Data Integration and Interpretation Report
July 2013

Purpose
This survey and the reporting of its results was intended to document and consolidate the methodologies and processes used by API companies to spatially integrate and normalize their data to support application of comparative techniques used in interpreting the various data sets, with a focus on ILI data. As such, these processes require careful consideration in their application by operators as the brevity of the response contained here may not sufficiently reflect all relevant assumptions underlying its applicability.

Structure of the Data
The following is a list of the various fields with a description of the intended contents.

Name
: The name the operator assigns to the process should be in consideration of the feature type(s) primarily and the purpose of the process.

Data Sources
: This is a listing of the primary data types used in improving the interpretation of assessment data

Specific Attributes Used
: This is a listing of the specific attributes of the data types that is utilized

Sensitivity to Spatial Alignment
: This is an expression, where available, of the opportunity for spatial misalignment of the data used in the process and the tolerance of the analysis to spatial error. Where the operator is unsure of this field, simply enter UNKOWN (i.e. do not get hung-up on this field such that it unduly delays summiting the data).

Criteria
: This is a succinct account of the criteria that is applied to interpret the data.

Interpretive Methodology
: This is an explanation of how the process is applied to the interpretation of the assessment data.

QC Methodology
: This is an explanation of how the process is applied to the quality control of the assessment data.

Implementation and Results
Contributions to the listing were solicited in two iterations over a two year period.

Table 1 provides a list of processes for consideration regarding additional means of leveraging and interpreting ILI data, as well as elevated engagement of the ILI vendor.

Aside from any immediate values the reference list may provide, it is envisioned that this format could be used as a framework for facilitating ongoing consolidation and redistribution of industry practices.

In the process of distilling the results down to a play book of data integration processes for consideration by pipeline operators, in some cases the responses were edited to improve clarity and minimize redundancy. However, variations in nomenclature still remain as an artefact of having numerous individuals and companies contribute.

The following general comments are provided here in an effort to streamline the responses and reduced redundancy.

<u>QC Methodology</u>

- Many operators provide the NDT (excavation) results to the vendor so that the ILI assessment can be refined based on field data.
- Another common statement was signal to signal analysis across different ILI runs in order to derive growth rates.

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Table 1 **Distillation of Data Integration and Interpretation Survey Results** July 2013

ID	Threat	Description	Data Source:	Specific Attributes Used:	Sensitivity to Spatial Alignment:	Criteria:	Interpretive Methodology:	QC Methodology:
1	ANY	**Threat Integration**	ILI tool data (Deformation, MFL, CMFL, Ultrasonic ML, and Ultrasonic Crack)	All types of defects from all types of ILI data	5tx5t	Defects from all types of ILI data	Threats are categorized as: internal ML, external ML, cracking, SCC, geometry, other (laminations, inclusions, manufacturing defects, etc.) Where two or more threats overlap spatially, they are carefully analyzed. This analysis may result in an excavation.	NDE results are reviewed for verification.
2	ANY	**Failure Pressure Anomalies**	Pipeline Maps, GIS, Operational Data	Pipeline Elevation data	N/A	Line elevation deviates >100'	Elevation data is integrated into the ILI vendor's report for all anomalies along the pipeline. After receiving the vendor report, a "local" MOP is calculated using elevation and most conservative product weight for every item on feature list, then ERF is recalculated for all anomalies between 15 and 80%. Vendor does not adjust ERF for elevation.	A review of the vendor's calculated failure pressures are accomplished prior to importing elevation data. This step assures the ILI vendor used the proper evaluation pressures and parameters in preparing the submitted vendor report.
3	ANY	**Appurtenance Reconciliation**	Geometry or Metal loss ILI	Features List	N/A	Appurtenance	A tap, stopple, tee, sleeve, patch, weld plus end, valve, flange, or other pipeline attachment which was unknown or installed with unapproved or unknown installation methods. Compare to GIS data to determine if the appurtenance is known and if it is located within a facility. Evaluate for removal if not needed on the system.	N/A
4	ANY	**A change since the previous assessment**	Geometry/ Metal Loss tool	Features list	N/A	An anomaly, predicted to have changed in depth, length, width, orientation, or any injurious manner from the previous assessment	An anomaly, predicted to have changed in depth, length, width, orientation, or any injurious manner from the previous assessment. Supplied to tool vendor to determine if growth since last assessment.	
5	ANY	**All ILI Anomalies: Sensor Loss**	ILI tool data (Deformation and/or MFL)	Current in-line inspection tool data	N/A – integral to ILI data	Per vendors spec	Sensor loss occurs when a sensor is damaged/inoperative and does not function properly through portions of or the entirety of an in-line inspection tool run. The number of sensors on an individual ILI tool varies based upon tool size and ILI vendor. Sensor loss can affect the in-line inspection tool's ability to correctly identify and size all anomalies per specifications. Variations The vendor must be able to meet the company specified vendor reporting requirements, including meeting detection thresholds. On possible approach is to implement a vendor reporting requirement that references the Pipeline Operators Forum and ensures complete of the pipeline segment has been assessed to a reasonable manner. Run failure criteria: < 95% coverage or if 2 or more adjacent sensors fail, or if multiple runs can not be combined reach adequate coverage.	In the event of sensor loss, a data quality certification letter facilitates a clear determination on whether the in-line inspection vendor is still able to correctly detect (i.e. minimum anomaly dimensions detectable with given sensor loss), identify, and size all anomalies in accordance with their published detection and sizing accuracy. Included in the letter would be a summary of the number of sensors damaged/inoperative and the impact on overall sensor coverage.
6	ANY	**Speed Excursions**	Tool Spec	ODO resolved speed in ft/sec	NA - integral to ILI data	Per vendors spec	Out or range speeds (typically over speeds) are primarily associated with gas lines (incompressible liquid column mitigates the occurrence). Different tool technologies have different levels of sensitivity to speed excursions, and the effect will negatively impact POD, POI and sizing.	Extrapolation of the results from correlation excavations needs to be in consideration of the tool speed at the correlation sites relative to the remainder of the line.
7	ANY	**Circumferential Additional Metal**	Extra Metal	Current in-line inspection tool data	N/A	Circumferential additional metal (Gain) not related to previous repair or casing	ILI reports area where circumferential additional metal is discovered that is not related to a previous repair or near by casing. Additional metal (gain) that is not otherwise accounted for.	Cross examination against other sources utilizing GIS software. If metal (gain) remains unaccounted for, further investigation should be considered.
8	ANY	**Girth Weld Quality**	Environmental hazard data	Pipeline maps, seismic surveys, etc.		Anomalies potentially exposed to environmental hazards	Girth welds with poor quality should be identified and reinforced or replaced if located in areas subject to ground movement, such as earthquake prone areas, near bodies of water likely to erode cover away from the pipeline, or at locations where the pipeline is exposed or suspended.	Additional anomalies could be added to the evaluation list.
9	ANY	**Longitudinal Seam Reconciliation**	Geometry or Metal loss ILI	ILI Log/Raw Data	N/A	Longitudinal seam (Y/N)	Review ILI raw data for indication of longitudinal seam or seamless pipe. Compare results to GIS and maps & records and update as needed. If previously unknown long-seam is confirmed, evaluate for long-seam threats.	In terms of weighing the potential manufacturing threat associated with the long seam, the vintage of the pipe would be a key determinant.

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10	**ANY**	**All ILI Anomalies: ILI Tool Correlation**	ILI tool data (Metal Loss and/or Deformation)	ILI data (as-called) and remediation results (as-found)		Per vendor spec	Correlation of ILI tool data is conducted to determine tool accuracy for each ILI run by comparing actual anomaly characteristics (as found) to the predicted ILI data (as called). By correlating data for each ILI run, you can account for individual tool performance, the specified tolerance, and other conditions specific to a particular pipeline segment inspection. Graphical representation (Unity Plots) of anomalies is employed to help identify trends in predicted versus actual anomalies for each tool run	If correlation results demonstrate that the data is not within the stated tool accuracy specifications, a determination regarding additional anomaly evaluations may require re-grading of data based on correlation results or continued evaluation of the assessment data based on the calculated tool accuracy and confidence level.
11	**CRK**	**Distance from U/S Pump Stations**	ILI	Pump Station Location	N/A	Greater of: 10% of pump to pump segment, or 5 miles, D/S of pump station	Focused assessment of crack ILI features. Utilize additional criteria for dig selection to account for increased potential for feature growth.	NDE results are reviewed for verification.
12	**CRK**	**Girth Weld Cracking**	MFL ILI data	Identified girth weld flaws	YES	Review of MFL and IMU ILI data to identify any areas requiring further assessment.	Reported GW are reviewed with regards to available strain data to determine if they are located in areas of measured strain based on IMU data. Axial strain may provide a growth mechanism for girth weld flaws.	ILI data reviewed for potential field excavation and repair.
13	**CRK**	**Cracks with Metal Loss**	Two ILI data sets	Feature list location	3T X 3T	Looking for cracks that may be interacting with metal loss	Ultrasonic shear wave ILI does not detect or report metal loss. The limitation can be overcome by integrating the shear wave ultrasonic list of cracking features with the metal loss feature list of another suitable ILI technology, and reviewing for interaction (i.e. spatial proximity or coincidence) of cracks with corrosion.	Depth and remaining strength may be affected by the interaction of defects.
14	**ML**	**Casing Short**	Metal Loss assessment	Metal loss feature	N/A	A metal loss anomaly (external) to have greater than 20% wall loss inside a casing	A metal loss anomaly (external) to have greater than 50% wall loss inside a casing. Information reviewed to determine if further investigation or mitigation of the casing is required. . <u>Variations</u> Anomalies are evaluated with metal loss > 40% in a casing Metal loss in casing showing growth from prior ILI reviewed to determine if further investigation or mitigation of the casing is required..	N/A
15	**ML**	**Metal Loss at foreign crossing**	Metal loss ILI	Features List	+/- 100’ of foreign crossing	Metal loss	Metal loss within 100’ of a foreign crossing may be an indication of third party damage. Locate anomaly and crossing is the field and if the metal loss is within 10’ investigate. <u>Variations</u> Anomalies are evaluated if within 50 feet of a casing, and 120 ft of a foreign line crossing. Qualified with a depth criterion of >= 60% 50' interaction criteria for crossing of another pipeline	N/A
16	**ML**	**Active Corrosion**	CP	Potential	Closer to 0.00V than -0.850V	Metal loss	A metal loss anomaly predicted by the metal loss tool to have greater than 20% wall loss in an area with cathodic potentials closer to 0.0V than -0.850V. <u>Variations</u> Any metal loss showing growth from prior ILI and in a low potential area is flagged to be addressed	
17	**ML**	**Touching/Close Metal Object Suspect Corrosion**	Metal Loss tool	Touching/Close metal object	N/A	Touching/Close Metal Object	A touching metal object, or Close Metal Object predicted by the metal loss tool to be located in an area with cathodic potentials closer to 0.0V than -0.850V. <u>Variations</u> If any close metal object is within the same or an adjacent joint of pipe containing another anomaly to be investigated, then the close metal object shall be evaluated. Gains near low potential areas investigated	

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18	**ML**	**Touching/Close Metal Object Suspect Corrosion Near Foreign Crossing**	Metal Loss tool	Touching/Close metal object	N/A	+/- 100' of foreign crossing	A touching metal object, or close metal object predicted by the metal loss tool to be located within 100' of a foreign pipeline crossing. The foreign pipeline must be marked in the field and be within 10' of the staked touching metal object.	
19	**ML**	**Metal Loss greater than 20% of nominal wall located at a touching metal object**	Metal Loss tool	Touching metal object	+/- 5' of touching metal object	Touching Metal Object within +/- 5' of touching metal object.	A metal loss anomaly, predicted by the metal loss tool to have greater than 20% wall loss within 5' of a touching metal object. Variations Correlated new or growing metal loss is checked for nearby causes like gains.	
20	**ML**	**Excessive metal loss in heavy wall pipe**	Metal Loss tool	Metal loss data	N/A	Metal loss anomaly, predicted to be greater than 50% wall loss in heavy wall pipe	A metal loss anomaly, predicted to be greater than 50% wall loss found in piping with a nominal wall thickness at least 2 nominal sizes larger than the smallest nominal wall thickness.	
21	**ML**	**Metal Loss greater than 20% of nominal wall located near girth welds in FBE coated pipe**	Metal Loss tool	Metal loss data	+/- 6"	A metal loss anomaly (external), predicted to be greater than 20% wall loss of the pipe body within 6" of a weld	A metal loss anomaly (external), predicted to be greater than 20% wall loss of the pipe body within 6" of a weld indicated possible shielding coating. Variations Correlated growing metal loss within 1" of weld is addressed.	
22	**ML**	**Metal Loss greater than 20% on nominal wall located in the pipe body in FBE coated pipe**	Metal Loss tool	Metal loss data	N/A	A metal loss anomaly (external), predicted to be greater than 20% wall loss of the pipe body on FBE coated pipe	A metal loss anomaly (external), predicted to be greater than 20% wall loss of the pipe body on FBE coated pipe indicates possible shielding repair coating.	
23	**ML**	**Anomaly within close proximity of a target item**	Metal loss tool	Metal loss	+/- 5'	An anomaly, predicted to be within 5' of a targeted item	An anomaly, predicted to be within 5' of another investigation.	
24	**ML**	**Coating Damage**	Close Interval Surveys	ON or OFF	+/- 50 ft	Depression not meeting Company criteria	Excluding foreign crossing interference, localized depressions in the CP (be it ON or OFF) would be indicative of a significant coating holiday (i.e. current drain). Assuming the presence of a non shielding coating, this is a potential validation parameter for the presence of active external corrosion. Dependent on information known about existing coating, bare pipe areas, etc.	N/A
25	**ML**	**Internal Metal Loss: Data Review**	Corrosion Coupon/Probes data, operational data, product history, frequency of operation, use of inhibitors, validation sites, ILI comparisons	Data sources integrated with ILI data		Compare reported internal metal loss with known information	ILI reported internal metal loss is reviewed against past reports (if available). The potential for growth is also determined by reviewing the data sources and determining if there have been verifiable calculated growth rates. Periodic scans of validation sites can be used to determine if there is actual growth or if the "growth" is due to tool deviation in the event coupons, history, etc., do not indicate growth.	As-found data is forwarded to ILI vendors for fine tuning the ILI results on internal metal loss calls.

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26	**ML**	**Active Corrosion**	Close Interval Surveys	OFF or polarization shift	+/- 50 ft +/- 50 ft	Per NACE SP0169	Assuming the presence of a non shielding coating and ignoring geometry effects, this is a direct measure of the polarization level of the pipe (assumed to be at the defect) and can be used to evaluate active vs. non-active corrosion. This technique is particularly valuable in terms of older lines where the CP has been significantly remediated or upgraded recently. This impacts growth based modeling for re-inspection intervals.	N/A
27	**ML**	**Complex Corrosion**	Metal Loss tool	ML boxes	N/A	Group all clusters within 2hr clock position in length and width	Identify large groups of axially aligned anomalies (i.e. at common clock position). Complete list of groups based on the 2hr clock interaction with and a sub list of those groups with a peak depth ≥ 50% and a length greater than 6”. Variations Pits are grouped based on interaction rule: 1" axial and 6t circumferential	Groups provided to tool vendor for a secondary review of the feature interaction.
28	**ML**	**Complex Corrosion**	Metal Loss tool	ML boxes	N/A	Clusters that have three or more ML boxes with depth ≥ 50%, within 3t x 3t of each other	Identify sub-clusters of ML boxes with depth ≥ 50% to see if there is overlapping signal or underlying metal loss signal response. Variations Pits are grouped based on interaction rule: 1" axial and 6t circumferential	Clusters provided to tool vendor for to manually verify clustering and failure pressure or sizing needs revision.
29	**ML**	**Complex Corrosion**	Metal Loss tool	ML boxes	N/A	Groups of 6t x 6t grouping with FPR ≤ 1.25	Identify potentially more severe anomalies (i.e. determine if there are any missed ML boxes that would join existing clusters). Variations Pits are grouped based on interaction rule: 1" axial and 6t circumferential	Groups provided to tool vendor for review to see if bridging ML box was missed.
30	**ML**	**External Metal Loss: Coating Review**	CIS Data, Historic Drawings, documents, & photos	Pipeline Stationing of reconditioned areas	Some errors integrating field measured PL station numbers to station number interpolated through GIS mapping	Compare CIS measurements against anticipated coatings based on drawings and historic data	Review CIS data and compare to boundaries of anticipated coated, painted, or potentially bare pipe. Gives a better understanding of why some CP measures may be lower than others. Assists in determining if pipe originally laid bare has been recoated as part of reconditioning projects. Reviews of past Integrity Digs in area can also be used to verify overall coating condition.	Reviews of ILI data may also show signs of reconditioning such as puddle welds, patches, sleeves, etc. Historically, joints that were reconditioned were also coated upon completion of the reconditioning work. Intact and well bonded coating at external corrosion features excludes these features from growth analysis. In joints where coating is noted to be well bonded and active corrosion is not likely, ILI data comparisons are used to assess report deviations from run to run.
31	**ML**	**Metal Loss Validation of Past Repairs**	ILI Data, Repair Records	Reported metal losses under composite repairs	N/A	Pre-remediation measurement vs. current measurement.	The ILI vendors are instructed to report metal losses beneath composite repairs. Past ILI data, repair locations, and sizings, are provided to the vendor’s for integration into the ILI reports. The vendor is to also use the known data to assist applying their sizing algorithms. Other known sizings (recoated anomalies) are reviewed once the vendor data is received to validate accuracy. This report validation is dependant on the the presence of past findings.	This process assists in determining the ability of the ILI vendor to accurately size anomalies in the ILI reports. It also speeds up the time needed to validate a new ILI report since numerous new digs are not necessarily required.
32	**ML**	**Corrosion Growth**	ILI Metal Loss	metal loss features from multiple ILI run	joint alignment across the various ILI runs	variances in max depth, number and volume of metal loss with a joint	This process leverages the definitive method of weld alignment to facilitate a course run to run comparison to highlight joints that merit additional scrutiny in terms of corrosion growth or feature characterization. The use of volume of metal loss is a means of accounting for differing interaction rules that result in artificial variances in anomaly populations. Additional caution needs to be exercised where there are potentially highly variable corrosion growth rates within a single joint (e.g. MIC). Variations For dig programs with suspected excessive corrosion growth, ensure the next assessment is performed using the same technology from the same vendor to accurately compare any metal loss growth, eliminating tool tolerance between different vendors with different tools. Joint corrosion volume is calculated and plotted	Internal and external metal loss handled separately, but then compared to identify ID/OD mischaracterization.

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							Identify anomalies for possible investigation where the maximum depth has increased by more than twice the tool tolerance.	
33	**ML**	**Metal loss in proximity of long seam**	Metal loss ILI tool	Metal loss and deformation anomalies from previous tool runs	NA	All anomalies	Existing anomalies are reviewed when new physical information obtained from subsequent tool runs is available.	Compare previous tool run data with current ILI data to identify if anomalies can be reclassified since the previous assessment. For example, if the current tool run identifies pipe seam orientation (when it was not known previously), anomalies are reexamined to determine if anomalies can be reclassified (e.g. a previously identified dent could be reclassified as a dent on a long seam).

34	**ML**	**Lifecycle Corrosion Analysis**	Metal loss ILI tool	Metal loss data	joint alignment across the various ILI runs, engineering stationing of anomalies and other data streams	All anomalies	Graphical alignment of the following data by engineering stationing:
							- ILI anomaly information as follows:
							  - Individual anomaly depth (multiple runs identified with different colors)
							  - Cumulative corrosion normalized to 1 over segment length
							- Previous repair information
								The analysis is used to seek areas where corrosion damage (that does not require repair based on regulatory or company criteria) appears to be increasing in depth, extent or density; or where existing damage is NOT increasing in depth, extent or density. It can be used to identify areas of suspect shielding coatings, coating damage/failure, and to prioritize areas for addition of cathodic protection, enhanced dig programs, reconditioning or replacement.

35	**ML**	**ML anomaly dimension**	Metal loss ILI tool	Metal loss data		ML features that are greater than 5 times in length than width	Perform a comparison of ILI data to other corrosion anomalies at the same o'clock position on the joint that might be an indication of selective seam corrosion, especially if it is in the bottom half of the pipeline orientation.	Could add anomalies to be evaluated and identify selective seam corrosion.
36	**ML**	**A/C corrosion from HVAC Power Lines**	ILI and PODS Close Interval Survey, A/C Survey, Corrosion Coupon Survey for current density calculations	Metal loss from multiple ILI compared to AC power corridors		Looking for change in metal loss in proximity to HVAC power lines, high A/C volts and current density	Pipeline sections entering, leaving and crossing at angles to HVAC power corridors are at a higher risk of increased corrosion rates especially on FBE coated lines or coatings with high dielectric strength.	Use close interval survey data, A/C survey, corrosion coupons, and ILI metal loss data to determine if further A/C modeling is necessary.
37	**ML**	**Internal Metal Loss: Data Review**	ILI, centerline, and operational data	Metal loss feature density, elevation, flow rate, corrosivity, pigging frequency and chemical treatments	joint alignment across the various ILI runs	Internal metal loss located in low areas	Review concentration of internal metal loss features in consideration of the supporting mechanism. This would typically be in close proximity to low lying areas, but contributing factors would be laminar flow and product corrosivity as well as mitigating measures such as cleaning runs and chemical treatment	
38	**ML**	**External Metal Loss**	ILI and CIS	ML density and depth, and CP ON/OFF	joint alignment across the various ILI runs	Metal loss change in areas of lower potentials	Review areas of increased corrosion activity in close proximity to lower potential levels indicated on the CIS although they may still meet criteria.	

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39	**ML**	**External Metal Loss**	ILI Data, Hydrotest data, Repair Records, CP data, Leak History, Pipe data, Coating data, MAOP data, Foreign Line Crossings	ILI features, Pipe-to-soil potentials, close interval surveys, condition of coating, previous reconditioning/repairs, corrosion rates, soil conditions	+/- 50 feet	Significant growth between ILI tool runs, P/S potentials below -850 mV, Disbonded or shielded coating areas, corrosion preferential to a seam or girth weld,	External Metal Loss can be reviewed in combination with other data such that active corrosion could meet repair criteria prior to the next scheduled In-Line Inspection.	ILI data is overlaid with other corrosion data (P/S Surveys and CIS Data) to look for localized hot spots and areas where corrosion protection systems may need enhancements. Coating data and historical excavation data are reviewed to see if an area may need reconditioning to arrest active corrosion.
40	**ML**	**Internal Metal Loss**	ILI Data, Hydrotest data, Repair Records, Product specifications, Pigging return corrosivity tests, Corrosion coupon tests, corrosion inhibitor records, Leak history, Pipe data, MAOP data	ILI features, previous reconditioning/repairs, corrosion rates, pipe elevation data	+/- 50 feet	Significant growth between ILI tool runs, corrosion preferential to a seam or girth weld, orientation of IC anomalies in reference to bottom of pipe or at likely water hold up areas	Internal Metal Loss can be reviewed in combination with other data such that active corrosion could meet repair criteria prior to the next scheduled In-Line Inspection.	ILI data is overlaid with other data (low elevation spots, areas of likely water hold up, seam orientation, girth weld proximity) to look for localized hot spots and areas where internal corrosion protection systems may need enhancements (more frequent maintenance pigging, different types of cleaning pigs, corrosion inhibitor enhancements, etc.)
41	**ML**	**External Metal Loss in a Casing**	ILI Data, Hydrotest data, Repair Records, CP data, Leak History, Pipe data, Coating data, MAOP data, Casing data	ext ML ILI features, casing records, Pipe-to-soil and casing to soil potentials record of filling casing/carrier annulus with di-electric filler	within cased crossing	100 mV separation between pipe and casing to soil potentials	Validating that casing and carrier pipe are electrically isolated.	ILI data is overlaid with other data to look for localized hot spots and areas where external corrosion protection systems may need enhancements (casing filling).
42	**ML**	**Corrosion Growth**	ILI Metal Loss	ML features from consecutive ILI	5tx5t	Variance in max depth and RPR	Three levels depending upon if consecutive inspections are available. Level 1 (historical based) include safety factor, level 2 (back to back ILI): feature matching at joint level, level 3 (signal matching): if back to back ILI is from the same vendor. Features that are growing higher than certain threshold are selected for further review and potentially selected for excavation.	
43	**ML**	**External ML: FBE coated pipelines**	ILI Metal Loss, AC/CIS/ACVG/DCVG survey	Feature listing	N/A	Metal loss features identified by ILI integrated with AC/CIS/ACVG/DCVG surveys to identify potential coating, CP or AC issues.	ILI metal loss features are overlaid with the survey data. Features are prioritized for excavations/verifications based on the depth and suspected interference from the field data. Additional scope is added to verify the corrosion mechanism and further mitigation methods are considered at other suspect locations. Remaining features are identified for continuous monitoring in subsequent inspections.	NDE results are reviewed for verification.
44	**ML**	**Orientation Graphs**	ILI Metal Loss, Elevation, Station Data, HCA, and CP survey	Feature listing	Elevation Data	Internal and External metal loss trending	The data from the different sources are plotted against the stationing data to identify any particular trend in the external and internal metal loss distribution. Trending from subsequent inspections is also compared to see any significant change in trendings from one inspection to other. The results of the analysis are used to identify and implement preventative measures.	N/A

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45	**ML**	**Internal Corrosion Susceptibility**	Flow Rates and Products Characteristics	Historical operations	N/A	Internal Corrosion Susceptibility Score: Mitigation Plan require or not.	A semi quantitative threat score is calculated using flow conditions and products characteristics. The results of the analysis are low, medium or high susceptibility. Mitigation strategies are planned and implement depending upon the susceptibility scores. The age and historical operations of the pipeline in conjunction with ILI data may trigger the mitigation or monitoring of the pipeline as well.	N/A
46	**ML**	**Internal Corrosion Mitigation Effectiveness**	ILI Metal Loss, Orientation Graphs, Corrosion Monitors	Back to back ILI corrosion growth rates	Elevation Data	Effectiveness of mitigation program: growth in depth or number of internal ml features.	The effectiveness of the mitigation program is judged by integrating and evaluating the data from different sources including back to back inspections.	N/A
47	**ML**	**Internal Corrosion Susceptibility**	ILI, IMU/Construction Records	Elevation	N/A	N/A	Elevation data and internal ML data are overlaid and analyzed. Particular attention is paid to over bends and under bends.	N/A
48	**ML**	**Back to back integration**	ILI	Feature Lists	YES	Features matched at two different points in time or between two different types of metal loss inspections MFL/UT/CMFL	Metal loss feature lists are integrated with the previous inspections or other metal loss technologies to identify major discrepancies. These discrepancies are required to be reconciled and have identified tool errors/limitations/strengths, ILI processing errors, ILI analyst errors and high corrosion growth rates.	All major discrepancies are reviewed internally and by the ILI vendor (as required) to ensure accuracy.
49	**ML**	**Air to Ground Interface corrosion**	ILI	Bends		Corrosion falls just downstream of a bend, growth	Metal loss features downstream of and in proximity to a bend undergo additional scrutiny. Could be indicative of coating failure at ground/air interface.	
50	**ML**	**Metal loss change from External to Internal**	Current and Prior ILI	Metal loss attribute		EXT to INT change, growth	Change from external to internal from one ILI to the next warrants further scrutiny as a possible through wall event. True depth of pinhole size pit can escape detection of tool.	
51	**ML**	**Metal Loss - Anomaly Density**	ILI Metal Loss	Number of metal loss anomalies per joint		All reported metal loss per type (internal, external) within a joint	Evaluating and plotting anomaly densities may provide indication of disbonded coating or identify higher priority evaluation areas. Integrating the anomaly density areas to CP readings and elevation profiles may identify causal factors. Utilizing anomaly depth categories (10% - 19%, 20% - 29%, etc.) is beneficial in identifying higher priority areas.	Remediation results will validate tool accuracy
52	**ML**	**Metal Loss - Casing Evaluation**	ILI Metal Loss and Features	Metal loss and features located in a casing		Metal loss located in a casing that coincides with casing features in contact with the pipe	Evaluate metal loss that coincides with a feature in a casing (metal casing spacer that is identified in the ILI data or at the end of the casing indicating interaction with a link seal or casing boot). Interaction of pipe with casing feature may affect pipe coating and the discrimination or accuracy of the ILI data. Casing features not identified in the ILI run may be detected by pattern of metal loss. Evaluation of metal loss from subsequent runs may be used to determine growth of metal loss features.	Remediation results will validate tool accuracy
53	**ML**	**Internal Metal Loss: ILI Data Review**	Metal loss tool	Internal metal loss data	N/A	all internal metal loss	In regards to gas service, assess the density of internal ML indications in the 4-7 o'clock position over a standard unit distance. Although this threshold would vary between lines, a general threshold rule for elevated scrutiny is 10 per 80'.	Data of concern are reviewed by engineering, verified by tool vendor if needed and used for integration with other IC data

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54	**SCC**	**Stress Corrosion Cracking**	ILI Data, Hydrotest Data, Operating Stress, Operating Temperature, Year of Pipe Manufacture, Proximity to Compressor or Pump Station, Type and condition of Coating, leak history, excavation data	Pipelines operating above 60% of SMYS, above 100 degrees F, within 20 miles of a compressor or pump station, more than 10 years old, coated with other than FBE are more likely to develop SCC	N/A	If conditions are more likely that SCC can develop, additional activities are added during routine inspections at likely locations of external corrosion or localized stress in order to detect SCC.	If "noteworthy" SCC is ever experienced on a pipeline segment, then that segment is subjected to additional integrity assessments such as with Crack Detection ILI tools (capable of detecting SCC) or hydrotesting to detect any ongoing SCC.	ILI data is overlaid with other data (external corrosion, dents, field bends, CP data) to look for common conditions where undetected SCC may be probable.
55	**TPD**	**Mechanical Damage: Dents in Close Proximity**	ILI Dents	Deformations within an ILI run	N/A	Axially aligned, on top side, within 1' of one another	ILI data is reviewed for potential dents in close proximity. The data is used to assist in identifying areas with potential gouges/stress concentrators within dents that may not have been categorized by the ILI vendors. Compare current ILI data sets to past ILI data sets to determine if the indications have appeared since the previous ILI which could indicate "new" mechanical damage. This comparison can be dependant on the past reporting criteria or ability to view raw signal data. Locations of possible damage are also mapped to determine if they occur at "suspect" areas such as road crossings, utility crossings/corridors, farm lands, etc.	The results of assessments are fed back to the MFL vendors to have the raw data reassessed to see if further categorizations could have been made or if the tool failed to see the gouges/stressors, within dents.
56	**TPD**	**Dent with Metal Loss Screening on Reconditioned Lines**	Historic Drawings, reconditioning specs, ILI data	Dent features within ILI data on reconditioned pipe and as-found dig findings	N/A	Examine ILI data for signs of previous reconditioning repairs	Review current ILI data versus past ILI data to determine if reported deformations are "new" since the previous ILI. Review vendor data to determine if the pipe joint has been previously reconditioned (presence of puddle welds, patches, sleeves, etc.). Compare this data and the reported metal losses to the alignment drawings to understand if the line had corrosion prior to the installation of coating and/or CP. Review findings at excavations and note if vendor reported "dents with metal loss" were actually due to mechanical damage, a corrosion cell specifically "attacking" a dent due to coating loss, or if it was minor corrosion coincidental to a dent.	Past and current findings are reviewed with MFL vendors. The intent is for the ILI vendors to utilize the data to assist in better categorizing mechanical dents w/ metal loss versus old reconditioned dents with minor coincidental corrosion for prioritization purposes.
57	**TPD**	**Bottom Side Deformation**	Dent feature from Geometry Assessment	Dent features within a single ILI	N/A	Axially aligned	Deformation located on the bottom of the pipeline (below 4 and 8 o'clock position) with a depth greater than 2% of the nominal diameter (greater than 0.250 inches in depth for a pipeline diameter less than Nominal Pipe Size (NPS) 12). Variations Bottom dents < 2% (or 0.25 for <12" pipe) are correlated to prior runs and all are put on pending dig list.	Deformations missed by the ILI are fed back to tool vendor to determine lack of reporting.

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58	**TPD**	**Mechanical Damage: Deformation(s) within close proximity to pipeline crossings, roads, or farmland**	ILI tool data (Deformation and Metal Loss)	Current and previous ILI tool data	Placement of centerline within geospatial data	A topside dent that does not meet repair criteria identified in the current ILI tool run, that was not identified in the previous ILI tool run as a dent (i.e. a "newly reported" dent indication), which is located in close proximity to a pipeline crossing, road, or farmland.	Identifying "newly reported" dent indications that do not meet repair criteria (i.e. does not have indication of metal loss because a dent with metal loss would meet repair criteria) which are located in areas with the potential to contain road construction/maintenance, pipeline construction/maintenance, or farming activities can be more successful at the identification of metal loss within dents than simply depending on ILI tool and vendor capabilities.	If a dent with metal loss is found, findings including field measurements are communicated to the ILI vendor. ILI vendor will be requested to perform root cause analysis for the missed calls. Lesson learned (if any) will be applied to improve the analysis processes.
59	**TPD**	**Comparison on the number of deformation reported on two successive ILI runs**	Deformation	Deformation indications from multiple ILI run	N/A	New topside dents >1%	Review of new topside dents > 1% when comparing current deformation results to previous deformation results. May be an indication of TPD or damage resulting from previous maintenance work performed on or nearby the top of pipe.	If such conditions exist, dig will be performed, check with One Call for any reported events, etc.
60	**TPD**	**Depth of cover and coating type**	Pipeline maps and surveys	Burial depth and coating type data		Depth less than 12 inches anywhere, greater than or equal to 12" and less than 24" in road residential areas, ROWs or cultivated fields	Perform a depth of cover survey to identify shallow burial depths and coating type to determine higher risk of third party damage	Could possibly add additional anomalies to be evaluated. Concrete coating or ditch shields may be identified in coating type which could explain shallower than normal depths.
61	**TPD**	**Failure of topside dents**	ILI deformation tool	Current in-line inspection tool data		All top-sided dents that were not evaluated during prior dig programs located 10 feet from known foreign line crossings	Perform surface evaluation of all top-sided deformations not evaluated in previous dig programs to determine if third party damage would be likely. Aggressiveness of the pressure cycles should be considered when decisions are made whether or not to excavate to evaluate the anomaly.	Additional anomalies could be added to the evaluation list.
62	**TPD**	**Dents at foreign crossing**	Dent ILI and PODS	Features List	+/- 100' of foreign crossing	Dents	Dents within 100' of a foreign crossing may be an indication of third party damage. Review orientation of the pipe crossing and compare to dent orientation. Ground truth and confirm locations of the anomaly and crossing.	N/A
63	**TPD**	**Dents and Depth of Cover**	ILI data, depth of cover and onecall density	Graphs	Topside dents per joint or orientation graph with depth of cover as a secondary axis.	Undug dents on top of pipe located in shallow cover in areas of high onecall density may need to be investigated.	Topside dents located on shallow pipe may be indicative of dents with metal loss even if the ILI tool did not interpret the dent to have metal loss.	Ground truthing may be needed to verify location of dents and shallow pipe.
64	**TPD**	**Dents, dents with Metal Loss**	ILI Data, Repair Records, Depth of Cover Surveys, Land Surface Use, One-Calls, Aerial Patrols, CP data	Smooth top dents > 1% of OD, Any top dent with any indication of metal loss	+/- 50 feet	< 2 feet DOC, Dent repairs in area, Cultivated Fields, Aerial Patrols indicating surface activity, CP data indicating coating damage	Dent indications with other data that indicates probability of TPD would elevate the dent indications to likely TPD and consideration for possible excavation or additional Preventive and Mitigative activities such as increased patrolling, additional signage, increased public awareness activities, possible lowering of the pipeline in place, and contact with land users.	Site visits and alignment of data that places possible TPD indications in the same field as shallow DOC data, Aerial Patrols indicating ongoing surface activity, damaged coating, crossings or one-call activity in the area

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65	**TPD**	**Off-axis Dent**	Geometry ILI data	geometry feature shape	N/A	Denotes whether or not the longitudinal axis of a geometry feature varies more than 15 degrees from the longitudinal or transverse axis of the pipeline	Geometry features oriented off-axis can be an indication of mechanical damage resulting from line strikes. Features identified as off-axis are reviewed in additional detail to determine if additional assessment is required.	ILI data, location data are reviewed for potential additional assessment requirements.
66	**TPD**	**Multi-Apex Dent**	Geometry ILI data	geometry feature shape data	N/A	Denotes whether or not the geometry of a dent has a singular or multiple apex points.	Multi-apex dents may have be an indication of complex or increased stress/strain. Features are reviewed in more detail to assess for the identification of stress concentrators reported by ILI data.	ILI data review
67	**WOF**	**Global Pipeline Strain**	ILI	reported locations of strain	YES	Reported areas of calculated strain based on IMU data are reviewed for potential mitigation	Areas of strain are monitored for change and to ensure that measured strain is within acceptable limits.	ILI data review is supplemented with ROW information to identify areas requiring mitigation or additional monitoring.
68	**WR**	**Wrinkle Bend Threats**	ILI Deformation and Metal loss	WB's with seam and anomalies	N/A	WB's reflecting weld seam running thru wrinkles, or indications of gouges or DMA's on wrinkles	Compare in ILI data tally the orientation of WB's to orientation of long seam. Data search for possible ML on or within 3 inches of wrinkle.	If found request detailed analysis or more in depth review by ILI vendor of the report data, and possible additional to dig list for further investigation.