Data Integration

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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

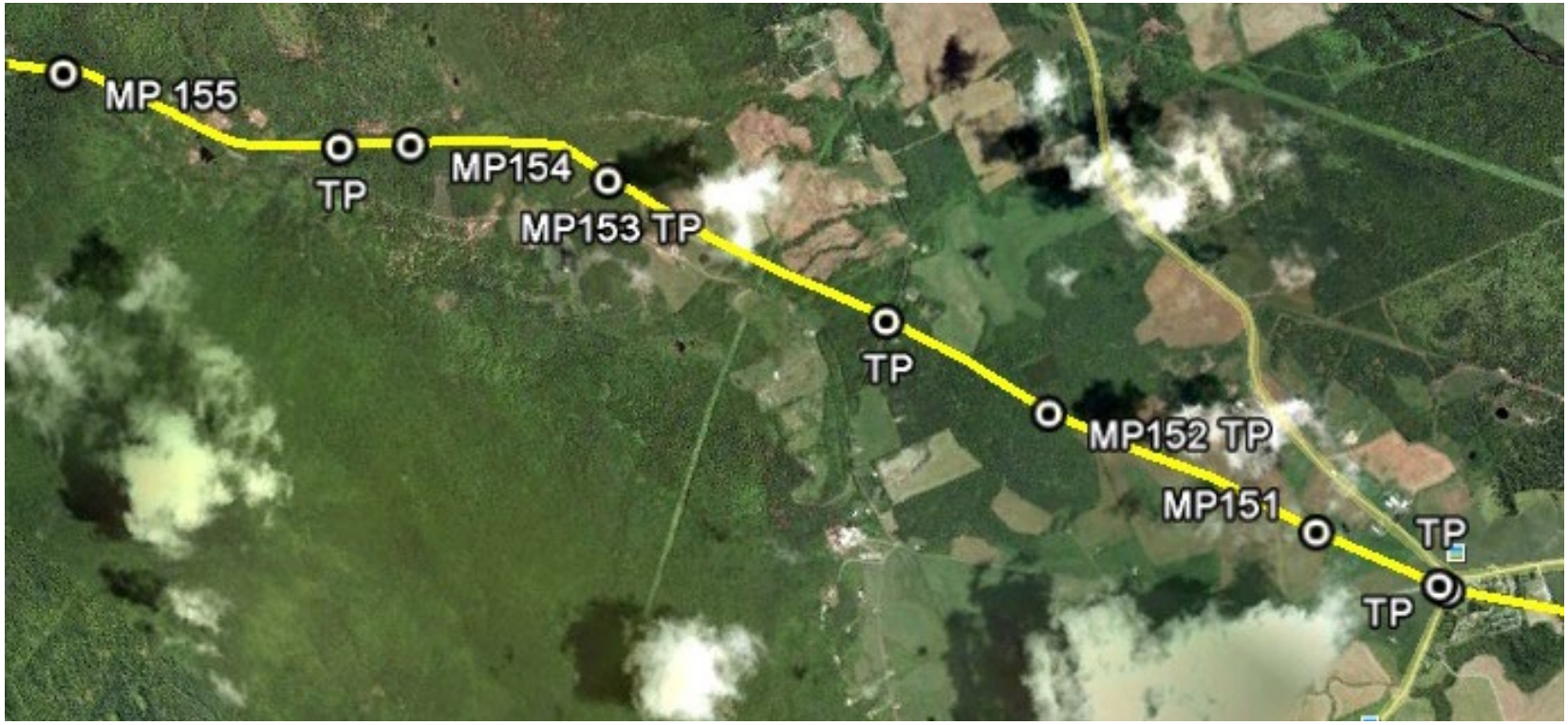
Important Information

- 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
- Pipe to soil 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

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

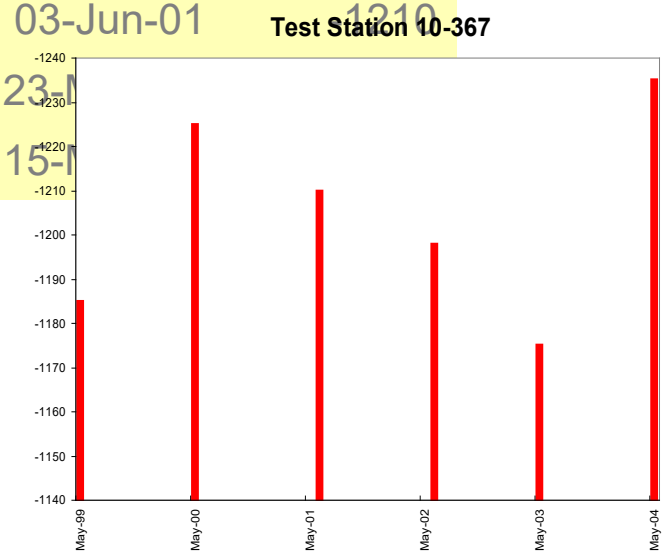
Modern Equipment

- 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

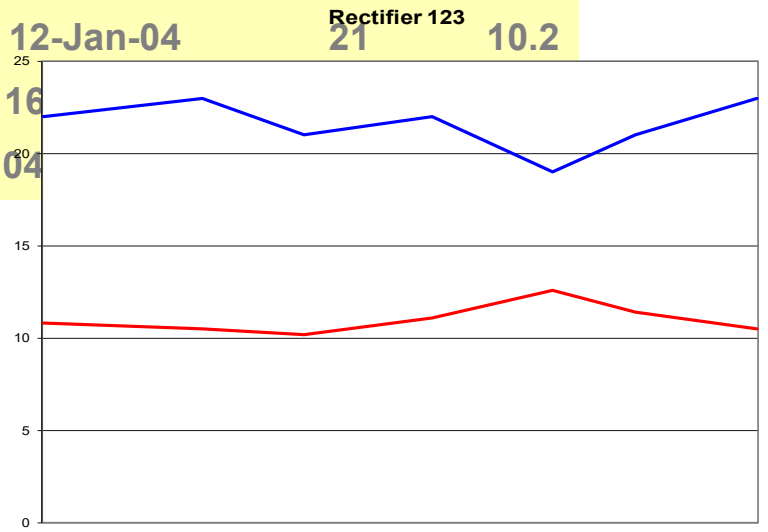
TP	10-367
10-May-04	-1235
02-May-03	-1175
08-Jun-02	-1198
03-Jun-01	-1210
23-M	
15-M	



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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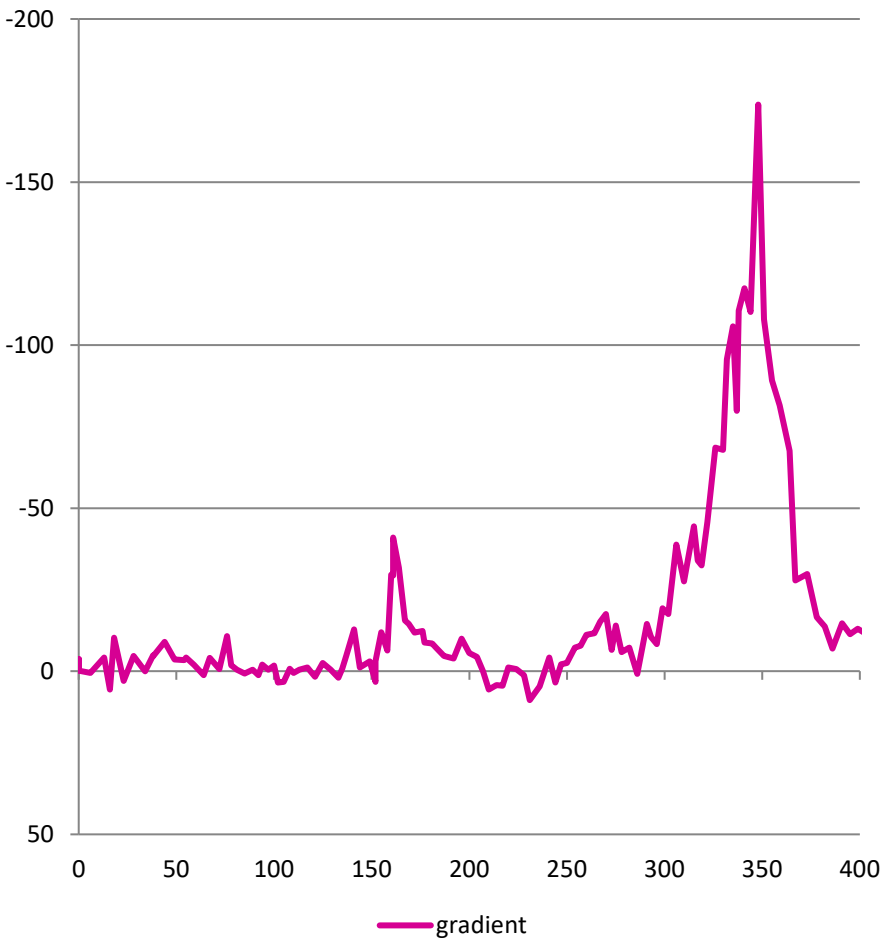
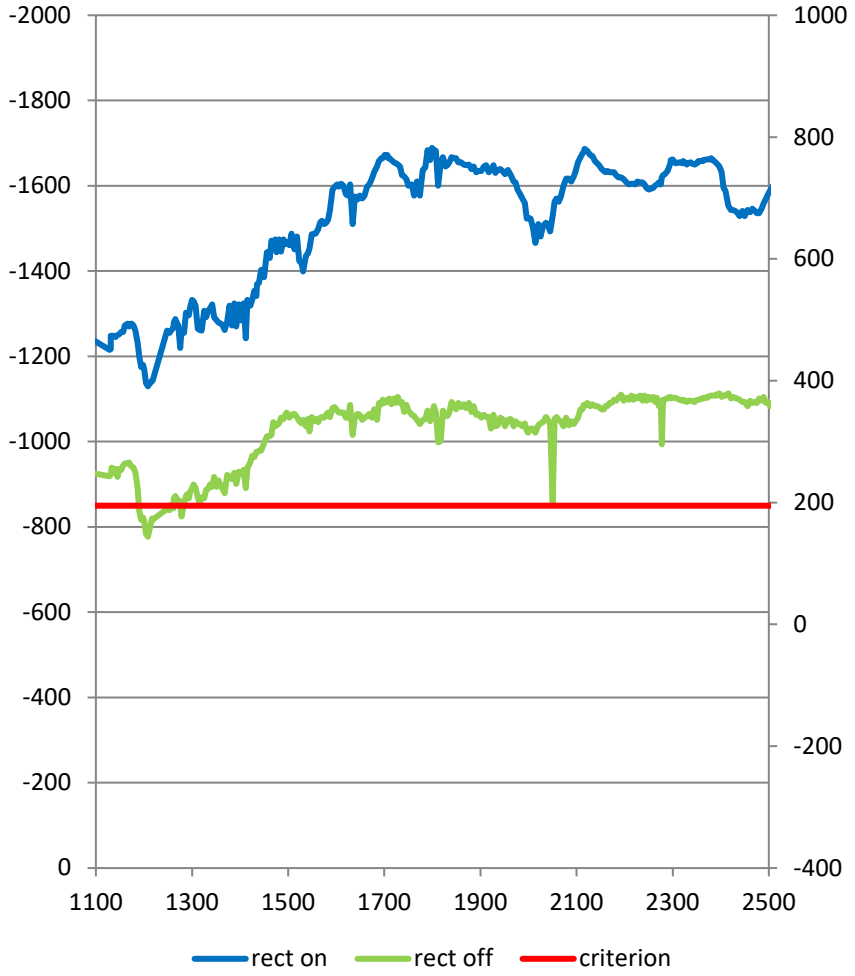
Voltage Gradient Surveys

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



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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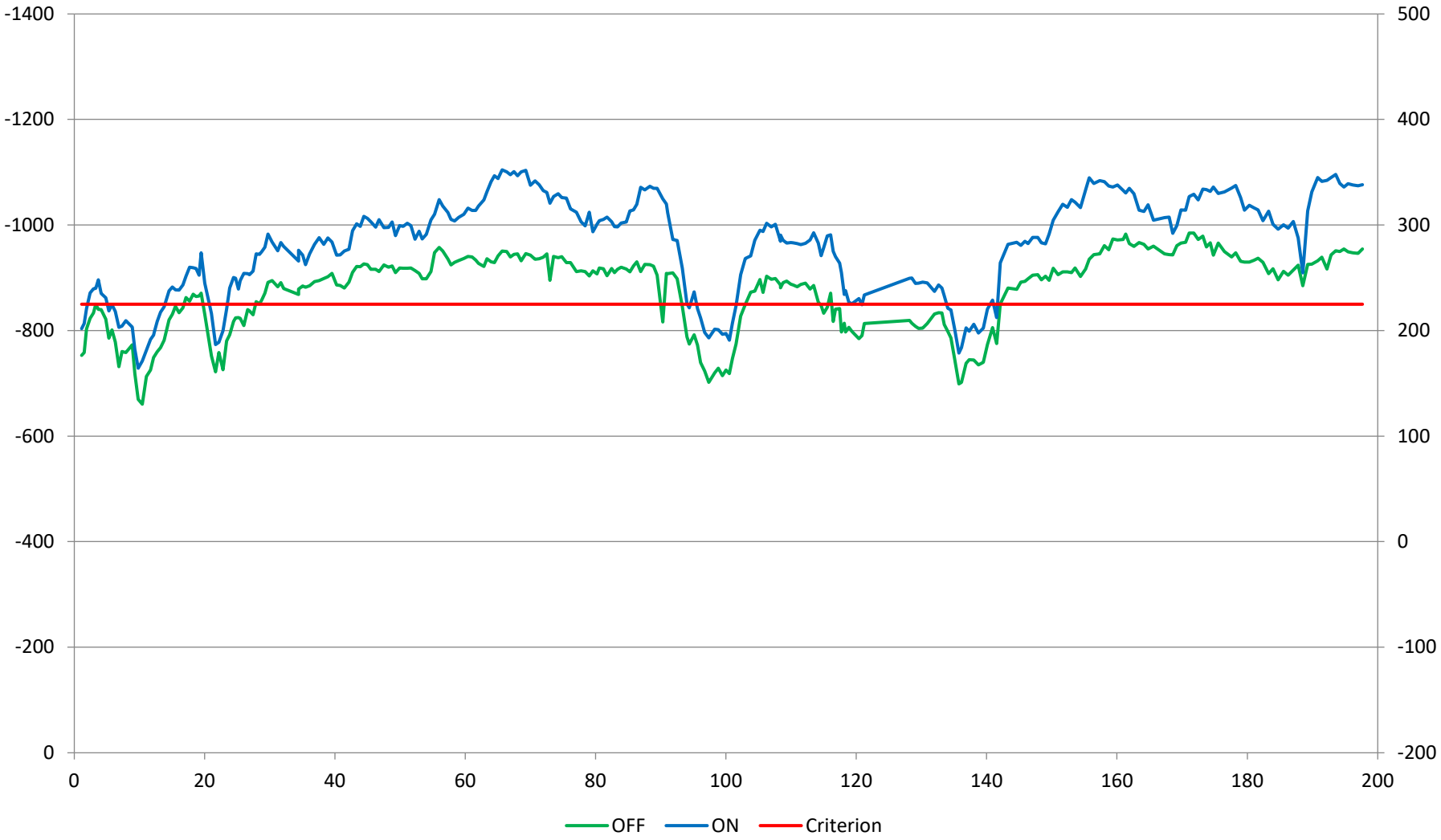
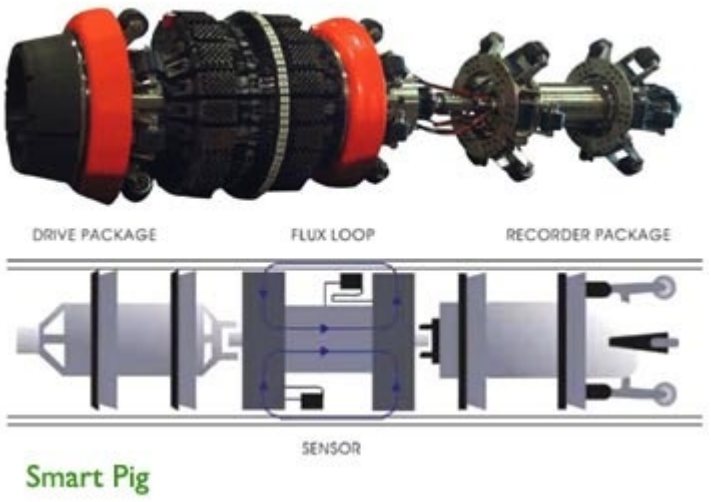
CIPS Data Graph



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

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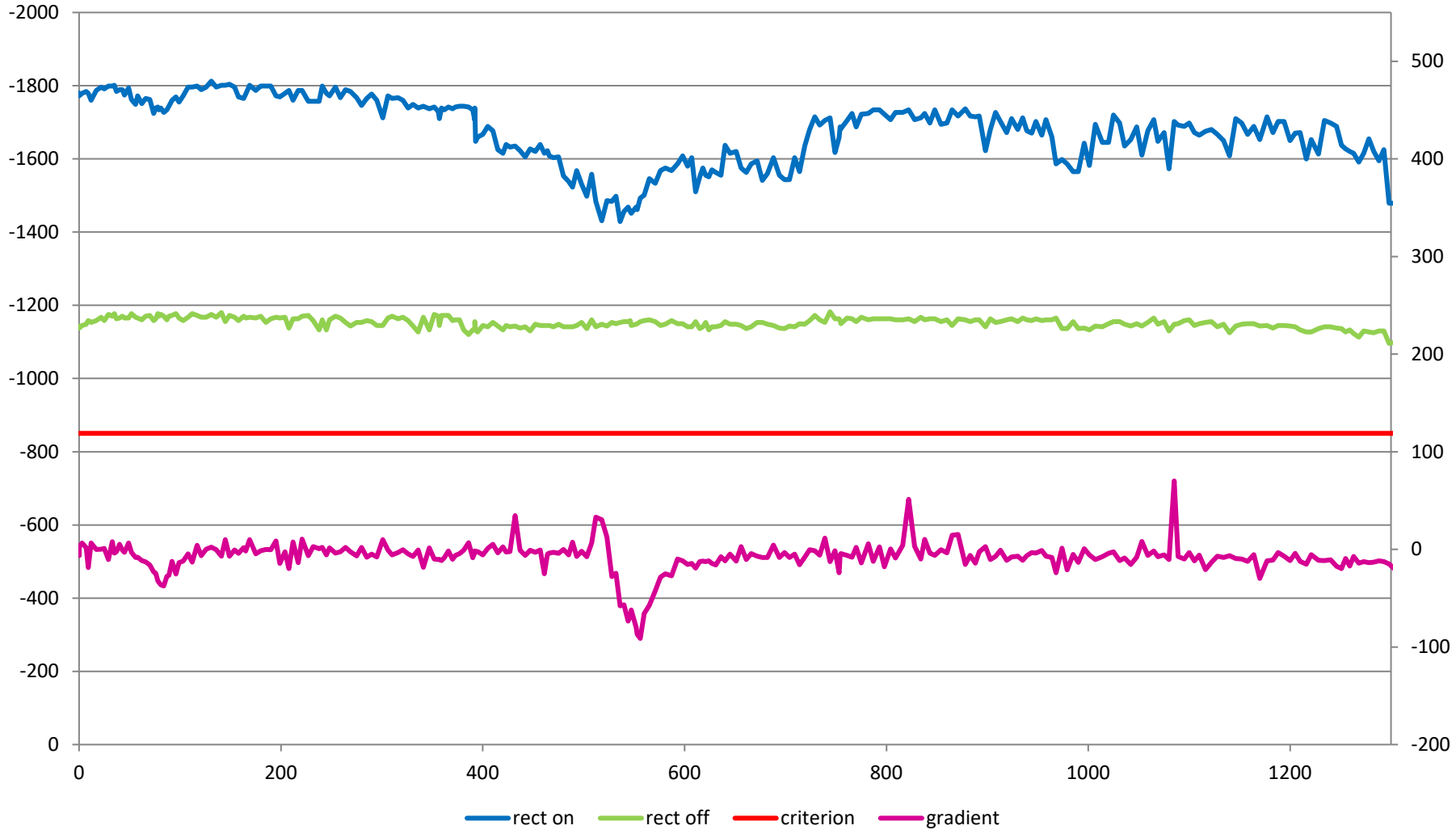
Combined CIPS + DCVG Surveys

- 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

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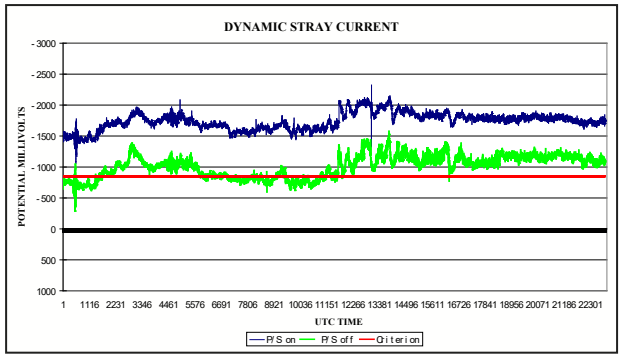
Stray Current Correction

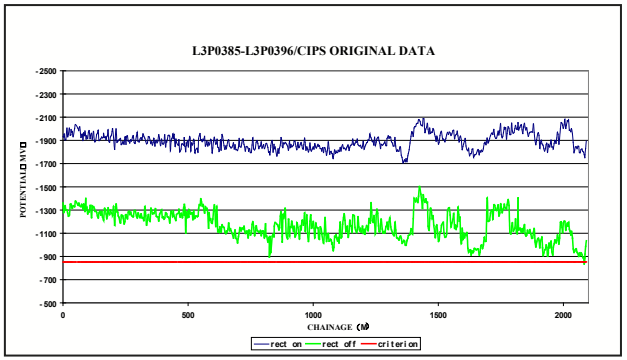
- GPS time stamp is used to compare the logger data with the mobile CIPS data
- Correcting for the stray current provides a more accurate reading of the CP on the pipeline
  - CIPSCorrected = CIPSTime X + (LoggerTime X – Average (LoggerTime Interval))

Stray Current

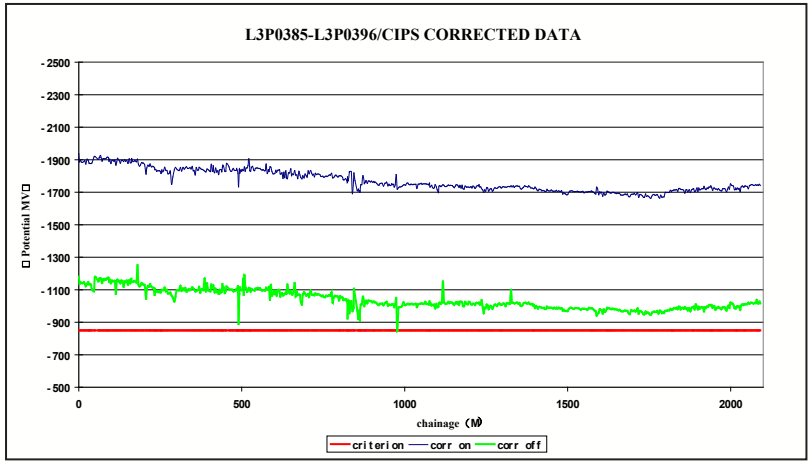
Data From Test Station



CIPS Data Along Pipeline



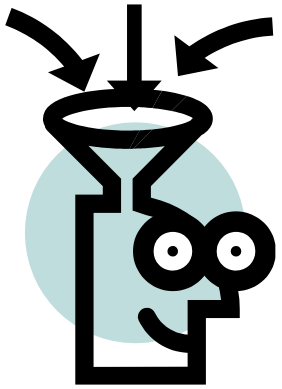
Corrected CIPS Data



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



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

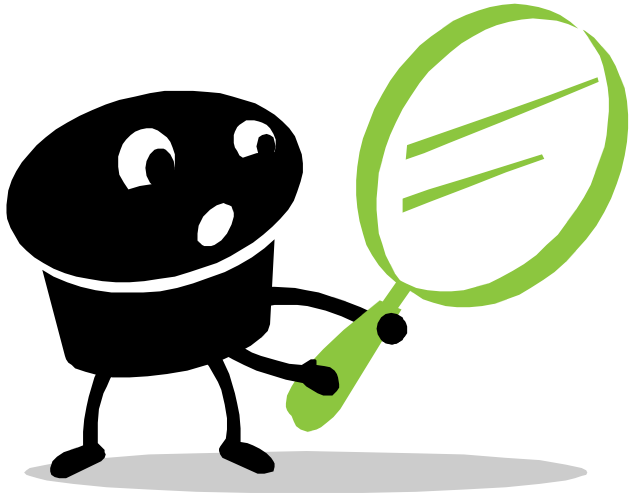
- CIPS goes below criterion, DCVG shows defect, new maps show a new subdivision in that area

- 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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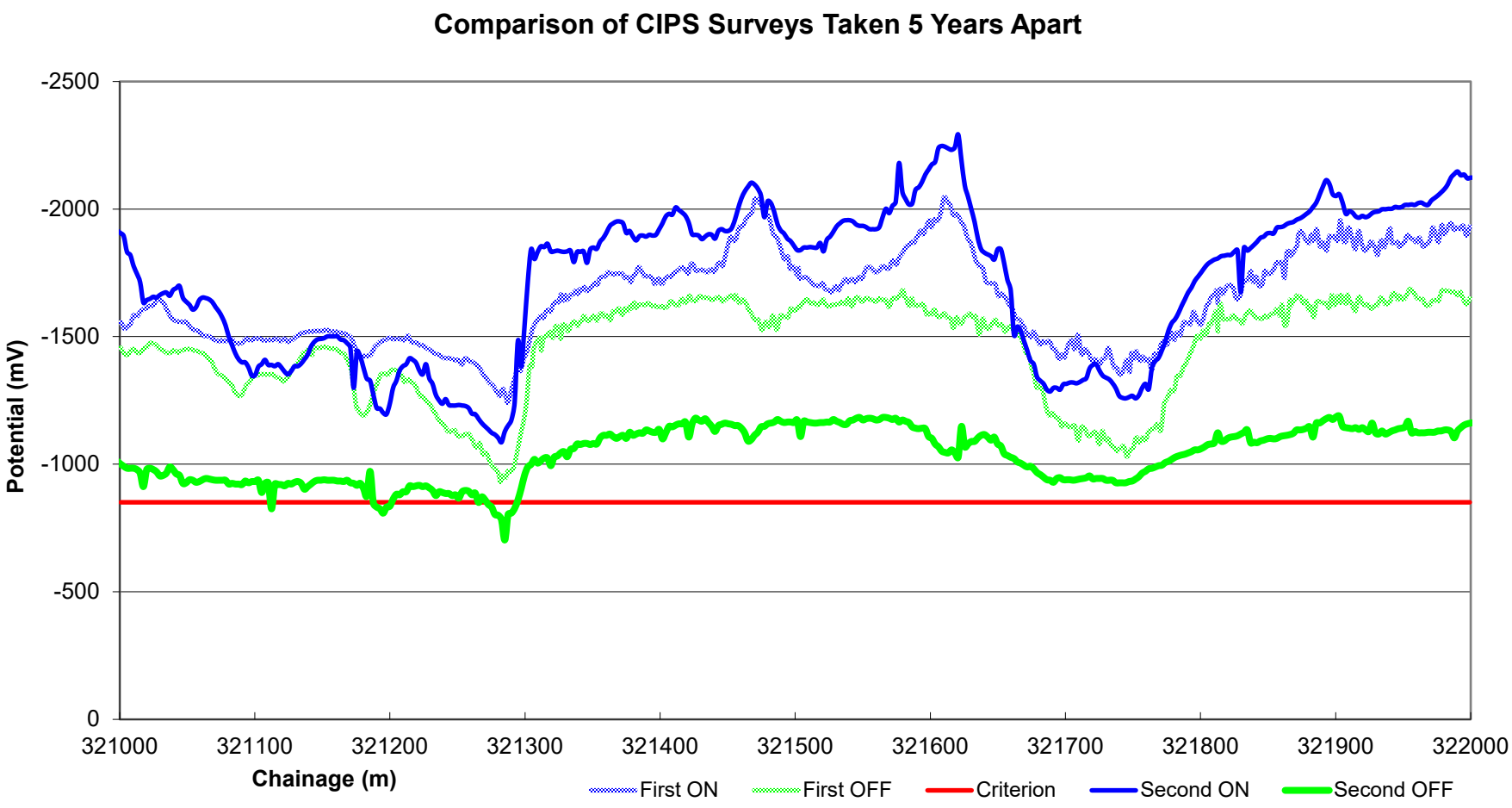
Comparing Years

- 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

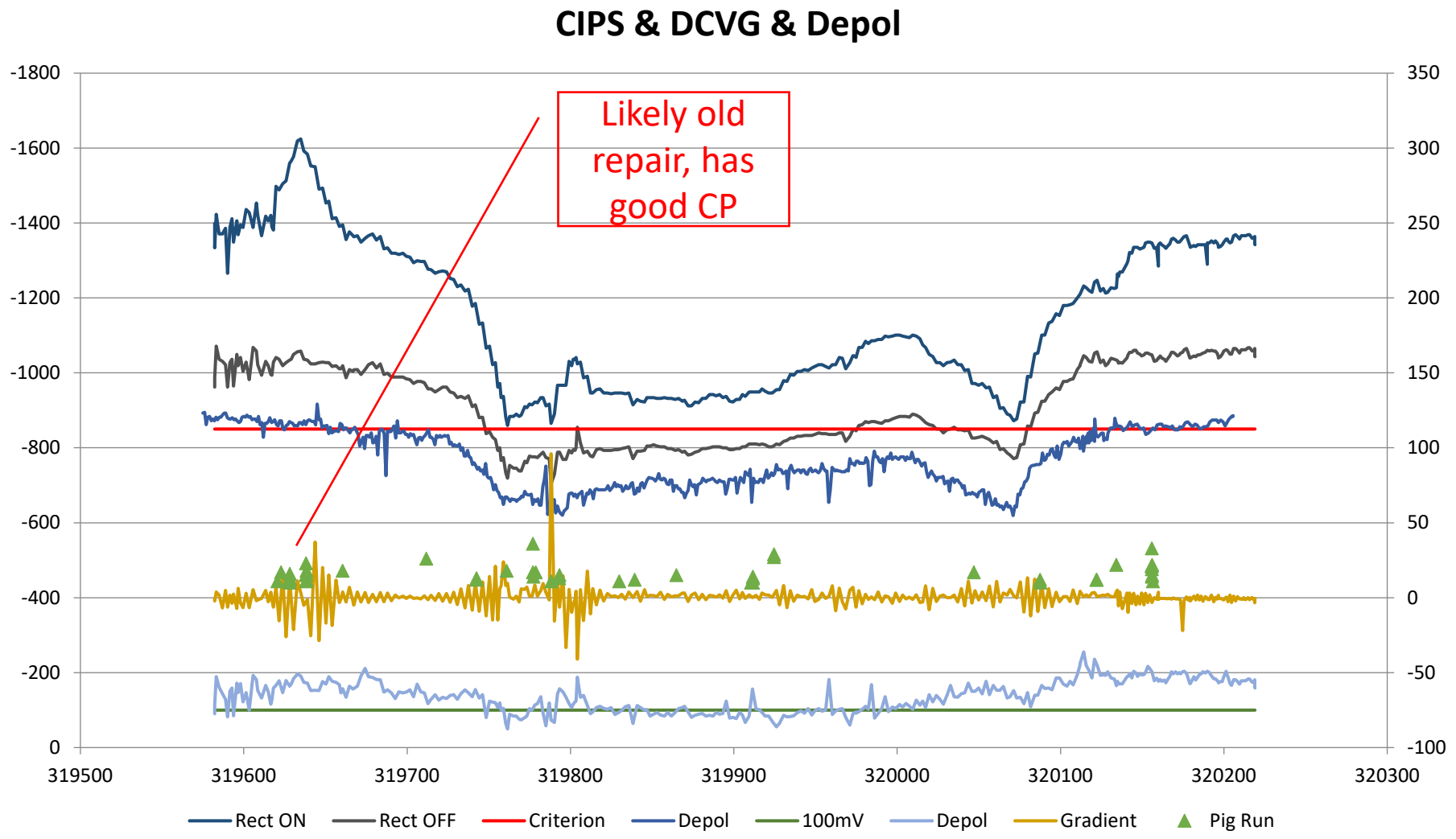
Comparing Years



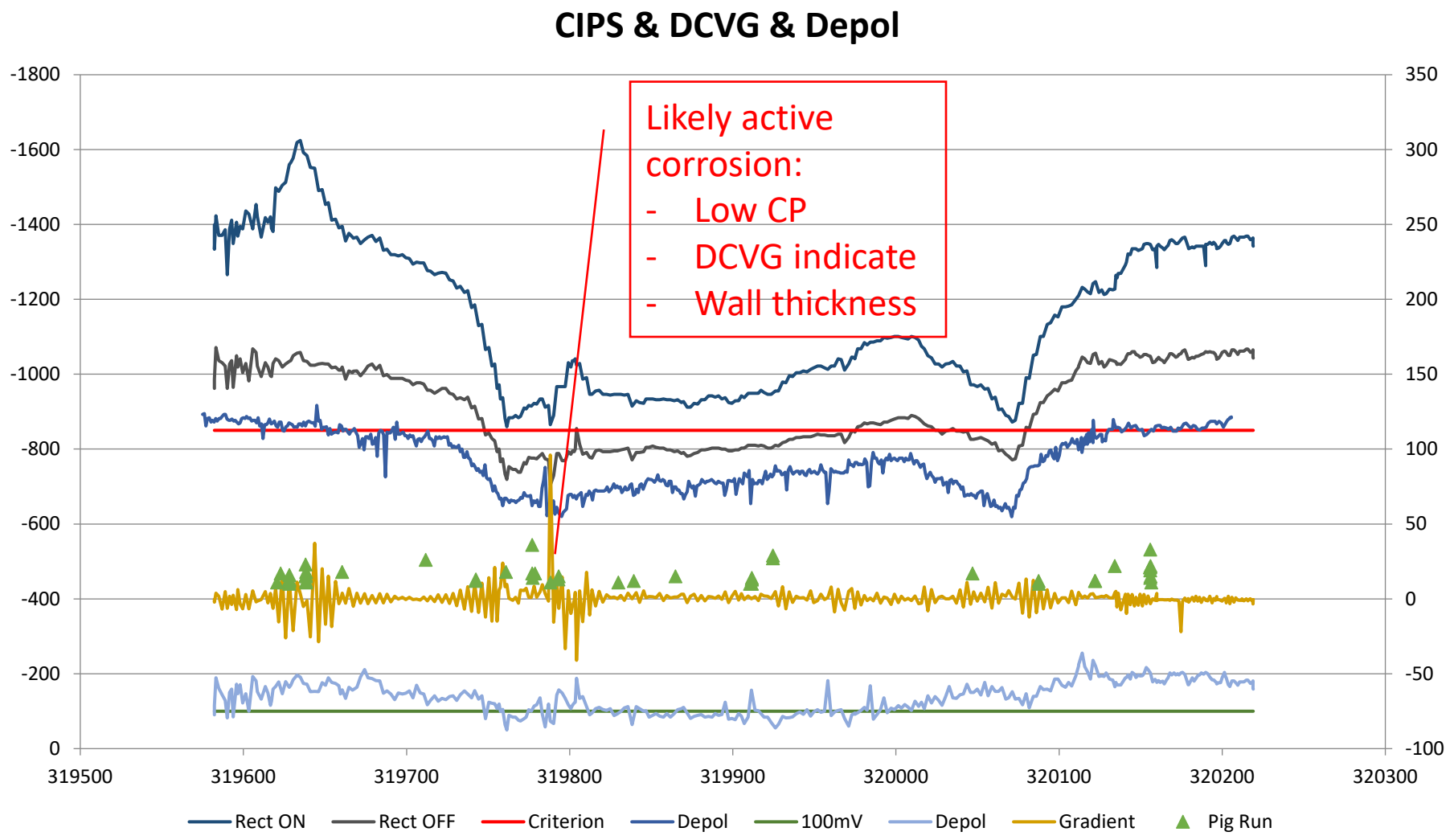
Comparing Years

- 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

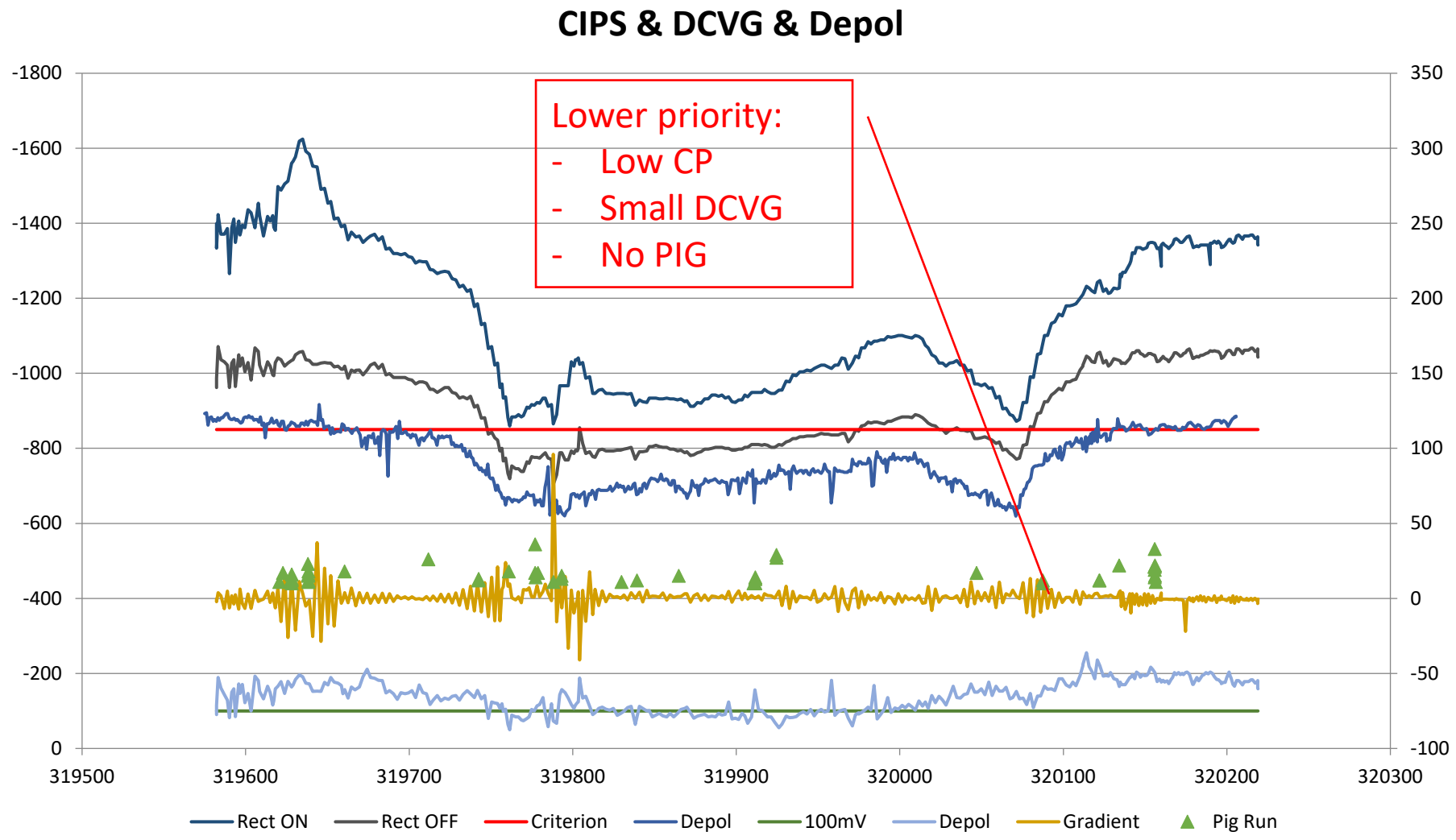
All Available Data



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
  - 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

PODS™
Pipeline Open Data Standard
www.pods.org

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>
Type_CL	varchar(16)	<fk2>
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

Event_ID	char(38)	<pk,fk7>
Type_CL	varchar(16)	<fk2>
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

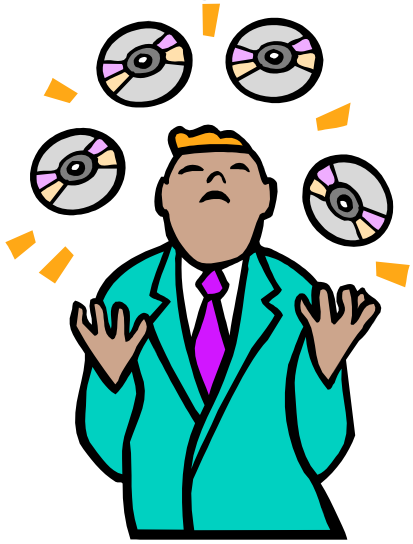
Event_ID	char(38)	<pk,fk5>
Inspection_Date	datetime	
Description	varchar(50)	
Reading	numeric(5,4)	
CP_Reading_Type_CL	varchar(16)	<fk3>
PI_CP_Event_ID	char(38)	<fk1>
Ref_Ground_Bed_Event_ID	char(38)	<fk2>
Source_CL	varchar(16)	<fk4>
Comments	varchar(255)	

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)	

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 Microsoft Office, 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

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