

NTSB Questions DR 129:

- Unity plots/graphs developed by Enbridge personnel during their performance analysis of the 2011 hard spot ILI data (Linalog® HR Plus & Hard Spot with INS/GPS ILI tool run in April of 2011)

Revised and Supplemental Response:

- Texas Eastern did not use ILI unity plots as a standard practice for comparison of ILI and excavation data during that time frame. The Tuboscope/NDT Linalog ILI Hard Spot tool was carefully selected for use on the Texas Eastern System after experience on Duke’s BC Pipeline system. Experience indicated that there was a high degree of correlation between ILI data for clusters of hard spots that were detected and the physical presence of a hard spot at the specified location¹. ILI hard spot features were sentenced, all reported features 300 Brinell or greater were excavated, assessed, and the hard spots were repaired based on excavation findings². Upon completion of the assessment and any required repairs, the line was recoated with field applied epoxy.
- The following tables show the 16 hard spots reported by the ILI vendor in 2011 for Tompkinsville to Danville Line 15:

ILI Reported Hardness	Total Number of ILI Reported Hard Spots
200 HB to 249 HB	5
250 HB to 299 HB	9
300 HB to 349 HB	1
350 HB to 399 HB	1
Total	16

NDT Job Number: 70130.01
Run Date: 05 April 2011

EVENT TYPE	DESCRIPTION	SURVEY STATION	DIAMETER in	WALL THICKNESS in	SMYS ps	MAOP ps	WHEEL COUNT ft	DISTANCE TO US WELD ft	CLOCK
NCA	HS 252 Brinell	1924935	30	0.375	52	1000	66057.100	6.825	8:00
NCA	HS 256 Brinell	2028345	30	0.375	52	1000	169609.175	1.417	3:50
NCA	HS 246 Brinell	2051083	30	0.375	52	1000	192322.842	21.142	7:15
NCA	HS 293 Brinell	2068815	30	0.375	52	1000	210039.700	37.475	10:10
NCA	HS 261 Brinell	2075711	30	0.375	52	1000	216932.100	4.692	7:55
NCA	HS 254 Brinell	2075713	30	0.375	52	1000	216934.767	7.358	1:45
NCA	HS 255 Brinell	2078733	30	0.375	52	1000	219958.433	35.183	3:25
NCA	HS 248 Brinell	2079178	30	0.375	52	1000	220405.400	5.350	5:30
NCA	HS 355 Brinell	2103637	30	0.375	52	1000	244877.883	2.217	1:30
NCA	HS 311 Brinell	2118767	30	0.375	52	1000	259993.442	30.733	5:30
NCA	HS 261 Brinell	2118768	30	0.375	52	1000	259994.008	31.300	5:30
NCA	HS 248 Brinell	2247609	30	0.375	52	1000	388650.833	38.417	4:50
NCA	HS 252 Brinell	2249639	30	0.375	52	1000	390684.608	2.258	8:55
NCA	HS 250 Brinell	2249640	30	0.375	52	1000	390684.767	2.417	6:45
NCA	HS 245 Brinell	2253137	30	0.375	52	1000	394221.833	2.533	8:10
NCA	HS 247 Brinell	2253368	30	0.375	52	1000	394455.108	1.708	3:45

¹ Owingsville Line 15 Hard Spot Assessment Plan, June 28, 2004.

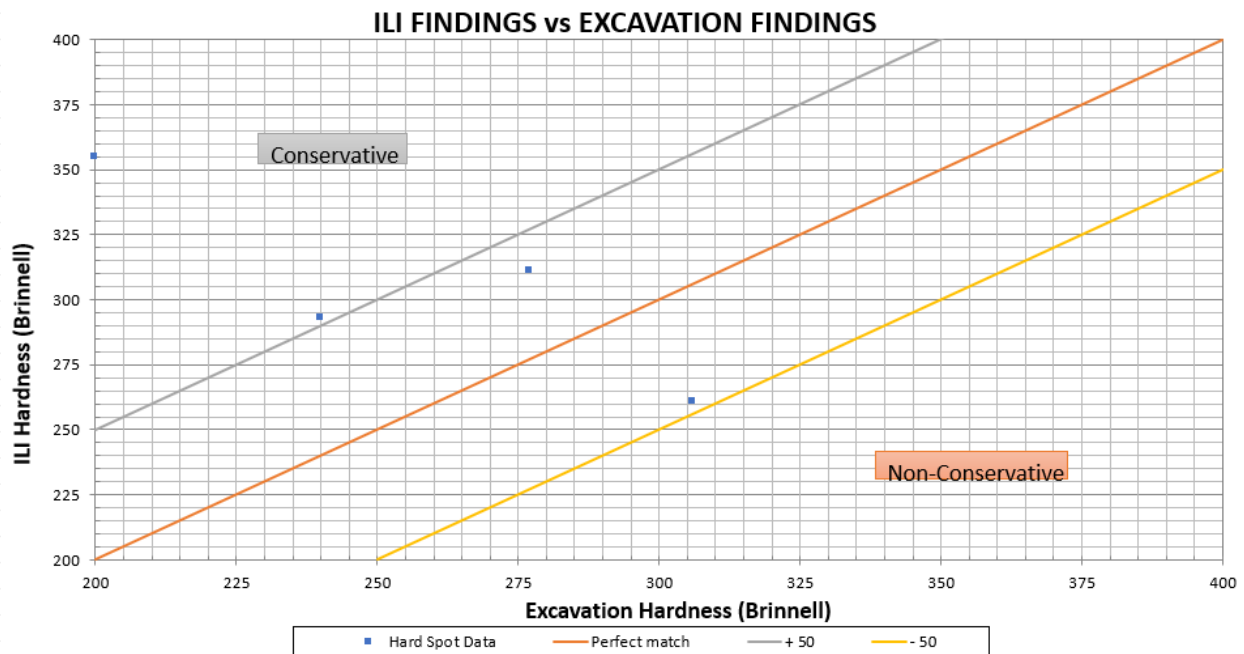
² Hard Spot Historical Review and Memorandum - Tompkinsville to Danville Hard Spot Tool Assessment, memo from Gary Vervake to Distribution Steve Rapp and Bob Travers, July 7, 2011.

Sixteen (16) hard spots were reported with estimated maximum hardness greater than 200 Brinell. Of those hard spots, two (2) hard spots with estimated hardness greater than 300 Brinell were sentenced for excavation. One of those excavations evaluated a second hard spot indication estimated at below 300 Brinell, but in close proximity to an indication greater than 300 Brinell. Additionally, one other hard spot indication was excavated. The following table shows the sentencing:

Distance (ft.)	Length (in.)	Clock	USW (ft.)	DSW (ft.)	Hardness (Brinell)	Grade (1-3)	Excavation Prioritization
66057.100	0.00	8:00	6.825	33.325	252	2	No Excavation
169609.175	0.00	3:50	1.417	38.675	256	2	No Excavation
192322.842	0.00	7:15	21.250	18.850	246	1	No Excavation
210039.700	0.00	10:10	37.475	2.442	293	2	Review*
216932.100	0.00	7:55	4.692	35.183	261	2	No Excavation
218540.050	0.00	1:45	7.358	32.517	254	2	No Excavation
219958.433	0.00	3:25	35.183	4.733	255	2	No Excavation
220405.400	0.00	5:30	5.350	34.658	248	1	No Excavation
244877.883	0.00	1:30	2.217	37.758	355	3	2011
259993.442	0.00	5:30	30.733	9.342	311	3	2011
259994.008	0.00	5:30	31.300	8.775	261	2	2011
388650.833	0.00	4:50	38.417	1.633	248	1	No Excavation
390684.608	0.00	8:55	2.258	37.657	252	2	No Excavation
390684.767	0.00	6:45	2.417	37.517	250	1	No Excavation
394221.833	0.00	8:10	2.533	37.350	245	1	No Excavation
394455.108	0.00	3:45	1.708	38.217	247	1	No Excavation

*Review excavation results and CP history to determine if bellhole assessment is required.

- A unity plot of the excavation results was generated in 2019 after the incident, and is provided below for the comparison of ILI and excavation findings in 2011:



Note: The ILI reported hardness for WC 244877.9 was 355 HB, and the excavation maximum hardness was 160 HB. For Unity plot purposes an excavation hardness of 200 HB was used due to graphing issues.

- All ILI reported hard spots in 2011 greater than 300 Brinell (HB) were excavated, as well as one hard spot with ILI estimated hardness of 293 Brinell. The remaining reported hard spots had estimated hardness of 261 HB or less. Three excavations were performed in 2011, to address 4 hard spots shown in the Table below:

Line Segment	Wheel Count	ILI Data ILI Max. Hardness (Brinell)	Excavation Data Excavation Max. Hardness (Brinell)
TOMP-DANV LN 15	210039.7	293	240
TOMP-DANV LN 15	244877.9	355	160
TOMP-DANV LN 15	259993.4	311	277
TOMP-DANV LN 15	259994.1	261	306

- At the time of the 2011 excavations, the only means understood to be reliable for finding hard spots on the pipeline was through HS ILI assessment and excavation assessment of the features reported by the ILI vendor. The ILI vendor identified hard spots by comparing the data collected from the ILI run with other known hard spots. “Known hard spots” were indications comparable in magnetic flux leakage signature that had been detected using the same technology in the same or similar pipeline environments. The vendor reported that known indications had been excavated and had their Brinell classifications confirmed and documented according to peak deflection, flux leakage characteristics, physical dimensions, and appearance^{3,3}
- Finding hard spots during opportunistic excavations for other reasons, or outside of the locations identified by the HS ILI tool would only have been possible if a visible flat spot had been detected for further investigation with hardness testing. No flat spots were detected during the excavations. In 2020, technology by Eddyfi is being investigated for an NDE method for detecting hard spots with eddy current. The technology allows for scanning of a full joint, with further investigation of identified features with polishing, etching, and hardness testing.
- Following the Lincoln County incident in 2019, Enbridge requested re-analysis of the 2011 ILI hard spot tool data with reporting of any hard spot features exceeding 200 Brinell. The following Tables show a summary of the 2019 re-analysis results:

ILI Reported Hardness	Total Number of ILI Reported Hard Spots
200 HB to 249 HB	416
250 HB to 299 HB	22
300 HB to 349 HB	1
350 HB to 399 HB	2
Total	441

Note: The 2011 reported hard spots are included in this table.

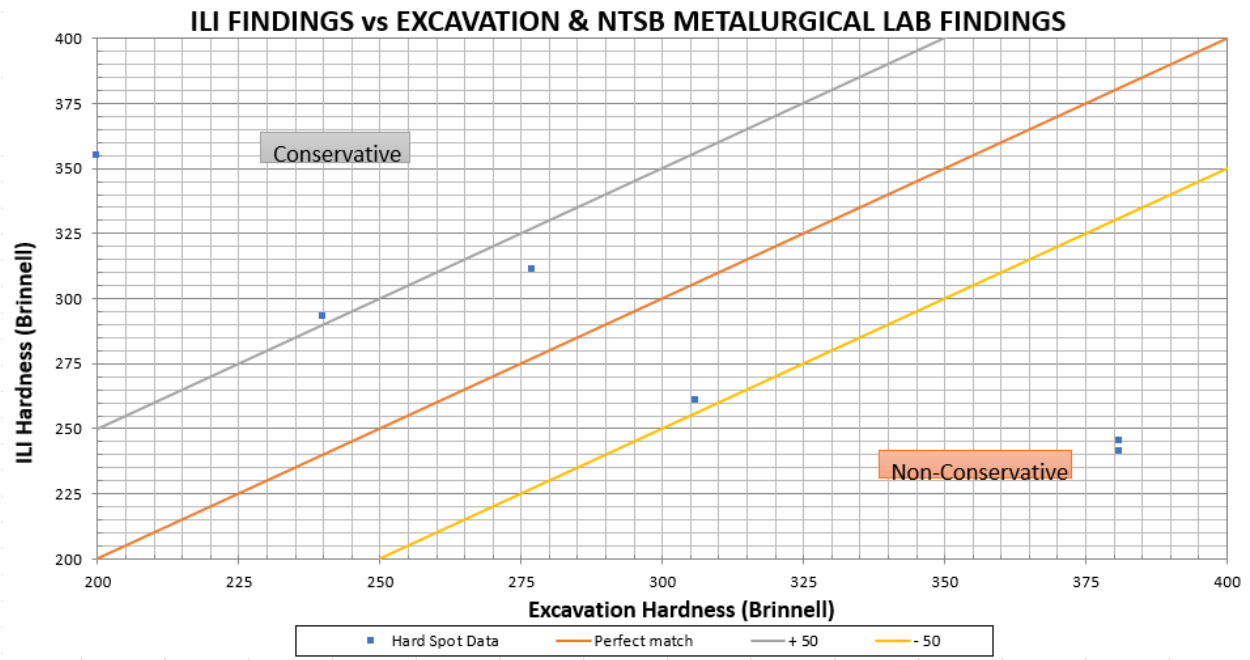
³ Linalog HR Plus & Hart Spot with INS/GPS Inspection Report, Job #70130.01, Release 26 Jul 2011, Section 3.3.

The following table includes the data from the Metallurgical Testing at NTSB Labs:

Line Segment	Wheel Count	ILI Data (Brinell)	Excavation Data Hardness (Brinell)
TOMP-DANV LN 15	210039.700	293	240
TOMP-DANV LN 15	244877.893	355	200
TOMP-DANV LN 15	259993.442	311	277
TOMP-DANV LN 15	259994.080	261	306
TOMP-DANV LN 15	376895.508	245	381
TOMP-DANV LN 15	376895.842	241	381
TOMP-DANV LN 15	376895.967	236	0

* Data from NTSB metallurgical lab testing of incident samples.

The updated unity plot after the incident is provided below:



The two non-conservative data points represent the Lincoln County incident origin hard spot. The ILI reported possible hard spot at WC 376895.967 was investigated with polishing and etching at the reported location, however no hard spot was found. It is represented in the table as 0 for metallurgical lab hardness; however the value 0 is not within the scale boundaries of the unity plot.

- Enbridge has requested additional testing of 6 hard spots (between WC 376895.508 and 376903.633) on the incident site samples at NTSB metallurgical lab in order to further assess the remaining possible hard spots identified by the ILI vendor during the re-analysis of the 2011 ILI data. The possible hard spot at WC 376911.425 is at NTSB facilities, however the sample was on a spool in the crater and was subjected to the effects of prolonged heat exposure. Testing of these data points would provide additional hardness values for the unity plot.