Data Integration

By: Elizabeth Nicholson, B. Eng, CP-3
Presented by: Pat Yaremko
Cathodic Technology Limited

Data Integration

- Data integration involves combining data from different sources and providing users with a unified view of these data.
- This is the backbone of any pipeline information management program
- This presentation will focus on data for corrosion through the ECDA process

ECDA Data

- External Corrosion Direct Assessment is a process to continually evaluate your structure / pipeline and ensure it remains free from corrosion
- It requires accurate record keeping and knowledge of your system

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Appalachian Underground Corrosion Short Course

Pipeline Information

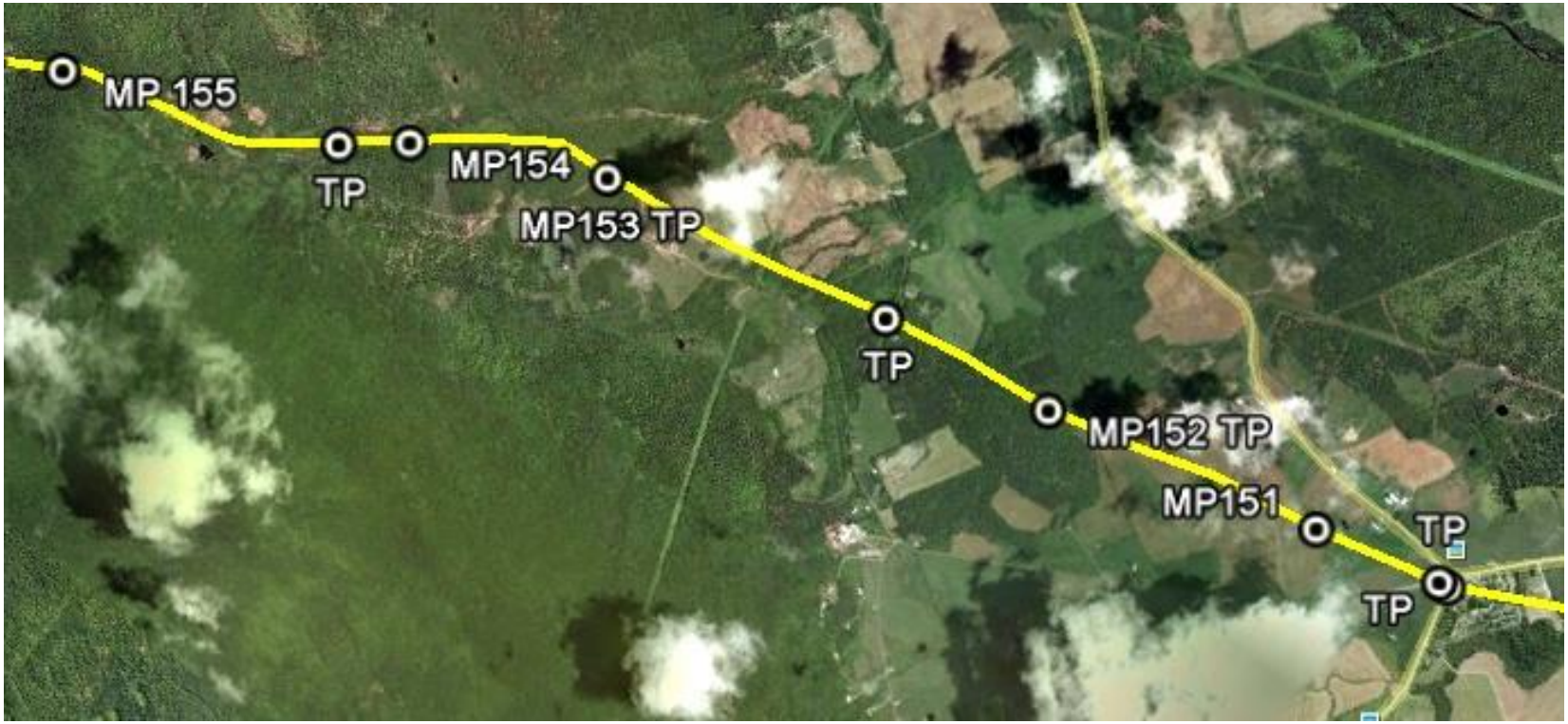
Important Information

- Pipeline history
  - Installation date & method
  - Material & coating
- System inventory
- Know where your pipeline is, maps, GPS, etc.
- Operation & maintenance history

Inventory Your System

- Test Stations
- Casings
- Bonds
- Rectifiers
- Insulated flanges
- Sleeves
- Sacrificial anodes
- Etc.

Mapping Your Pipeline



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Pipeline Location

- Use a pipe locator for accurate location
- Field data can be correlated with other test data
- GPS and available sub-meter systems can be used to map the pipe

High Consequence Areas

- Population density
- Sensitive environmental areas
- Foreign crossings
- Historically / Culturally significant areas

Operating History

- What product & pressure
- Leak history
- Maintenance work & digs
- Repair work

Personnel

- Sometimes the field guys know things the office guys don’t.
  - How many times that area has been dug up
  - Were anodes installed directly to the pipe?
  - Landowner issues

Test Results

Test Results

- There are a number of ways to monitor the corrosion potential of a pipeline;
- Test station surveys
- Rectifier logs
- Close Interval Potential Surveys
- Voltage Gradient Surveys (DCVG, ACVG, PCM, Pearson)
- Internal inspection tools (Pigs – wall thickness)
- Physical inspection from digs
- Corrosion coupons

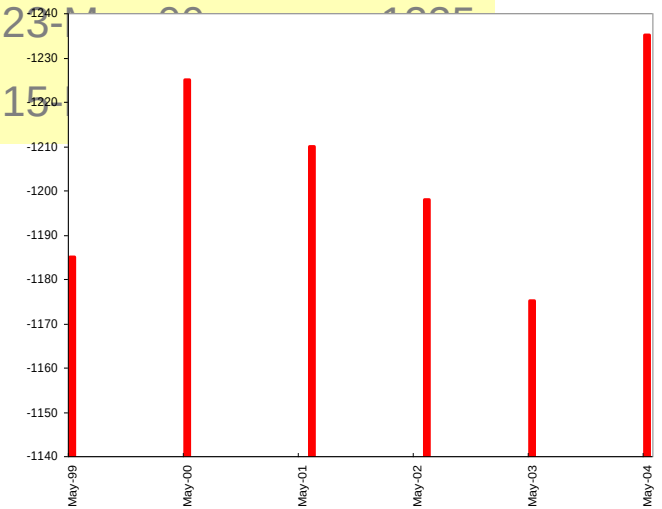
Modern Equipment

- Digital
- GPS integrated
  - Synchronization
  - Location, date, time
- Custom comments
- No more handwritten notes
  - Transcription errors
  - ‘Coffee shop’ readings

Test Station Surveys

- Performed on a regular basis
- When compared with prior readings, changes to the CP are seen

TP	10-367
10-May-04	-1235
02-May-03	-1175
08-Jun-02	-1198
03-Jun-01	-1210
23-	
15	



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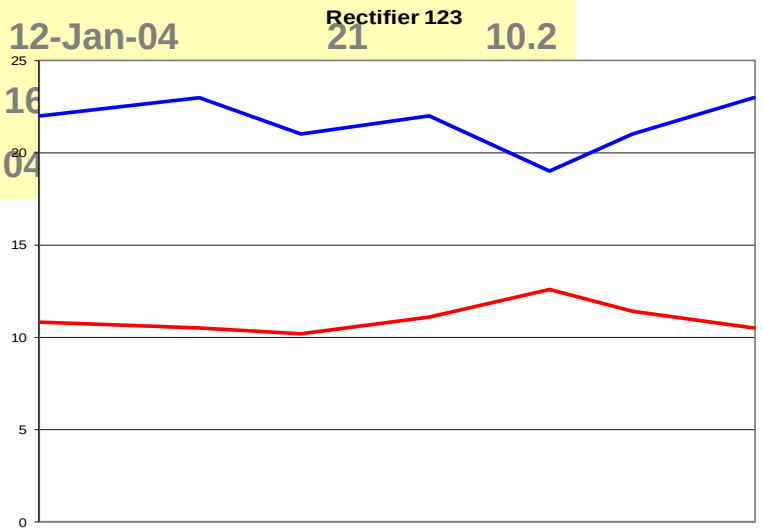
Rectifier Logs

- Obtained by field crews or through remote monitoring
- Graphing the data over time can reveal trends

Rectifier	123	
	Volts	Amps
11-May-04	23	10.5
09-Apr-04	21	11.4
18-Mar-04	19	12.6
15-Feb-04	22	11.1
12-Jan-04	21	10.2
16		
04		



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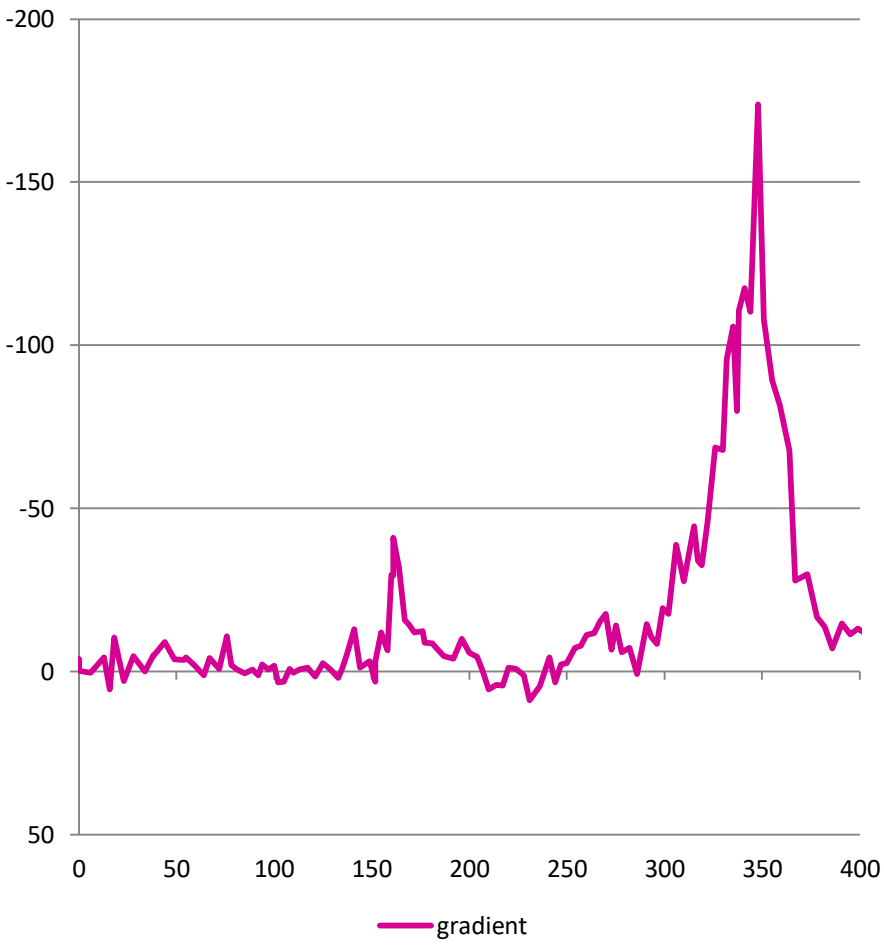
Voltage Gradient Surveys

- Provide indication of coating damage
- Direct Current
  - DCVG
- Alternating Current
  - ACVG
  - PCM
  - Pearson



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CIPS Surveys

- Close Interval Potential Survey records the level of CP along a pipeline
- Used with NACE SP0169 criterion
- Confirm if Cathodic Protection is adequate

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CIPS Survey Equipment

- Close Interval Potential Survey, also called CIS – Close Interval Survey
- Walk the pipeline & record pipe to soil voltage every 3 to 10 feet
- Digitally records pipe to soil voltages

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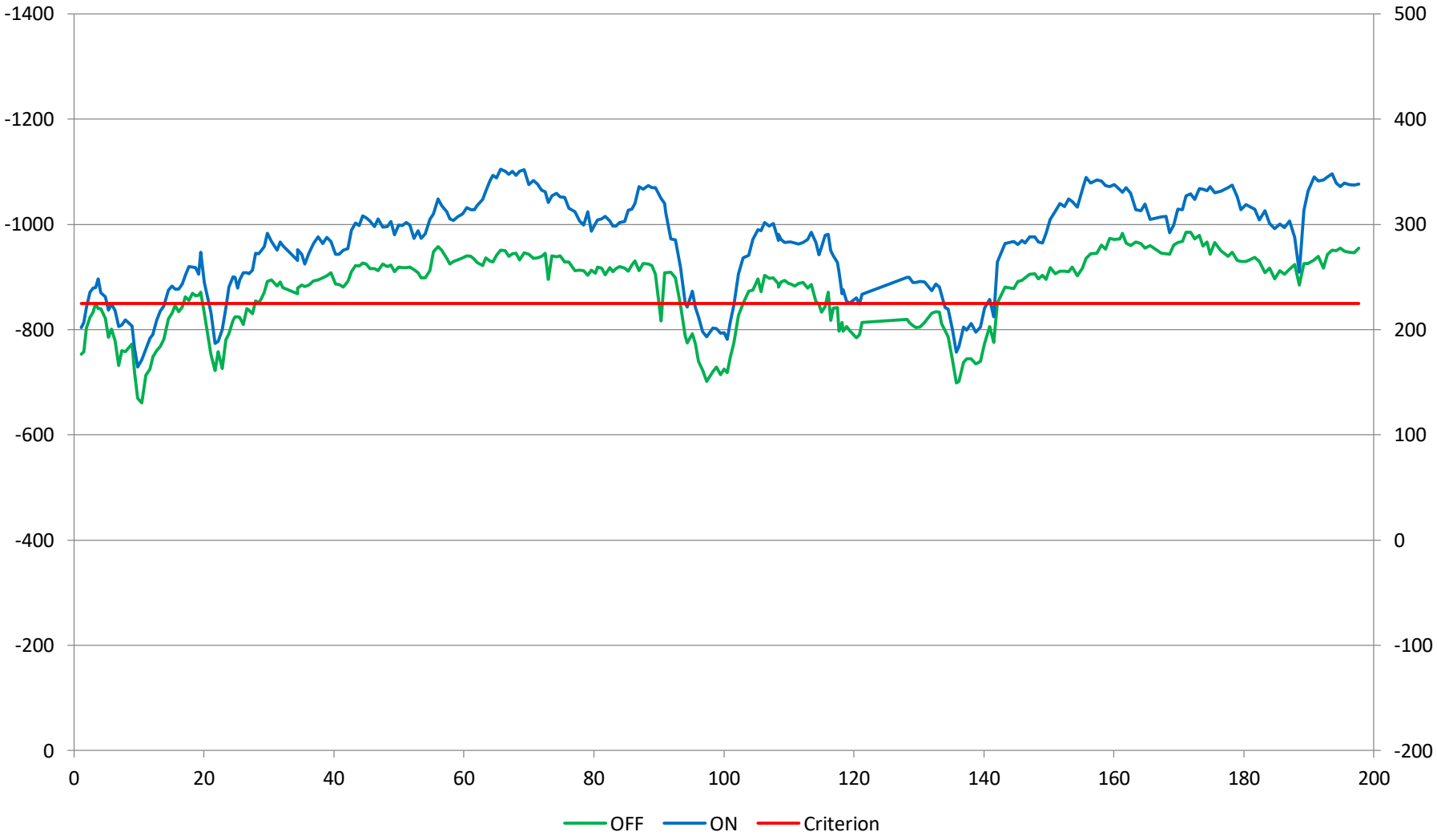
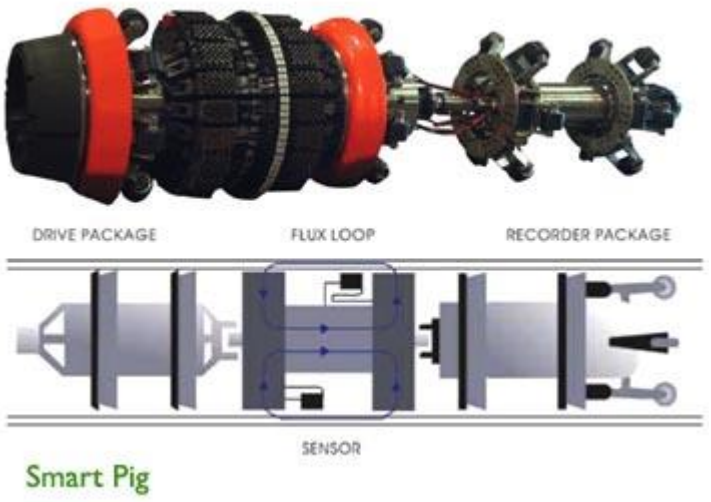
CIPS Data Graph



Internal Inspection

- Inline inspection tools (smart pigs) can be used to monitor the wall thickness of a pipeline
- Changes in wall thickness can indicate a corrosion problem



Smart Pig

Correlation Digs

- Dig results are recorded
  - Pipe to soil potential
  - pH of soil
  - Size & type of damage
  - Coating condition
- Compared with general knowledge of the pipeline

Combining Data

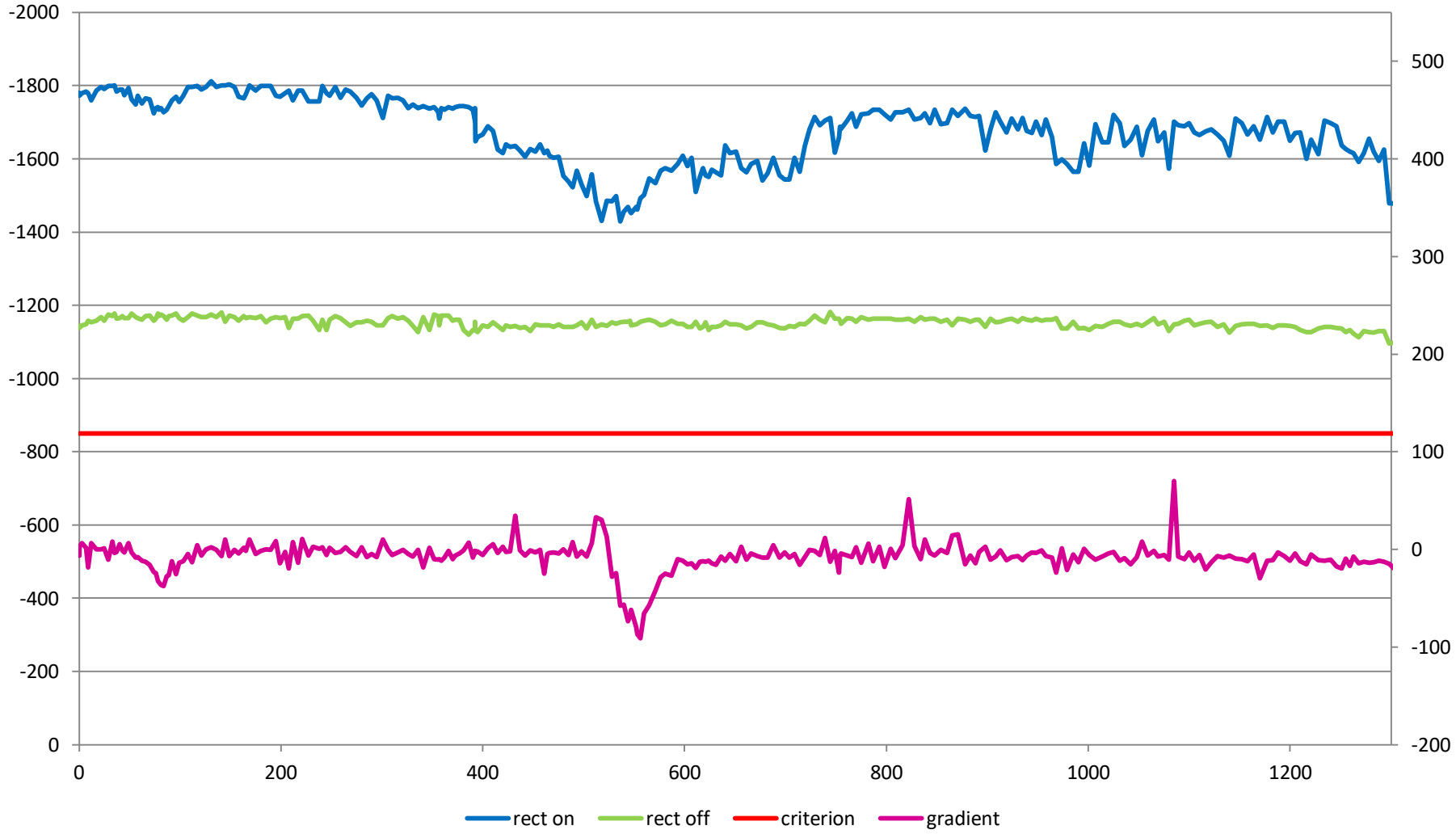
Integrated CIPS & DCVG

- CIPS and DCVG surveys can be undertaken simultaneously for increased accuracy
- Same time, soil conditions, equipment

Combined CIPS + DCVG Surveys

- The combined data makes it easier to assess the requirement for mitigation
- Coating defects that result in unprotected pipe should be repaired
- CIPS + DCVG not only point out the coating defects but the areas where corrosion is likely occurring.

Combined CIPS + DCVG Surveys



Combined CIPS & DCVG Surveys

Stray Current

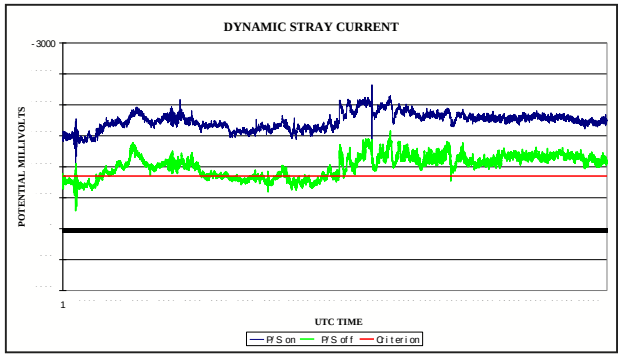
- When performing a CIPS, set out a stationary data logger in the survey area
- The data will show any telluric or dynamic stray current on the line

Stray Current Correction

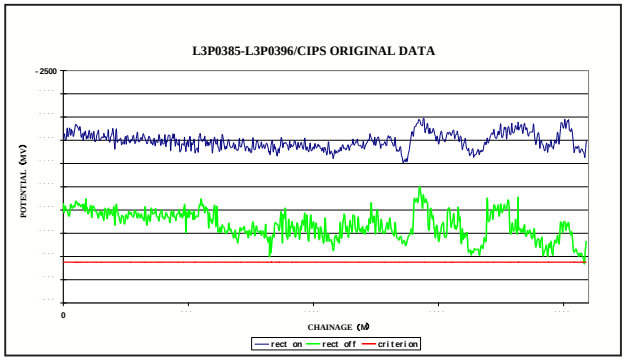
- GPS time stamp is used to compare the logger data with the mobile CIPS data
- Correcting for the stray current provides a more accurate reading of the CP on the pipeline
  - CIPSCorrected = CIPSTime X + (LoggerTime X – Average (LoggerTime Interval))

Stray Current

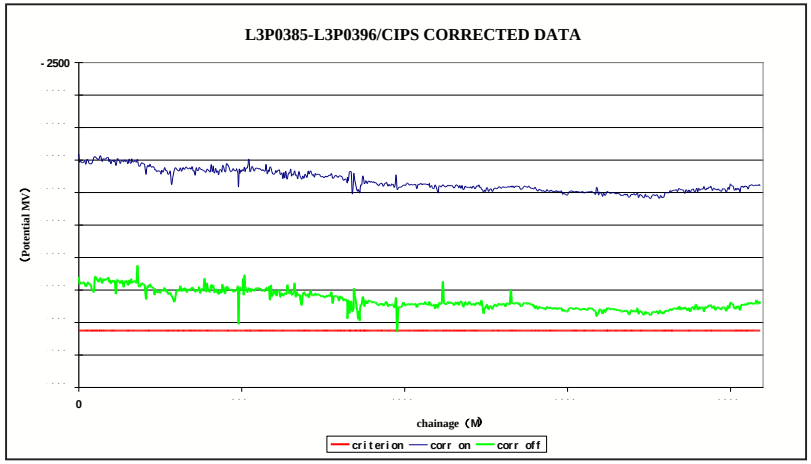
Data From Test Station



CIPS Data Along Pipeline



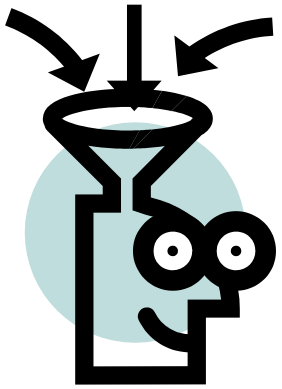
Corrected CIPS Data



Data Examples

Combining Multiple Sources

- All of the data sources above can be looked at together
- By knowing the pipeline information and results from multiple tests, a complete picture of the line condition can be seen



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Example

- CIPS meets criterion, DCVG shows defect, no construction in the area in years, PIG shows consistent wall thickness

- Monitor
  - low probability of corrosion

Example

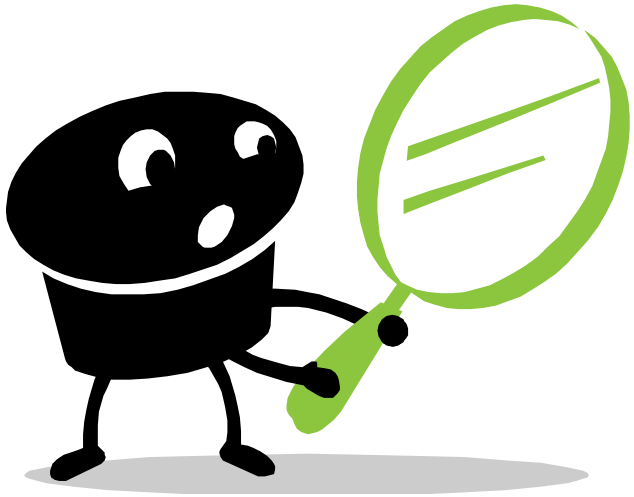
- CIPS goes below criterion, DCVG shows defect, new maps show a new subdivision in that area

- High priority for repair
  - Coating damage
  - High consequence area
  - Inadequate levels of CP

Example

- CIPS goes below criterion, DCVG shows no defect, foreign line in the area

- More investigation
  - Possible stray current interference
    - Foreign pipeline
    - DC transit, welding, mining, etc.
  - Soil resistivity



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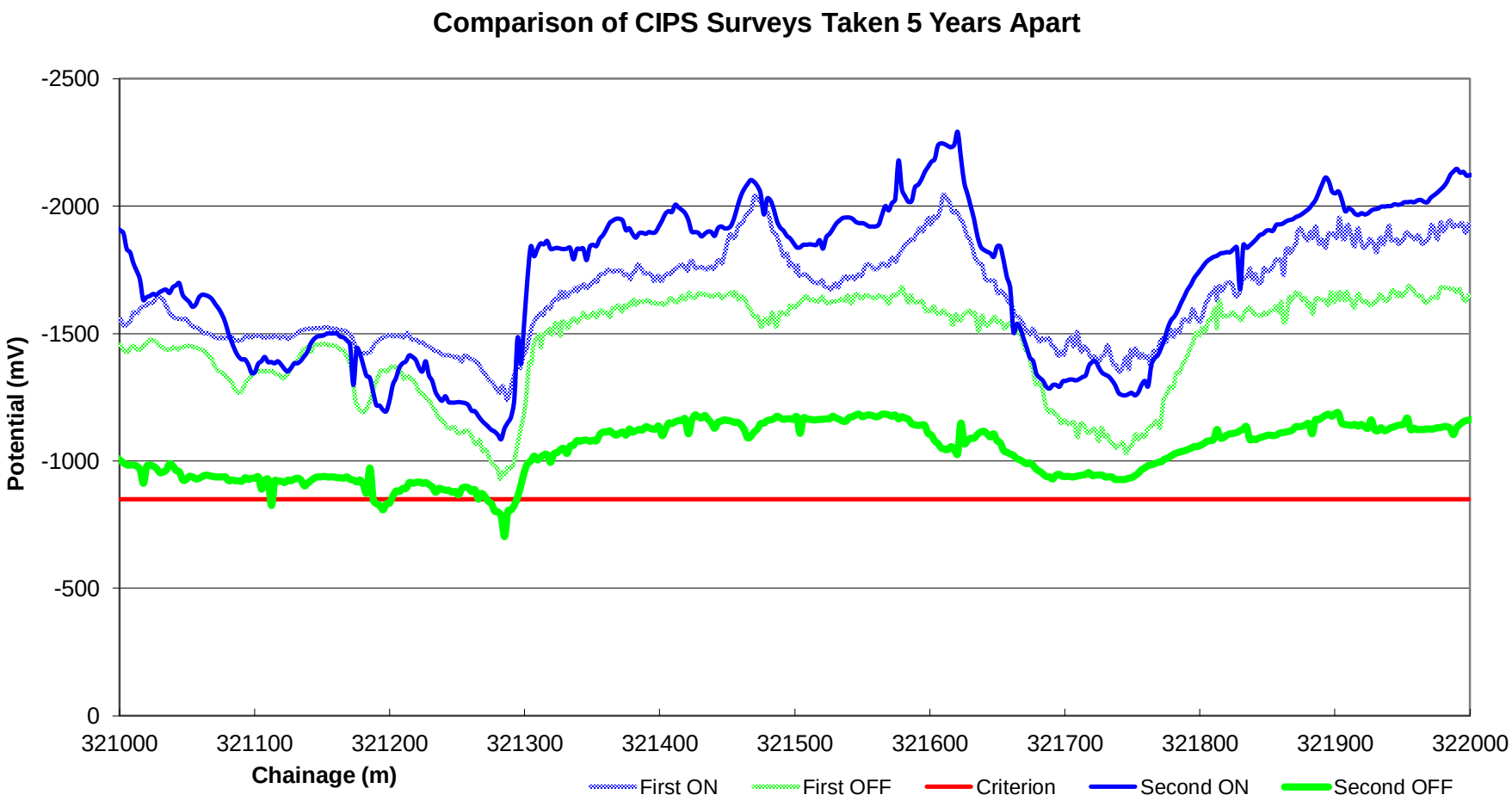
Comparing Years

- Another test data source is from prior years and surveys
- When you have access to multiple years of data for your pipeline, it can be useful to compare the results
- Trends can appear
- Also acts as a check for your survey methodology

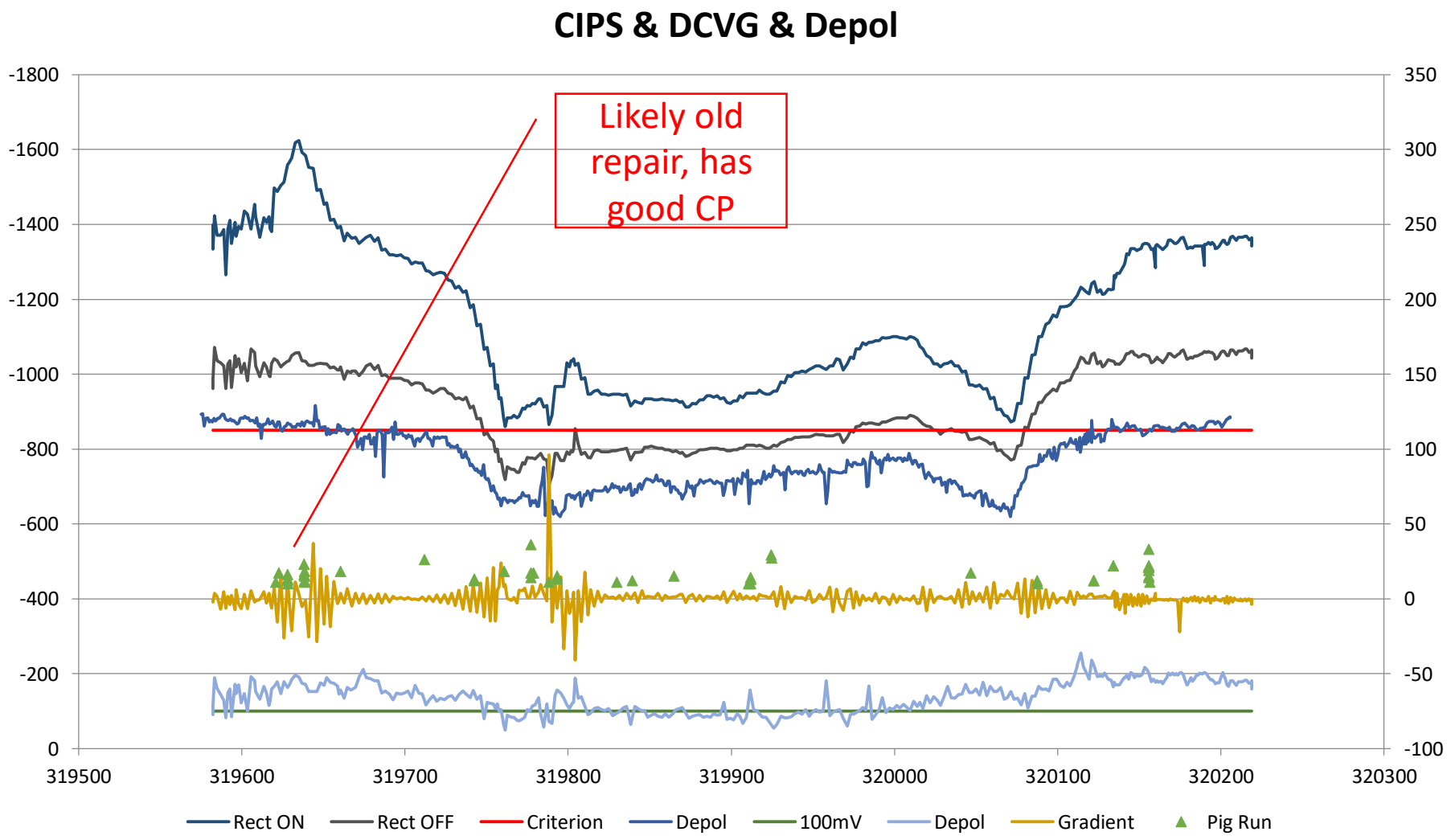
Comparing Years



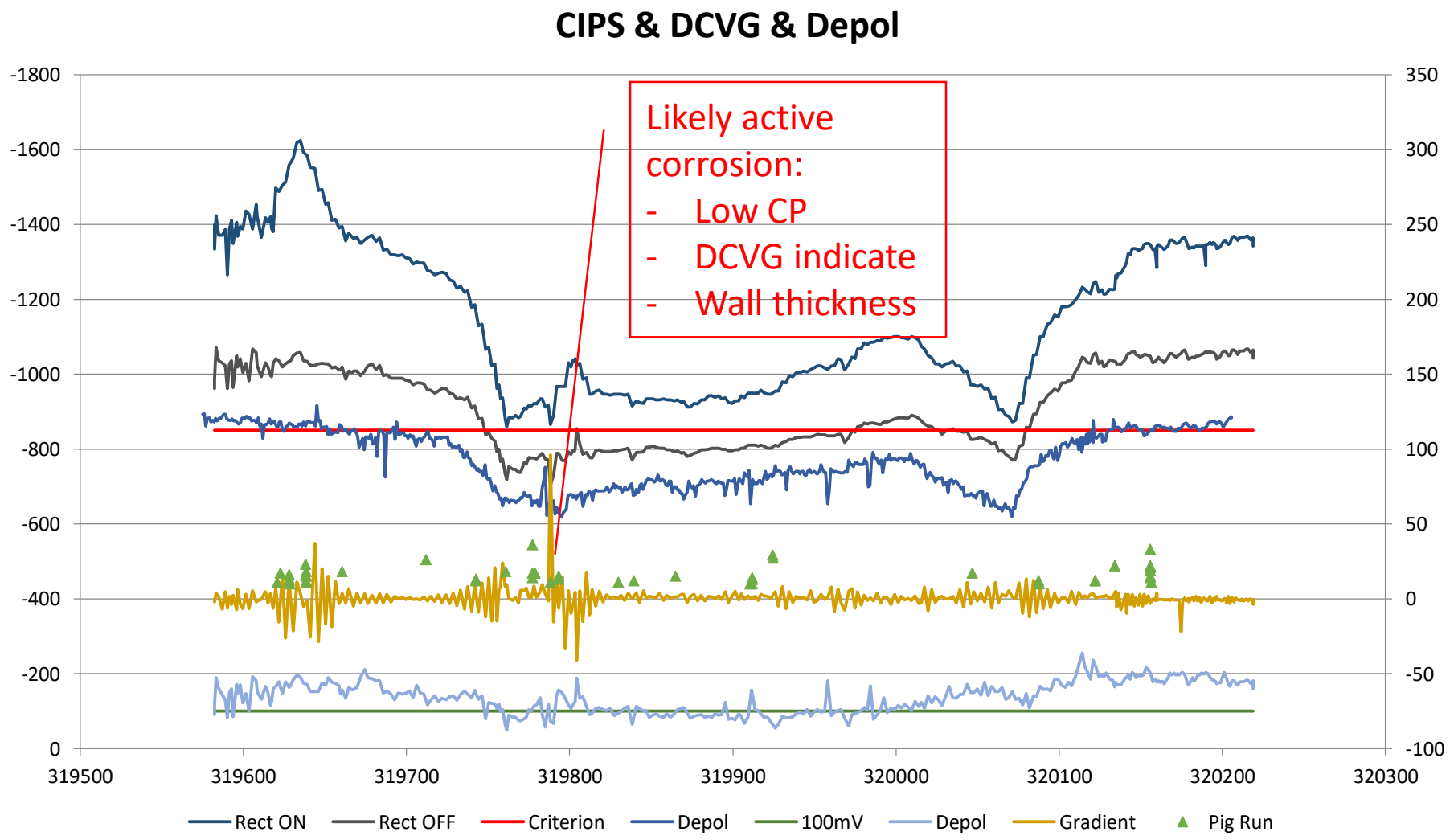
Comparing Years

- 2 surveys 5 years apart
- ON potential (BLUE) very similar
  - Good indication of accuracy for both surveys
- OFF potential (GREEN) different
  - Same shape = survey in the same area
  - Previous survey had higher values
  - Possible causes:
    - Not all rectifiers interrupted during old survey
    - Rectifier output reduced between surveys

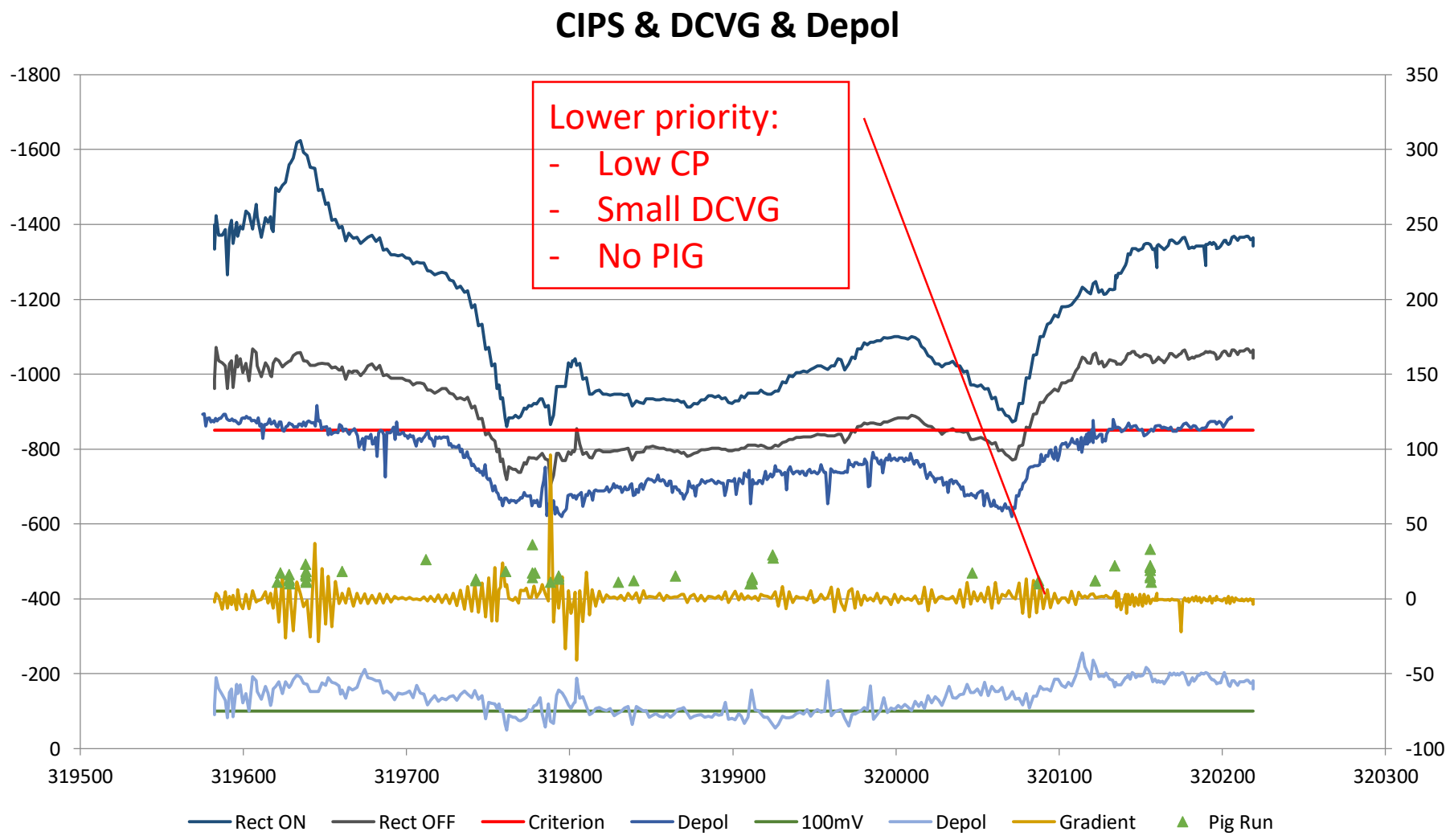
All Available Data



All Available Data



All Available Data



Conclusions

- More data = more information
  - Have the ability to access the raw data
  - Manipulate the data to combine multiple sources
- In this case, the first low CIPS indication is higher priority for repair than the second

Consistent Analysis

Lots of Data – Now What?

- Analysis of data by Corrosion Professional
- Reports to management
- Prepare for audit from inspectors (PHMSA, etc)
- Data available for future comparisons with surveys, digs, leaks, etc.

Analysis Tools

Done by One Person

- Subjective – based on their education & experience
- Usually has lots of knowledge of pipeline history
- If that person leaves…

Analysis Tools

- Decision matrix
- Fuzzy logic
- Priority table
- Must take time / experience to develop
- Creates long term consistency

Setting priorities

Lower Priority

- Factors that can influence the growth of damage
  - Soil type
  - Soil resistivity / pH
  - Leak / repair history
  - Presence of bacteria

Higher Priority

- Anything that indicates damage to pipe wall = potential leak
  - Coating damage indication (DCVG, ACVG, etc)
  - ILI indication, especially if they show growth over time
  - CIPS below -850mV criterion
  - Stray current area

Priority System Example Results

DEFECT #	IR%	DCVG Class.	OFF (mV)	CIPS Class.	Dip (mV)	Dip Class.	ρ (Ω.cm)	Resistivity Class.	P	Overall Class.
1	56.15	B	-688.00	Unprotected	341.20	Severe	199760.87	Not corrosive	**0.421087**	**Severe**
2	56.70	B	-797.00	Unprotected	230.40	Severe	7329.99	Moderately corrosive	**0.496444**	**Severe**
3	51.75	B	-817.00	Unprotected	80.00	Moderate	360412.26	Not corrosive	**0.574235**	**Severe**
4	38.40	B	-817.00	Unprotected	232.80	Severe	4626.72	Moderately corrosive	**1.227086**	**Moderate**
5	44.52	B	-742.00	Unprotected	342.80	Severe	71741.80	Not corrosive	**1.260247**	**Moderate**
6	35.79	B	-880.00	Protected	189.00	Severe	517684.56	Not corrosive	**1.448639**	**Moderate**
7	28.57	C	-815.00	Unprotected	214.80	Severe	369954.15	Not corrosive	**1.488386**	**Moderate**
8	27.96	C	-859.00	Protected	75.60	Moderate	112725.28	Not corrosive	**1.488757**	**Moderate**
9	36.43	B	-959.00	Protected	84.00	Moderate	353654.09	Not corrosive	**1.503045**	**Moderate**
10	27.80	C	-817.00	Unprotected	153.60	Severe	287568.83	Not corrosive	**1.515706**	**Moderate**
11	5.31	D	-943.00	Protected	28.80	Minor	470715.27	Not corrosive	**2.000000**	**Minor**

Model Development

- Model should be based on your pipeline & sound corrosion engineering
  - Available data
  - History of your pipe, surveys vs leaks
- Many companies have developed something
  - Ask colleagues, survey contractors
  - Look up NACE papers (2010-10054, C2012-1231, C2012-1479, C2015-5675)

Database Considerations

Data Integration

- There is lots of data available, now what?
  - Know where the information/reports are stored in the office or on the computer, the cloud?
  - Insist that any surveys done provide you with an electronic copy of the data
  - Purchase a database program to bring the different pieces of data together
  - Design your own database program

Data Base Programs

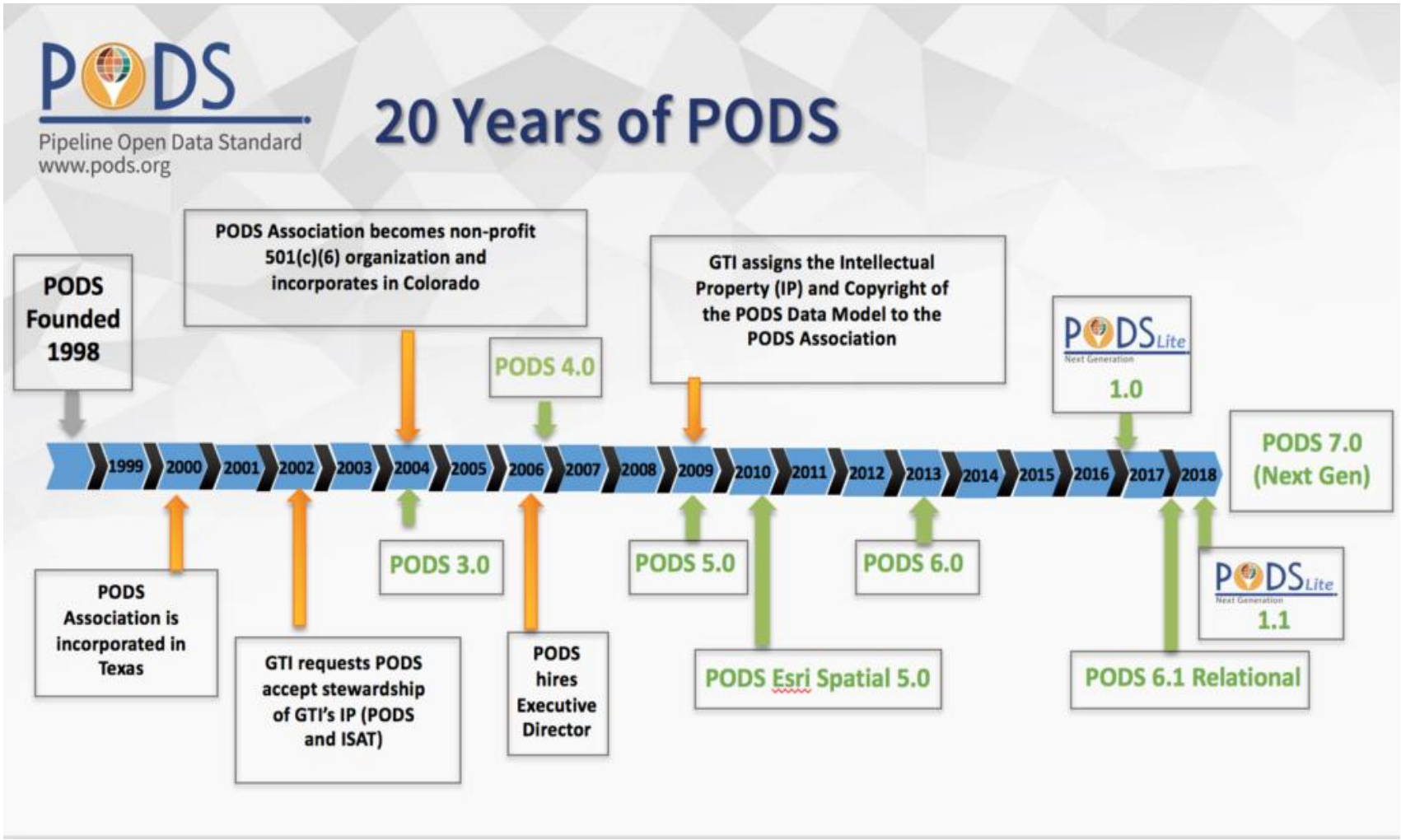
- There are several commercially available data base programs on in which you can store the information required for ECDA
- Be careful about proprietary data formats

- General DB:
  - Oracle
  - Microsoft Access
  - MySQL
- Pipeline Specific:
  - PCS
  - ProActive

PODS

- Pipeline Open Data Standard
- Not for profit association of:
  - Equipment manufacturers
  - Database programmers
  - Oil & Gas companies
- Sets data storage and format for oil & gas industry data
- Produced joint PODS/NACE standard practice SP0507-2014 ECDA Integrity Data Exchange (IDX) Format

PODS


PODS
Pipeline Open Data Standard
www.pods.org
20 Years of PODS
PODS Founded 1998
PODS Association becomes non-profit 501(c)(6) organization and incorporates in Colorado
PODS 4.0
GTI assigns the Intellectual Property (IP) and Copyright of the PODS Data Model to the PODS Association
PODS Lite Next Generation 1.0
PODS 7.0 (Next Gen)
1999
2000
2001
2002
2003
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2010
2011
2012
2013
2014
2015
2016
2017
2018
PODS Association is incorporated in Texas
GTI requests PODS accept stewardship of GTI's IP (PODS and ISAT)
PODS 3.0
PODS hires Executive Director
PODS 5.0
PODS Esri Spatial 5.0
PODS 6.0
PODS Lite Next Generation 1.1
PODS 6.1 Relational

SP0507-2014

- The objective is to develop an ECDA data interchange structure
- enable electronic integration of data and standardize reporting within the pipeline industry
- allow transfer between different software packages or computer systems.

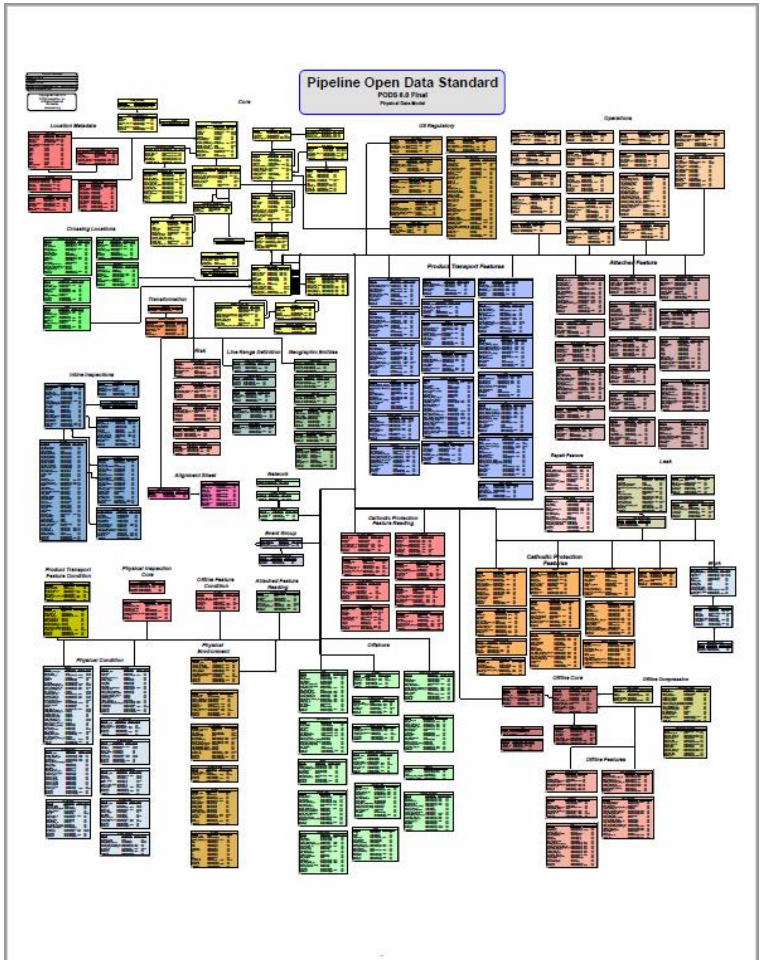
PODS

- provides the architecture to store, analyze and manage this data which can then be visualized in any GIS platform.
- houses asset information, construction, inspection, integrity management, regulatory compliance, risk analysis, history, and operational data
- central source of information that eliminates localized silos of information that are often unconnected.

Typical PODS Data

- Typical information stored in a PODS database includes (partial list):
- centerline location
- pipeline materials and coatings
- MAOP
- valves and pipeline components
- cathodic protection facilities and inspection results
- hydrotesting
- operating conditions
- physical inspection results
- leak detection surveys
- repairs
- foreign line crossings
- inline inspection (ILI) results
- close-interval survey results
- pump and compression equipment specs
- geographic boundaries
- external records
- risk analysis methods and results
- regulatory reports
- pipeline and ROW maintenance activities

PODS framework



PODS Module Example

PODS™
Pipeline Open Data Standard

Cathodic Protection Features Module

Ground_Bed

Event_ID	char(38)	<pk,fk9>
Name	varchar(32)	
Installation_CL	varchar(16)	<fk8>
Material_CL	varchar(16)	<fk2>
Anodes_Quantity	numeric(4)	
Depth_of_Cover	numeric(6,2)	
Description	varchar(50)	
Type_CL	varchar(16)	<fk7>
Date_Installed	datetime	
Anode_Spacing	numeric(8,4)	
Pos_Cable_Insulation_Type_CL	varchar(16)	<fk6>
Pos_Cable_Gauge_CL	varchar(16)	<fk4>
Pos_Cable_Insulation_Color_CL	varchar(16)	<fk5>
Back_Fill_Material_CL	varchar(16)	<fk1>
Rectifier_Enclosure_ID	varchar(16)	
Horizontal_LF	char(1)	
Length	numeric(4)	
Source_CL	varchar(16)	<fk3>
Comments	varchar(255)	

Anode

Event_ID	char(38)	<pk,fk8>
Type_CL	varchar(16)	<fk4>
Anode_Mass	numeric(4,1)	
Model	varchar(32)	
Ground_Bed_Event_ID	char(38)	<fk1>
Description	varchar(50)	
Depth_of_Cover	numeric(6,4)	
Back_Fill_Material_CL	varchar(16)	<fk6>
Anode_Diameter	numeric(5,1)	
Anode_Length	numeric(5,1)	
Manufacturer_CL	varchar(16)	<fk7>
Material_CL	varchar(16)	<fk2>
Package_Fill_CL	varchar(16)	<fk5>
Package_Diameter	numeric(8,4)	
Package_Length	numeric(4)	
Date_Installed	datetime	
Galvanic_LF	char(1)	
Source_CL	varchar(16)	<fk3>
Comments	varchar(255)	

Bond_Lead

Event_ID	char(38)	<pk,fk8>
Name	varchar(32)	
Material_CL	varchar(16)	<fk2>
Description	varchar(50)	
Type_CL	varchar(16)	<fk4>
Date_Installed	datetime	
Ref_Test_Lead_Event_ID	char(38)	<fk1>
Max_Resistance	numeric(5,2)	
Bonded_Company_CL	varchar(16)	<fk5>
Resistor_Type_CL	varchar(16)	<fk6>
Resistor_Power_Rating	numeric(5,2)	
Gauge_Size_CL	varchar(16)	<fk7>
Source_CL	varchar(16)	<fk3>
Comments	varchar(255)	

Rectifier_Enclosure

Event_ID	char(38)	<pk,fk8>
Rectifier_Enclosure_ID	varchar(16)	
Type_CL	varchar(16)	<fk2>
Manufacturer_CL	varchar(16)	<fk7>
Power_Billing_Source_CL	varchar(16)	<fk5>
Description	varchar(50)	
Name	varchar(255)	
Model_Number	varchar(32)	
Date_Installed	datetime	
Neg_Cable_Insulation_Type_CL	varchar(16)	<fk1>
Neg_Cable_Gauge_CL	varchar(16)	<fk3>
Neg_Cable_Insulation_Color_CL	varchar(16)	<fk4>
Source_CL	varchar(16)	<fk6>
Comments	varchar(255)	

Rectifier

Event_ID	char(38)	<pk,fk8>
Rectifier_ID	varchar(16)	
Amp_Rating	varchar(16)	
Type_CL	varchar(16)	<fk2>
Manufacturer_CL	varchar(16)	<fk3>
Description	varchar(50)	
Volt_Rating	varchar(16)	
Model_Number	varchar(32)	
Shunt_Type_CL	varchar(16)	<fk7>
Lightning_Arrestor_Type_CL	varchar(16)	<fk6>
Cooling_System_CL	varchar(16)	<fk5>
Date_Installed	datetime	
Diode_Number	varchar(16)	
Stack_Serial_Number	varchar(16)	
Stack_Fuse_Serial_Number	varchar(16)	
Ref_Rect_Enclosure_Event_ID	char(38)	<fk1>
Source_CL	varchar(16)	<fk4>
Comments	varchar(255)	

Test_Lead

Event_ID	char(38)	<pk,fk4>
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Status_CL	varchar(16)	<fk3>
Description	varchar(50)	
Name	varchar(32)	
Date_Installed	datetime	
Source_CL	varchar(16)	<fk1>
Comments	varchar(255)	

Junction_Box_Pole_CL

Code	varchar(16)	<pk>
Description	varchar(254)	
Name	varchar(50)	
Active_Indicator_LF	char(1)	
Source_CL	varchar(16)	<fk>

Chemical_Injector

Event_ID	char(38)	<pk,fk3>
Injector_Name	varchar(16)	
Date_Installed	datetime	
Description	varchar(50)	
Type_CL	varchar(16)	<fk1>
Source_CL	varchar(16)	<fk2>
Comments	varchar(255)	

Chemical_Injection_Log

Event_ID	char(38)	<pk,fk4>
Inspection_Date	datetime	
Description	varchar(50)	
Chemical_Type_CL	varchar(16)	<fk3>
Chemical_Measurement	numeric(6,4)	
Ref_Chem_Injector_Event_ID	char(38)	<fk1>
Source_CL	varchar(16)	<fk2>
Comments	varchar(255)	

Coupon_Site

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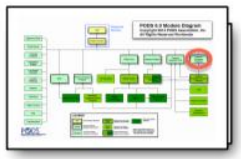
Description	varchar(50)	
Name	varchar(32)	
Model	varchar(32)	
Direction_CL	varchar(16)	<fk5>
Bearing_From_Line	float(53)	
Offset	numeric(4)	
Back_Fill_Material_CL	varchar(16)	<fk4>
Number_of_Coupons	numeric(3)	
Date_Installed	datetime	
Ref_Test_Lead_Event_ID	char(38)	<fk1>
Manufacturer_CL	varchar(16)	<fk3>
Source_CL	varchar(16)	<fk6>
Comments	varchar(255)	

Coupon

Coupon_ID	char(38)	<pk>
Coupon_Site_Event_ID	char(38)	<fk1>
Metal_Density	numeric(7,3)	
Type_CL	varchar(16)	<fk5>
Material_CL	varchar(16)	<fk4>
Surface_Area	numeric(6,4)	
Surface_Finish_CL	varchar(16)	<fk2>
Mass_At_Install	numeric(6,4)	
Depth_of_Cover	numeric(6,4)	
Description	varchar(50)	
Date_Installed	datetime	
Manufacturer_CL	varchar(16)	<fk3>
Source_CL	varchar(16)	<fk6>



PODS 6.0

PODS Module Example

PODS™
Pipeline Open Data Standard

Cathodic Protection Feature Reading Module

PODS 6.0

PI_CIS_Reading

Event_ID	char(38)	<pk,fk3>
Inspection_Date	datetime	
PS_ON	numeric(5,4)	
PS_OFF	numeric(5,4)	
Static	numeric(5,4)	
DC_Potential_Volts	numeric(5,4)	
PI_CP_Event_ID	char(38)	<fk1>
Description	varchar(50)	
Source_CL	varchar(16)	<fk2>
Comments	varchar(255)	

PI_CP_Inspection

Event_ID	char(38)	<pk,fk7>
Inspection_Date	datetime	
Criteria_CL	varchar(16)	<fk1>
Type_CL	varchar(16)	<fk2>
Result_CL	varchar(16)	<fk3>
Nominal_Spacing	numeric(7,3)	
Tool_CL	varchar(16)	<fk5>
PI_Event_ID	char(38)	<fk6>
Description	varchar(50)	
Source_CL	varchar(16)	<fk4>
Comments	varchar(255)	

PI_Anode_Reading

Event_ID	char(38)	<pk,fk5>
Inspection_Date	datetime	
Description	varchar(50)	
Reading	numeric(5,4)	
CP_Reading_Type_CL	varchar(16)	<fk4>
PI_CP_Event_ID	char(38)	<fk1>
Ref_Anode_Event_ID	char(38)	<fk3>
Source_CL	varchar(16)	<fk2>
Comments	varchar(255)	

PI_Bond_Reading

Event_ID	char(38)	<pk,fk5>
Inspection_Date	datetime	
Description	varchar(50)	
Reading	numeric(5,4)	
CP_Reading_Type_CL	varchar(16)	<fk3>
PI_CP_Event_ID	char(38)	<fk1>
Ref_Bond_Lead_Event_ID	char(38)	<fk2>
Source_CL	varchar(16)	<fk4>
Comments	varchar(255)	

PI_CP_Reading

PI_CP_Reading_ID	char(38)	<pk>
Event_ID	char(38)	<fk5>
Type_CL	varchar(16)	<fk2>
Description	varchar(50)	
Reading	numeric(5,4)	
CP_Reading_Type_CL	varchar(16)	<fk3>
Inspection_Date	datetime	
PI_CP_Event_ID	char(38)	<fk1>
PS_ON	numeric(5,4)	
PS_OFF	numeric(5,4)	
Ref_Test_Lead_Event_ID	char(38)	<fk4>
Source_CL	varchar(16)	<fk6>
Comments	varchar(255)	

PI_Rectifier_Reading

Event_ID	char(38)	<pk,fk6>
Inspection_Date	datetime	
Description	varchar(50)	
Reading	numeric(5,4)	
CP_Reading_Type_CL	varchar(16)	<fk4>
PI_CP_Event_ID	char(38)	<fk1>
Ref_Rectifier_Event_ID	char(38)	<fk2>
AC_Voltage_CL	numeric(4)	<fk3>
Source_CL	varchar(16)	<fk5>
Comments	varchar(255)	

PI_Ground_Bed_Reading

Event_ID	char(38)	<pk,fk5>
Inspection_Date	datetime	
Description	varchar(50)	
Reading	numeric(5,4)	
CP_Reading_Type_CL	varchar(16)	<fk3>
PI_CP_Event_ID	char(38)	<fk1>
Ref_Ground_Bed_Event_ID	char(38)	<fk2>
Source_CL	varchar(16)	<fk4>
Comments	varchar(255)	

PI_IC_Coupon_Reading

Event_ID	char(38)	<pk,fk4>
Inspection_Date	datetime	
Description	varchar(50)	
Mass_At_Inspection	numeric(6,4)	
Surface_Area_At_Inspection	numeric(6,4)	
Ref_Coupon_ID	char(38)	<fk1>
PI_Event_ID	char(38)	<fk2>
Source_CL	varchar(16)	<fk3>
Comments	varchar(255)	

Some PODS Member Companies

PODS Trial Version

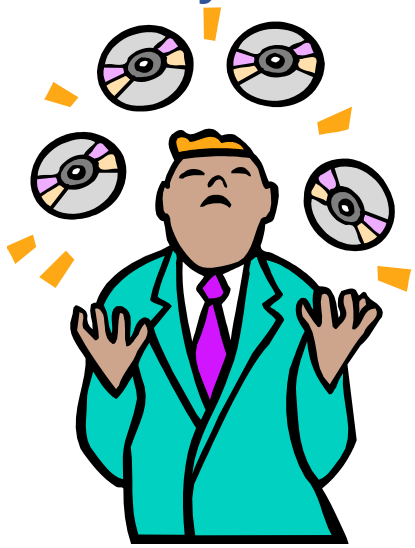
The PODS Association has launched the PODS Lite Data Model free of charge to anyone wishing to evaluate and understand how the PODS Pipeline Data Model can support their needs.

https://www.pods.org/next-generation/pods-lite/

PODS Membership Annual Dues Schedule:
Large Pipeline Operator – **$7,000**
Small Pipeline Operator (<1,000 miles) – **$2,750**
Service Provider – **$2,750**
Government Agency – **$750**
Other Organization types, please contact Executive Director Kathy Mayo for special rates.
Kathy Mayo, kathy.mayo@pods.org, or 907-347-3279

Database Considerations

- Before purchasing software consider:
  - Number & ability of users
  - Other systems that need to connect, i.e. remote monitoring
  - In house technical ability
  - Type and amount of data to be tracked
  - Import/export ability, especially for your survey data
  - Budget



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General Database

Pro's

- Customizable
- Access is included with some Microsoft Office suites, no additional cost
- Accessed by many people, no per-seat cost
- Can be password protected

Con's

- Requires programming
- Knowledgeable person to design & maintain database
- Tricky to interface with other programs
- May not graph well

Pipeline Specific

Pro's

- Scalable with choice of different modules
- Manages many pieces of pipeline information
- Remote access
- Already set up for pipeline oriented data
- Can pay for customization if needed

Con's

- Cost to purchase
- Cost per seat
- Costs may be yearly, not just one time
- Confirm that current computers / network can handle
- Sometimes issues exporting data out

Physical Security

- How to protect the data integrity
  - Backup on a regular schedule
  - Protect computers from power surges
  - Daily emails from site
- Remote access from other offices / field techs
- Off-site backup
  - In case something ever happens to your office

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Intellectual Security

- Who has access to info?
  - Who decides?
- Is there information that is confidential?
  - Can you have different levels of access?
- Can you view/print/share information when needed?
- Unauthorized data entry

Database Information

- What information do you need to store?
  - Alignment / GPS
  - Valves
  - Pumps
  - ECDA (surface surveys & digs)
  - Metal & coating
  - Internal corrosion
  - Product history (flow, pressure)
- Needs vs Wants

Suggested Questions

- Cost? Initial, per year, per seat
- Ability to import & export data (format)
- Database stored on site or remote
- Remote access from other offices / field
- Will it handle all info needed
- Interface with other programs (accounting, work orders, etc)
- Computer & network capacity
- Customizable
- Training

In Conclusion

- Know your pipeline and what data is available to you
- Know what works for you and your company
- Keep the data together as much as possible
- Compare different data sets to look for commonalities and changes

Thank You For Your Time and Attention

By: Elizabeth Nicholson, B.Eng, CP3
Presented by: Pat Yaremko
Cathodic Technology Ltd
www.cath-tech.com

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