Safe Design
- Third Party damage prevention
- Public Education
- Audits & Operator Qualification
- Data Collection, Correlation, Integration, Comparison, & Analysis

Assessment - Future – Charlottesville Division

When is the target set to reach the goal:

- Close Interval Survey – First Pass (6 years)
- Close Interval Survey – Second Pass (10-15 years)
- Install groundbeds to address low pipe to soils found on CIS – First Pass (6 years)
- Install groundbeds and/or perform recoat to address low pipe to soils found on CIS – Second Pass (ongoing)
- Smart Pig all HCA sections - Baseline (10 years)
- Smart Pig all HCA sections – Second Pass (7 years)
- Smart Pig all non-HCA sections – First Pass (finish by 2017)

Assessment – Future: Charlottesville Division

- What commitments need to be made by the company in resources?
- What commitments need to be made by the company in capital monies?
- How will the overall project be managed and documented?

Assessment – Future: Charlottesville Division

Who will provide oversight and guidance – Pipeline Integrity Team Lead:

- Support, Training, and Coordination of Specialists
- Groundbeds (project management and engineering support)
- Recoat (project management and engineering support)
- Review and maintenance of all compliance records
- Audit facilitation with regard to the area of Pipeline Integrity
- First year Smart Pig log review and anomaly selection
- Anomaly Investigation program (Year 2 and beyond)
- Corrosion database management and testing
- OQ program oversight and database management
- Data Integration software testing and implementation
- Participation in special projects and groups (i.e. hand held data collector, forms automation, coordinating committees, boards)

Assessment – Future: Charlottesville Division

Who will perform and/or oversee on site work – Pipeline Integrity Specialists:

- Annual Survey
- Bi-Monthly Survey
- Maintenance of Rectifiers, Test Stations, and Bonds
- 1-Year & 3-Year Atmospheric Survey
- Recoat Project Inspection and Documentation
- Anomaly Dig Investigation
- Testing, Design, and Installation of Groundbeds
- Interference Testing
- Coating Selection and Application

Deciding on a Direction and Counting the Cost(s)

What is the direction? Close Interval Survey 100% in 6 years and Smart Pig 100% in 15 years.

Once the direction is decided, think it through to the logical end, play it out in terms of what will be required to make it happen (i.e. time, resources, capital, etc).

After thinking the direction through, be sure to count the costs both in time an actual dollars. Deciding to do something can be deceptively easy, making it happen year after year for a number of years is another, much more difficult, objective to achieve.

Compliance with Code

Subpart I - § 192.457 – External Corrosion Control: Buried or submerged pipelines installed BEFORE August 1, 1971:

- (a) – "…each buried or submerged pipeline installed before August 1, 1971, must be cathodically protected along the entire area that is effectively coated…"

Compliance with Code

Subpart I - § 192.455 – External corrosion control: Buried or submerged pipelines installed AFTER July 31, 1971:

- (a) – "…each buried or submerged pipeline installed after July 31, 1971, must be protected against external corrosion, including the following:
- (a).(1) – "It must have an external protective coating meeting the requirements of Section 192.461."
- (a).(2) – "It must have a cathodic protection system designed to protect the pipeline in accordance with this subpart, installed and placed in operation within 1 year after completion of construction."

Compliance with Code

Subpart I - § 192.463 – External corrosion control: Buried or submerged pipelines installed AFTER July 31, 1971:

- (a) – "Each cathodic protection system required by this subpart must provide a level of cathodic protection that complies with one or more of the applicable criteria contained in appendix D of this part (192)."

Compliance with Code

Appendix D to Part 192 – Criteria for Cathodic Protection and Determination of Measurements:

- I. Criteria for cathodic protection—
- A. Steel, cast iron, and ductile iron structures.
- (1) – "A negative (cathodic) voltage of at least 0.85 volt…protective current applied…in accordance with sections II and IV of this appendix." (Section II deals with IR drops)."
- (2) – "A negative (cathodic) voltage shift of 300 millivolts."
- (3) – "A minimum negative (cathodic) polarization voltage shift of 100 millivolts."

Compliance with Code

Bottom line – Application of cathodic protection criteria to 100% of buried pipeline(s) so that they are polarized to a sufficient level.

Discussion Question – Does strict compliance with code ensure a safe pipeline(s)? Will code maintain the integrity of the pipeline(s)?

Management and Education

Management expectations:

- The integrity of the pipeline(s) are maintained and safe.
- The local and federal laws would be followed.
- The cost of maintenance would be as low as possible.

Education of Management:

- Start early.
- Continue at regular intervals, as often as the opportunity presents itself.
- Communicate to a wide audience (District Manager, Division Director, HQ Accounting Personnel, Operations VP, President, etc).
- The objective is ultimately understanding which should bring with it support for the program.

Safety Expectations

Target:

- Compliance with code in all the area, 100% of the time.
- No corrosion growth vs. critical corrosion growth rate.
- No leaks or ruptures.

It needs to be understood that no leaks or ruptures should be the target or goal, but maintaining compliance 100% of the time and achieving no corrosion growth are very costly and difficult to achieve in a large diameter multi-pipeline corridor with thousands of miles of 40+ year old asphalt coatings.

The Pipeline Maintenance Toolbox

- Routine Inspection Data
- Close Interval Survey
- In Line Inspections (ILI)
- Soil Resistivity Survey
- DCVG / ACVG / Current Mapper
- Pipe Line Inspection Reports
- Foreign Line Crossing Reports
- Depth of Cover Surveys

The Pipeline Maintenance Toolbox Compliance Inspections

- Annuals (January to April)
- Low pipe to soils: Perform CIS and Adjust existing groundbeds or Budget for new ones (March to May)
- Use alternate criteria (March to May)
- Design and Budget for new groundbeds (June)
- Install new groundbeds (following year)
- Follow up readings (July to September)

The Pipeline Maintenance Toolbox Close Interval Survey (CIS)

- Six (6) Year Plan – entire division (~1800 miles)
  - 2001: 566.5 miles
  - 2002: 331.1 miles
  - 2003: 534.6 miles
  - 2004: 107.2 miles
  - 2005: 98.2 miles
  - 2006: 143.2 miles
- Ten (10) Year Plan – entire division 2007-2016
  - 2007: 171.7 miles
  - 2008: 551.8 miles
  - 2009: 309.0 miles

The Pipeline Maintenance Toolbox Groundbeds & Recoat

- 1999: $ 1.1M
- 2000: $ 1.7M
- 2001: $ 3.1M
- 2002: $ 4.4M
- 2003: $ 6.3M
- 2004: $ 8.1M
- 2005: $ 7.3M
- 2006: $11.9M
- 2007: $ 9.5M
- 2008: $10.0M
- 2009: $12.1M Allocated ($86.9M spent 1999 to 2009)

- 2010: $ 9.1M Projected ($96.0M spent 1999 to 2010)

The Pipeline Maintenance Toolbox In-Line Inspection (ILI) or Smart Pig

2004 (2011) (153.2 miles):
- 41.1 miles of 36″ Mainline "C" - Station 140 to Station 145 (SC to NC)
- 60.6 miles of 30″ Mainline "C" – MLV 180-15 to Station 190 (VA to MD)
- 45.8 miles of 30″ Mainline "A" - Station 190 to Station 195 (MD to PA)
- 45.8 miles of 30″ Mainline "B" - Station 190 to Station 195 (MD to PA)

2005 (2012) (45.3 miles):
- 20.5 miles of 30″ Mainline "A" - Station 185 to Potomac River (VA)
- 24.8 miles of 30″ Mainline "A" - Potomac River to Station 190 (MD)

2006 (2013) (229.0 miles):
- 44.3 miles of 30″ Mainline "B" – Station 150 to MLV 155-2 (NC)
- 54.9 miles of 36″ Mainline "B" – MLV 155-2 to MLV 160-10 (NC)
- 46.0 miles of 30″ Mainline "A" – MLV 170-21 (James River) to Station 180 (VA)
- 43.0 miles of 30″ Mainline "A" – Station 180 to Station 185 (VA)
- 45.8 miles of 36″ Mainline "C" - Station 190 to Station 195 (MD to PA)

The Pipeline Maintenance Toolbox
In-Line Inspection (ILI) or Smart Pig

2007 (2014) (325.5 miles):

- 40.0 miles of 30" Mainline "A" – Station 145 to Station 150 (NC)
- 40.2 miles of 30" Mainline "B" – Station 145 to Station 150 (NC)
- 46.1 miles of 36" Mainline "A" – Station 145 to Station 150 (NC)
- 68.1 miles of 36" Mainline "C" – Station 150 to MLV 155-20 (NC)
- 20.4 miles of 42" Mainline "D" - MLV 150-10 to Station 155 (NC)
- 39.5 miles of 42" Mainline "C" – MLV 155-20 to MLV 160-15 (NC to VA)
- 71.2 miles of 30" Mainline "B" - MLV 180-10 to Station 190 (VA to MD)

2008 (2015) (259.9 miles):

- 24.6 miles of 42" Mainline "D" - MLV 140-10 to Station 145 (SC to NC)
- 23.2 miles of 42" Mainline "D" – MLV 145-20 to Station 150 (NC)
- 82.4 miles of 30" Mainline "A" – Station 150 to Station 160 (NC)
- 64.9 miles of 30" Mainline "B" – Station 170 to MLV 175-20 (VA)
- 64.8 miles of 36" Mainline "C" – Station 170 to MLV 175-20 (VA)

The Pipeline Maintenance Toolbox
In-Line Inspection (ILI) or Smart Pig

2009 (2016) (480.8 miles):

- 41.2 miles of 30" Mainline "A" Station 140 to Station 145 (SC to NC)
- 41.3 miles of 30" Mainline "B" Station 140 to Station 145 (SC to NC)
- 124.9 miles of 30" Mainline "A" Station 160 to MLV 170-20 (NC to VA)
- 70.7 miles of 30" Mainline "B" MLV 160-10 to Station 170 (NC to VA)
- 62.6 miles of 36" Mainline "C" MLV 160-15 to Station 170 (VA)
- 36.0 miles of 36" Mainline "B" MLV 175-20 to MLV 180-10 (VA)
- 46.3 miles of 36" Mainline "C" MLV 175-20 to MLV 180-15 (VA)
- 17.7 miles of 42" Mainline "D" Cove Point Tap to Potomac River (VA)
- 26.2 miles of 42" Mainline "D" Potomac River to Station 190 (MD)
- 13.9 miles of 42" Mainline "D" MLV 190-20 to Station 195 (MD to PA)

2010 (2017) (186.9 miles):

- 6.74 miles of 42" Mainline "D" Station 150 to MLV 150-5 (NC)
- 17.8 miles of 10" Maiden Lateral "A" MLV 145-21 to EOL (NC)
- 17.8 miles of 16" Maiden Lateral "B" MLV 145-21 to EOL (NC)
- 69.1 miles of 20" South Virginia Lateral Station 165 to Station 165 (VA)
- 75.5 miles of 20" South Virginia Lateral Station 167 to EOL (VA to NC)

2012 AUCSC - 5/15/2012

The Pipeline Maintenance Toolbox
In-Line Inspection (ILI) or Smart Pig

2011 (2018) (258.2 miles):

- 41.1 miles of 36″ Mainline "C" - Station 140 to Station 145 (SC to NC)
- 60.6 miles of 30″ Mainline "C" – MLV 180-15 to Station 190 (VA to MD)
- 45.8 miles of 30″ Mainline "A" - Station 190 to Station 195 (MD to PA)
- 45.8 miles of 30″ Mainline "B" - Station 190 to Station 195 (MD to PA)
- 105.0 miles of 24″ Cardinal Lateral "A" Station 160 to EOL (NC)

2012 (2019) (45.3 miles):

- 20.5 miles of 30″ Mainline "A" - Station 185 to Potomac River (VA)
- 24.8 miles of 30″ Mainline "A" - Potomac River to Station 190 (MD)

The Pipeline Maintenance Toolbox
In-Line Inspection (ILI) or Smart Pig

Summary of Baseline (First 10 years in Integrity Management Plan 2002-2012):

- 2004: 153.2 miles (153.2 miles cumulative) - Baseline
- 2005: 45.3 miles (198.5 miles cumulative) - Baseline
- 2006: 229.0 miles (427.5 miles cumulative) - Baseline
- 2007: 325.5 miles (752.0 miles cumulative) - Baseline
- 2008: 259.9 miles (1,011.9 miles cumulative) - Baseline
- 2009: 480.8 miles (1,492.7 miles cumulative) - Baseline
- 2010: 186.9 miles (1,679.6 miles cumulative) - Baseline
- 2011: 105.0 miles (1,784.6 miles cumulative) - Baseline
- 2012: 45.3 miles (1,829.9 miles cumulative) - Baseline

2012 AUCSC - 5/15/2012

The Pipeline Maintenance Toolbox
In-Line Inspection (ILI) or Smart Pig

Summary of Second Pass (Next 7 years in IMP 2011-2017):

- 2011: 258.2 miles (2,283.8 miles cumulative) – Second Pass*
- 2012: 178.4 miles (2,462.2 miles cumulative) – Second Pass*
- 2013: 229.0 miles (2,691.2 miles cumulative) – Second Pass
- 2014: 325.0 miles (3,016.2 miles cumulative) – Second Pass
- 2015: 240.1 miles (3,256.3 miles cumulative) – Second Pass
- 2016: 608.0 miles (3,864.3 miles cumulative) – Second Pass
- 2017: 186.9 miles (4,051.2 miles cumulative) – Second Pass

* 2011 & 2012 cumulative total includes the Baseline distance.

Starting the Program

- Pick the highest risk areas first and perform surveys on them.
- The first couple years are the most difficult climbing the learning curve.
- Realize that many groups need to be involved: Operations, Engineering, Survey, Drafting, Land, Permits, Environmental, etc.
- Keep data integration in mind so that sections of pipeline(s) can be analyzed with more than one set of data involved and helping to decide where work needs to be done.

Benefits

- Existing problems are kept from getting worse.
- Lower the risk on given sections of pipeline(s).
- Lessen capital expenditures in the future.

The Future

Regular programs of CIS, Groundbeds, and Recoat will do the following:

- Lessen severity of future anomalies found on ILI (smart pig) data.
- Allow a more predictable forecast of expenditures.

Mistakes and the Hard Lessons Learned

- Do not survey more area than can be mitigated in a reasonable amount of time (i.e. 500 miles of CIS or 500 miles of ILI).
- Choose the right type of anode with enough output to supply enough cathodic protection current.
- Do not mix impressed and galvanic systems unless blocking diodes are used and bring all galvanic anode connections above ground.
- Try to avoid having new pipelines in the same right of way with older pipelines because of the difficulty in supplying enough cathodic protection to the older one without supplying harmful levels of to the newer one. If it cannot be avoided consider recoating or changing groundbeds as the new line is installed.
- Think long and hard about clustering rules and make sure the ILI vendor has the ability to assist with problems and supply data in the format required. In addition, make sure the vendor has a proven track record doing run comparison.

Practical Advice

Several things that will help you achieve the goal that I have found to be crucial to success:

- If you don't know something ask.
- Take opportunities to educate and be educated.
- Have a support network of people you can go to in order to discuss problems and ask advice.
- Each day can be used to further the goal, take small steps instead of giant leaps (i.e. the lion doesn't eat the elephant in one bite).
- Realize the need to stay open and teachable to any and all that offer advice, but be ready to determine if the source is reliable and filter out advice when the source is not reliable.
- Beware of conclusions that are drawn and then presented when they are based on only a partial set of facts.
- If you don't know how to type, learn.
- If you don't know how to use Outlook Tasks, Calendar, Word, or Excel…learn.
- Keep a good journal…what happens, who you talk to and what is said, why you made certain decisions, etc.

The End Result?

Is it compliance? Yes and No…

It is, but it is a small part…there is more to it…

Bottom line, it is no ruptures or leaks, few anomalies found on smart pig runs and few low pipe to soils found during annual surveys, close interval surveys, and routine pipe inspections.