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Edwardsville Failure Analysis

Final Report

Prepared for

Marathon Pipe Line LLC

100440-RP01-Rev1-071723

WHEN TECHNOLOGY WORKS, TREMENDOUS THINGS ARE POSSIBLE.

July 2023

Edwardsville Failure Analysis

Final Report

Prepared for

Marathon Pipe Line LLC

Findlay, OH

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Reviewed by:

Rhett Dotson, PE

[redacted]

Reviewed by:

Chris Alexander, PhD, PE

[redacted]

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EXECUTIVE SUMMARY

On March 11, 2022, an incident occurred involving a 22-inch diameter crude oil pipeline operated by Marathon Pipeline, LLC (MPL) near Edwardsville, IL adjacent to Cahokia Creek. At the time of the accident, the pipeline was transporting Wyoming Asphaltic Sour Crude. The failed pipeline was the northernmost of three parallel pipelines that shared the right-of-way, and the closest to the creek. Soil stabilization had been previously completed in 2014 in the area where the failure occurred. The affected pipeline was constructed from API 5L Grade X46 pipe with a 0.344-inch wall thickness and installed in 1949.

Numerical analysis was performed using calibrated models based on information collected from previous IMU inspections in 2018 and 2021 in addition to information collected after the incident. The numerical models considered representative soils and operating conditions at the time of failure. The following conclusions were made based on the results of the numerical analysis.

1. The area near the failure had a maximum combined bending strain of 0.33% based on the 2018 bending strain results with a 5.7-ft horizontal deviation from straight. The same area exhibited change between 2018 and 2021 with the combined bending strain increasing to 0.41% and the horizontal deviation increasing to 8-ft. The data collected at the time of failure showed a marginal increase in horizontal deviation to 8.2 feet.

2. Calibrated numerical models were developed representing both undrained (clay) and drained (sand) soil conditions; however, the models were easier to calibrate for the undrained conditions indicating that the soil behavior is more likely representative of undrained conditions at the time of failure, which is consistent with the soil conditions observed near the incident.

3. Both the drained and undrained models showed that the pipeline developed a fully yielded cross section (i.e., a plastic hinge) near the failed girth weld between the 2021 IMU inspection and the time of failure. The strains rapidly increased at this location as the membrane and bending strains accumulated at the location of the plastic hinge.

4. The numerical models showed that the location and magnitude of the strains at the plastic hinge depend on soil properties and the extents of the movement profile. However, interaction of the plastic hinge with the failed girth weld is considered likely.

5. The maximum total strain within the plastic hinge ranged from 0.61% to 0.83% in the numerical models. The bending strains and membrane strains contributed almost equally to the total strain at this location.

6. As a result of the plastic hinge forming, the strains near the critical location were changing more rapidly between 2021 and the time of the failure than the strains near the peak pipeline displacement or the location of maximum bending strain.

7. The dimensions of the feature in the girth weld exceeded the size limitations of the PRCI SIA-1-7 strain capacity calculator. However, a feature was assessed with a size approximating the identified girth weld feature with respect to the peak depth. The assessed feature had a length of 3.27 inches with a depth of 80% NWT. This assessed feature is shorter than the actual feature, but with a depth near the measured peak depth. The tensile strain capacity (TSC) based on this feature was 0.29%. The calculated tensile strains from the numerical model were greater than this TSC, indicating that the girth weld failed because the increased demand from soil movement exceeded the TSC of the girth weld.

CONTENTS

1.0 BACKGROUND

On March 11, 2022, an incident occurred on a 22-inch diameter crude oil pipeline operated by Marathon Pipeline, LLC (MPL) near Edwardsville, IL adjacent to Cahokia Creek. At the time of the incident, the pipeline was transporting Wyoming Asphaltic Sour Crude. The failed pipeline was the northernmost of three parallel pipelines that shared the right-of-way, and the closest to the creek. Soil stabilization had been previously completed in the area where the failure occurred. The affected pipeline was constructed in 1949 from API-5L Grade X-46 material with a 0.344-inch nominal wall thickness.

The failed pipeline transports refined products from Wood River, IL to Patoka, IL and is referred to as the "WoodPat" system. The incident and subsequent product release occurred because a girth weld failed during operations. Images taken during the remediation of the girth weld failure are shown in Figure 1.1. The image on the left is taken looking upstream across the incident site toward the failed girth weld with Cahokia creek on the right-hand side of the image. The image shows that the WoodPat pipeline experienced both horizontal and vertical displacements. The image on the right-hand side of Figure 1.1 shows an image of the failed girth weld. The pipeline separated both laterally and axially at the failure location. An aerial image of the remediation site is shown in Figure 1.2.

Figure 1.1: Failed Girth Weld During Excavation

Figure 1.2: Aerial Image of Failure Location

2.0 OBJECTIVE

MPL requested that ADV Integrity, Inc. (ADV) help identify the causal factors that resulted in the accident. Specifically, ADV was asked to develop numerical models simulating the condition of the pipeline prior to the incident. The models were expected to account for the as-laid condition of the pipeline and the influence of ground movement near Cahokia Creek. The objective of the numerical analysis is to provide information on the strain demand near the failed girth weld at the time of the incident. Furthermore, the strain demand from the models will be compared to representative strain capacities determined through material testing and the methodology from the Pipeline Research Council International (PRCI) project SIA-1-7 (Wang, 2019).

To achieve these objectives, the scope of work proposed by ADV included the following tasks:

- Task 1: Review historical data, including inspection information, operating conditions, and prior stabilization efforts.
- Task 2: Determine initial as-laid condition based on a review of as-built drawings and historical IMU information.
- Task 3: Construct an FEA model and calibrate the model to measured conditions.
- Task 4: Use the model to investigate variations in soil properties and movement.
- Task 5: Estimate strains near the failed girth weld at the time of failure and compare strain capacities based on metallurgical evaluation and material testing.

3.0 SUPPORTING INFORMATION

This section presents a summary of the information provided to ADV and reviewed as part of Task 1. A summary of the documents is included in Table 3-1.

Table 3-1: Documents Reviewed

Document	Description
22in_Woopat Pipeline_Wood River to Patoka_2021_IMU Data	2021 High Resolution IMU Data
22in_Woopat Pipeline_Wood River to Patoka_2021_Weld Log	2021 Girth Weld Listing
Rosen 2021 Pipeline Movement and Bending Strain Assessment Report 3-30	Strain Comparison Report
22in_Woopat Pipeline_Wood River to Patoka_2018_IMU Data	2018 High Resolution IMU Data
22in_Woopat Pipeline_Wood River to Patoka_2018_Weld Log	2018 Girth Weld Listing
2012 Roxana - Patoka Woodpat (120265_22A) IMU Raw Data	2012 High Resolution IMU Data
2012 GE Pii CAL CMFL	2012 Feature Listing
IR#14 - Alignment Sheet with stationing of Release location	Alignment Sheet
TXG0258_Marathon_Edwardsville Geotech Site Assessment	Geohazard Assessment
TXG0258-MPL Edwardsville-Borehole Logs-Final	Borehole Results
MPL - Cahokia Canal DOC Exhibit	Post-Incident Survey Locations
3-0220457 - Original 03-12-22 Adjusted with LatLong	Post-Incident Geospatial Locations
Post-Accident Excavation Notes -PRELIMINARY	Field Notes

3.1 IMU Data Review

The bending strains based on the inspection from October 28, 2021 are reproduced in Figure 3.1. The maximum combined bending strain at this location is 0.41%. The girth weld that failed is #7630, located at odometer 32709.3 ft, and is annotated in the image with the red arrow. The IMU data indicates approximately 8-ft of horizontal deviation from a straight line across the impacted area and 9.3 feet of vertical deviation from a straight line across the impacted area.

ADV aligned and compared all the available IMU data sets as shown in Figure 3.2. ADV observed that the out-of-straightness (OOS) profiles from the 2012 IMU data do not appear plausible. When the IMU data was examined outside of the area of interest in stable locations, the horizontal and vertical geospatial information from 2012 often showed deviations that were inconsistent with the information from the inspections in 2018 and 2021. However, the bending strain profiles calculated from the pitch and azimuth did appear consistent with the other two data sets. These types of issues with geospatial accuracy are more common in older IMU data sets. While they do not restrict the ability to compare calculated strains between the data sets, the OOS profiles often cannot be compared.

When comparing the strains in Figure 3.2, a clear progression in the horizontal, vertical, and combined strains is evident from 2012 to 2018 and from 2018 to 2021. This data confirms that the pipeline was experiencing external loads and being subjected to both horizontal and vertical movement in the time between 2012 and 2021.

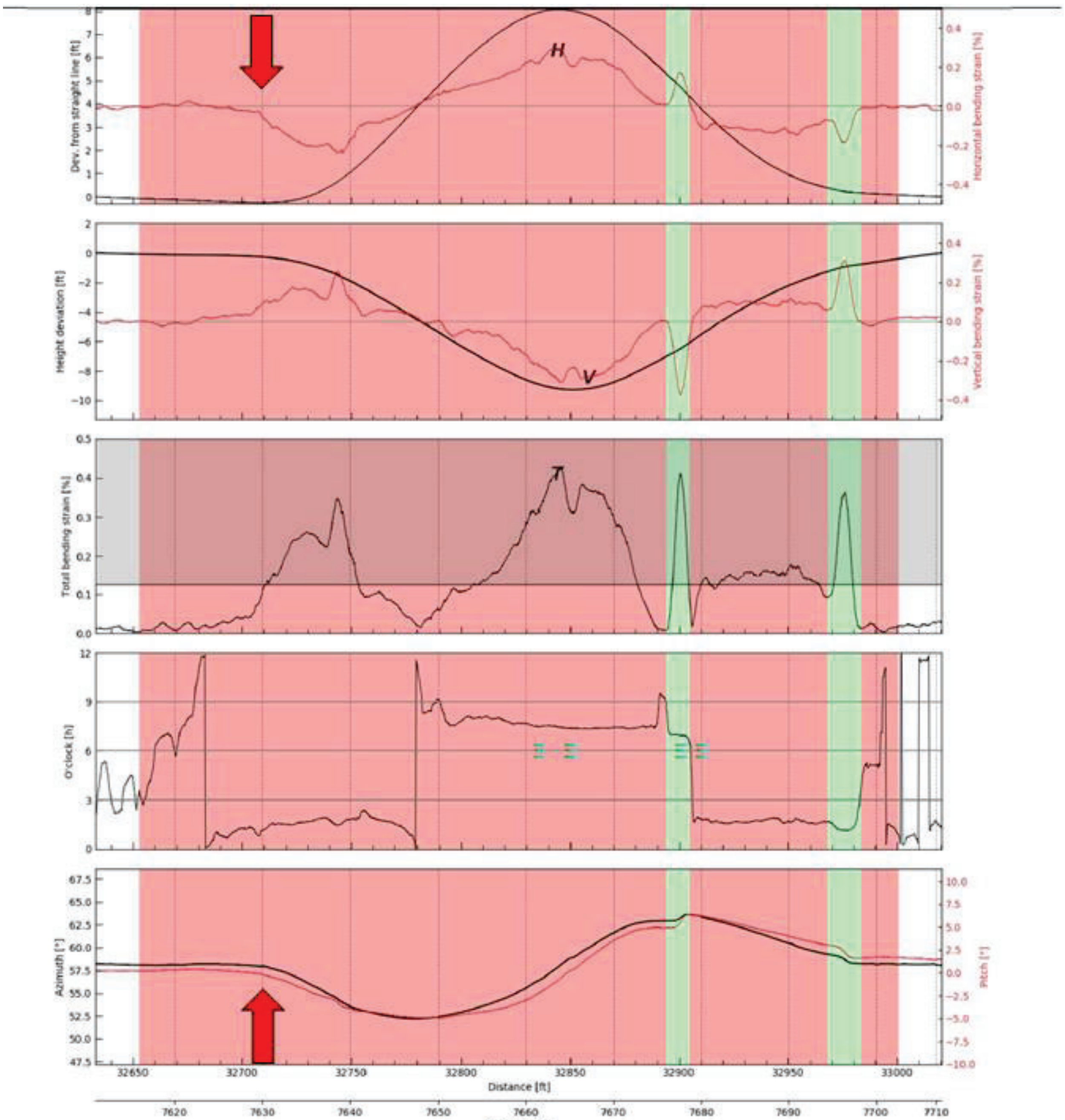


Figure 3.1: Bending Strain Site #7610 (ref: Strain Comparison Report)

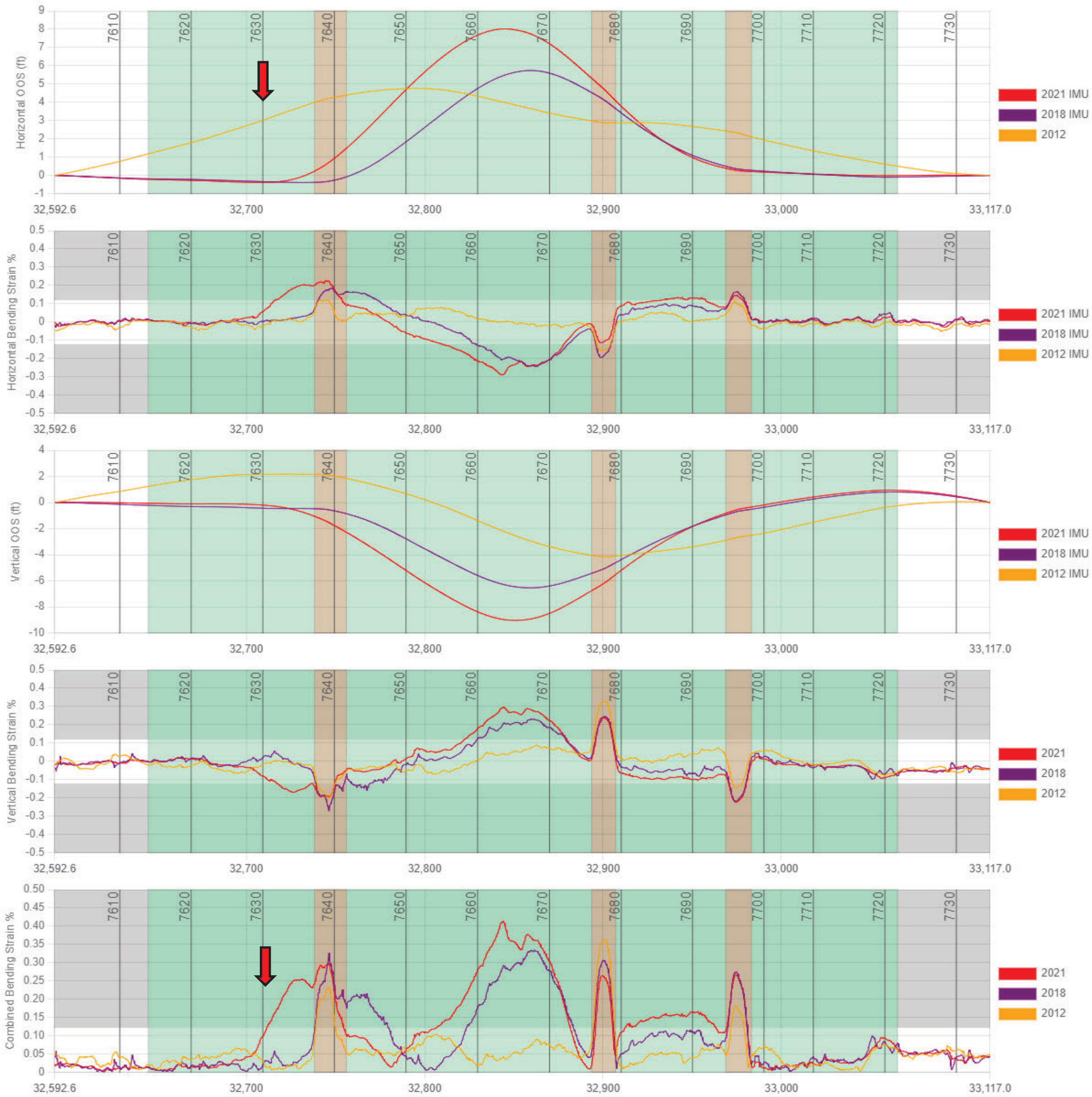


Figure 3.2: IMU Comparison for 2012, 2018, and 2021

3.2 Alignment Sheet Information

Information showing the original pipeline construction location from 1949 was not available. Marathon provided alignment sheets with information on the surface elevation, top of pipe elevation, and depth of cover. The information from the alignment sheet near the failure is enlarged in Figure 3.3. This information does not reflect as-built conditions but was collected prior to the incident (the alignment sheet was dated February 18, 2022). The information shows that the ground elevation near the failure was characteristic of a depression with the low-point approximately 4-6 feet lower than the surrounding area. This information was confirmed by satellite imagery showing a drainage channel crossed over the pipeline near the failure location. The alignment sheet also confirmed the depth of cover near the failure varies from 22 to 57 inches.

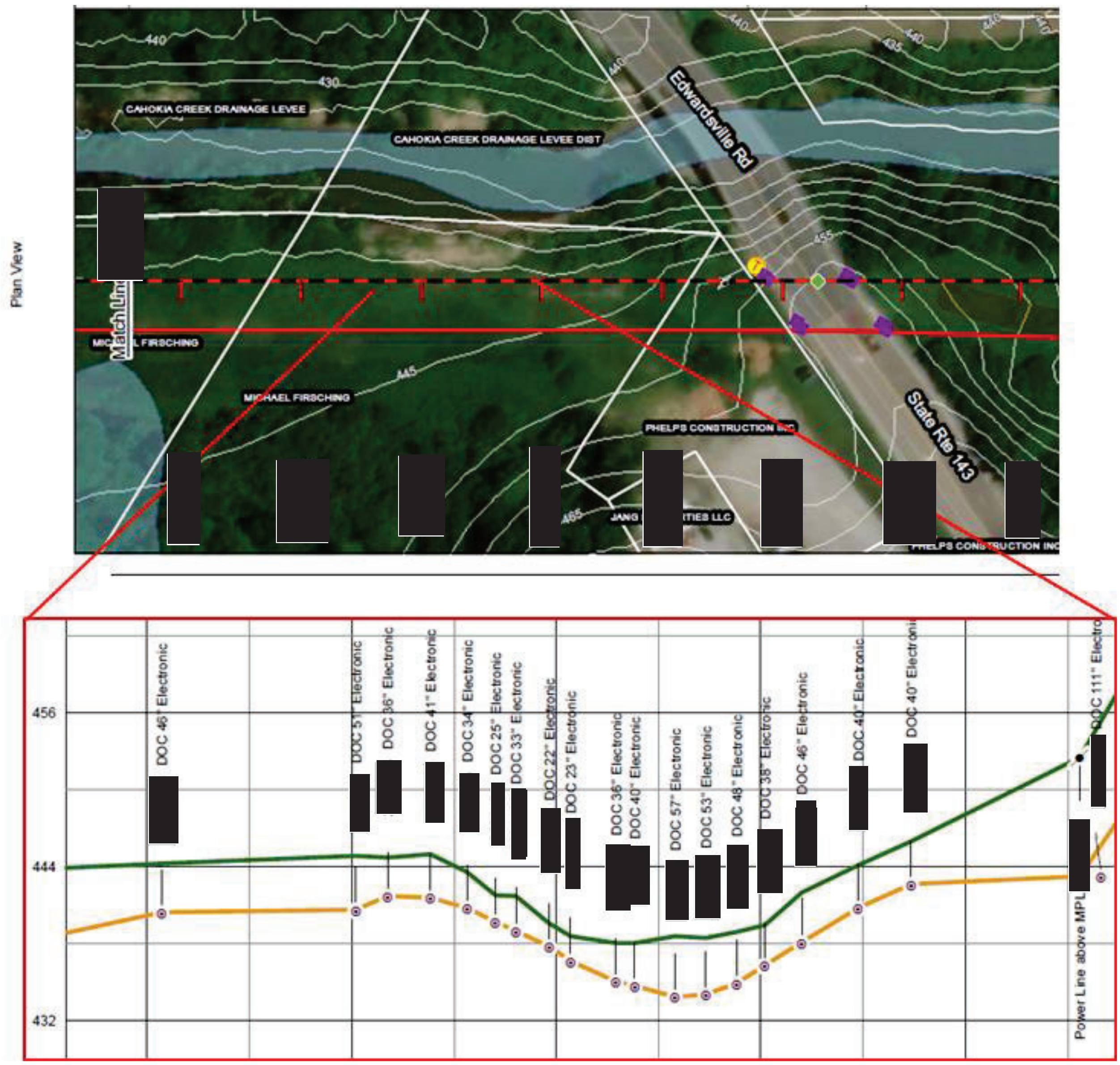
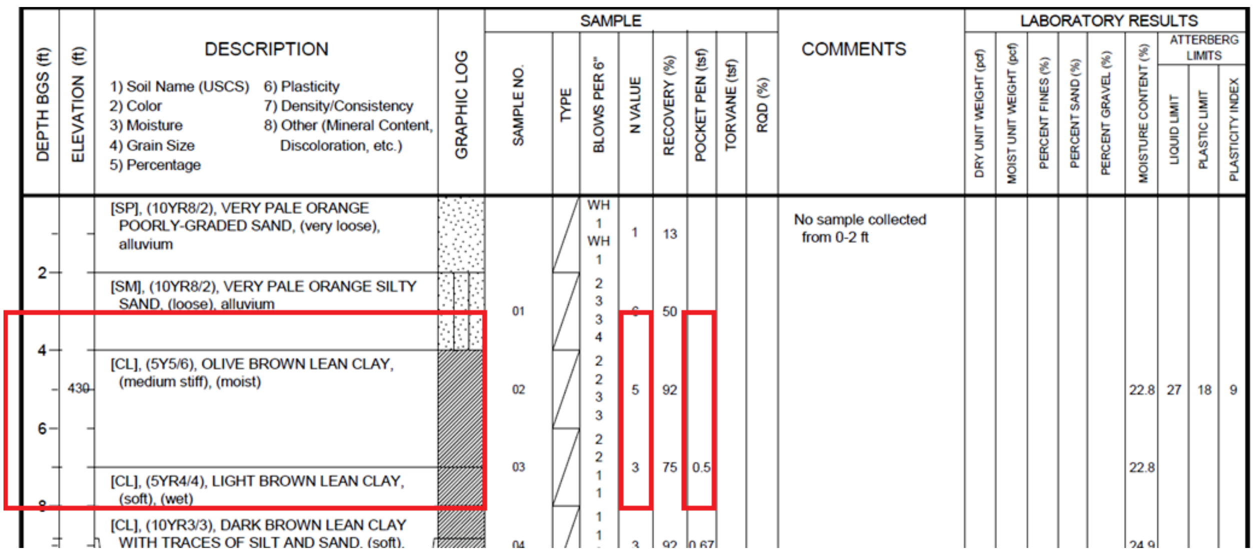


Figure 3.3: Alignment Sheet Information

3.3 Soil Data

Soil characteristics were collected from two boreholes located near the failure as shown in Figure 3.4. Based on the depth of cover survey, the soils of interest would occur between 3 and 8 feet deep. An image of the data from the IN/PZ1 borehole is provided in Figure 3.5. The IN/PZ1 borehole shows soft to medium stiff clays at the pipeline depth. The information from the IN/PZ2 borehole is provided in Figure 3.6, showing soft clay at the pipeline depth. The pocket penetration values for unconfined compressive strength varied from 0.5 to 1 ton per square foot between the two boreholes. The lab results indicated a dry unit weight of 100.3 pcf and a moist unit weight of 125.8 pcf.

Figure 3.4: Borehole Locations



DEPTH BGS (ft)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, etc.)	GRAPHIC LOG	SAMPLE: SAMPLE NO.	TYPE	BLOWS PER 6"	N VALUE	RECOVERY (%)	POCKET PEN (tsf)	TORVANE (tsf)	RQD (%)	COMMENTS	LABORATORY RESULTS: DRY UNIT WEIGHT (pcf)	MOIST UNIT WEIGHT (pcf)	PERCENT FINES (%)	PERCENT SAND (%)	PERCENT GRAVEL (%)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
		[SP], (10YR8/2), VERY PALE ORANGE POORLY-GRADED SAND, (very loose), alluvium				WH 1 WH 1	1	13				No sample collected from 0-2 ft									
2		[SM], (10YR8/2), VERY PALE ORANGE SILTY SAND, (loose), alluvium		01		2 3 3 4	6	50													
4	430	[CL], (5Y5/6), OLIVE BROWN LEAN CLAY, (medium stiff), (moist)		02		2 2 3 3	5	92										22.8	27	18	9
6				03		2 2 1 1	3	75	0.5									22.8			
8		[CL], (5YR4/4), LIGHT BROWN LEAN CLAY, (soft), (wet)																			
		[CL], (10YR3/3), DARK BROWN LEAN CLAY WITH TRACES OF SILT AND SAND, (soft),		04		1 1	3	92	0.67									24.9			

Figure 3.5: IN/PZ1 Borehole Information

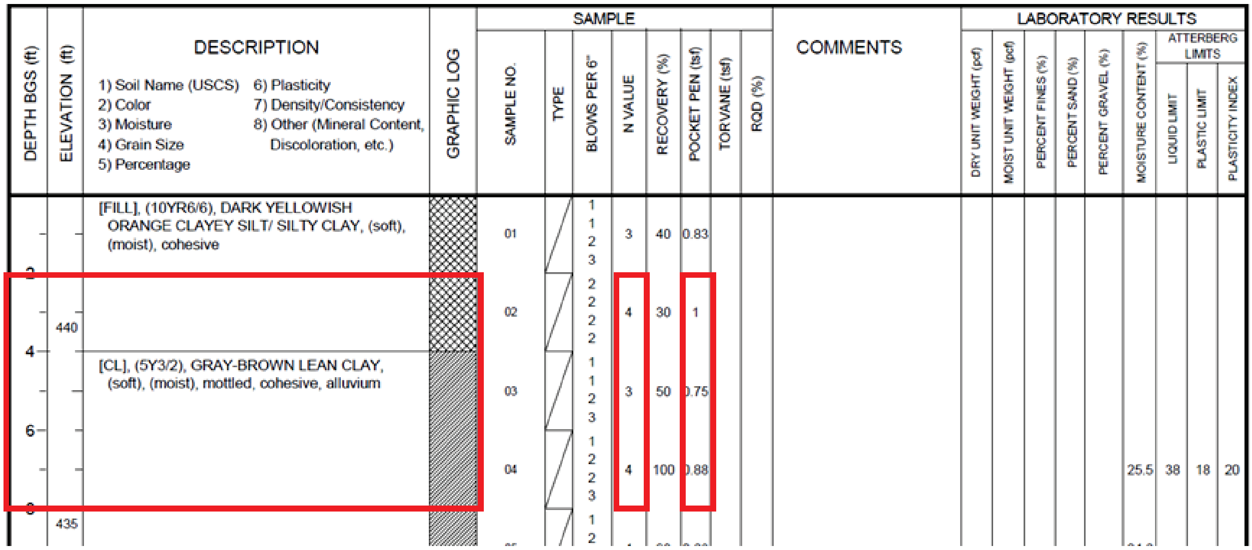


Figure 3.6: IN/PZ2 Borehole Information

3.4 In-Situ Information

ADV received information describing the geospatial location (latitude, longitude, and elevation) of the pipeline post-failure at select locations. Additionally, field notes taken during the remediation captured information pertaining to the pipe “separation” at the failed girth weld. The information is reproduced in Table 3-2.

Table 3-2: Pipe Separation Measurements

Orientation	Separation Distance
12 o’clock (TDC)	7 ½ inches
3 o’clock (south)	8 inches
6 o’clock (bottom)	7 inches
9 o’clock (north)	6 ¾ inches
Lateral (12 o’clock)	4 ¼ inches
Lateral (6 o’clock)	7 ¾ inches

The information from the as-found survey was aligned and overlaid with the available IMU data sets. The comparison for the horizontal and vertical out-of-straightness profiles are shown in Figure 3.7. The survey information shows that the Woodpat pipeline exhibited slight additional movement after the 2021 survey with a total horizontal out-of-straightness of 8.2 feet. The vertical out-of-straightness did not show a measurable difference when compared to the 2021 IMU data set with a total vertical deviation of 9-feet.

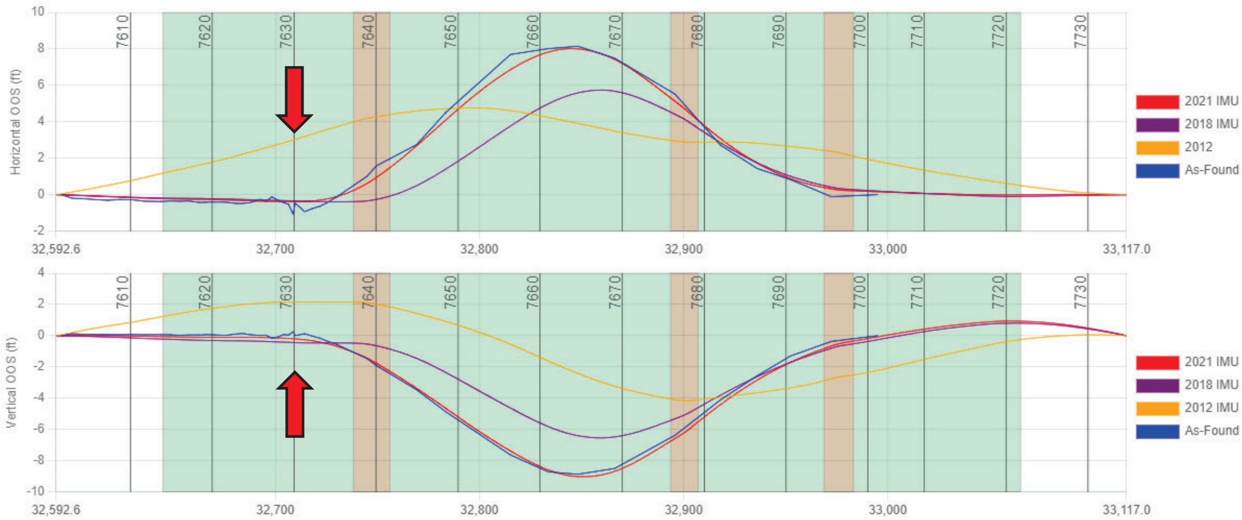


Figure 3.7: As-Found Survey

3.5 Operating Conditions

The WoodPat system is composed of 22-inch Diameter, 0.344 NWT, API 5L Grade X46 pipe material at the location of the incident. At the time of the failure, the Woodpat system was transporting crude oil with an API Gravity of 21.6°. The pressure at the Roxana discharge station was recorded as 476 psi at 8:15 AM.

4.0 NUMERICAL MODEL

4.1 Structural Properties

The numerical model was evaluated using the Abaqus general-purpose finite element code and utilized beam elements (type PIPE31) to represent the pipeline. The beam elements were modeled as 22-inch outer diameter with a nominal wall thickness of 0.344-inches. The effective weight of the elements was modeled as 1,370 lb/in^3 accounting for the weight of the steel pipe and internal contents. Elastic-plastic material properties were specified for the pipe material based on the specified minimum properties for API 5L Grade X46 pipe material. A Ramberg-Osgood formulation was used to generate the true stress – true strain curve based on a yield strength of 46,400 psi and an ultimate tensile strength of 63,100 psi. The resulting material curve is shown in Figure 4.1.

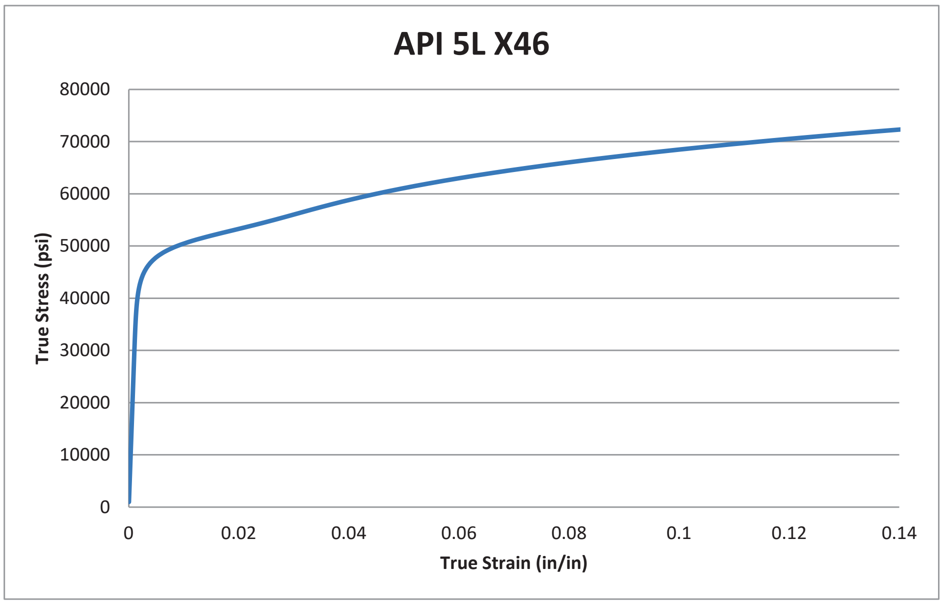


Figure 4.1: API 5L Grade X46 Elastic Plastic Material Properties

4.2 As-Laid Configuration

Identifying the as-laid condition of the pipeline consisted of three tasks. First, the heading angles (pitch and azimuth) recorded by the IMU during inspections were reviewed to identify which components of the pipeline within the bending strain area are consistent with manufactured bends. Second, the heading angles were reviewed to identify a plausible as-laid trajectory, and then the heading angles were reconstructed to fit this as-laid trajectory. Finally, the reconstructed heading angles were used to generate an as-laid centerline for the pipeline.

Figure 4.2 provides a comparison of the horizontal out-of-straightness profiles and azimuth angles from the 2018 and the 2021 inspections. The 2012 data was not included in the comparison as the heading angles and out-of-straightness profile were not considered accurate as discussed in the previous section. Both inspections show similar behavior in the azimuth angle consistent with external loads acting on the pipeline. The azimuth angle is approximately 58-degrees near the beginning and end of the bending strain and movement area in both inspections. Two minor 2-degree horizontal manufactured bends appear in the data near odometer 32,900 feet and 39,990 feet. This information suggests that the pipeline was initially laid nearly straight throughout this area with minor deviations. This pattern is typical of most pipelines. Within the displaced area, the azimuth shows a distinct “S”-shaped pattern. This pattern is produced when a pipeline is displaced from its initial location. It is reasonable to conclude that the pipeline was initially laid straight through the area and account for the two minor manufactured bends in the recreated heading profile as shown with a dashed line in Figure 4.2.

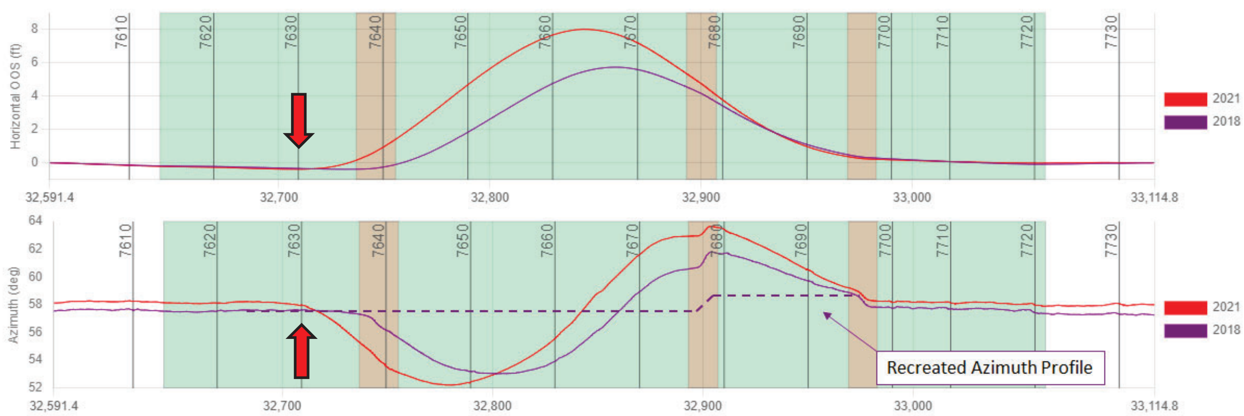


Figure 4.2: Azimuth Recreation

Figure 4.3 provides a comparison of the vertical out-of-straightness profiles and the pitch angles from the 2018 and the 2021 inspections. Both inspections show similar behavior in the pitch angle consistent with external loads acting on the pipeline. Near the beginning of the movement area, both tools enter with a near-flat pitch of approximately 0.5-degrees and exit the movement area with a pitch of approximately 2-degrees. Within the movement area, three small vertical bends can be seen near odometer 32750 feet, 32,900 feet, and 33,990 feet. These vertical bends form an overbend-sagbend-overbend combination that is typical of pipeline construction at shallow crossings. The presence of these vertical manufactured bends confirms the information from the depth of cover assessment that showed a shallow drainage area at this location. It is reasonable to conclude that the pipeline was constructed with shallow bends to cross the drainage. Similar to the azimuth heading angles, the pitch angles in both inspections show the characteristic “S” shape within the movement area as a result of external loads. The recreated pitch profile is shown in Figure 4.3 with the dashed line. The recreated profile preserves the manufactured bends near 32,900 feet and 33,990 feet.

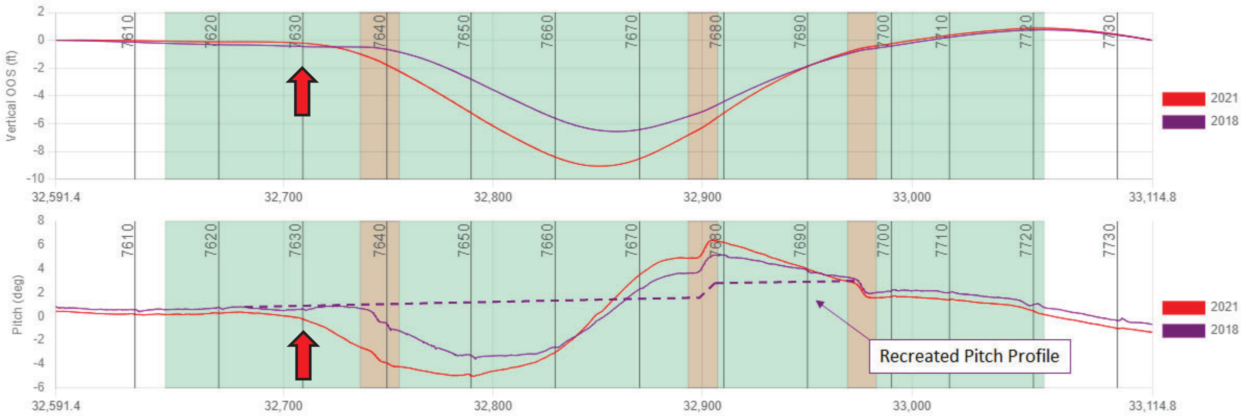


Figure 4.3: Pitch Recreation

The resulting as-laid condition used for the baseline is shown in Figure 4.4 for both the horizontal and vertical profiles. The recreated as-built profile is shown as a green line. The horizontal out-of-straightness shows a near straight trajectory with less than 1-ft of deviation, and the vertical out-of-straightness shows an initial vertical change of approximately 3-ft. This agrees well with the depth of cover information which showed similar deviations in the ground elevation near the drain crossing.

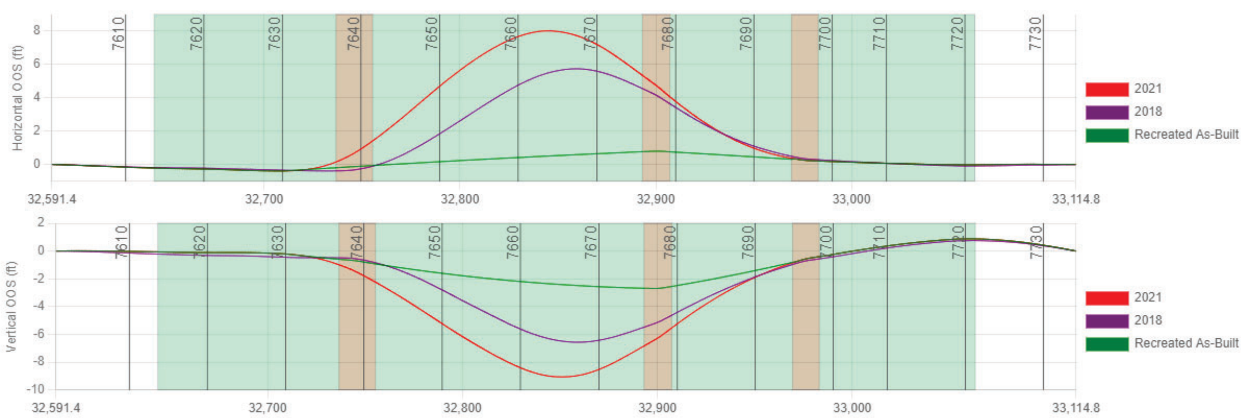


Figure 4.4: Recreated Out-of-Straightness Profiles

4.3 Soil Properties

The Abaqus model used pipe-soil interaction elements (type PSI34) to capture the behavior of the soil at the WoodPat system based on the data captured in the borings. PSI34 elements represent the interaction between the pipeline and the soil as a series of non-linear springs in the horizontal, vertical, and axial direction. The formulations for the soil springs are based on documentation from the American Lifelines Alliance document (American Lifelines Alliance, 2005). The soil was indicated to be primarily made of clay at the pipeline depth with stiffness ranging from soft to firm. Therefore, analysis models were developed using clay (i.e., undrained soil response) formulations that are based on the shear strength of the soil. The upper and lower bound properties used in the assessment are shown in Table 4-1.

Table 4-1: Clay (Undrained) Properties

Property	Lower Bound (weak) Undrained Values	Upper Bound (firm) Undrained Values
Shear Strength	3.62 psi (25 kPa)	7.25 psi (50 kPa)
Alpha	0.94	0.69
Nch (horizontal factor)	6.25	6.25
Ncv (uplift factor)	5.4	5.4
Nc (bearing factor)	5.14	5.14

While the borings did not show sandy material near the depth of the pipeline, the geotechnical review did observe coarse-grained materials (i.e., sand) near the water line. Therefore, the analysis also considered soil properties using sand (i.e., drained soil response) formulations that are based on unit weight and friction angle. Like the clay properties, upper and lower bound values were generated as shown in Table 4-2. The soil friction angle was taken from publicly available sources as this value is not typically characterized for clay soils (Oswell, 2016).

Table 4-2: Sand (Drained) Properties

Property	Lower Bound (weak) Drained Values	Upper Bound (firm) Drained Values
Effective Unit Weight	63.4 pcf	63.4 pcf
Θ, Friction Angle	10°	30°
Nqh (lateral factor)	3.0	7.6
Nqv (uplift factor)	1.0	2.0
Nq (bearing factor)	2.4	18.4
Nγ (bearing factor)	0.5	18.1

4.4 Assessment Methodology

The analysis utilized an iterative approach to determine the strain demand placed on the weld prior to failure. This approach is shown graphically in Figure 4.5. The as-laid configuration as described in the previous section was taken as the starting point for the analysis. The as-laid configuration was assumed to be constructed in a stress-free condition. Displacements were applied to the soil nodes which in turn produce pipeline displacements. The soil displacements are incrementally applied to match the conditions from the 2018 and 2021 inspections as well as the as-found measurements. The strains and resulting pipeline displacements from each increment are compared to the displacements captured from the IMU tool or the as-found survey measurements. If a good match is obtained, the strains at the girth weld of interest are extracted from the model. If a match is not obtained, the displacement profile is iteratively adjusted until a match is obtained. For the purposes of this report, only the final calibrated models and associated results are presented.

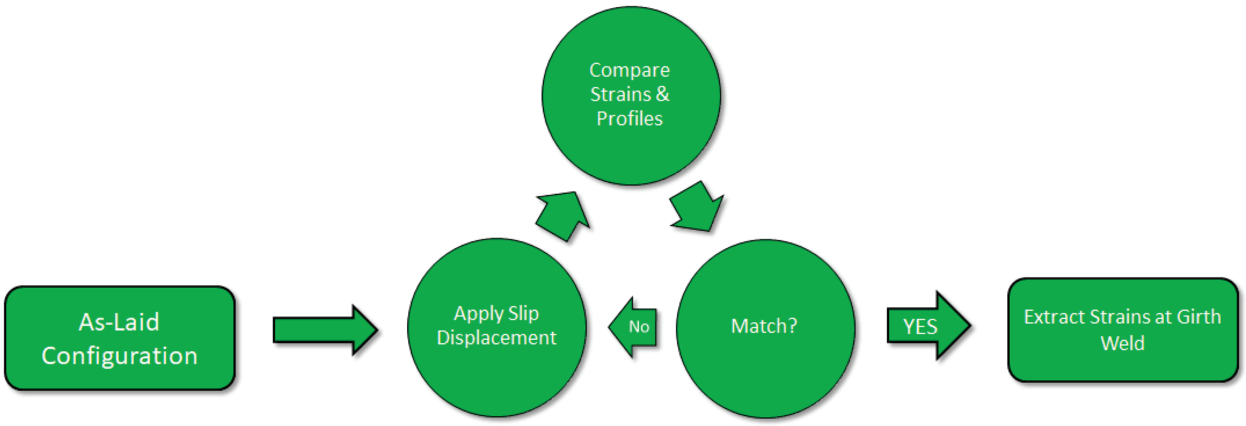


Figure 4.5: Analysis Methodology

4.5 Load Cases

The assessment of the Edwardsville failure addressed four load cases, which are described in Table 4-3. Four load cases were assessed considering variations in the soil type and properties. All load cases included gravity and an internal pressure specified as 476 psi.

Table 4-3: Load Case Description

Load Case	Description
Load Case 1	Upper Bound Undrained (Clay) properties
Load Case 2	Lower Bound Undrained (Clay) properties
Load Case 3	Lower Bound Drained (Sand) properties
Load Case 4	Upper Bound Drained (Sand) Properties

4.6 Post Failure Simulation

The response after the failure was modeled for each load case by “deleting” the elements near the girth weld and allowing the pipeline to respond. The separations observed in the model were then compared to the results recorded during the response shown in Table 3-2.

5.0 RESULTS

The results from the numerical analysis are presented in detail for Load Case 1 and then summarized more briefly for each of the remaining load cases. The process for evaluating the Load Cases is shown graphically in Figure 5.1. The numerical analysis proceeded in steps, and the results are compared for each of the following steps: 2018 alignment, 2021 alignment, and as-found Alignment. Iterative adjustments were made as needed to achieve the results shown for each load case.

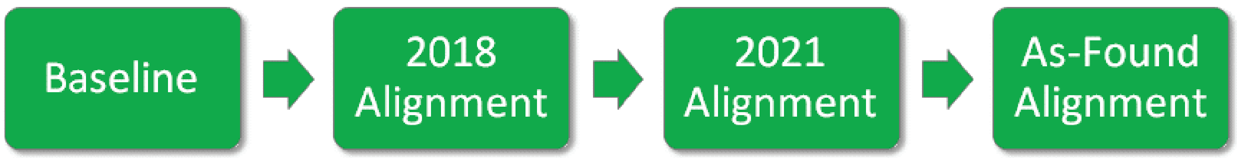


Figure 5.1: Results Comparisons

It is also important to clarify the nomenclature regarding strains. The bending strains determined from the heading angles recorded by the IMU tool and presented in the previous sections are calculated based on curvature in the horizontal and vertical planes. These bending strains do not include membrane strains, which reflect how much the pipe may have “stretched” or “compressed” because of uniform axial loading.

In contrast, the numerical models can provide bending, membrane, and total strains by post-processing the available axial strains at locations around the pipe circumference. The total strain includes both the bending and membrane components. When the results from the numerical models are compared to the IMU bending strain data, the axial strains are processed to render the bending strain components in the horizontal and vertical directions providing an equivalent comparison. When the results present the total strains from the numerical models, these values are inclusive of the membrane and bending strains. The total strains are not compared to the bending strains calculated from IMU.

5.1 Load Case 1 – Upper Bound Undrained Properties

The results for Load Case 1 are shown in Figure 5.2. Except for the total strain panel, each panel compares the results from the IMU tool (or as-found field measurements) to the numerical models with matching colors. Results from the numerical model are shown with dashed lines while the results from the IMU or field measurements are shown with solid lines. It should be noted that strains are not available for the as-found field measurements, but they are presented for the calibrated numerical model representing the same condition. The results of each comparison based on the information in the panels are summarized below:

- Horizontal OOS: The horizontal OOS shows excellent agreement for the 2018, 2021, and as-found data sets. The peak displacements match to within 0.1-ft for each of these conditions.

- Horizontal Bending Strain: The horizontal bending strains show excellent agreement with the available IMU data sets from 2018 and 2021. The horizontal strains for the as-found condition from the numerical model show a sharp increase from the 2021 values near the upstream flank of the landslide with peak horizontal bending strains of 0.38%.

- Vertical OOS: The vertical OOS shows agreement for the 2018, 2021, and as-found data sets.

- Vertical Bending Strain: The vertical bending strains show excellent agreement with the available IMU data sets from 2018 and 2021. There are no significant changes in the vertical strains from 2021 to the as-found condition in the numerical model.

- Combined Bending Strain: The combined bending strains show excellent agreement with the available IMU data sets from 2018 and 2021. The combined strains for the as-found condition from the numerical model show a sharp increase from the 2021 values near the upstream flank of the landslide with peak bending strains of 0.42%. This increase is primarily due to the increase in the horizontal bending strain.

- Total Strain: The total strains show progressive increases from 2018 to 2021 and the as-found condition in the numerical models. The maximum total strain in 2018 was 0.61% located near the peak displacement in the landslide. The maximum total strain in 2021 was 0.76% also located near the peak displacement in the landslide. In addition, the 2021 value shows rapidly changing total strains in the bend near odometer 32,900 feet. This rapid change is due to the “straightening” of the 2-degree field bend at this location. The numerical model also shows significant change near the upstream flank of the landslide adjacent to the failed girth weld 7630 at odometer 32,709 feet. At this location, the total strains show a sharp increase with total strains of 0.83%. This rapid change in total strain near the failure is attributed to the pipe cross section becoming fully yielded (i.e., forming a plastic hinge) near the upstream flank of the landslide thereby creating a location where strains can accumulate.

In summary, the comparison for Load Case 1 shows that the horizontal bending and total strains changed rapidly near the upstream flank of the landslide adjacent to the location of the failed girth weld. While the actual total strains are 0.18% at the location of the failed girth weld, the peak total strain occurs less than 10-feet away from the girth weld. Given the uncertainties with the precise position of the WoodPat pipeline prior to failure with respect to the landslide extents, it is possible that the strains were as high as 0.83% in the weld if the upstream flank of the landslide is shifted slightly upstream from where it is located based on the 2021 IMU data.

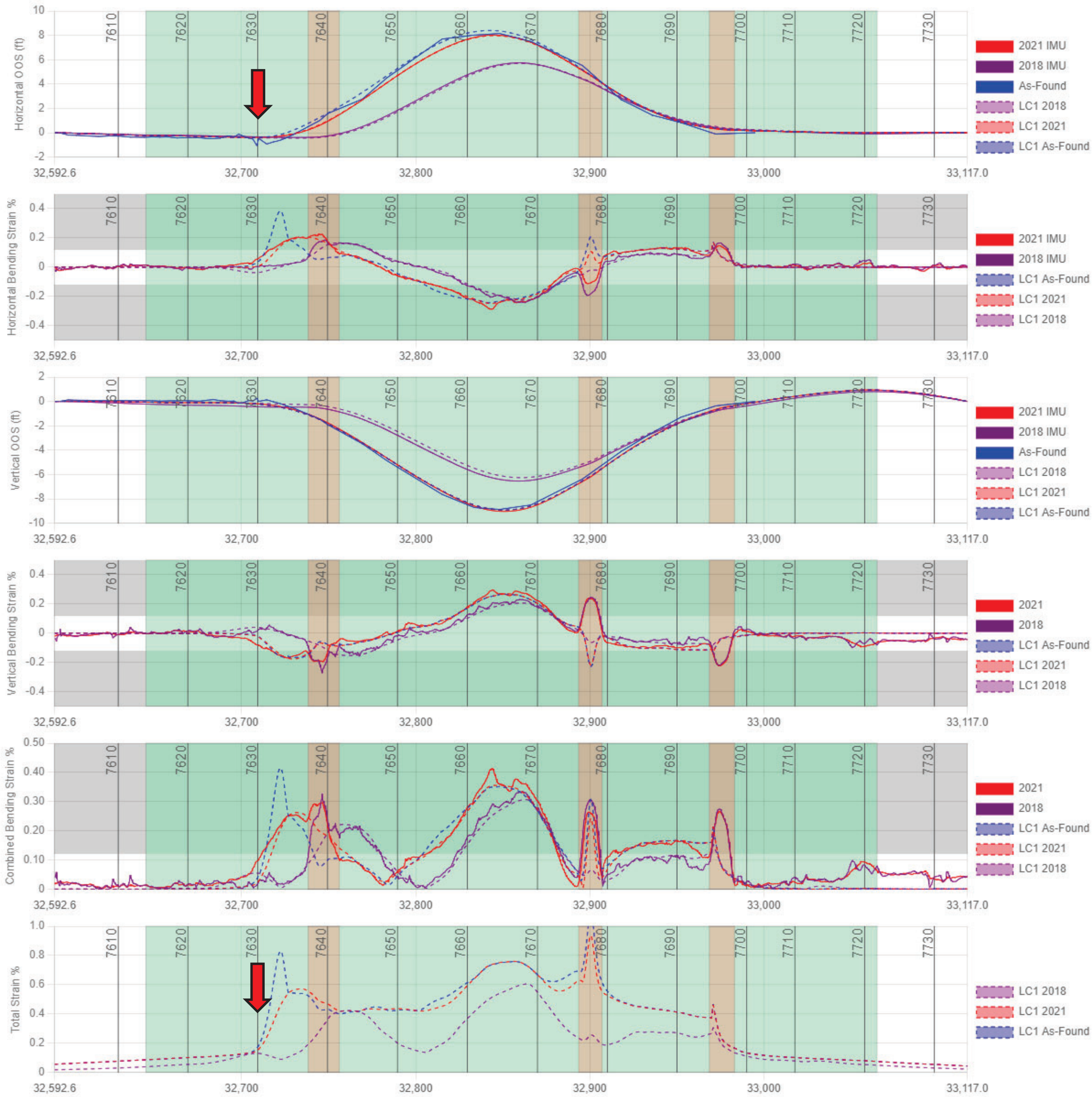


Figure 5.2: Load Case 1, Upper Bound Undrained, Results Comparison

5.2 Load Case 2 – Lower Bound Undrained Properties

The results for Load Case 2 with lower bound undrained properties are shown in Figure 5.3. Except for the total strain panel, each panel compares the results from the IMU tool (or as-found field measurements) to the numerical models with matching colors. Results from the numerical model are shown with dashed lines, while the results from the IMU or field measurements are shown with solid lines. It should be noted that strains are not available for the as-found field measurements, but they are presented for the calibrated numerical model.

With respect to the out-of-straightness plots, the results from Load Case 2 are nearly identical to the results from Load Case 1. Both the horizontal and vertical out-of-straightness plots show excellent agreement with the 2018, 2021, and as-found data sets. However, the results do show differences in the horizontal, combined, and total strains. The sharp peak observed in Load Case 1 is more muted for Load Case 2 with lower overall strains near the upstream flank of the landslide. The horizontal bending strain near the upstream flank is 0.26% while the total strain is 0.61%. The strains are lower for Load Case 2 because the axial and bending resistance of the soil is weaker for the lower-bound load properties. The weaker properties delay the formation of the plastic hinge, but do not prevent its formation.

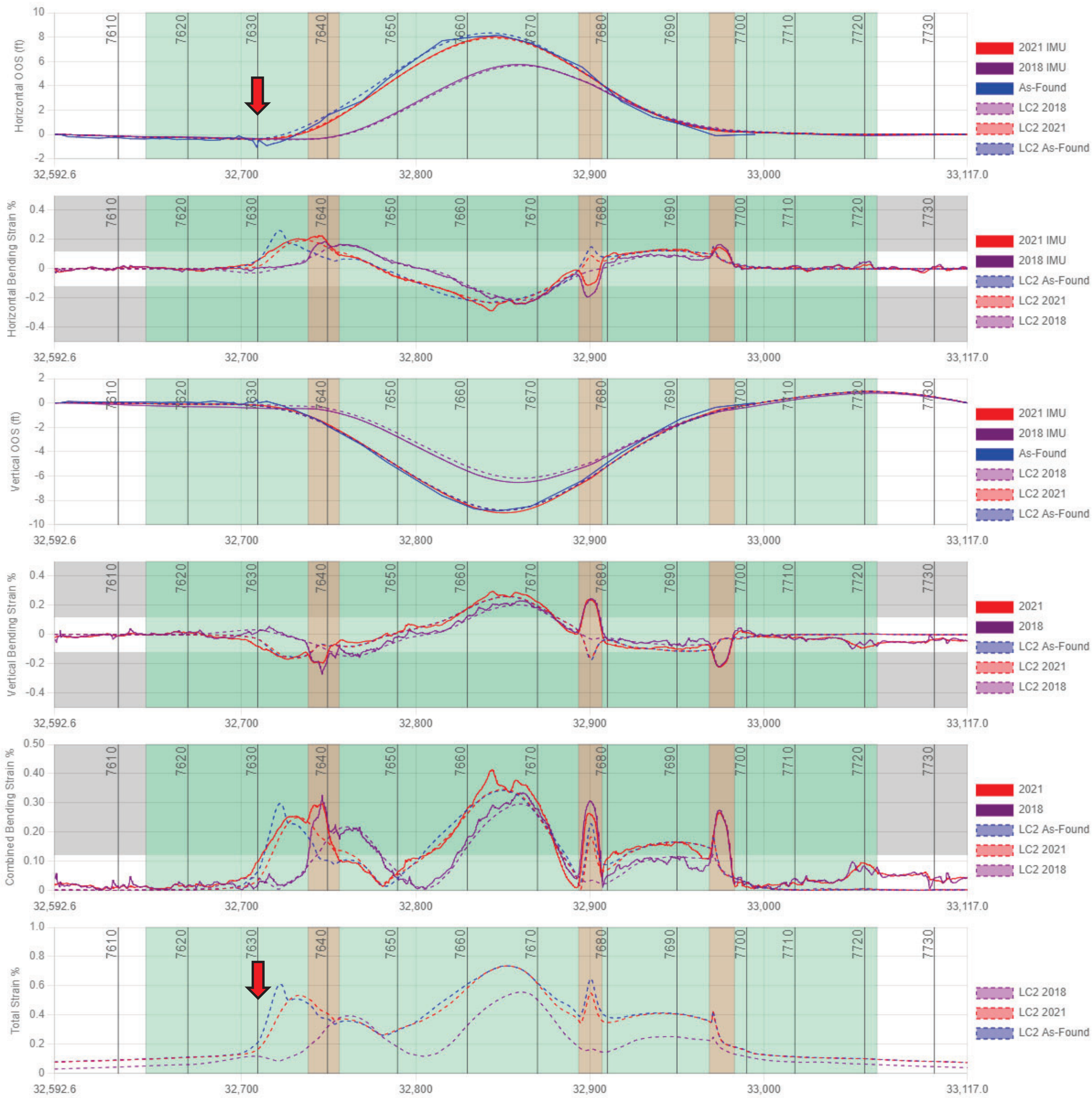


Figure 5.3: Load Case 2, Lower Bound Undrained, Results Comparison

5.3 Load Case 3 – Upper Bound Drained Properties

The comparison of the results for Load Case 3 with upper bound drained properties are shown in Figure 5.4. Except for the total strain panel, each panel compares the results from the IMU tool or as-found field measurements to the numerical models with matching colors. Results from the numerical model are shown with dashed lines while the results from the IMU are shown with solid lines. It should be noted that strains are not available for the as-found field measurements, but they are presented for the calibrated numerical model.

With respect to the out-of-straightness plots, the results for the horizontal displacements from Load Case 3 are nearly identical to the previous results. However, the vertical displacements do not match quite as well. Additionally, the calibration of the vertical displacements required the use of the saturated unit weight (125.4 pcf) rather than the equivalent unit weight (63 pcf). Since the vertical strength of drained materials is a function on the unit weight and the burial depth, this has the effect of increasing the vertical soil resistance. In this assessment, an increase in the unit weight was required to achieve agreement in the displacements.

Regarding the strains, the results from Load Case 3 show similar results to Load Case 1. A localized peak in the strains is evident near the upstream flank of the landslide. The horizontal bending strain near the upstream flank is 0.29% while the total strain is 0.64%. These strains are slightly lower than the results for the upper bound undrained properties in Load Case 1.

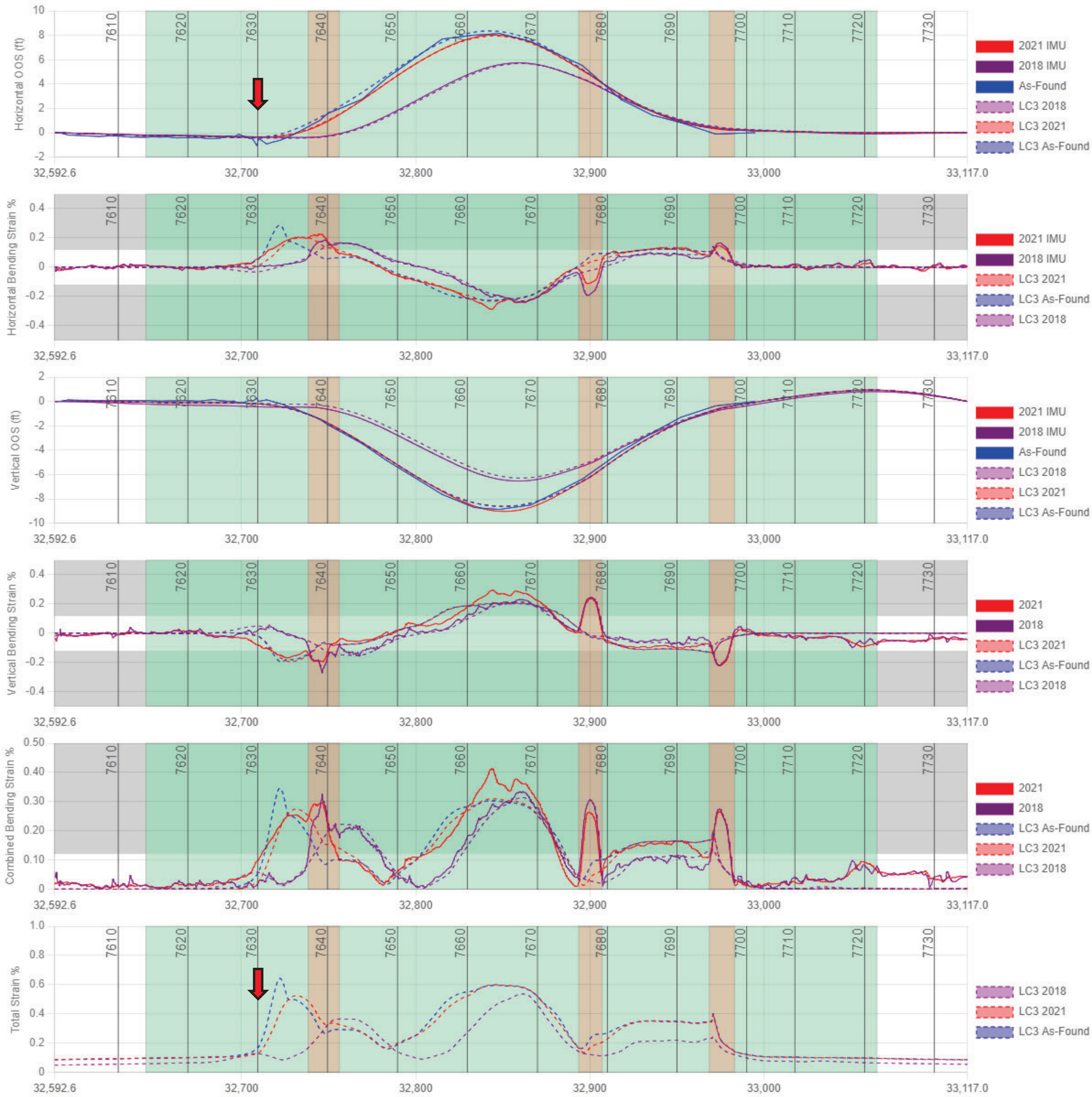


Figure 5.4: Load Case 3, Upper Bound Drained, Results Comparison

5.4 Load Case 4 – Lower Bound Drained Properties

The results for Load Case 4 with lower bound drained properties are shown in Figure 5.5. Except for the total strain panel, each panel compares the results from the IMU tool or as-found field measurements to the numerical models with matching colors. Results from the numerical model are shown with dashed lines while the results from the IMU are shown with solid lines. It should be noted that strains are not available for the as-found field measurements, but they are presented for the calibrated numerical model.

Calibrating the numerical models to the measured strains and displacements based on the recorded IMU data was challenging for Load Case 4. Even with the alteration to the unit weight as described in the previous section, the displacements and strains did not match well. Additionally, the model proved to be numerically unstable at displacements beyond the 2021 values. The comparisons showed that the displacements for the 2018 load case had reasonable agreement, but the comparisons did not match as well as any of the other load cases. In addition, the displacements near the peak and upstream flank of the landslide do not show good agreement for the 2021 load case. The weaker horizontal strength of the soil resulted in a noticeably smoother profile with lower strains near the upstream flank of the landslide.

Regarding the strains, the results for Load Case 4 show significantly lower strains than the other load cases. The vertical and horizontal strains for the 2021 condition show poor agreement with the IMU data. While additional modifications to the soil properties may provide improvements to the comparison, it is unlikely that the vertical displacements will be able to be calibrated. These results indicate that the lower bound drained properties are not an accurate representation of the conditions observed at the failure location based on the 2021 IMU data and information collected at the time of failure. Therefore, the results from Load Case 4 were disregarded for future use.

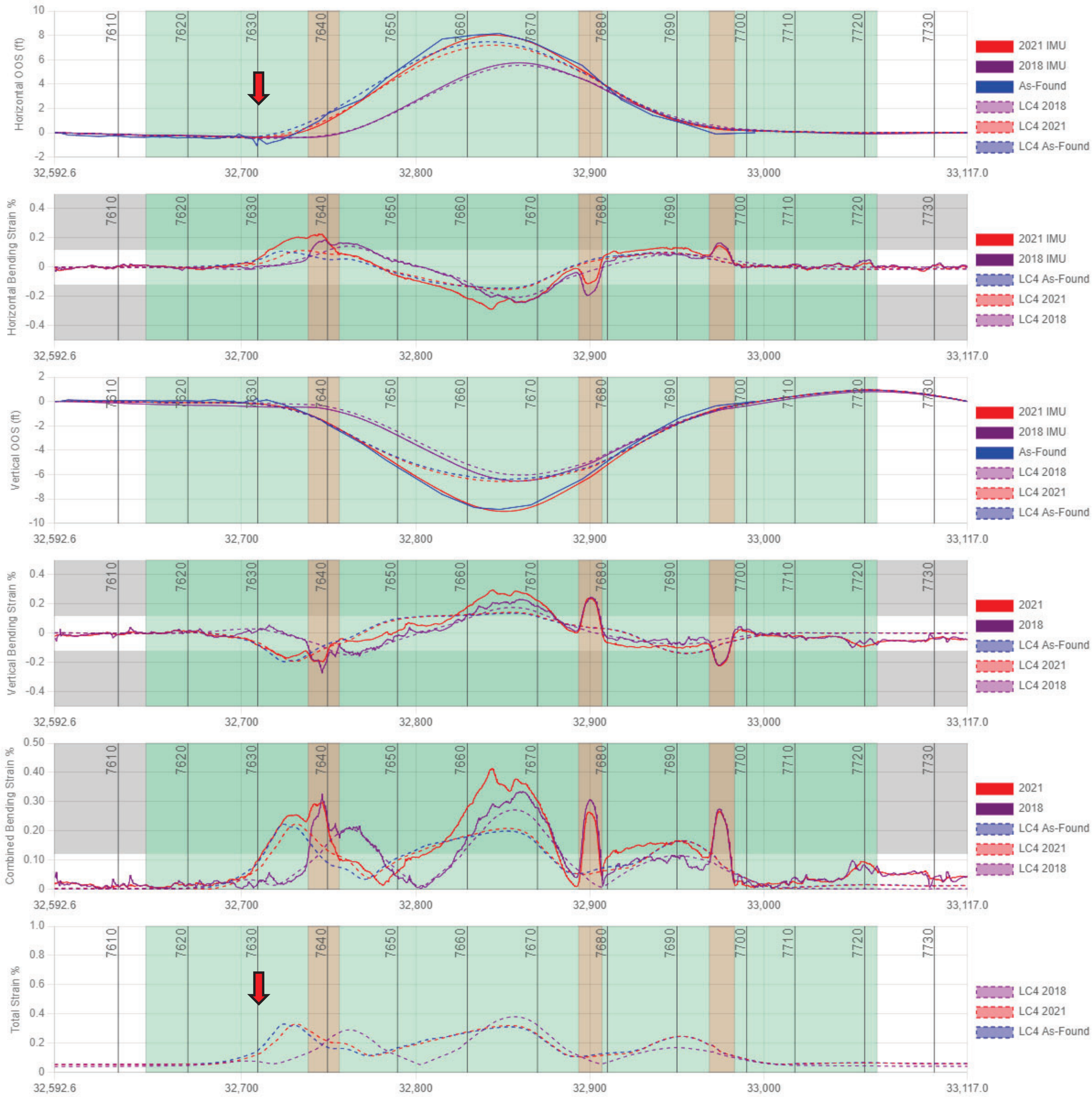


Figure 5.5: Load Case 4, Lower Bound Drained, Results Comparison

5.5 Post Failure Axial Separation

For Load Cases 1 through 3, the analysis models were progressed to simulate the conditions at the time of failure. This was accomplished by deleting the element nearest the girth weld and allowing the pipeline to separate as the soil elements relaxed. It is important to recognize that the results from this step are only considered appropriate when used as a qualitative order-of-magnitude type assessment. The conditions just prior to the failure are not likely to resemble the conditions during the response from 2012 to 2021. The conditions near the girth weld are expected to change as the soil interacts with released hydrocarbons, and some excavation is required for access to the girth weld. Both conditions will change the local restraint near the girth weld. Nevertheless, the measurements recorded during the investigation provide a useful point of comparison to judge the accuracy of the models.

An average axial separation of 7.3-inches was recorded during the remediation activities. In comparison, Load Case 1 showed a separation of 4.8-inches, and Load Case 2 showed a separation of 6.5-inches. Load Case 3 showed a separation of 6.6-inches. It is interesting that the lower bound undrained properties and the upper bound drained properties showed better agreement than the upper bound undrained properties; however, all the results show reasonable agreement given the challenges in replicating the actual conditions after the failure.

5.6 Other Analysis Considerations

Two additional considerations were addressed in the analysis at the request of MPL. First, the sensitivity of the results to the soil displacements near GW 7630 at the upstream flank of the landslide was investigated. The results from the initial assessments produced a “sharp” change near the upstream flank of the landslide between the 2021 and the as-found simulations. This change was tapered over a 10-ft length to “soften” the change. The results showed no significant difference in the out-of-straightness profiles; however, the total strains did reduce from 0.83% to 0.69% for Load Case 1. These results confirm that the region where the plastic hinge forms adjacent to the girth weld will be sensitive to soil properties and applied displacements.

The second consideration addressed in the analysis was whether repair sleeves installed in 2014 within the displaced section could have influenced the results. Four repair sleeves varying from 1 to 2 feet in length were installed in 2014. The sleeves were located near the following odometers: 32,840 feet, 32,851 feet, 32,900 feet, and 32,911 feet. The failure was located at odometer 32,709 feet, or 131 feet from the nearest sleeve. The sleeves were included in the model by locally increasing the wall thickness for the elements at the sleeve location to account for the additional material. The results showed no difference in the peak strains observed for Load Case 1. Therefore, it was concluded that the presence of the installed sleeves did not contribute to the failure.

5.7 Numerical Analysis Results Summary

The results from the numerical analysis are summarized in Table 5-1. All the load cases showed a sharp increase in strain approximately 10-ft from the girth weld where the incident occurred. The total strains in the girth weld ranged from 0.61 – 0.83%, with the membrane strains accounting for approximately half of these total strains in each load case. While the strains at the girth weld within the model were lower than the maximum values near the girth weld (0.17 – 0.21%), uncertainties in the precise extents of the landslide profile combined with the sharp changes in strain near the girth weld make it likely that the girth weld was experiencing strains higher than the exact values predicted at the girth weld.

Table 5-1: Results Summary

	LC1	LC2	LC3
Total Strain at Girth Weld 7630	0.18%	0.21%	0.17%
Max Bending Strain Near Girth Weld 7630	0.42%	0.30%	0.35%
Max Membrane Strain Near Girth Weld 7630	0.41%	0.31%	0.29%
Max Total Strain Near Girth Weld 7630	0.83%	0.61%	0.64%
Simulated Displacement After Failure (As-found 7.3 inches)	4.8-inches	6.5-inches	6.6-inches

6.0 DISCUSSION

The metallurgical examination (ADV Integrity, 2023) of the girth weld identified two planar features near the failure origin. The largest feature had a length of 7.2-inches with an average depth of 50% nominal wall thickness (NWT) and a peak depth of 88% NWT. The material testing determined that the weld properties and pipe properties were within specifications. The full-size equivalent Charpy energies for the weld centerline and heat affected zone were 58.2 ft-lb and 55.2 ft-lb, respectively. The metallurgical report is included in the appendices.

The tensile strain capacity (TSC) was estimated using PRCI SIA-1-7 with an apparent CTOD value of 0.0177 inches. The exact dimensions of the feature (7.2-inch x 88% NWT) could not be specified as a feature size due to limitations in the SIA-1-7 method. However, a feature was assessed with a size approximating the identified feature with respect to the peak depth. The assessed feature had a length of 3.27 inches with a depth of 80% NWT. This assessed feature is shorter than the actual feature, but with a depth near the measured peak depth. The predicted TSC based on this feature and the measured properties was 0.29%. It is reasonable to conclude that the TSC of the actual feature is not likely to be larger than this value.

This calculated TSC of 0.29% is exceeded by the predicted strains from the numerical model. All the calibrated numerical models indicated that the pipe cross section as fully yielded at a location near the failed girth weld. As a result of the fully plastic cross section, the strains are shown to accumulate rapidly near the failed girth weld with only small increases in additional movement. For example, the peak total strain near the failed girth weld in Load Case 1 was estimated as 0.44% at odometer 32722 feet based on the 2021 IMU inspection. While the pipeline displacements were not substantially different between the 2021 inspection and those recorded after the failure (8 ft vs. 8.2 ft), the peak total strain from the as-found simulation had increased to 0.83% at this same location. These results indicate that the strains near the girth weld increased by 89% with only small changes in movement. The peak total strains at the same location were only 0.1% based on the 2018 inspection.

It is also noteworthy that the maximum overall bending strain did not change as significantly from 2018 to 2021 as the bending strains near the girth weld. The maximum bending strain from the 2018 IMU was 0.33% (total strain 0.60%) while the maximum bending strain in 2021 was 0.41% (total strain 0.76%). This represents an increase of approximately 25% in the reported maximum bending strains. However, the change in bending strain near the girth weld that failed was more significant. The bending strain near the girth weld changed from 0.02% in 2018 to 0.25% in 2021. The bending strain from the as-found condition was estimated at 0.42% representing a 61% increase from 2021 to the time of failure. This information supports the fact that the strains near the critical location were changing more rapidly than the strains near the peak displacement or the location of maximum bending strain within the previously identified area.

Another noteworthy observation in this analysis is that the membrane strains were equal to the calculated bending strains. It is common for pipeline operators to manage geohazard threats based on calculated bending strains alone. For most bending strain locations with smaller displacements and lower strain values, the membrane strains are not significant and add less than 0.1% strain to the bending strain value. However, at larger displacements, the membrane strains can become significant with magnitudes equal to or greater than the calculated bending strain values as seen in this assessment.

7.0 REFERENCES

ADV Integrity. (2023, June). Woodpat Pipeline Girth Weld Testing, Edwardsville Illinois Pipe Sample .

American Lifelines Alliance. (2005, February). Guidelines for the Design of Buried Steel Pipe.

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APPENDIX A

Metallurgical Report

Woodpat Pipeline Girth Weld Testing, Edwardsville Illinois Pipe Sample

Final Report

Prepared for

Marathon Pipe Line, LLC

100794-RP01-Rev0-061623

WHEN TECHNOLOGY WORKS, TREMENDOUS THINGS ARE POSSIBLE.

June 2023

Woodpat Pipeline Girth Weld Testing, Edwardsville Illinois Pipe Sample

Final Report

Prepared for

Marathon Pipe Line, LLC

Findlay, OH

June 2023

Prepared by:

David Futch, PE

[redacted]

Reviewed by:

Rhett Dotson, PE

[redacted]

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100794-RP01-Rev0-061623

Rev	Date	Description	Prepared	Checked	Reviewed
B	06.09.2023	Issued for Client Review	DBF	---	RLD
0	06.16.2023	Issued for Use	DBF	---	RLD

Texas Registered Engineering Firm F-19081

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Friday, June 16, 2023 100794-RP01-Rev0-061623

Nic Roniger, P.E. | *MPL Mainline Integrity Supervisor*
Marathon Pipe Line, LLC
539 S Main St, Findlay, OH 45840

Nic,

Enclosed is our report documenting the mechanical testing and tensile strain capacity estimation of an intact girth weld removed from the Woodpat pipeline segment. This girth weld was removed due to the Edwardsville, Illinois incident occurring on March 11, 2022. Marathon reported that the pipeline in question was installed in 1949 using nominal 22-inch OD x 0.344-inch WT, API 5L, Grade X46 pipe material. Marathon reported that the pipeline transports crude oil at a maximum allowable operating pressure of 881 psig, and the failure occurred at 479 psig.

Thank you for the opportunity to complete this work and please do not hesitate to contact us with any questions.

Regards,

David Futch, PE | Director, Materials Engineering

ADV Integrity, Inc.
4027 Pinehurst Meadow | Magnolia, TX 77355
Office: [redacted] | E-[redacted]
Texas Registered Engineering Firm F-19081

Reviewed by: Rhett Dotson, PE | Chief Engineer – Pipeline Integrity

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION AND BACKGROUND

Marathon Pipe Line, LLC (Marathon) contracted ADV Integrity, Inc. (ADV) to perform mechanical testing of an intact girth weld removed from the Woodpat pipeline segment. This girth weld was removed due to the Edwardsville, Illinois incident occurring on March 11, 2022. The National Transportation Safety Board (NTSB) performed a metallurgical examination of the failed girth weld and a partial examination of the intact weld provided. Marathon reported that the pipeline in question was installed in 1949 using nominal 22-inch OD x 0.344-inch WT, API 5L, Grade X46 pipe material. Marathon reported that the pipeline transports crude oil at a maximum allowable operating pressure of 881 psig and the failure occurred at 479 psig.

Marathon requested that ADV perform a series of examinations and mechanical testing to determine the weld's quality and estimate the tensile strain capacity of the weld. To do so, ADV suggested a test matrix to include: pipe body and girth weld tensile tests, Charpy v-Notch testing of the girth weld per API 1104, CTODs of the welds per API 1104, girth weld macros, and full hardness maps. The cross girth weld tensile tests were monitored via digital image correlation (DIC) to provide additional details regarding strain during the tensile test. The results from each examination are summarized in the sections below.

ADV utilized feature dimensions determined via the NTSB examination on the failed girth weld and the feature dimensions present determined via radiographic testing (RT) of the intact girth weld. Based on review of the NTSB data, ADV determined the following:

- Planar feature length within the failed weld:
  - Incomplete Penetration, 7.2-inch long, 1:15 to 1:30 o'clock orientation (0.6 to 1.2 feet); shown in Figure 1 and Figure 2
    - Metallurgical depth of 7.7 mm at deepest point, average 2-4 mm along the length of feature
  - Incomplete Penetration, 1.2-inch long, 3:20 to 3:32 o'clock orientation (1.6 to 1.7 feet)
  - Incomplete Penetration, 0.5 inch long, 6:46 to 6:53 o'clock orientation (3.25 to 3.3 feet)
  - Incomplete Penetration, 0.5 inch long, 10:25 to 10:32 o'clock orientation (5 to 5.05 feet)
- Intact weld: shown in Figure 3
  - Volumetric Features:
    - Elongated slag inclusions and porosity, 0.5 inch long, 12:47 to 12:52 o'clock orientation (4.5 inch to 5 inch)
    - Elongated slag inclusions, 2 inches long, 2:20 to 2:40 o'clock orientation (13.5 inch to 15.5 inch)
    - Elongated slag inclusions, 1.5 inches long, 3:45 to 4:00 o'clock orientation (21.5 inch to 23 inch)
    - Scattered porosity, 5 inches long, 5:12 to 6:05 o'clock orientation (30 inch to 35 inch)
    - Elongated slag inclusions, 3 inches long, 7:38 to 8:10 o'clock orientation (44 inch to 47 inch)
  - Planar features:

- Incomplete Penetration, 0.5-inch long, 4:15 to 4:21 o'clock orientation (24.5 inch to 25 inch)
    - Metallurgical depth 1.3 mm
- Incomplete Fusion, 0.5-inch long, 6:54 to 7:00 o'clock orientation (39.75 inch to 40.25 inch)
- Burn through, 0.25 inch long, 9:20 to 9:23 o'clock orientation (53.75 inch to 54 inch)

Figure 1: Photograph of fracture surface. Numbered scale divisions are inches.

Figure 2: Photograph of fracture surface.

Figure 3: RT image of intact girth weld.

2.0 EXAMINATION OF INTACT WELD

2.1 Tensile Tests

ADV performed tensile testing of the base pipe from both sides of the intact girth weld and three cross weld tensile tests around the circumference of the girth weld. The tensile straps were removed from the top of the pipe (12:00 o'clock orientation) and either the 3:00 o'clock orientation or 9:00 o'clock orientation, and the bottom of the pipe (6:00 o'clock orientation) guided by the RT images in an attempt to avoid flaws present. The cross girth weld tensile tests were monitored via digital image correlation (DIC). DIC utilizes a defined speckle pattern applied to the viewing surface (in this case the through thickness weld profile) created through black and white spray paint to monitor displacement over a given time. Relationship between the starting pattern and how that pattern deforms relative to adjacent patterns is then later interpreted as strain.

The results were compared to the closest API 5L edition from the time of manufacturing: API 5LX, 5th Edition (1954). Tensile test (per ASTM A370) results, summarized in Table 1, respectively, are consistent with the requirements of API 5L, Grade X46 material. The cross girth weld tensile test prepared at the 12:00 and 3:00 o'clock orientation failed in the weld metal with obvious signs of weld flaws (incomplete penetration and porosity). Images of all three tensiles are shown in Figure 4 through Figure 6. Videos of the DIC tests were provided in a separate file. Some of these videos failed outside the virtual extensometer as they failed in the base pipe. These results are considered further in the tensile strain capacity calculations.

Table 1: Tensile Strength Results

Sample	Yield Strength (psi)	Tensile Strength (psi)	Elongation (%)
Pipe Body, Longitudinal, Upstream Pipe	51,200	82,600	30.0
Pipe Body, Longitudinal, Downstream Pipe	55,700	82,000	30.0
API 5LX, Grade X46 5th Edition (1954)	46,000 (min)	63,000 (min)	23.5 (min)
Cross Girth Weld 1 (12:00)	---	69,400 [1]	---
Cross Girth Weld 2 (3:00)	---	69,400 [1]	---
Cross Girth Weld 3 (6:00)	---	81,200 [2]	---

Longitudinal, 3/4" wide reduced sections
[1] Failed in base material, [2] Failed in girth weld or HAZ

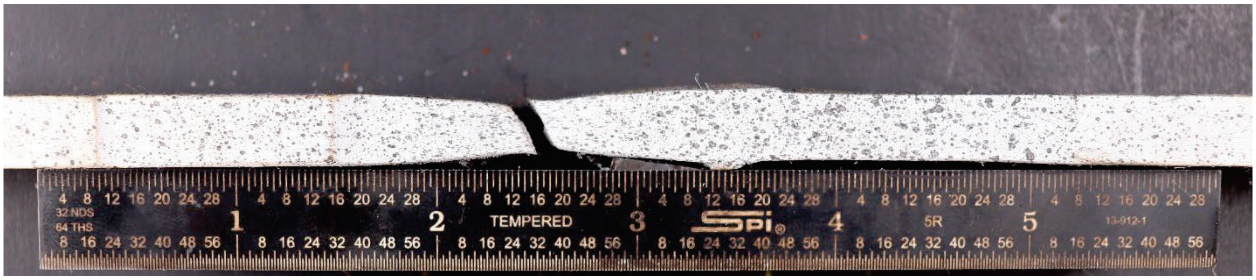


Figure 4: 12:00 o’clock orientation cross girth weld tensile.

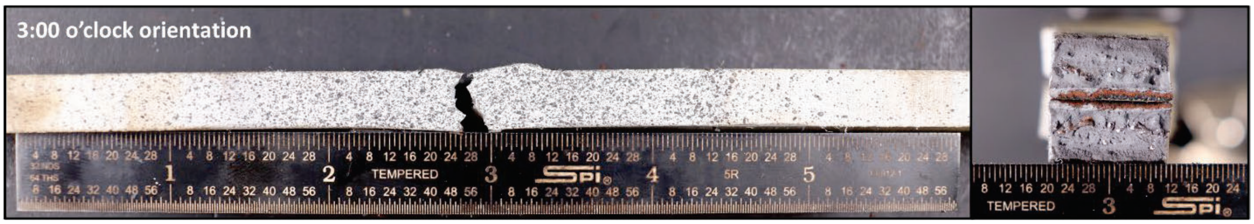


Figure 5: 3:00 o’clock orientation cross girth weld tensile.

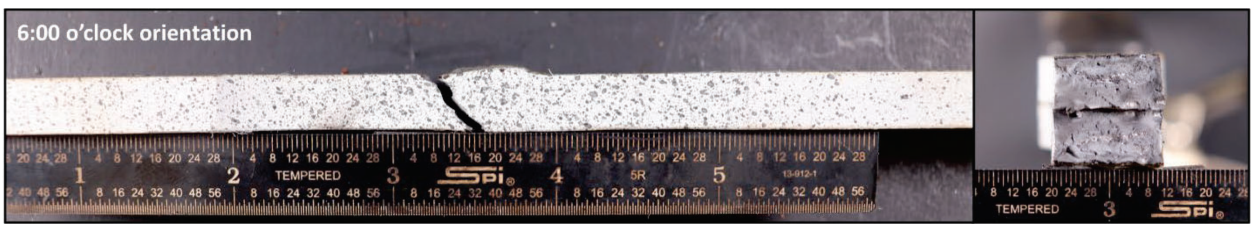


Figure 6: 6:00 o’clock orientation cross girth weld tensile.

2.2 Charpy v-Notch Tests

Girth weld centerline and girth weld heat affected zone (HAZ), two-thirds size Charpy V-notch tests (per ASTM A370) were performed to generate a transition curve; results are summarized in Table 2. Charpy V-notch transition curves were generated using a hyperbolic tangent curve-fit (API 579, Annex 9F) and summarized in Figure 7 and Figure 8.

Table 2: Charpy V-notch Results

Location	Specimen	Temperature	Absorbed Energy (ft-lb)	Approx. Full-Size Equivalent Absorbed Energy (ft-lb)	Percent Shear (%)
Weld Centerline	1	-110	12	17.9	30
	2	-90	4.5	6.7	25
	3	-70	21	31.3	40
	4	-20	22	32.8	60
	5	32	41	61.2	100
	6	74	39	58.2	100
Weld HAZ	1	-70	4	6.0	10
	2	-20	8	11.9	40
	3	32	34	50.7	60
	4	74	37	55.2	70
	5	120	41	61.2	80
	6	170	49	73.1	100

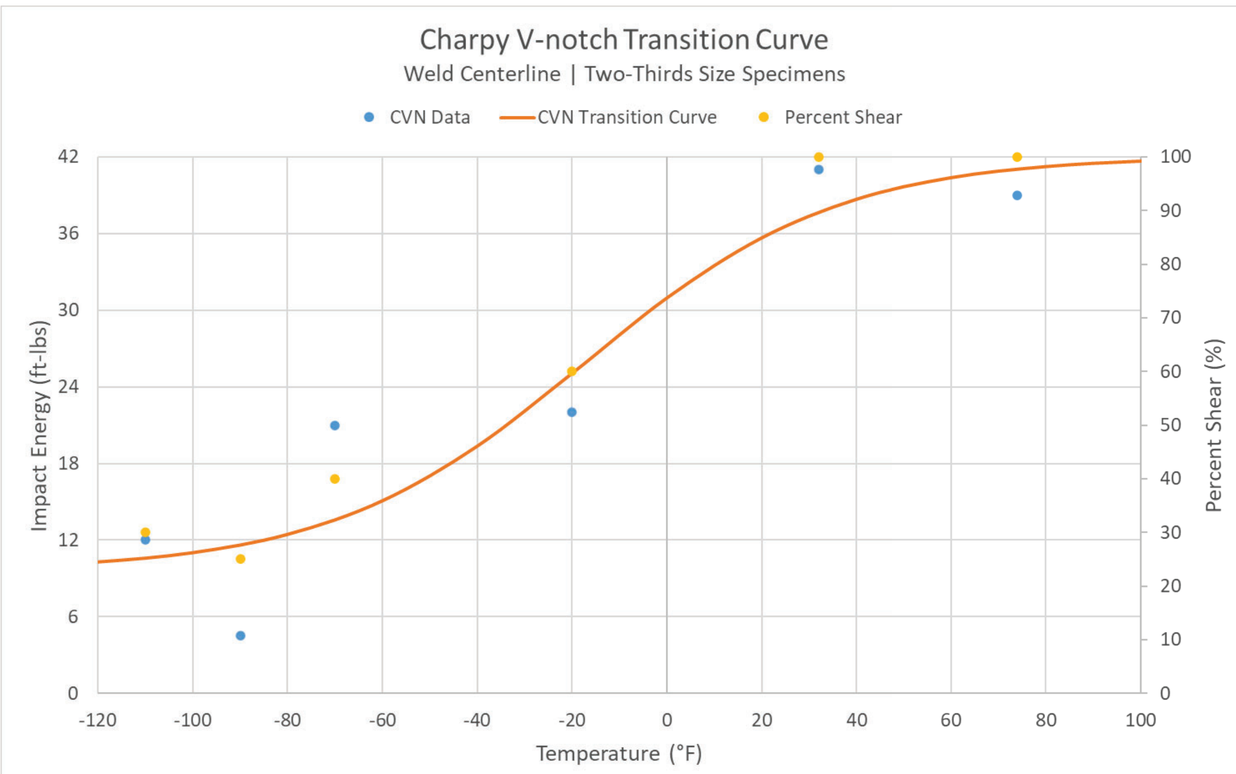


Figure 7: Girth weld centerline CVN transition curve.

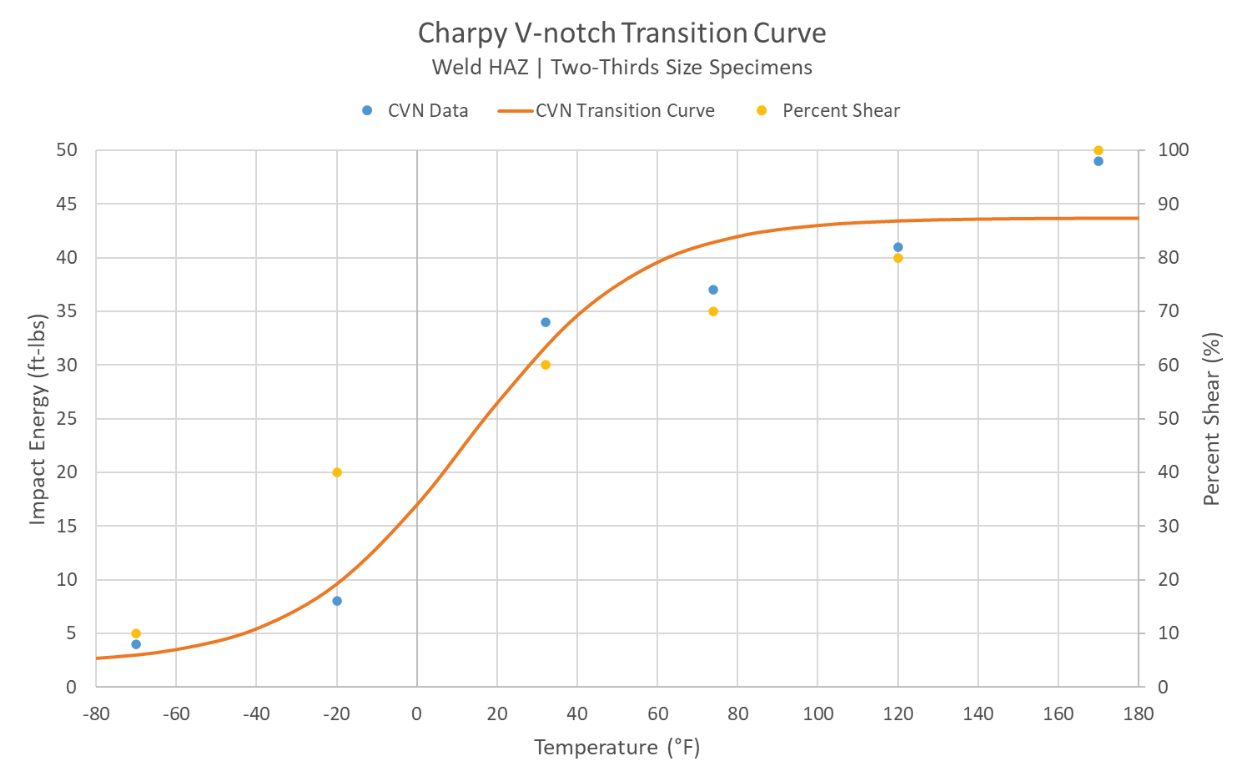


Figure 8: Girth weld HAZ CVN transition curve.

2.3 CTODs

ADV contracted Anderson and Associates to perform Bx2B SE(B) CTODs notched in the weld HAZ and the weld centerline. These tests were performed at ambient temperature at three circumferential locations: 12:00 o'clock, 3:00 o'clock, and 6:00 o'clock orientation. The results are summarized in Table 3.

Table 3: CTOD Results

Location		CTOD (in)	Average CTOD (in)
HAZ	12:00	0.011	0.0097
	3:00	0.0073	
	6:00	0.011	
Weld Centerline	12:00	0.012	0.0109
	3:00	0.011	
	6:00	0.0098 [1]	

[1] Invalid result due to weld flaw present.

2.4 Girth Weld Macros and Hardness Testing

ADV prepared two metallurgical cross sections of the girth weld, one at the 12:00 o'clock and one at the 3:00 o'clock orientation. These cross sections are shown in Figure 9 and Figure 10, respectively. High-lo was identified in the 3:00 o'clock cross section, as annotated in the figure. The high-lo present at the 3:00

o'clock orientation is shown in Figure 11. An area of incomplete penetration was identified connected to the high-lo present. The base pipe microstructure on both sides of the girth weld is consistent with a ferrite-pearlite mixture expected for carbon steel, shown in Figure 12 and Figure 13.

Full hardness maps were performed on the cross sections at a 500-gram load (HV0.5). Images of the hardness traverse are shown in Figure 14 and Figure 15, respectively. No evidence of widespread heat affected zone softening was identified. ADV further calculated a weld strength factor (weld strength / pipe strength) for each macro: both were approximately 0.95. The full hardness reports are attached in Appendix B.

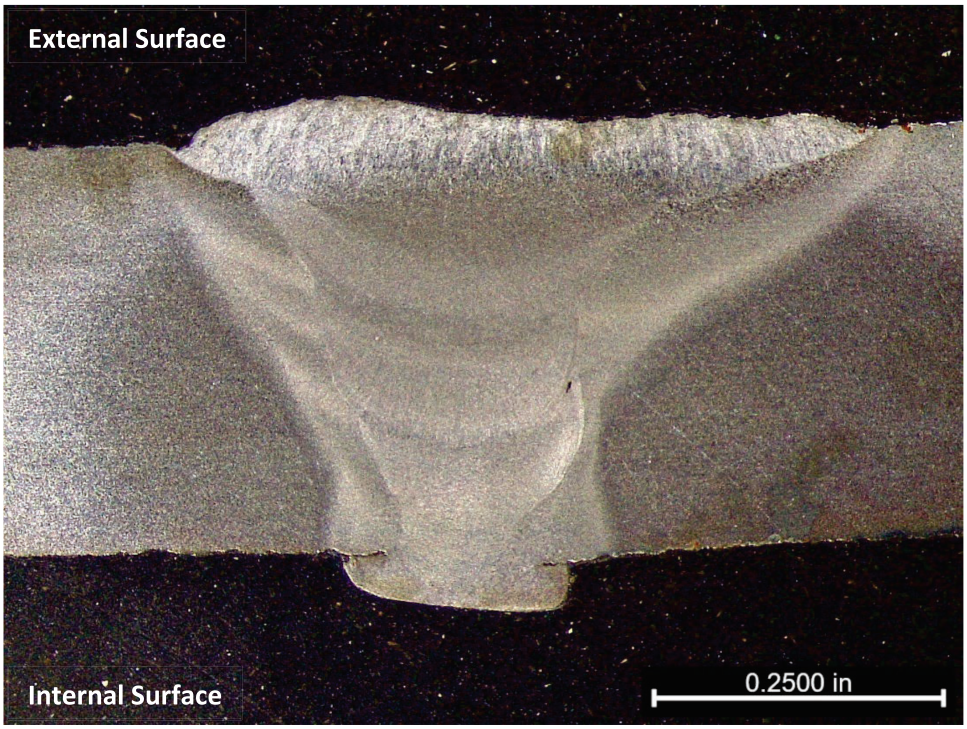


Figure 9: Photomicrograph of across the intact girth weld at the 12:00 o'clock orienation. Etchant is 2% Nital; original mangification is 0.6x.

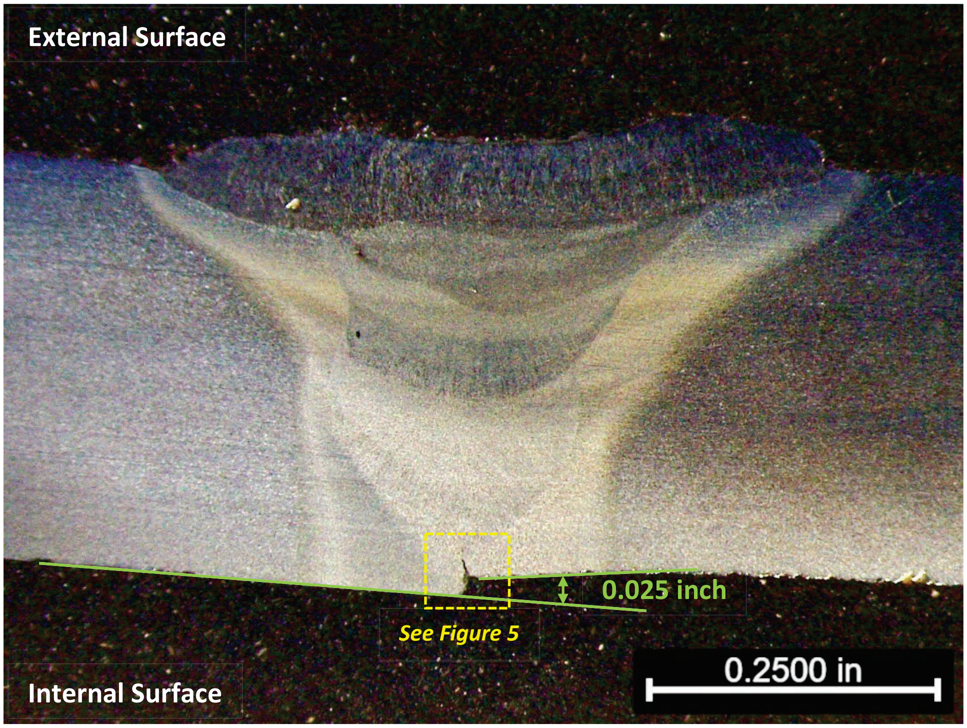


Figure 10: Photomicrograph of across the intact girth weld at the 3:00 o'clock orienation. Etchant is 2% Nital; original mangification is 0.6x.

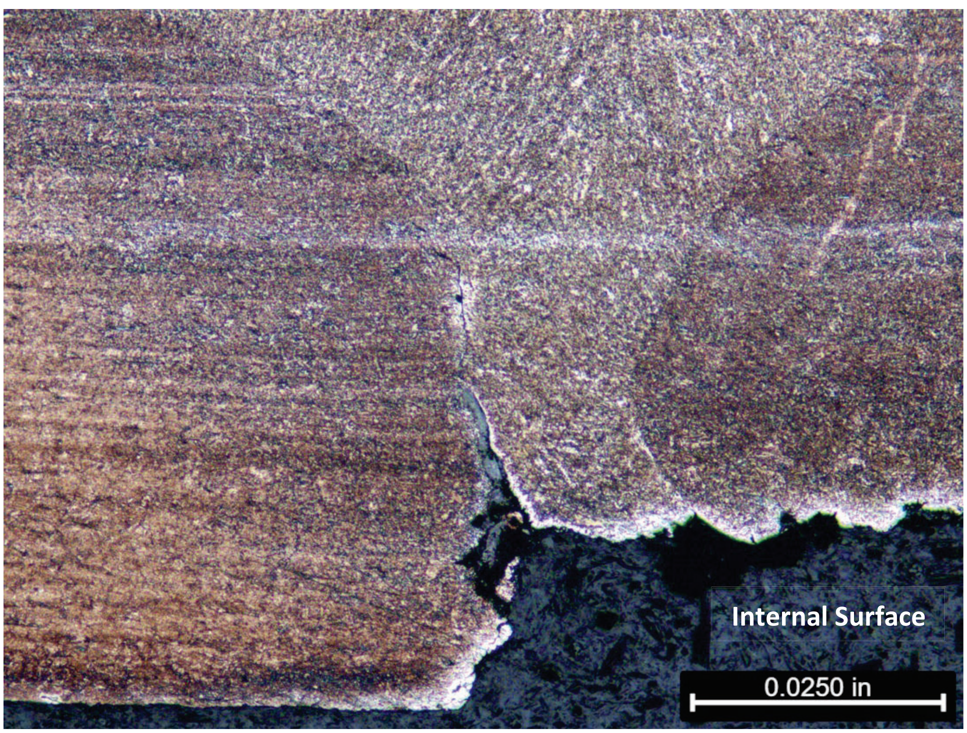


Figure 11: Photomicrograph of girth weld feature present along the internal surface of the 3:00 o'clock cross section. Etchant is 2% Nital; original mangification is 50x.

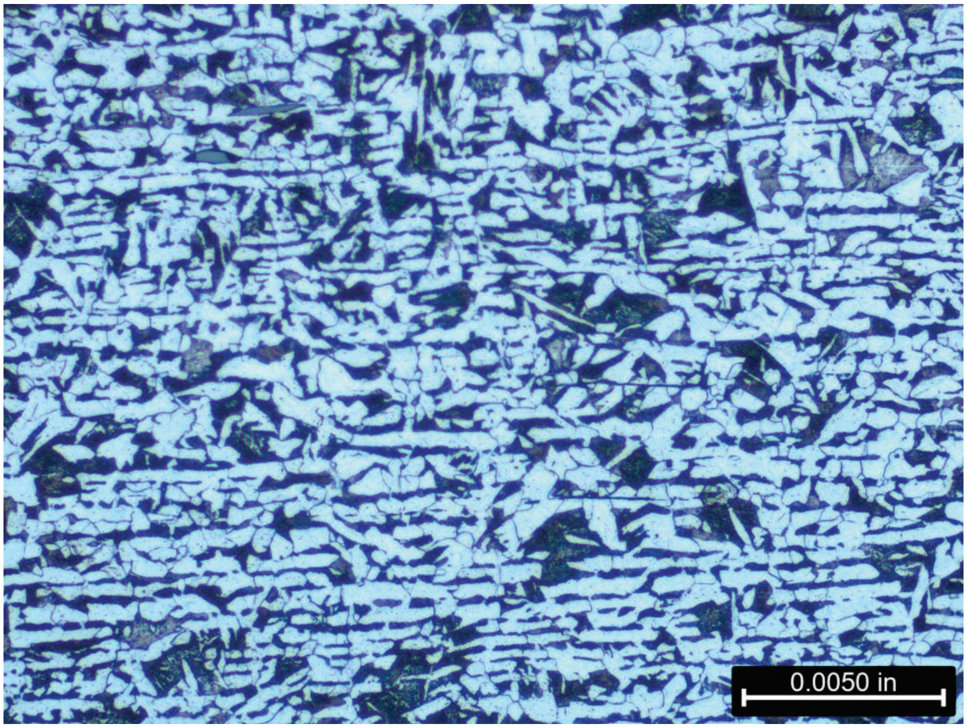


Figure 12: Photomicrograph of the base pipe material upstream of the girth weld. Etchant is 2% Nital; original mangification is 200x.

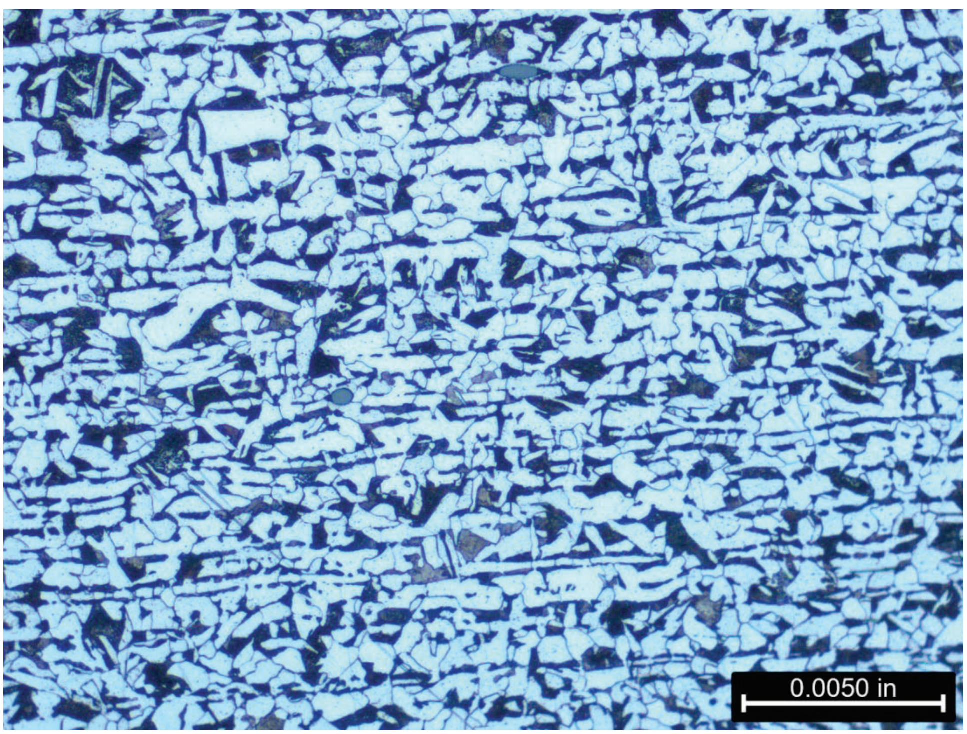


Figure 13: Photomicrograph of the base pipe material downstream of the girth weld. Etchant is 2% Nital; original mangification is 200x.

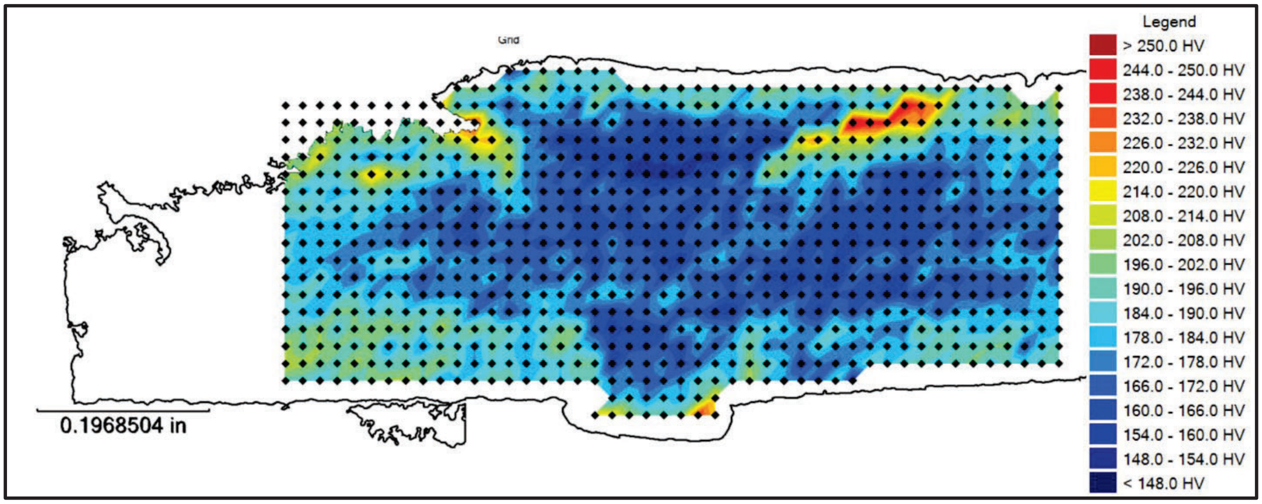


Figure 14: HV0.5 hardness map of weld, 12:00 o'clock orientation.

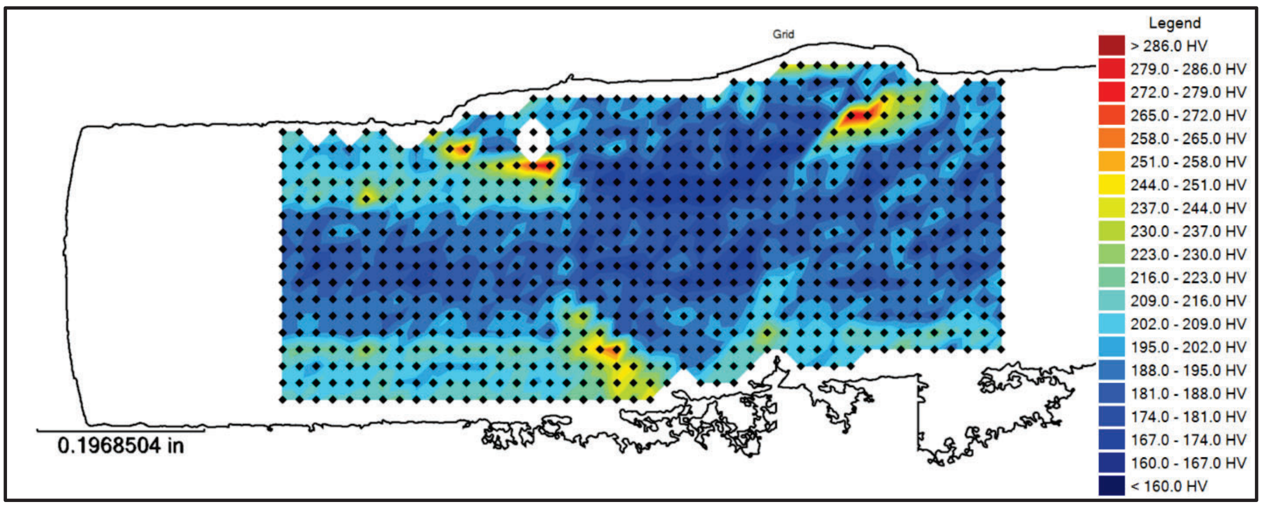


Figure 15: HV0.5 hardness map of weld, 3:00 o'clock orientation.

2.5 Calculated Tensile Strain Capacity (TSC)

ADV followed PRCI SIA-1-7 to estimate the TSC of the weld, which contains a 0.67 safety factor. The assumptions utilized in the calculations are shown in Table 4. These assumptions were based upon the test results described in the subsections above.

Load case 1 was utilized to represent a feature of similar depth to that of the failure origin. The PRCI SIA-1-7 software contains a maximum allowable aspect ratio of 12 and a maximum depth of 80% of the nominal wall thickness. Therefore, the flaw identified is outside the limits of the available industry tool. This limited the analysis to a feature that measured 6.95 mm deep (0.274 inches deep) with a length of 3.27 inches. This resulted in a feature that was slightly shallower (compared to the peak depth) and approximately half the length than found during the metallurgical examination, resulting in a TSC of 0.29. Load case 2 is based on the longest allowable feature within the PRCI SIA-1-7 software with a depth of 3.5

mm (similar to the average depth along the identified feature). Load case 3 is based on the feature length and depth identified via RT and metallography of the intact girth weld provided. These load cases are repeated with the pressure being modified from the MOP (881 psig) to the reported failure pressure (479 psig).

Table 4: Tensile Strain Capacity Inputs and Results

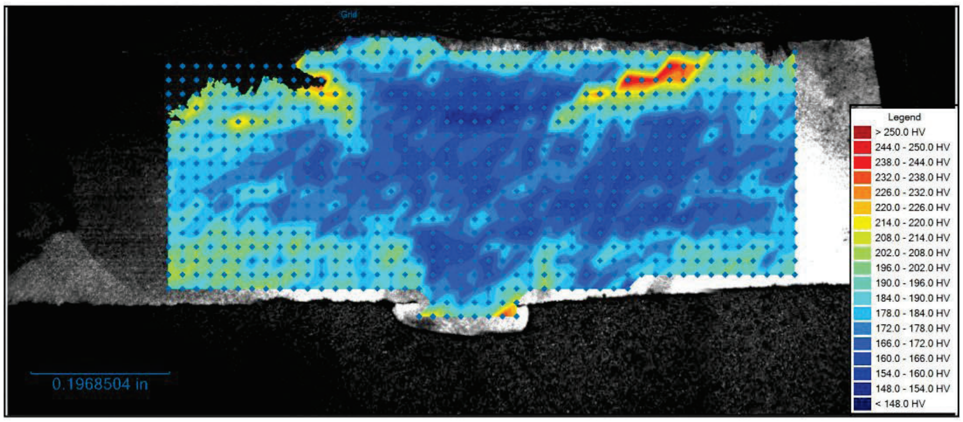
Input	Case					
	1	2	3	4	5	6
Pipe OD (in)	22					
Pipe WT (in)	0.344 (8.7 mm)					
Pipe Grade	Grade X46 (46 ksi yield)					
Pressure Factor	0.61 (881 psi)			0.33 (479 psi)		
Misalignment (mm)	0.80					
Weld Strength Factor	0.95					
Flaw Length (in)	3.27	1.65	0.5	3.27	1.65	0.5
Flaw Depth (mm)	6.95	3.5	1.5	6.95	3.5	1.5
CTOD (in)	0.0097 (Avg), 0.0073 (Low)					
Apparent Toughness, CTODa (in)	0.0177					
Result (TSC %)	**0.29**	**0.89**	**>2.0**	**0.35**	**1.1**	**>2.0**

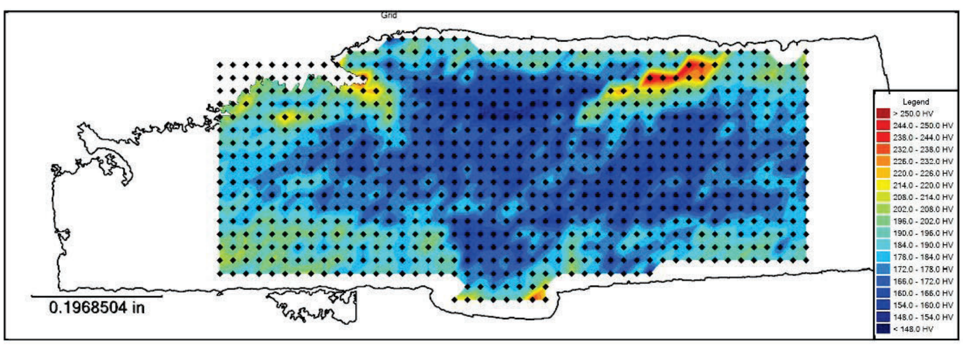
APPENDIX A: HARDNESS TESTING REPORTS

Hardness Map

ADV PN 100794 12:00 o'clock

Date: 05-25-2023
Tester: Admin
Program: Hardness Map





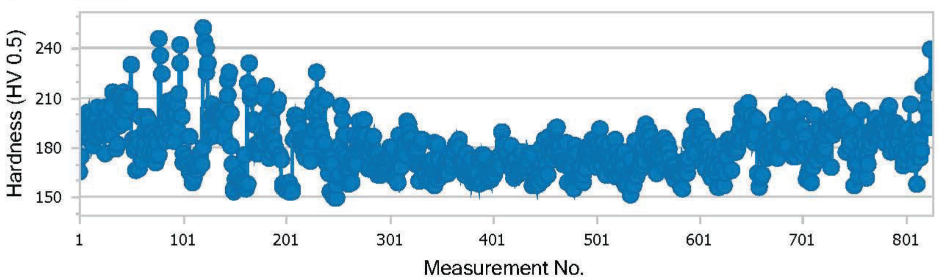
www.advintegrity.com Page 1 of 23

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Grid

Mean	Minimum	Maximum	Range	Std. deviation
180.3	149.4	252.2	102.9	15.9

Hardness Trace



Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
1	-	165.0 HV 0.5	85.0 HRB	74.0 µm	75.9 µm	
2	-	174.1 HV 0.5	87.5 HRB	75.9 µm	70.0 µm	
3	-	197.0 HV 0.5	92.4 HRB	68.4 µm	68.8 µm	
4	-	186.1 HV 0.5	90.2 HRB	70.2 µm	70.9 µm	
5	-	192.4 HV 0.5	91.5 HRB	69.6 µm	69.2 µm	
6	-	187.2 HV 0.5	90.4 HRB	70.6 µm	70.2 µm	
7	-	188.9 HV 0.5	90.8 HRB	69.4 µm	70.7 µm	
8	-	195.5 HV 0.5	92.1 HRB	68.7 µm	69.0 µm	
9	-	201.1 HV 0.5	93.2 HRB	68.8 µm	67.0 µm	
10	-	197.8 HV 0.5	92.6 HRB	67.9 µm	69.0 µm	
11	-	186.5 HV 0.5	90.3 HRB	70.6 µm	70.5 µm	
12	-	194.9 HV 0.5	92.0 HRB	68.0 µm	70.0 µm	
13	-	199.4 HV 0.5	92.9 HRB	69.1 µm	67.2 µm	
14	-	180.5 HV 0.5	89.1 HRB	71.7 µm	71.6 µm	
15	-	185.4 HV 0.5	90.1 HRB	72.5 µm	68.9 µm	
16	-	190.6 HV 0.5	91.1 HRB	70.3 µm	69.2 µm	
17	-	197.7 HV 0.5	92.5 HRB	68.7 µm	68.3 µm	
18	-	186.8 HV 0.5	90.4 HRB	70.1 µm	70.8 µm	
19	-	203.9 HV 0.5	93.8 HRB	66.4 µm	68.4 µm	
20	-	191.6 HV 0.5	91.3 HRB	68.3 µm	70.8 µm	
21	-	191.6 HV 0.5	91.3 HRB	68.7 µm	70.5 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
22	-	188.2 HV 0.5	90.6 HRB	70.2 µm	70.2 µm	
23	-	189.0 HV 0.5	90.8 HRB	71.0 µm	69.1 µm	
24	-	194.1 HV 0.5	91.8 HRB	68.3 µm	69.9 µm	
25	-	176.5 HV 0.5	88.1 HRB	72.4 µm	72.6 µm	
26	-	204.2 HV 0.5	93.8 HRB	65.8 µm	68.9 µm	
27	-	196.6 HV 0.5	92.3 HRB	69.6 µm	67.7 µm	
28	-	190.7 HV 0.5	91.1 HRB	70.9 µm	68.6 µm	
29	-	199.1 HV 0.5	92.8 HRB	68.2 µm	68.3 µm	
30	-	193.2 HV 0.5	91.6 HRB	68.0 µm	70.5 µm	
31	-	204.5 HV 0.5	93.9 HRB	67.5 µm	67.2 µm	
32	-	187.4 HV 0.5	90.5 HRB	70.6 µm	70.1 µm	
33	-	213.5 HV 0.5	95.6 HRB	65.8 µm	66.0 µm	
34	-	194.6 HV 0.5	91.9 HRB	70.6 µm	67.5 µm	
35	-	194.9 HV 0.5	92.0 HRB	71.5 µm	66.4 µm	
36	-	179.4 HV 0.5	88.8 HRB	70.3 µm	73.5 µm	
37	-	211.9 HV 0.5	95.3 HRB	65.2 µm	67.1 µm	
38	-	181.6 HV 0.5	89.3 HRB	75.1 µm	67.8 µm	
39	-	192.9 HV 0.5	91.6 HRB	69.5 µm	69.2 µm	
40	-	197.5 HV 0.5	92.5 HRB	68.0 µm	69.0 µm	
41	-	211.0 HV 0.5	95.2 HRB	65.0 µm	67.6 µm	
42	-	203.7 HV 0.5	93.7 HRB	68.7 µm	66.2 µm	
43	-	212.9 HV 0.5	95.5 HRB	67.5 µm	64.5 µm	
44	-	194.5 HV 0.5	91.9 HRB	66.8 µm	71.3 µm	
45	-	205.0 HV 0.5	94.0 HRB	68.6 µm	66.0 µm	
46	-	202.5 HV 0.5	93.5 HRB	67.4 µm	67.9 µm	
47	-	202.3 HV 0.5	93.5 HRB	66.5 µm	68.9 µm	
48	-	211.2 HV 0.5	95.2 HRB	64.8 µm	67.7 µm	
49	-	204.6 HV 0.5	93.9 HRB	65.2 µm	69.4 µm	
50	-	210.9 HV 0.5	95.2 HRB	66.8 µm	65.8 µm	
51	-	230.3 HV 0.5	98.4 HRB	64.2 µm	62.7 µm	
52	-	184.5 HV 0.5	89.9 HRB	71.6 µm	70.2 µm	
53	-	181.5 HV 0.5	89.3 HRB	71.5 µm	71.4 µm	
54	-	178.0 HV 0.5	88.5 HRB	73.1 µm	71.3 µm	
55	-	165.9 HV 0.5	85.2 HRB	75.5 µm	74.0 µm	
56	-	179.5 HV 0.5	88.9 HRB	71.1 µm	72.7 µm	
57	-	185.1 HV 0.5	90.0 HRB	72.6 µm	68.9 µm	
58	-	182.4 HV 0.5	89.5 HRB	71.5 µm	71.1 µm	
59	-	166.9 HV 0.5	85.5 HRB	75.8 µm	73.3 µm	
60	-	198.8 HV 0.5	92.8 HRB	69.3 µm	67.3 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
61	-	173.0 HV 0.5	87.2 HRB	73.4 µm	73.0 µm	
62	-	171.5 HV 0.5	86.8 HRB	74.7 µm	72.4 µm	
63	-	176.7 HV 0.5	88.2 HRB	73.4 µm	71.4 µm	
64	-	181.8 HV 0.5	89.4 HRB	71.5 µm	71.3 µm	
65	-	189.9 HV 0.5	91.0 HRB	69.6 µm	70.2 µm	
66	-	198.4 HV 0.5	92.7 HRB	69.2 µm	67.6 µm	
67	-	196.8 HV 0.5	92.4 HRB	68.7 µm	68.6 µm	
68	-	177.4 HV 0.5	88.4 HRB	73.8 µm	70.8 µm	
69	-	189.0 HV 0.5	90.8 HRB	71.8 µm	68.3 µm	
70	-	185.6 HV 0.5	90.1 HRB	70.9 µm	70.5 µm	
71	-	189.5 HV 0.5	90.9 HRB	70.3 µm	69.6 µm	
72	-	174.3 HV 0.5	87.6 HRB	73.1 µm	72.8 µm	
73	-	177.6 HV 0.5	88.4 HRB	71.8 µm	72.7 µm	
74	-	170.4 HV 0.5	86.5 HRB	73.1 µm	74.5 µm	
75	-	186.4 HV 0.5	90.3 HRB	70.3 µm	70.8 µm	
76	-	183.2 HV 0.5	89.6 HRB	71.8 µm	70.5 µm	
77	-	174.9 HV 0.5	87.7 HRB	72.9 µm	72.7 µm	
78	-	246.0 HV 0.5	-	63.0 µm	59.8 µm	
79	-	235.3 HV 0.5	99.2 HRB	62.1 µm	63.5 µm	
80	-	224.1 HV 0.5	97.4 HRB	64.5 µm	64.1 µm	
81	-	189.2 HV 0.5	90.8 HRB	68.5 µm	71.5 µm	
82	-	188.1 HV 0.5	90.6 HRB	69.2 µm	71.2 µm	
83	-	183.6 HV 0.5	89.7 HRB	72.0 µm	70.1 µm	
84	-	196.3 HV 0.5	92.3 HRB	71.0 µm	66.5 µm	
85	-	201.3 HV 0.5	93.3 HRB	67.8 µm	67.9 µm	
86	-	189.4 HV 0.5	90.9 HRB	69.0 µm	70.9 µm	
87	-	207.6 HV 0.5	94.5 HRB	65.7 µm	67.9 µm	
88	-	198.9 HV 0.5	92.8 HRB	68.4 µm	68.1 µm	
89	-	206.3 HV 0.5	94.3 HRB	69.9 µm	64.2 µm	
90	-	186.6 HV 0.5	90.3 HRB	71.8 µm	69.1 µm	
91	-	208.4 HV 0.5	94.7 HRB	66.2 µm	67.2 µm	
92	-	198.1 HV 0.5	92.6 HRB	68.3 µm	68.6 µm	
93	-	183.8 HV 0.5	89.8 HRB	71.2 µm	70.8 µm	
94	-	200.4 HV 0.5	93.1 HRB	67.2 µm	68.9 µm	
95	-	190.9 HV 0.5	91.2 HRB	68.6 µm	70.8 µm	
96	-	205.7 HV 0.5	94.1 HRB	67.5 µm	66.8 µm	
97	-	212.7 HV 0.5	95.4 HRB	67.0 µm	65.1 µm	
98	-	231.3 HV 0.5	98.6 HRB	64.9 µm	61.7 µm	
99	-	242.1 HV 0.5	-	61.3 µm	62.5 µm	

www.advintegrity.com Page 4 of 23

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
100	-	198.7 HV 0.5	92.7 HRB	67.5 µm	69.1 µm	
101	-	176.2 HV 0.5	88.0 HRB	72.7 µm	72.4 µm	
102	-	170.4 HV 0.5	86.5 HRB	73.4 µm	74.1 µm	
103	-	171.5 HV 0.5	86.8 HRB	73.7 µm	73.3 µm	
104	-	173.0 HV 0.5	87.2 HRB	73.4 µm	73.0 µm	
105	-	173.7 HV 0.5	87.4 HRB	72.5 µm	73.7 µm	
106	-	170.0 HV 0.5	86.3 HRB	74.3 µm	73.4 µm	
107	-	186.3 HV 0.5	90.3 HRB	70.3 µm	70.8 µm	
108	-	164.7 HV 0.5	84.9 HRB	76.1 µm	74.0 µm	
109	-	164.5 HV 0.5	84.8 HRB	77.4 µm	72.8 µm	
110	-	158.6 HV 0.5	82.9 HRB	77.3 µm	75.6 µm	
111	-	161.4 HV 0.5	83.8 HRB	75.4 µm	76.2 µm	
112	-	171.5 HV 0.5	86.8 HRB	74.4 µm	72.6 µm	
113	-	167.9 HV 0.5	85.7 HRB	73.1 µm	75.6 µm	
114	-	165.9 HV 0.5	85.2 HRB	75.2 µm	74.3 µm	
115	-	168.5 HV 0.5	85.9 HRB	74.4 µm	74.0 µm	
116	-	172.6 HV 0.5	87.1 HRB	73.2 µm	73.4 µm	
117	-	174.9 HV 0.5	87.7 HRB	74.8 µm	70.8 µm	
118	-	176.0 HV 0.5	88.0 HRB	73.1 µm	72.1 µm	
119	-	169.8 HV 0.5	86.3 HRB	73.2 µm	74.6 µm	
120	-	179.7 HV 0.5	88.9 HRB	70.6 µm	73.1 µm	
121	-	252.2 HV 0.5	-	61.2 µm	60.1 µm	
122	-	243.8 HV 0.5	-	61.8 µm	61.5 µm	
123	-	240.7 HV 0.5	-	61.0 µm	63.1 µm	
124	-	225.1 HV 0.5	97.5 HRB	64.2 µm	64.1 µm	
125	-	231.1 HV 0.5	98.5 HRB	63.7 µm	63.0 µm	
126	-	196.9 HV 0.5	92.4 HRB	69.1 µm	68.2 µm	
127	-	192.1 HV 0.5	91.4 HRB	68.2 µm	70.7 µm	
128	-	186.0 HV 0.5	90.2 HRB	70.9 µm	70.3 µm	
129	-	199.9 HV 0.5	93.0 HRB	67.9 µm	68.4 µm	
130	-	205.6 HV 0.5	94.1 HRB	68.4 µm	65.9 µm	
131	-	200.6 HV 0.5	93.1 HRB	69.2 µm	66.7 µm	
132	-	187.2 HV 0.5	90.4 HRB	70.2 µm	70.5 µm	
133	-	199.3 HV 0.5	92.9 HRB	68.2 µm	68.2 µm	
134	-	199.8 HV 0.5	93.0 HRB	66.3 µm	69.9 µm	
135	-	200.3 HV 0.5	93.1 HRB	68.5 µm	67.6 µm	
136	-	202.6 HV 0.5	93.5 HRB	67.3 µm	68.1 µm	
137	-	200.0 HV 0.5	93.0 HRB	66.7 µm	69.5 µm	
138	-	194.9 HV 0.5	92.0 HRB	68.2 µm	69.7 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
139	-	201.0 HV 0.5	93.2 HRB	68.6 µm	67.3 µm	
140	-	200.6 HV 0.5	93.1 HRB	66.2 µm	69.7 µm	
141	-	194.6 HV 0.5	91.9 HRB	68.0 µm	70.1 µm	
142	-	185.9 HV 0.5	90.2 HRB	68.8 µm	72.5 µm	
143	-	204.0 HV 0.5	93.8 HRB	67.6 µm	67.2 µm	
144	-	211.8 HV 0.5	95.3 HRB	66.3 µm	66.0 µm	
145	-	220.6 HV 0.5	96.8 HRB	64.7 µm	65.0 µm	
146	-	225.8 HV 0.5	97.6 HRB	64.9 µm	63.2 µm	
147	-	200.4 HV 0.5	93.1 HRB	67.4 µm	68.6 µm	
148	-	180.6 HV 0.5	89.1 HRB	71.9 µm	71.4 µm	
149	-	169.5 HV 0.5	86.2 HRB	74.5 µm	73.4 µm	
150	-	152.6 HV 0.5	80.9 HRB	78.4 µm	77.5 µm	
151	-	155.0 HV 0.5	81.7 HRB	76.6 µm	78.1 µm	
152	-	160.2 HV 0.5	83.4 HRB	76.3 µm	75.8 µm	
153	-	162.5 HV 0.5	84.2 HRB	75.0 µm	76.1 µm	
154	-	163.1 HV 0.5	84.4 HRB	75.9 µm	74.9 µm	
155	-	159.6 HV 0.5	83.2 HRB	76.6 µm	75.9 µm	
156	-	156.7 HV 0.5	82.2 HRB	76.6 µm	77.2 µm	
157	-	157.4 HV 0.5	82.5 HRB	76.6 µm	76.9 µm	
158	-	158.5 HV 0.5	82.8 HRB	76.8 µm	76.2 µm	
159	-	156.7 HV 0.5	82.2 HRB	76.4 µm	77.5 µm	
160	-	174.8 HV 0.5	87.7 HRB	73.1 µm	72.6 µm	
161	-	158.1 HV 0.5	82.7 HRB	77.2 µm	76.0 µm	
162	-	154.4 HV 0.5	81.5 HRB	77.5 µm	77.5 µm	
163	-	157.6 HV 0.5	82.5 HRB	75.6 µm	77.8 µm	
164	-	218.7 HV 0.5	96.5 HRB	65.9 µm	64.4 µm	
165	-	231.4 HV 0.5	98.6 HRB	63.5 µm	63.1 µm	
166	-	209.7 HV 0.5	94.9 HRB	66.0 µm	67.0 µm	
167	-	212.4 HV 0.5	95.4 HRB	67.0 µm	65.2 µm	
168	-	213.6 HV 0.5	95.6 HRB	66.2 µm	65.6 µm	
169	-	194.0 HV 0.5	91.8 HRB	69.7 µm	68.6 µm	
170	-	196.9 HV 0.5	92.4 HRB	69.0 µm	68.2 µm	
171	-	195.0 HV 0.5	92.0 HRB	69.1 µm	68.8 µm	
172	-	176.7 HV 0.5	88.2 HRB	72.1 µm	72.8 µm	
173	-	181.9 HV 0.5	89.4 HRB	70.2 µm	72.6 µm	
174	-	177.8 HV 0.5	88.4 HRB	71.4 µm	73.0 µm	
175	-	176.2 HV 0.5	88.1 HRB	69.5 µm	75.5 µm	
176	-	181.8 HV 0.5	89.4 HRB	69.3 µm	73.6 µm	
177	-	190.6 HV 0.5	91.1 HRB	67.5 µm	72.0 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
178	-	184.1 HV 0.5	89.8 HRB	69.7 µm	72.2 µm	
179	-	182.9 HV 0.5	89.6 HRB	72.7 µm	69.7 µm	
180	-	209.3 HV 0.5	94.9 HRB	67.1 µm	66.0 µm	
181	-	197.8 HV 0.5	92.6 HRB	68.1 µm	68.9 µm	
182	-	216.9 HV 0.5	96.1 HRB	62.3 µm	68.4 µm	
183	-	191.4 HV 0.5	91.3 HRB	72.5 µm	66.8 µm	
184	-	183.7 HV 0.5	89.7 HRB	70.5 µm	71.6 µm	
185	-	173.0 HV 0.5	87.3 HRB	70.6 µm	75.8 µm	
186	-	183.4 HV 0.5	89.7 HRB	73.4 µm	68.8 µm	
187	-	176.3 HV 0.5	88.1 HRB	71.2 µm	73.8 µm	
188	-	194.4 HV 0.5	91.9 HRB	68.4 µm	69.7 µm	
189	-	184.7 HV 0.5	89.9 HRB	70.6 µm	71.1 µm	
190	-	180.4 HV 0.5	89.1 HRB	70.2 µm	73.2 µm	
191	-	203.8 HV 0.5	93.8 HRB	67.0 µm	67.9 µm	
192	-	205.0 HV 0.5	94.0 HRB	67.6 µm	66.9 µm	
193	-	209.1 HV 0.5	94.8 HRB	65.6 µm	67.6 µm	
194	-	174.1 HV 0.5	87.5 HRB	74.3 µm	71.7 µm	
195	-	175.0 HV 0.5	87.8 HRB	73.6 µm	71.9 µm	
196	-	172.7 HV 0.5	87.2 HRB	73.4 µm	73.1 µm	
197	-	155.9 HV 0.5	82.0 HRB	77.6 µm	76.6 µm	
198	-	157.3 HV 0.5	82.4 HRB	77.4 µm	76.2 µm	
199	-	155.7 HV 0.5	81.9 HRB	78.1 µm	76.3 µm	
200	-	155.6 HV 0.5	81.9 HRB	76.9 µm	77.5 µm	
201	-	154.1 HV 0.5	81.4 HRB	78.0 µm	77.1 µm	
202	-	155.5 HV 0.5	81.8 HRB	77.7 µm	76.7 µm	
203	-	158.2 HV 0.5	82.7 HRB	76.9 µm	76.2 µm	
204	-	152.6 HV 0.5	80.9 HRB	77.5 µm	78.4 µm	
205	-	153.0 HV 0.5	81.0 HRB	77.5 µm	78.2 µm	
206	-	155.1 HV 0.5	81.7 HRB	78.1 µm	76.5 µm	
207	-	153.0 HV 0.5	81.0 HRB	77.5 µm	78.2 µm	
208	-	184.3 HV 0.5	89.9 HRB	70.7 µm	71.2 µm	
209	-	199.4 HV 0.5	92.9 HRB	66.2 µm	70.2 µm	
210	-	197.1 HV 0.5	92.4 HRB	68.4 µm	68.8 µm	
211	-	187.3 HV 0.5	90.5 HRB	68.7 µm	72.0 µm	
212	-	198.7 HV 0.5	92.7 HRB	67.8 µm	68.8 µm	
213	-	193.8 HV 0.5	91.8 HRB	68.6 µm	69.7 µm	
214	-	190.7 HV 0.5	91.1 HRB	69.0 µm	70.5 µm	
215	-	184.3 HV 0.5	89.9 HRB	69.4 µm	72.5 µm	
216	-	182.0 HV 0.5	89.4 HRB	69.8 µm	73.0 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
217	-	179.1 HV 0.5	88.8 HRB	70.5 µm	73.4 µm	
218	-	175.0 HV 0.5	87.8 HRB	71.7 µm	73.8 µm	
219	-	182.8 HV 0.5	89.6 HRB	71.9 µm	70.5 µm	
220	-	173.2 HV 0.5	87.3 HRB	71.5 µm	74.8 µm	
221	-	180.9 HV 0.5	89.2 HRB	70.4 µm	72.8 µm	
222	-	184.7 HV 0.5	89.9 HRB	72.3 µm	69.4 µm	
223	-	177.3 HV 0.5	88.3 HRB	73.2 µm	71.4 µm	
224	-	183.7 HV 0.5	89.7 HRB	70.0 µm	72.0 µm	
225	-	171.4 HV 0.5	86.8 HRB	72.5 µm	74.6 µm	
226	-	201.3 HV 0.5	93.3 HRB	66.5 µm	69.2 µm	
227	-	206.8 HV 0.5	94.4 HRB	67.4 µm	66.6 µm	
228	-	190.0 HV 0.5	91.0 HRB	68.8 µm	70.9 µm	
229	-	190.0 HV 0.5	91.0 HRB	69.0 µm	70.8 µm	
230	-	201.9 HV 0.5	93.4 HRB	67.4 µm	68.1 µm	
231	-	225.5 HV 0.5	97.6 HRB	66.1 µm	62.1 µm	
232	-	211.7 HV 0.5	95.3 HRB	66.9 µm	65.5 µm	
233	-	205.3 HV 0.5	94.1 HRB	66.3 µm	68.1 µm	
234	-	192.9 HV 0.5	91.6 HRB	67.7 µm	71.0 µm	
235	-	188.5 HV 0.5	90.7 HRB	69.9 µm	70.4 µm	
236	-	180.7 HV 0.5	89.1 HRB	72.5 µm	70.8 µm	
237	-	177.3 HV 0.5	88.3 HRB	72.6 µm	72.0 µm	
238	-	182.7 HV 0.5	89.5 HRB	68.9 µm	73.6 µm	
239	-	208.4 HV 0.5	94.7 HRB	66.9 µm	66.5 µm	
240	-	174.1 HV 0.5	87.5 HRB	72.5 µm	73.5 µm	
241	-	170.1 HV 0.5	86.4 HRB	71.7 µm	75.9 µm	
242	-	164.5 HV 0.5	84.8 HRB	75.8 µm	74.3 µm	
243	-	173.4 HV 0.5	87.3 HRB	74.5 µm	71.7 µm	
244	-	153.0 HV 0.5	81.0 HRB	80.8 µm	74.9 µm	
245	-	169.6 HV 0.5	86.2 HRB	74.1 µm	73.8 µm	
246	-	150.5 HV 0.5	80.2 HRB	76.8 µm	80.2 µm	
247	-	152.0 HV 0.5	80.7 HRB	78.4 µm	77.8 µm	
248	-	149.5 HV 0.5	79.8 HRB	79.7 µm	77.8 µm	
249	-	149.4 HV 0.5	79.8 HRB	80.0 µm	77.5 µm	
250	-	156.4 HV 0.5	82.1 HRB	78.1 µm	75.9 µm	
251	-	162.1 HV 0.5	84.0 HRB	75.3 µm	76.0 µm	
252	-	180.9 HV 0.5	89.2 HRB	71.3 µm	71.8 µm	
253	-	163.0 HV 0.5	84.3 HRB	76.0 µm	74.9 µm	
254	-	204.6 HV 0.5	93.9 HRB	68.3 µm	66.4 µm	
255	-	196.8 HV 0.5	92.4 HRB	68.1 µm	69.2 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
256	-	175.9 HV 0.5	88.0 HRB	70.5 µm	74.7 µm	
257	-	187.2 HV 0.5	90.4 HRB	70.9 µm	69.9 µm	
258	-	174.3 HV 0.5	87.6 HRB	76.0 µm	69.8 µm	
259	-	187.5 HV 0.5	90.5 HRB	70.2 µm	70.5 µm	
260	-	164.8 HV 0.5	84.9 HRB	74.4 µm	75.7 µm	
261	-	165.2 HV 0.5	85.0 HRB	72.2 µm	77.6 µm	
262	-	157.9 HV 0.5	82.6 HRB	77.2 µm	76.1 µm	
263	-	165.1 HV 0.5	85.0 HRB	75.4 µm	74.5 µm	
264	-	158.7 HV 0.5	82.9 HRB	77.5 µm	75.4 µm	
265	-	172.1 HV 0.5	87.0 HRB	72.8 µm	74.0 µm	
266	-	169.9 HV 0.5	86.3 HRB	74.1 µm	73.7 µm	
267	-	177.2 HV 0.5	88.3 HRB	72.6 µm	72.1 µm	
268	-	186.9 HV 0.5	90.4 HRB	70.0 µm	70.8 µm	
269	-	169.6 HV 0.5	86.2 HRB	73.4 µm	74.4 µm	
270	-	178.2 HV 0.5	88.5 HRB	70.7 µm	73.6 µm	
271	-	183.1 HV 0.5	89.6 HRB	70.5 µm	71.8 µm	
272	-	195.8 HV 0.5	92.2 HRB	69.1 µm	68.5 µm	
273	-	180.9 HV 0.5	89.2 HRB	72.0 µm	71.2 µm	
274	-	187.0 HV 0.5	90.4 HRB	68.9 µm	72.0 µm	
275	-	179.8 HV 0.5	88.9 HRB	71.7 µm	71.9 µm	
276	-	183.9 HV 0.5	89.8 HRB	68.1 µm	73.9 µm	
277	-	196.8 HV 0.5	92.4 HRB	68.6 µm	68.7 µm	
278	-	187.3 HV 0.5	90.5 HRB	69.8 µm	70.9 µm	
279	-	178.6 HV 0.5	88.7 HRB	71.8 µm	72.3 µm	
280	-	176.1 HV 0.5	88.0 HRB	72.1 µm	73.0 µm	
281	-	166.9 HV 0.5	85.5 HRB	73.4 µm	75.7 µm	
282	-	167.7 HV 0.5	85.7 HRB	72.5 µm	76.2 µm	
283	-	175.2 HV 0.5	87.8 HRB	72.5 µm	73.0 µm	
284	-	181.9 HV 0.5	89.4 HRB	71.1 µm	71.8 µm	
285	-	186.8 HV 0.5	90.4 HRB	71.5 µm	69.4 µm	
286	-	177.4 HV 0.5	88.4 HRB	71.5 µm	73.1 µm	
287	-	167.4 HV 0.5	85.6 HRB	73.1 µm	75.7 µm	
288	-	166.7 HV 0.5	85.4 HRB	73.6 µm	75.6 µm	
289	-	163.4 HV 0.5	84.5 HRB	75.0 µm	75.6 µm	
290	-	176.0 HV 0.5	88.0 HRB	72.9 µm	72.2 µm	
291	-	169.2 HV 0.5	86.1 HRB	73.5 µm	74.5 µm	
292	-	171.7 HV 0.5	86.9 HRB	73.9 µm	73.1 µm	
293	-	163.4 HV 0.5	84.5 HRB	74.7 µm	76.0 µm	
294	-	165.5 HV 0.5	85.1 HRB	75.1 µm	74.6 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
295	-	170.9 HV 0.5	86.6 HRB	73.6 µm	73.7 µm	
296	-	166.7 HV 0.5	85.4 HRB	74.2 µm	75.0 µm	
297	-	167.0 HV 0.5	85.5 HRB	73.0 µm	76.1 µm	
298	-	167.2 HV 0.5	85.6 HRB	73.3 µm	75.6 µm	
299	-	169.5 HV 0.5	86.2 HRB	74.4 µm	73.5 µm	
300	-	172.1 HV 0.5	87.0 HRB	74.7 µm	72.1 µm	
301	-	174.5 HV 0.5	87.6 HRB	75.3 µm	70.5 µm	
302	-	179.7 HV 0.5	88.9 HRB	72.1 µm	71.6 µm	
303	-	178.4 HV 0.5	88.6 HRB	72.7 µm	71.5 µm	
304	-	162.8 HV 0.5	84.3 HRB	76.7 µm	74.3 µm	
305	-	180.2 HV 0.5	89.0 HRB	71.9 µm	71.5 µm	
306	-	168.6 HV 0.5	85.9 HRB	74.1 µm	74.2 µm	
307	-	164.4 HV 0.5	84.8 HRB	73.3 µm	76.9 µm	
308	-	162.2 HV 0.5	84.1 HRB	74.5 µm	76.7 µm	
309	-	158.4 HV 0.5	82.8 HRB	75.5 µm	77.5 µm	
310	-	169.8 HV 0.5	86.3 HRB	74.8 µm	73.0 µm	
311	-	187.2 HV 0.5	90.4 HRB	68.7 µm	72.1 µm	
312	-	168.3 HV 0.5	85.8 HRB	73.7 µm	74.7 µm	
313	-	177.5 HV 0.5	88.4 HRB	70.4 µm	74.2 µm	
314	-	177.0 HV 0.5	88.2 HRB	70.6 µm	74.2 µm	
315	-	178.1 HV 0.5	88.5 HRB	73.3 µm	71.0 µm	
316	-	182.5 HV 0.5	89.5 HRB	73.7 µm	68.8 µm	
317	-	174.8 HV 0.5	87.7 HRB	71.8 µm	73.8 µm	
318	-	196.2 HV 0.5	92.2 HRB	70.4 µm	67.1 µm	
319	-	194.0 HV 0.5	91.8 HRB	66.9 µm	71.4 µm	
320	-	185.5 HV 0.5	90.1 HRB	68.4 µm	73.0 µm	
321	-	189.1 HV 0.5	90.8 HRB	68.6 µm	71.4 µm	
322	-	183.9 HV 0.5	89.8 HRB	72.3 µm	69.7 µm	
323	-	185.5 HV 0.5	90.1 HRB	69.3 µm	72.1 µm	
324	-	180.2 HV 0.5	89.0 HRB	69.8 µm	73.6 µm	
325	-	180.4 HV 0.5	89.1 HRB	71.4 µm	72.0 µm	
326	-	176.8 HV 0.5	88.2 HRB	70.0 µm	74.9 µm	
327	-	169.9 HV 0.5	86.3 HRB	74.7 µm	73.0 µm	
328	-	179.3 HV 0.5	88.8 HRB	70.8 µm	73.1 µm	
329	-	159.5 HV 0.5	83.2 HRB	74.9 µm	77.6 µm	
330	-	169.2 HV 0.5	86.1 HRB	73.4 µm	74.6 µm	
331	-	182.7 HV 0.5	89.5 HRB	70.5 µm	72.0 µm	
332	-	184.2 HV 0.5	89.8 HRB	69.6 µm	72.3 µm	
333	-	167.1 HV 0.5	85.5 HRB	74.5 µm	74.4 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
334	-	166.4 HV 0.5	85.4 HRB	73.1 µm	76.2 µm	
335	-	163.1 HV 0.5	84.4 HRB	75.1 µm	75.7 µm	
336	-	164.4 HV 0.5	84.8 HRB	76.1 µm	74.1 µm	
337	-	170.8 HV 0.5	86.6 HRB	73.4 µm	74.0 µm	
338	-	159.4 HV 0.5	83.1 HRB	76.1 µm	76.4 µm	
339	-	169.0 HV 0.5	86.0 HRB	73.5 µm	74.6 µm	
340	-	171.0 HV 0.5	86.7 HRB	73.9 µm	73.4 µm	
341	-	163.4 HV 0.5	84.5 HRB	75.6 µm	75.1 µm	
342	-	160.6 HV 0.5	83.5 HRB	77.3 µm	74.6 µm	
343	-	172.7 HV 0.5	87.2 HRB	73.1 µm	73.5 µm	
344	-	156.6 HV 0.5	82.2 HRB	77.4 µm	76.5 µm	
345	-	182.4 HV 0.5	89.5 HRB	73.4 µm	69.2 µm	
346	-	163.5 HV 0.5	84.5 HRB	74.4 µm	76.2 µm	
347	-	160.2 HV 0.5	83.4 HRB	76.0 µm	76.1 µm	
348	-	182.1 HV 0.5	89.4 HRB	70.8 µm	72.0 µm	
349	-	172.0 HV 0.5	87.0 HRB	75.0 µm	71.8 µm	
350	-	164.2 HV 0.5	84.7 HRB	76.1 µm	74.2 µm	
351	-	163.1 HV 0.5	84.4 HRB	74.1 µm	76.7 µm	
352	-	166.7 HV 0.5	85.4 HRB	73.1 µm	76.0 µm	
353	-	163.3 HV 0.5	84.4 HRB	75.4 µm	75.2 µm	
354	-	164.5 HV 0.5	84.8 HRB	74.3 µm	75.9 µm	
355	-	165.1 HV 0.5	85.0 HRB	74.9 µm	75.0 µm	
356	-	171.5 HV 0.5	86.8 HRB	74.5 µm	72.6 µm	
357	-	167.2 HV 0.5	85.5 HRB	74.7 µm	74.3 µm	
358	-	164.0 HV 0.5	84.7 HRB	72.1 µm	78.3 µm	
359	-	176.7 HV 0.5	88.2 HRB	71.4 µm	73.5 µm	
360	-	169.6 HV 0.5	86.2 HRB	71.2 µm	76.7 µm	
361	-	169.0 HV 0.5	86.0 HRB	71.1 µm	77.0 µm	
362	-	172.8 HV 0.5	87.2 HRB	71.5 µm	75.0 µm	
363	-	171.3 HV 0.5	86.8 HRB	73.2 µm	74.0 µm	
364	-	176.9 HV 0.5	88.2 HRB	71.6 µm	73.2 µm	
365	-	182.1 HV 0.5	89.4 HRB	71.2 µm	71.5 µm	
366	-	182.2 HV 0.5	89.4 HRB	70.8 µm	71.9 µm	
367	-	180.1 HV 0.5	89.0 HRB	70.5 µm	73.0 µm	
368	-	184.5 HV 0.5	89.9 HRB	69.5 µm	72.3 µm	
369	-	180.2 HV 0.5	89.0 HRB	72.4 µm	71.1 µm	
370	-	171.5 HV 0.5	86.8 HRB	72.5 µm	74.5 µm	
371	-	171.9 HV 0.5	87.0 HRB	73.7 µm	73.2 µm	
372	-	165.8 HV 0.5	85.2 HRB	74.3 µm	75.3 µm	

www.advintegrity.com Page 11 of 23

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
373	-	171.8 HV 0.5	86.9 HRB	75.0 µm	71.9 µm	
374	-	163.4 HV 0.5	84.5 HRB	73.4 µm	77.3 µm	
375	-	165.9 HV 0.5	85.2 HRB	74.8 µm	74.8 µm	
376	-	176.5 HV 0.5	88.1 HRB	73.0 µm	72.0 µm	
377	-	164.9 HV 0.5	85.0 HRB	73.7 µm	76.2 µm	
378	-	164.3 HV 0.5	84.8 HRB	75.5 µm	74.8 µm	
379	-	169.5 HV 0.5	86.2 HRB	73.9 µm	74.0 µm	
380	-	172.8 HV 0.5	87.2 HRB	73.2 µm	73.3 µm	
381	-	163.7 HV 0.5	84.6 HRB	74.3 µm	76.2 µm	
382	-	158.7 HV 0.5	82.9 HRB	75.9 µm	77.0 µm	
383	-	164.7 HV 0.5	84.9 HRB	76.3 µm	73.8 µm	
384	-	159.2 HV 0.5	83.1 HRB	76.6 µm	76.0 µm	
385	-	166.4 HV 0.5	85.4 HRB	75.2 µm	74.1 µm	
386	-	164.0 HV 0.5	84.7 HRB	74.7 µm	75.7 µm	
387	-	157.9 HV 0.5	82.6 HRB	75.5 µm	77.8 µm	
388	-	173.8 HV 0.5	87.5 HRB	72.7 µm	73.3 µm	
389	-	171.3 HV 0.5	86.8 HRB	74.0 µm	73.2 µm	
390	-	158.3 HV 0.5	82.8 HRB	76.3 µm	76.8 µm	
391	-	175.0 HV 0.5	87.7 HRB	72.3 µm	73.3 µm	
392	-	175.0 HV 0.5	87.8 HRB	73.5 µm	72.0 µm	
393	-	170.2 HV 0.5	86.4 HRB	73.7 µm	73.9 µm	
394	-	174.4 HV 0.5	87.6 HRB	71.9 µm	73.9 µm	
395	-	163.8 HV 0.5	84.6 HRB	74.8 µm	75.6 µm	
396	-	161.4 HV 0.5	83.8 HRB	76.3 µm	75.2 µm	
397	-	159.3 HV 0.5	83.1 HRB	76.1 µm	76.5 µm	
398	-	165.5 HV 0.5	85.1 HRB	73.7 µm	76.0 µm	
399	-	160.3 HV 0.5	83.4 HRB	73.6 µm	78.5 µm	
400	-	161.8 HV 0.5	83.9 HRB	76.1 µm	75.2 µm	
401	-	166.1 HV 0.5	85.3 HRB	73.8 µm	75.7 µm	
402	-	163.4 HV 0.5	84.5 HRB	74.9 µm	75.8 µm	
403	-	170.0 HV 0.5	86.3 HRB	74.7 µm	73.0 µm	
404	-	167.4 HV 0.5	85.6 HRB	75.9 µm	72.9 µm	
405	-	168.5 HV 0.5	85.9 HRB	73.4 µm	75.0 µm	
406	-	172.2 HV 0.5	87.0 HRB	71.9 µm	74.8 µm	
407	-	174.2 HV 0.5	87.5 HRB	72.9 µm	73.1 µm	
408	-	172.8 HV 0.5	87.2 HRB	73.0 µm	73.5 µm	
409	-	168.9 HV 0.5	86.0 HRB	75.9 µm	72.3 µm	
410	-	189.2 HV 0.5	90.8 HRB	69.6 µm	70.5 µm	
411	-	179.0 HV 0.5	88.7 HRB	71.3 µm	72.6 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
412	-	182.6 HV 0.5	89.5 HRB	71.7 µm	70.9 µm	
413	-	182.2 HV 0.5	89.4 HRB	70.7 µm	72.0 µm	
414	-	175.7 HV 0.5	87.9 HRB	70.6 µm	74.7 µm	
415	-	174.1 HV 0.5	87.5 HRB	72.6 µm	73.3 µm	
416	-	175.2 HV 0.5	87.8 HRB	70.4 µm	75.1 µm	
417	-	169.1 HV 0.5	86.0 HRB	72.6 µm	75.5 µm	
418	-	180.9 HV 0.5	89.2 HRB	71.0 µm	72.2 µm	
419	-	170.8 HV 0.5	86.6 HRB	73.1 µm	74.3 µm	
420	-	166.3 HV 0.5	85.3 HRB	73.7 µm	75.6 µm	
421	-	161.8 HV 0.5	83.9 HRB	74.9 µm	76.5 µm	
422	-	172.6 HV 0.5	87.2 HRB	72.6 µm	73.9 µm	
423	-	172.8 HV 0.5	87.2 HRB	71.3 µm	75.2 µm	
424	-	166.7 HV 0.5	85.4 HRB	73.8 µm	75.3 µm	
425	-	162.8 HV 0.5	84.3 HRB	77.0 µm	74.0 µm	
426	-	166.3 HV 0.5	85.3 HRB	74.3 µm	75.0 µm	
427	-	166.7 HV 0.5	85.4 HRB	75.7 µm	73.4 µm	
428	-	164.6 HV 0.5	84.9 HRB	75.0 µm	75.2 µm	
429	-	177.3 HV 0.5	88.3 HRB	73.4 µm	71.3 µm	
430	-	164.7 HV 0.5	84.9 HRB	73.8 µm	76.2 µm	
431	-	165.1 HV 0.5	85.0 HRB	75.3 µm	74.6 µm	
432	-	165.4 HV 0.5	85.1 HRB	74.4 µm	75.3 µm	
433	-	165.1 HV 0.5	85.0 HRB	75.0 µm	74.9 µm	
434	-	167.8 HV 0.5	85.7 HRB	73.8 µm	74.9 µm	
435	-	170.7 HV 0.5	86.6 HRB	73.3 µm	74.1 µm	
436	-	176.3 HV 0.5	88.1 HRB	72.2 µm	72.9 µm	
437	-	171.0 HV 0.5	86.7 HRB	73.3 µm	74.0 µm	
438	-	176.3 HV 0.5	88.1 HRB	72.8 µm	72.3 µm	
439	-	175.1 HV 0.5	87.8 HRB	72.8 µm	72.7 µm	
440	-	156.7 HV 0.5	82.2 HRB	78.0 µm	75.8 µm	
441	-	165.0 HV 0.5	85.0 HRB	73.1 µm	76.8 µm	
442	-	161.6 HV 0.5	83.9 HRB	74.2 µm	77.3 µm	
443	-	156.3 HV 0.5	82.1 HRB	75.9 µm	78.2 µm	
444	-	161.9 HV 0.5	84.0 HRB	75.2 µm	76.2 µm	
445	-	165.3 HV 0.5	85.1 HRB	73.9 µm	75.9 µm	
446	-	157.5 HV 0.5	82.5 HRB	75.8 µm	77.7 µm	
447	-	163.1 HV 0.5	84.4 HRB	74.6 µm	76.2 µm	
448	-	179.8 HV 0.5	89.0 HRB	71.5 µm	72.1 µm	
449	-	171.0 HV 0.5	86.7 HRB	72.4 µm	74.9 µm	
450	-	160.4 HV 0.5	83.5 HRB	75.0 µm	77.0 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
451	-	174.5 HV 0.5	87.6 HRB	72.3 µm	73.5 µm	
452	-	184.1 HV 0.5	89.8 HRB	71.5 µm	70.4 µm	
453	-	169.4 HV 0.5	86.1 HRB	72.5 µm	75.4 µm	
454	-	163.2 HV 0.5	84.4 HRB	73.4 µm	77.3 µm	
455	-	178.6 HV 0.5	88.6 HRB	71.8 µm	72.3 µm	
456	-	186.8 HV 0.5	90.4 HRB	71.9 µm	69.0 µm	
457	-	181.8 HV 0.5	89.4 HRB	72.0 µm	70.8 µm	
458	-	178.5 HV 0.5	88.6 HRB	71.1 µm	73.1 µm	
459	-	173.0 HV 0.5	87.2 HRB	71.2 µm	75.2 µm	
460	-	178.5 HV 0.5	88.6 HRB	72.1 µm	72.1 µm	
461	-	182.4 HV 0.5	89.5 HRB	70.8 µm	71.8 µm	
462	-	191.3 HV 0.5	91.3 HRB	71.5 µm	67.8 µm	
463	-	191.7 HV 0.5	91.3 HRB	68.7 µm	70.4 µm	
464	-	182.9 HV 0.5	89.6 HRB	71.3 µm	71.1 µm	
465	-	174.4 HV 0.5	87.6 HRB	72.9 µm	72.9 µm	
466	-	180.9 HV 0.5	89.2 HRB	71.7 µm	71.5 µm	
467	-	175.2 HV 0.5	87.8 HRB	72.0 µm	73.5 µm	
468	-	171.5 HV 0.5	86.8 HRB	73.1 µm	74.0 µm	
469	-	169.5 HV 0.5	86.2 HRB	72.4 µm	75.5 µm	
470	-	171.6 HV 0.5	86.9 HRB	73.5 µm	73.5 µm	
471	-	169.6 HV 0.5	86.2 HRB	73.9 µm	74.0 µm	
472	-	182.5 HV 0.5	89.5 HRB	71.2 µm	71.3 µm	
473	-	168.7 HV 0.5	85.9 HRB	74.0 µm	74.3 µm	
474	-	158.5 HV 0.5	82.8 HRB	76.1 µm	76.9 µm	
475	-	171.9 HV 0.5	87.0 HRB	74.6 µm	72.3 µm	
476	-	170.9 HV 0.5	86.6 HRB	74.3 µm	73.0 µm	
477	-	166.8 HV 0.5	85.4 HRB	75.2 µm	73.9 µm	
478	-	160.0 HV 0.5	83.3 HRB	76.4 µm	75.9 µm	
479	-	155.3 HV 0.5	81.8 HRB	73.1 µm	81.4 µm	
480	-	173.7 HV 0.5	87.4 HRB	74.0 µm	72.1 µm	
481	-	180.5 HV 0.5	89.1 HRB	72.6 µm	70.8 µm	
482	-	176.5 HV 0.5	88.1 HRB	73.7 µm	71.3 µm	
483	-	162.2 HV 0.5	84.1 HRB	76.3 µm	74.9 µm	
484	-	167.2 HV 0.5	85.5 HRB	72.3 µm	76.6 µm	
485	-	165.2 HV 0.5	85.1 HRB	72.8 µm	77.0 µm	
486	-	162.3 HV 0.5	84.1 HRB	75.3 µm	75.9 µm	
487	-	168.7 HV 0.5	85.9 HRB	72.9 µm	75.4 µm	
488	-	158.6 HV 0.5	82.9 HRB	77.5 µm	75.4 µm	
489	-	163.5 HV 0.5	84.5 HRB	74.7 µm	75.9 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
490	-	173.5 HV 0.5	87.4 HRB	74.6 µm	71.6 µm	
491	-	180.0 HV 0.5	89.0 HRB	71.4 µm	72.1 µm	
492	-	166.7 HV 0.5	85.4 HRB	72.3 µm	76.8 µm	
493	-	173.4 HV 0.5	87.4 HRB	69.6 µm	76.6 µm	
494	-	175.3 HV 0.5	87.8 HRB	72.0 µm	73.5 µm	
495	-	179.8 HV 0.5	89.0 HRB	71.3 µm	72.3 µm	
496	-	178.1 HV 0.5	88.5 HRB	73.7 µm	70.6 µm	
497	-	179.0 HV 0.5	88.8 HRB	72.5 µm	71.5 µm	
498	-	184.7 HV 0.5	89.9 HRB	70.2 µm	71.5 µm	
499	-	183.9 HV 0.5	89.8 HRB	69.2 µm	72.8 µm	
500	-	184.5 HV 0.5	89.9 HRB	70.6 µm	71.2 µm	
501	-	167.6 HV 0.5	85.6 HRB	75.7 µm	73.0 µm	
502	-	181.9 HV 0.5	89.4 HRB	70.5 µm	72.3 µm	
503	-	177.2 HV 0.5	88.3 HRB	71.0 µm	73.6 µm	
504	-	191.1 HV 0.5	91.2 HRB	69.1 µm	70.2 µm	
505	-	179.3 HV 0.5	88.8 HRB	70.1 µm	73.7 µm	
506	-	168.8 HV 0.5	86.0 HRB	75.3 µm	73.0 µm	
507	-	182.4 HV 0.5	89.5 HRB	69.7 µm	72.9 µm	
508	-	175.4 HV 0.5	87.9 HRB	72.7 µm	72.7 µm	
509	-	176.7 HV 0.5	88.2 HRB	72.2 µm	72.7 µm	
510	-	163.3 HV 0.5	84.4 HRB	75.4 µm	75.2 µm	
511	-	175.7 HV 0.5	87.9 HRB	71.0 µm	74.2 µm	
512	-	171.5 HV 0.5	86.8 HRB	71.2 µm	75.8 µm	
513	-	176.0 HV 0.5	88.0 HRB	71.8 µm	73.4 µm	
514	-	181.6 HV 0.5	89.3 HRB	72.2 µm	70.7 µm	
515	-	171.0 HV 0.5	86.7 HRB	72.2 µm	75.1 µm	
516	-	174.3 HV 0.5	87.6 HRB	74.0 µm	71.9 µm	
517	-	165.8 HV 0.5	85.2 HRB	76.4 µm	73.1 µm	
518	-	167.7 HV 0.5	85.7 HRB	73.5 µm	75.2 µm	
519	-	184.3 HV 0.5	89.9 HRB	71.6 µm	70.3 µm	
520	-	162.7 HV 0.5	84.2 HRB	75.3 µm	75.7 µm	
521	-	177.2 HV 0.5	88.3 HRB	71.6 µm	73.1 µm	
522	-	164.6 HV 0.5	84.9 HRB	74.9 µm	75.2 µm	
523	-	172.6 HV 0.5	87.2 HRB	73.0 µm	73.6 µm	
524	-	162.7 HV 0.5	84.2 HRB	75.2 µm	75.8 µm	
525	-	175.1 HV 0.5	87.8 HRB	73.4 µm	72.1 µm	
526	-	166.7 HV 0.5	85.4 HRB	74.4 µm	74.8 µm	
527	-	168.1 HV 0.5	85.8 HRB	73.1 µm	75.4 µm	
528	-	158.8 HV 0.5	82.9 HRB	75.5 µm	77.3 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
529	-	176.9 HV 0.5	88.2 HRB	73.0 µm	71.7 µm	
530	-	156.6 HV 0.5	82.2 HRB	76.6 µm	77.3 µm	
531	-	157.9 HV 0.5	82.6 HRB	75.8 µm	77.5 µm	
532	-	157.3 HV 0.5	82.4 HRB	76.2 µm	77.3 µm	
533	-	163.8 HV 0.5	84.6 HRB	74.9 µm	75.6 µm	
534	-	151.6 HV 0.5	80.5 HRB	75.5 µm	80.9 µm	
535	-	172.5 HV 0.5	87.1 HRB	73.8 µm	72.8 µm	
536	-	162.8 HV 0.5	84.3 HRB	73.6 µm	77.4 µm	
537	-	161.2 HV 0.5	83.7 HRB	74.4 µm	77.3 µm	
538	-	156.5 HV 0.5	82.2 HRB	77.1 µm	76.9 µm	
539	-	183.9 HV 0.5	89.8 HRB	70.6 µm	71.4 µm	
540	-	164.6 HV 0.5	84.9 HRB	73.6 µm	76.5 µm	
541	-	162.7 HV 0.5	84.2 HRB	74.4 µm	76.6 µm	
542	-	167.7 HV 0.5	85.7 HRB	73.6 µm	75.1 µm	
543	-	166.4 HV 0.5	85.4 HRB	72.5 µm	76.7 µm	
544	-	172.7 HV 0.5	87.2 HRB	73.0 µm	73.5 µm	
545	-	168.7 HV 0.5	85.9 HRB	73.9 µm	74.3 µm	
546	-	180.4 HV 0.5	89.1 HRB	69.9 µm	73.5 µm	
547	-	172.0 HV 0.5	87.0 HRB	70.6 µm	76.2 µm	
548	-	190.2 HV 0.5	91.0 HRB	67.5 µm	72.2 µm	
549	-	193.4 HV 0.5	91.7 HRB	67.8 µm	70.7 µm	
550	-	182.3 HV 0.5	89.5 HRB	68.3 µm	74.3 µm	
551	-	183.4 HV 0.5	89.7 HRB	71.1 µm	71.1 µm	
552	-	190.2 HV 0.5	91.0 HRB	68.4 µm	71.2 µm	
553	-	175.1 HV 0.5	87.8 HRB	70.2 µm	75.3 µm	
554	-	186.9 HV 0.5	90.4 HRB	69.2 µm	71.7 µm	
555	-	181.1 HV 0.5	89.2 HRB	70.7 µm	72.4 µm	
556	-	171.4 HV 0.5	86.8 HRB	72.2 µm	74.9 µm	
557	-	175.3 HV 0.5	87.8 HRB	71.8 µm	73.7 µm	
558	-	177.5 HV 0.5	88.4 HRB	71.2 µm	73.3 µm	
559	-	173.8 HV 0.5	87.5 HRB	71.4 µm	74.7 µm	
560	-	163.9 HV 0.5	84.6 HRB	72.9 µm	77.5 µm	
561	-	174.0 HV 0.5	87.5 HRB	72.0 µm	74.0 µm	
562	-	179.8 HV 0.5	88.9 HRB	71.7 µm	71.9 µm	
563	-	183.7 HV 0.5	89.7 HRB	71.5 µm	70.5 µm	
564	-	182.7 HV 0.5	89.5 HRB	71.1 µm	71.4 µm	
565	-	171.6 HV 0.5	86.9 HRB	73.9 µm	73.1 µm	
566	-	183.4 HV 0.5	89.7 HRB	70.6 µm	71.6 µm	
567	-	185.6 HV 0.5	90.1 HRB	70.9 µm	70.5 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
568	-	181.4 HV 0.5	89.3 HRB	71.1 µm	71.9 µm	
569	-	168.2 HV 0.5	85.8 HRB	74.2 µm	74.3 µm	
570	-	182.8 HV 0.5	89.6 HRB	70.8 µm	71.6 µm	
571	-	179.4 HV 0.5	88.8 HRB	72.0 µm	71.8 µm	
572	-	170.6 HV 0.5	86.5 HRB	73.7 µm	73.7 µm	
573	-	173.5 HV 0.5	87.4 HRB	73.2 µm	73.0 µm	
574	-	164.3 HV 0.5	84.8 HRB	75.4 µm	74.9 µm	
575	-	167.1 HV 0.5	85.5 HRB	75.3 µm	73.7 µm	
576	-	169.1 HV 0.5	86.0 HRB	73.5 µm	74.6 µm	
577	-	160.9 HV 0.5	83.6 HRB	76.6 µm	75.2 µm	
578	-	169.1 HV 0.5	86.0 HRB	73.8 µm	74.3 µm	
579	-	164.2 HV 0.5	84.7 HRB	75.4 µm	74.9 µm	
580	-	165.3 HV 0.5	85.1 HRB	75.2 µm	74.6 µm	
581	-	162.7 HV 0.5	84.2 HRB	74.8 µm	76.2 µm	
582	-	163.7 HV 0.5	84.6 HRB	75.6 µm	74.9 µm	
583	-	155.9 HV 0.5	82.0 HRB	75.5 µm	78.7 µm	
584	-	163.0 HV 0.5	84.3 HRB	74.9 µm	75.9 µm	
585	-	155.1 HV 0.5	81.7 HRB	79.0 µm	75.6 µm	
586	-	172.0 HV 0.5	87.0 HRB	72.0 µm	74.8 µm	
587	-	166.8 HV 0.5	85.4 HRB	72.0 µm	77.1 µm	
588	-	169.0 HV 0.5	86.0 HRB	74.7 µm	73.4 µm	
589	-	164.6 HV 0.5	84.9 HRB	75.0 µm	75.1 µm	
590	-	170.0 HV 0.5	86.3 HRB	71.5 µm	76.2 µm	
591	-	173.8 HV 0.5	87.4 HRB	72.5 µm	73.6 µm	
592	-	183.2 HV 0.5	89.6 HRB	72.1 µm	70.2 µm	
593	-	184.3 HV 0.5	89.9 HRB	71.5 µm	70.4 µm	
594	-	187.3 HV 0.5	90.5 HRB	68.9 µm	71.8 µm	
595	-	182.2 HV 0.5	89.4 HRB	70.0 µm	72.7 µm	
596	-	176.6 HV 0.5	88.2 HRB	71.0 µm	73.9 µm	
597	-	197.5 HV 0.5	92.5 HRB	69.7 µm	67.3 µm	
598	-	198.1 HV 0.5	92.6 HRB	67.7 µm	69.1 µm	
599	-	185.6 HV 0.5	90.1 HRB	70.9 µm	70.5 µm	
600	-	193.3 HV 0.5	91.7 HRB	69.1 µm	69.4 µm	
601	-	185.2 HV 0.5	90.0 HRB	71.1 µm	70.4 µm	
602	-	192.0 HV 0.5	91.4 HRB	70.1 µm	68.9 µm	
603	-	189.3 HV 0.5	90.9 HRB	70.0 µm	69.9 µm	
604	-	189.1 HV 0.5	90.8 HRB	69.8 µm	70.2 µm	
605	-	169.9 HV 0.5	86.3 HRB	73.4 µm	74.4 µm	
606	-	181.0 HV 0.5	89.2 HRB	71.4 µm	71.7 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
607	-	166.6 HV 0.5	85.4 HRB	71.4 µm	77.8 µm	
608	-	175.1 HV 0.5	87.8 HRB	71.4 µm	74.1 µm	
609	-	184.9 HV 0.5	90.0 HRB	70.1 µm	71.5 µm	
610	-	179.5 HV 0.5	88.9 HRB	73.4 µm	70.3 µm	
611	-	174.1 HV 0.5	87.5 HRB	70.0 µm	76.0 µm	
612	-	163.1 HV 0.5	84.4 HRB	76.3 µm	74.5 µm	
613	-	161.0 HV 0.5	83.7 HRB	75.1 µm	76.7 µm	
614	-	167.0 HV 0.5	85.5 HRB	75.2 µm	73.8 µm	
615	-	170.3 HV 0.5	86.4 HRB	71.6 µm	75.9 µm	
616	-	176.9 HV 0.5	88.2 HRB	73.7 µm	71.1 µm	
617	-	163.7 HV 0.5	84.6 HRB	73.7 µm	76.8 µm	
618	-	167.7 HV 0.5	85.7 HRB	76.3 µm	72.4 µm	
619	-	155.8 HV 0.5	81.9 HRB	76.5 µm	77.8 µm	
620	-	156.0 HV 0.5	82.0 HRB	75.0 µm	79.2 µm	
621	-	175.0 HV 0.5	87.7 HRB	73.0 µm	72.6 µm	
622	-	170.4 HV 0.5	86.5 HRB	74.2 µm	73.3 µm	
623	-	180.6 HV 0.5	89.1 HRB	71.6 µm	71.7 µm	
624	-	166.6 HV 0.5	85.4 HRB	74.8 µm	74.4 µm	
625	-	156.6 HV 0.5	82.2 HRB	78.3 µm	75.6 µm	
626	-	174.6 HV 0.5	87.7 HRB	71.5 µm	74.2 µm	
627	-	163.7 HV 0.5	84.6 HRB	76.2 µm	74.3 µm	
628	-	174.5 HV 0.5	87.6 HRB	71.5 µm	74.3 µm	
629	-	184.4 HV 0.5	89.9 HRB	69.5 µm	72.3 µm	
630	-	182.9 HV 0.5	89.6 HRB	71.4 µm	71.0 µm	
631	-	179.7 HV 0.5	88.9 HRB	69.6 µm	74.1 µm	
632	-	165.7 HV 0.5	85.2 HRB	74.4 µm	75.2 µm	
633	-	179.0 HV 0.5	88.8 HRB	72.0 µm	71.9 µm	
634	-	180.0 HV 0.5	89.0 HRB	69.6 µm	74.0 µm	
635	-	185.7 HV 0.5	90.1 HRB	69.9 µm	71.4 µm	
636	-	178.7 HV 0.5	88.7 HRB	72.5 µm	71.6 µm	
637	-	176.7 HV 0.5	88.2 HRB	71.9 µm	73.0 µm	
638	-	178.6 HV 0.5	88.7 HRB	69.3 µm	74.8 µm	
639	-	183.4 HV 0.5	89.7 HRB	70.7 µm	71.5 µm	
640	-	190.5 HV 0.5	91.1 HRB	69.3 µm	70.3 µm	
641	-	195.3 HV 0.5	92.1 HRB	66.7 µm	71.1 µm	
642	-	203.0 HV 0.5	93.6 HRB	68.1 µm	67.1 µm	
643	-	185.1 HV 0.5	90.0 HRB	72.0 µm	69.6 µm	
644	-	199.9 HV 0.5	93.0 HRB	67.8 µm	68.4 µm	
645	-	201.5 HV 0.5	93.3 HRB	68.5 µm	67.1 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
646	-	201.3 HV 0.5	93.3 HRB	65.9 µm	69.8 µm	
647	-	200.8 HV 0.5	93.2 HRB	67.8 µm	68.1 µm	
648	-	185.6 HV 0.5	90.1 HRB	70.2 µm	71.2 µm	
649	-	207.1 HV 0.5	94.4 HRB	66.1 µm	67.7 µm	
650	-	189.7 HV 0.5	90.9 HRB	70.1 µm	69.8 µm	
651	-	199.7 HV 0.5	92.9 HRB	67.7 µm	68.6 µm	
652	-	191.8 HV 0.5	91.4 HRB	71.8 µm	67.2 µm	
653	-	190.9 HV 0.5	91.2 HRB	71.5 µm	67.9 µm	
654	-	182.4 HV 0.5	89.5 HRB	68.3 µm	74.3 µm	
655	-	187.5 HV 0.5	90.5 HRB	71.2 µm	69.4 µm	
656	-	197.3 HV 0.5	92.5 HRB	68.6 µm	68.5 µm	
657	-	197.1 HV 0.5	92.4 HRB	69.7 µm	67.5 µm	
658	-	164.5 HV 0.5	84.8 HRB	74.1 µm	76.1 µm	
659	-	155.9 HV 0.5	82.0 HRB	76.9 µm	77.3 µm	
660	-	161.5 HV 0.5	83.8 HRB	74.1 µm	77.4 µm	
661	-	161.0 HV 0.5	83.7 HRB	75.1 µm	76.7 µm	
662	-	163.5 HV 0.5	84.5 HRB	73.8 µm	76.8 µm	
663	-	182.1 HV 0.5	89.4 HRB	71.1 µm	71.7 µm	
664	-	181.0 HV 0.5	89.2 HRB	71.0 µm	72.2 µm	
665	-	176.6 HV 0.5	88.2 HRB	70.7 µm	74.2 µm	
666	-	173.6 HV 0.5	87.4 HRB	71.0 µm	75.2 µm	
667	-	188.6 HV 0.5	90.7 HRB	69.7 µm	70.5 µm	
668	-	187.8 HV 0.5	90.6 HRB	68.7 µm	71.8 µm	
669	-	183.0 HV 0.5	89.6 HRB	69.9 µm	72.5 µm	
670	-	177.5 HV 0.5	88.4 HRB	70.9 µm	73.6 µm	
671	-	174.1 HV 0.5	87.5 HRB	73.9 µm	72.0 µm	
672	-	190.8 HV 0.5	91.2 HRB	69.0 µm	70.4 µm	
673	-	184.4 HV 0.5	89.9 HRB	72.0 µm	69.8 µm	
674	-	179.6 HV 0.5	88.9 HRB	71.9 µm	71.8 µm	
675	-	174.3 HV 0.5	87.6 HRB	72.4 µm	73.4 µm	
676	-	173.0 HV 0.5	87.2 HRB	73.7 µm	72.7 µm	
677	-	199.3 HV 0.5	92.9 HRB	66.3 µm	70.1 µm	
678	-	188.4 HV 0.5	90.7 HRB	69.3 µm	71.0 µm	
679	-	190.4 HV 0.5	91.1 HRB	69.8 µm	69.8 µm	
680	-	180.7 HV 0.5	89.1 HRB	70.9 µm	72.3 µm	
681	-	180.6 HV 0.5	89.1 HRB	72.8 µm	70.5 µm	
682	-	191.3 HV 0.5	91.3 HRB	70.4 µm	68.9 µm	
683	-	189.7 HV 0.5	90.9 HRB	69.9 µm	70.0 µm	
684	-	179.5 HV 0.5	88.9 HRB	72.5 µm	71.3 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
685	-	180.6 HV 0.5	89.1 HRB	69.4 µm	73.9 µm	
686	-	206.1 HV 0.5	94.2 HRB	67.1 µm	67.0 µm	
687	-	193.4 HV 0.5	91.7 HRB	69.6 µm	68.9 µm	
688	-	203.9 HV 0.5	93.8 HRB	66.9 µm	68.0 µm	
689	-	198.3 HV 0.5	92.7 HRB	68.0 µm	68.7 µm	
690	-	191.9 HV 0.5	91.4 HRB	66.4 µm	72.6 µm	
691	-	198.4 HV 0.5	92.7 HRB	67.5 µm	69.2 µm	
692	-	174.8 HV 0.5	87.7 HRB	73.1 µm	72.6 µm	
693	-	190.8 HV 0.5	91.2 HRB	70.0 µm	69.4 µm	
694	-	174.5 HV 0.5	87.6 HRB	73.6 µm	72.2 µm	
695	-	189.6 HV 0.5	90.9 HRB	70.4 µm	69.5 µm	
696	-	189.3 HV 0.5	90.9 HRB	69.4 µm	70.6 µm	
697	-	178.0 HV 0.5	88.5 HRB	72.5 µm	71.9 µm	
698	-	193.3 HV 0.5	91.7 HRB	66.7 µm	71.8 µm	
699	-	186.5 HV 0.5	90.3 HRB	71.5 µm	69.5 µm	
700	-	176.5 HV 0.5	88.1 HRB	72.3 µm	72.7 µm	
701	-	191.7 HV 0.5	91.3 HRB	70.1 µm	69.0 µm	
702	-	203.5 HV 0.5	93.7 HRB	68.2 µm	66.8 µm	
703	-	186.4 HV 0.5	90.3 HRB	72.2 µm	68.9 µm	
704	-	178.6 HV 0.5	88.7 HRB	72.2 µm	71.9 µm	
705	-	160.2 HV 0.5	83.4 HRB	74.9 µm	77.2 µm	
706	-	162.6 HV 0.5	84.2 HRB	76.9 µm	74.1 µm	
707	-	164.6 HV 0.5	84.9 HRB	76.6 µm	73.5 µm	
708	-	167.5 HV 0.5	85.6 HRB	74.5 µm	74.3 µm	
709	-	158.1 HV 0.5	82.7 HRB	76.5 µm	76.7 µm	
710	-	179.0 HV 0.5	88.7 HRB	72.4 µm	71.6 µm	
711	-	167.8 HV 0.5	85.7 HRB	74.5 µm	74.2 µm	
712	-	180.7 HV 0.5	89.1 HRB	71.7 µm	71.5 µm	
713	-	199.1 HV 0.5	92.8 HRB	67.7 µm	68.8 µm	
714	-	173.5 HV 0.5	87.4 HRB	73.8 µm	72.4 µm	
715	-	175.6 HV 0.5	87.9 HRB	71.7 µm	73.6 µm	
716	-	171.2 HV 0.5	86.7 HRB	74.0 µm	73.2 µm	
717	-	190.7 HV 0.5	91.1 HRB	69.1 µm	70.4 µm	
718	-	179.7 HV 0.5	88.9 HRB	70.4 µm	73.2 µm	
719	-	175.4 HV 0.5	87.9 HRB	71.7 µm	73.7 µm	
720	-	177.8 HV 0.5	88.4 HRB	72.3 µm	72.1 µm	
721	-	183.9 HV 0.5	89.8 HRB	70.4 µm	71.6 µm	
722	-	179.3 HV 0.5	88.8 HRB	69.9 µm	73.9 µm	
723	-	187.5 HV 0.5	90.5 HRB	70.6 µm	70.1 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
724	-	194.9 HV 0.5	92.0 HRB	69.2 µm	68.7 µm	
725	-	189.9 HV 0.5	91.0 HRB	69.5 µm	70.2 µm	
726	-	193.6 HV 0.5	91.7 HRB	68.1 µm	70.3 µm	
727	-	196.4 HV 0.5	92.3 HRB	67.8 µm	69.6 µm	
728	-	197.7 HV 0.5	92.5 HRB	67.3 µm	69.6 µm	
729	-	167.9 HV 0.5	85.7 HRB	69.4 µm	79.2 µm	
730	-	187.1 HV 0.5	90.4 HRB	70.3 µm	70.5 µm	
731	-	193.9 HV 0.5	91.8 HRB	67.7 µm	70.6 µm	
732	-	210.1 HV 0.5	95.0 HRB	65.4 µm	67.5 µm	
733	-	205.8 HV 0.5	94.2 HRB	67.5 µm	66.7 µm	
734	-	198.7 HV 0.5	92.7 HRB	68.9 µm	67.7 µm	
735	-	192.6 HV 0.5	91.5 HRB	67.7 µm	71.1 µm	
736	-	204.7 HV 0.5	93.9 HRB	67.4 µm	67.2 µm	
737	-	197.4 HV 0.5	92.5 HRB	68.4 µm	68.7 µm	
738	-	189.8 HV 0.5	91.0 HRB	70.5 µm	69.3 µm	
739	-	191.9 HV 0.5	91.4 HRB	69.0 µm	70.0 µm	
740	-	194.7 HV 0.5	91.9 HRB	66.8 µm	71.2 µm	
741	-	201.1 HV 0.5	93.2 HRB	68.0 µm	67.8 µm	
742	-	189.9 HV 0.5	91.0 HRB	69.6 µm	70.1 µm	
743	-	176.7 HV 0.5	88.2 HRB	74.1 µm	70.7 µm	
744	-	189.4 HV 0.5	90.9 HRB	69.8 µm	70.2 µm	
745	-	188.7 HV 0.5	90.7 HRB	69.6 µm	70.6 µm	
746	-	179.9 HV 0.5	89.0 HRB	71.8 µm	71.8 µm	
747	-	184.5 HV 0.5	89.9 HRB	70.3 µm	71.4 µm	
748	-	183.9 HV 0.5	89.8 HRB	70.4 µm	71.7 µm	
749	-	197.1 HV 0.5	92.4 HRB	68.2 µm	69.0 µm	
750	-	196.1 HV 0.5	92.2 HRB	68.2 µm	69.3 µm	
751	-	156.9 HV 0.5	82.3 HRB	75.0 µm	78.7 µm	
752	-	171.6 HV 0.5	86.9 HRB	73.9 µm	73.1 µm	
753	-	169.5 HV 0.5	86.2 HRB	73.3 µm	74.6 µm	
754	-	175.4 HV 0.5	87.8 HRB	72.3 µm	73.1 µm	
755	-	162.5 HV 0.5	84.2 HRB	75.0 µm	76.1 µm	
756	-	169.5 HV 0.5	86.2 HRB	74.3 µm	73.6 µm	
757	-	183.5 HV 0.5	89.7 HRB	71.1 µm	71.1 µm	
758	-	176.6 HV 0.5	88.2 HRB	70.1 µm	74.8 µm	
759	-	201.8 HV 0.5	93.4 HRB	67.2 µm	68.4 µm	
760	-	188.3 HV 0.5	90.7 HRB	69.1 µm	71.2 µm	
761	-	182.2 HV 0.5	89.4 HRB	70.6 µm	72.0 µm	
762	-	161.1 HV 0.5	83.7 HRB	74.0 µm	77.8 µm	

Date: 05-25-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
763	-	173.3 HV 0.5	87.3 HRB	74.0 µm	72.3 µm	
764	-	170.1 HV 0.5	86.4 HRB	73.8 µm	73.9 µm	
765	-	179.8 HV 0.5	88.9 HRB	72.2 µm	71.4 µm	
766	-	188.5 HV 0.5	90.7 HRB	69.3 µm	71.0 µm	
767	-	182.4 HV 0.5	89.5 HRB	70.9 µm	71.7 µm	
768	-	190.1 HV 0.5	91.0 HRB	70.2 µm	69.4 µm	
769	-	191.3 HV 0.5	91.3 HRB	69.9 µm	69.3 µm	
770	-	186.7 HV 0.5	90.3 HRB	70.0 µm	71.0 µm	
771	-	193.3 HV 0.5	91.7 HRB	69.0 µm	69.5 µm	
772	-	197.9 HV 0.5	92.6 HRB	68.7 µm	68.2 µm	
773	-	186.7 HV 0.5	90.3 HRB	70.2 µm	70.7 µm	
774	-	192.5 HV 0.5	91.5 HRB	68.5 µm	70.3 µm	
775	-	185.7 HV 0.5	90.1 HRB	70.2 µm	71.1 µm	
776	-	191.0 HV 0.5	91.2 HRB	68.6 µm	70.7 µm	
777	-	194.9 HV 0.5	92.0 HRB	68.3 µm	69.6 µm	
778	-	194.0 HV 0.5	91.8 HRB	65.4 µm	72.9 µm	
779	-	191.1 HV 0.5	91.2 HRB	68.5 µm	70.8 µm	
780	-	183.1 HV 0.5	89.6 HRB	69.5 µm	72.8 µm	
781	-	196.3 HV 0.5	92.3 HRB	70.5 µm	67.0 µm	
782	-	188.6 HV 0.5	90.7 HRB	68.8 µm	71.4 µm	
783	-	200.9 HV 0.5	93.2 HRB	68.4 µm	67.4 µm	
784	-	203.3 HV 0.5	93.7 HRB	66.5 µm	68.6 µm	
785	-	205.2 HV 0.5	94.0 HRB	67.2 µm	67.2 µm	
786	-	195.5 HV 0.5	92.1 HRB	69.2 µm	68.5 µm	
787	-	176.9 HV 0.5	88.2 HRB	72.2 µm	72.6 µm	
788	-	182.6 HV 0.5	89.5 HRB	71.0 µm	71.5 µm	
789	-	188.5 HV 0.5	90.7 HRB	69.3 µm	71.0 µm	
790	-	191.3 HV 0.5	91.3 HRB	69.6 µm	69.6 µm	
791	-	194.4 HV 0.5	91.9 HRB	67.8 µm	70.3 µm	
792	-	177.6 HV 0.5	88.4 HRB	69.6 µm	74.9 µm	
793	-	193.1 HV 0.5	91.6 HRB	70.0 µm	68.6 µm	
794	-	182.9 HV 0.5	89.6 HRB	70.5 µm	71.9 µm	
795	-	192.1 HV 0.5	91.4 HRB	68.7 µm	70.2 µm	
796	-	189.4 HV 0.5	90.9 HRB	70.1 µm	69.9 µm	
797	-	177.4 HV 0.5	88.4 HRB	72.6 µm	72.0 µm	
798	-	172.9 HV 0.5	87.2 HRB	72.3 µm	74.1 µm	
799	-	169.2 HV 0.5	86.1 HRB	74.2 µm	73.9 µm	
800	-	171.4 HV 0.5	86.8 HRB	72.1 µm	75.0 µm	
801	-	176.5 HV 0.5	88.1 HRB	73.8 µm	71.2 µm	

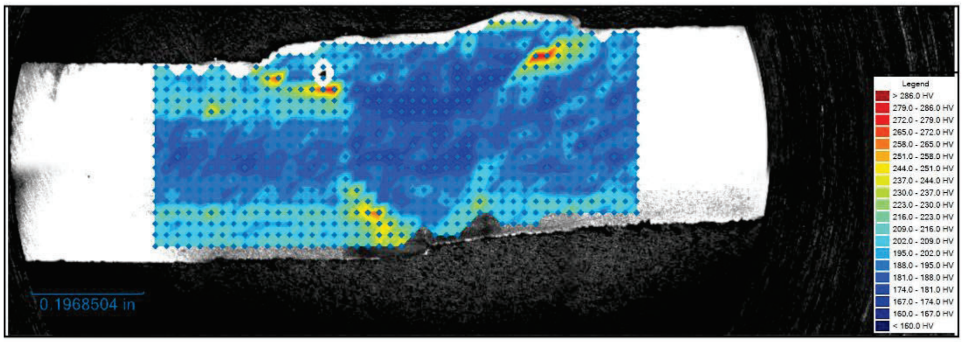
Date: 05-25-2023
Tester: Admin
Program: Hardness Map

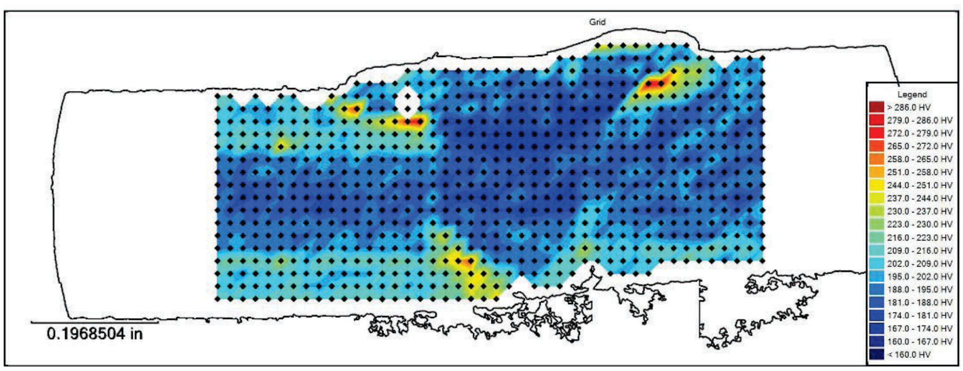
Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
802	-	189.5 HV 0.5	90.9 HRB	70.3 µm	69.6 µm	
803	-	191.3 HV 0.5	91.3 HRB	69.5 µm	69.7 µm	
804	-	182.9 HV 0.5	89.6 HRB	70.5 µm	71.9 µm	
805	-	206.2 HV 0.5	94.2 HRB	66.4 µm	67.7 µm	
806	-	183.6 HV 0.5	89.7 HRB	71.0 µm	71.2 µm	
807	-	179.3 HV 0.5	88.8 HRB	71.5 µm	72.3 µm	
808	-	173.4 HV 0.5	87.3 HRB	74.6 µm	71.7 µm	
809	-	169.4 HV 0.5	86.1 HRB	73.8 µm	74.2 µm	
810	-	189.4 HV 0.5	90.9 HRB	68.6 µm	71.4 µm	
811	-	157.9 HV 0.5	82.6 HRB	82.0 µm	71.3 µm	
812	-	177.2 HV 0.5	88.3 HRB	71.1 µm	73.6 µm	
813	-	187.9 HV 0.5	90.6 HRB	70.5 µm	70.0 µm	
814	-	173.0 HV 0.5	87.3 HRB	71.9 µm	74.5 µm	
815	-	184.9 HV 0.5	90.0 HRB	69.6 µm	72.1 µm	
816	-	178.5 HV 0.5	88.6 HRB	72.9 µm	71.3 µm	
817	-	191.4 HV 0.5	91.3 HRB	67.6 µm	71.6 µm	
818	-	217.0 HV 0.5	96.2 HRB	65.3 µm	65.4 µm	
819	-	217.7 HV 0.5	96.3 HRB	64.7 µm	65.8 µm	
820	-	218.2 HV 0.5	96.4 HRB	65.4 µm	64.9 µm	
821	-	203.8 HV 0.5	93.8 HRB	67.7 µm	67.2 µm	
822	-	192.3 HV 0.5	91.5 HRB	68.3 µm	70.5 µm	
823	-	192.4 HV 0.5	91.5 HRB	69.4 µm	69.4 µm	
824	-	197.8 HV 0.5	92.6 HRB	65.8 µm	71.2 µm	
825	-	239.2 HV 0.5	99.9 HRB	61.8 µm	62.7 µm	
826	-	221.1 HV 0.5	96.8 HRB	64.1 µm	65.4 µm	

Hardness Map

ADV PN 100794 3:00 o'clock

Date: 05-24-2023
Tester: Admin
Program: Hardness Map





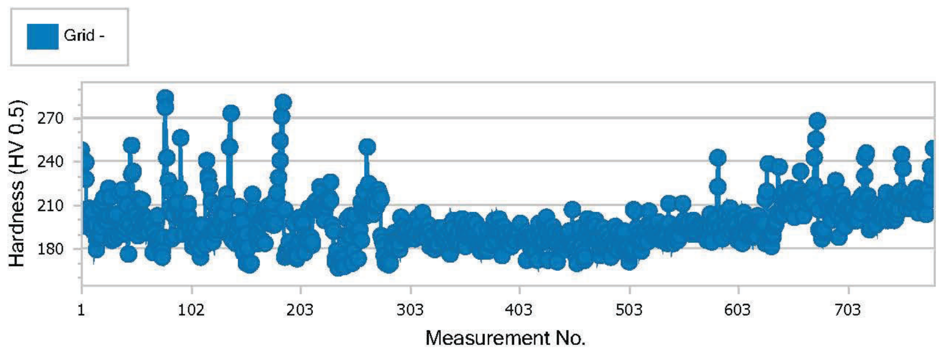
www.advintegrity.com Page 1 of 22

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Grid

Mean	Minimum	Maximum	Range	Std. deviation
197.2	166.4	283.7	117.3	16.9

Hardness Trace



Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
1	-	247.8 HV 0.5	-	61.4 µm	61.0 µm	
2	-	241.5 HV 0.5	-	61.2 µm	62.8 µm	
3	-	227.3 HV 0.5	97.9 HRB	63.9 µm	63.8 µm	
4	-	239.9 HV 0.5	100.0 HRB	61.2 µm	63.2 µm	
5	-	227.3 HV 0.5	97.9 HRB	63.6 µm	64.1 µm	
6	-	195.1 HV 0.5	92.0 HRB	68.3 µm	69.5 µm	
7	-	207.3 HV 0.5	94.5 HRB	67.1 µm	66.7 µm	
8	-	198.9 HV 0.5	92.8 HRB	69.3 µm	67.3 µm	
9	-	200.6 HV 0.5	93.1 HRB	67.4 µm	68.6 µm	
10	-	205.4 HV 0.5	94.1 HRB	67.4 µm	67.0 µm	
11	-	191.6 HV 0.5	91.3 HRB	68.7 µm	70.5 µm	
12	-	196.0 HV 0.5	92.2 HRB	68.0 µm	69.5 µm	
13	-	196.0 HV 0.5	92.2 HRB	67.7 µm	69.8 µm	
14	-	179.1 HV 0.5	88.8 HRB	72.8 µm	71.1 µm	
15	-	186.5 HV 0.5	90.3 HRB	71.5 µm	69.5 µm	
16	-	188.1 HV 0.5	90.6 HRB	70.6 µm	69.8 µm	
17	-	208.3 HV 0.5	94.7 HRB	66.8 µm	66.7 µm	
18	-	188.1 HV 0.5	90.6 HRB	69.6 µm	70.8 µm	
19	-	195.3 HV 0.5	92.1 HRB	68.9 µm	68.9 µm	
20	-	211.4 HV 0.5	95.2 HRB	66.1 µm	66.3 µm	
21	-	215.4 HV 0.5	95.9 HRB	64.9 µm	66.4 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
22	-	200.5 HV 0.5	93.1 HRB	66.8 µm	69.2 µm	
23	-	197.6 HV 0.5	92.5 HRB	66.5 µm	70.5 µm	
24	-	198.3 HV 0.5	92.7 HRB	67.4 µm	69.4 µm	
25	-	221.8 HV 0.5	97.0 HRB	64.5 µm	64.8 µm	
26	-	202.5 HV 0.5	93.5 HRB	66.4 µm	68.9 µm	
27	-	215.4 HV 0.5	95.9 HRB	65.2 µm	66.0 µm	
28	-	188.2 HV 0.5	90.6 HRB	70.9 µm	69.5 µm	
29	-	185.0 HV 0.5	90.0 HRB	71.2 µm	70.4 µm	
30	-	202.5 HV 0.5	93.5 HRB	66.8 µm	68.6 µm	
31	-	186.4 HV 0.5	90.3 HRB	69.6 µm	71.4 µm	
32	-	201.6 HV 0.5	93.3 HRB	67.1 µm	68.6 µm	
33	-	203.4 HV 0.5	93.7 HRB	66.8 µm	68.3 µm	
34	-	188.2 HV 0.5	90.6 HRB	67.7 µm	72.7 µm	
35	-	193.0 HV 0.5	91.6 HRB	69.7 µm	68.9 µm	
36	-	218.7 HV 0.5	96.4 HRB	65.8 µm	64.4 µm	
37	-	190.7 HV 0.5	91.1 HRB	68.7 µm	70.8 µm	
38	-	220.7 HV 0.5	96.8 HRB	65.8 µm	63.9 µm	
39	-	189.8 HV 0.5	91.0 HRB	68.7 µm	71.1 µm	
40	-	190.8 HV 0.5	91.2 HRB	67.7 µm	71.7 µm	
41	-	194.2 HV 0.5	91.8 HRB	69.6 µm	68.6 µm	
42	-	197.9 HV 0.5	92.6 HRB	69.0 µm	67.9 µm	
43	-	209.3 HV 0.5	94.9 HRB	67.7 µm	65.4 µm	
44	-	176.0 HV 0.5	88.0 HRB	73.1 µm	72.1 µm	
45	-	195.8 HV 0.5	92.2 HRB	68.7 µm	68.9 µm	
46	-	250.7 HV 0.5	-	62.0 µm	59.6 µm	
47	-	231.3 HV 0.5	98.5 HRB	64.1 µm	62.5 µm	
48	-	232.7 HV 0.5	98.8 HRB	62.4 µm	63.8 µm	
49	-	207.0 HV 0.5	94.4 HRB	68.2 µm	65.6 µm	
50	-	191.6 HV 0.5	91.3 HRB	69.5 µm	69.7 µm	
51	-	202.4 HV 0.5	93.5 HRB	68.1 µm	67.3 µm	
52	-	188.4 HV 0.5	90.7 HRB	67.1 µm	73.2 µm	
53	-	197.8 HV 0.5	92.6 HRB	66.8 µm	70.2 µm	
54	-	214.0 HV 0.5	95.7 HRB	65.3 µm	66.4 µm	
55	-	191.6 HV 0.5	91.3 HRB	69.6 µm	69.5 µm	
56	-	195.1 HV 0.5	92.0 HRB	68.3 µm	69.5 µm	
57	-	213.4 HV 0.5	95.6 HRB	65.8 µm	66.0 µm	
58	-	202.5 HV 0.5	93.5 HRB	68.0 µm	67.3 µm	
59	-	195.6 HV 0.5	92.1 HRB	67.7 µm	70.0 µm	
60	-	196.9 HV 0.5	92.4 HRB	69.9 µm	67.3 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
61	-	200.6 HV 0.5	93.1 HRB	66.8 µm	69.2 µm	
62	-	190.9 HV 0.5	91.2 HRB	70.2 µm	69.1 µm	
63	-	196.9 HV 0.5	92.4 HRB	68.3 µm	68.9 µm	
64	-	200.6 HV 0.5	93.1 HRB	67.1 µm	68.9 µm	
65	-	195.6 HV 0.5	92.1 HRB	69.2 µm	68.5 µm	
66	-	177.1 HV 0.5	88.3 HRB	70.1 µm	74.6 µm	
67	-	191.6 HV 0.5	91.3 HRB	69.3 µm	69.8 µm	
68	-	191.2 HV 0.5	91.2 HRB	69.9 µm	69.4 µm	
69	-	184.0 HV 0.5	89.8 HRB	70.9 µm	71.1 µm	
70	-	186.6 HV 0.5	90.3 HRB	70.5 µm	70.5 µm	
71	-	202.5 HV 0.5	93.5 HRB	68.0 µm	67.3 µm	
72	-	182.2 HV 0.5	89.4 HRB	72.4 µm	70.2 µm	
73	-	180.7 HV 0.5	89.1 HRB	72.1 µm	71.1 µm	
74	-	178.4 HV 0.5	88.6 HRB	74.0 µm	70.2 µm	
75	-	173.9 HV 0.5	87.5 HRB	72.4 µm	73.7 µm	
76	-	187.3 HV 0.5	90.5 HRB	70.2 µm	70.5 µm	
77	-	283.7 HV 0.5	-	57.3 µm	57.0 µm	
78	-	277.4 HV 0.5	-	59.5 µm	56.1 µm	
79	-	242.3 HV 0.5	-	61.2 µm	62.5 µm	
80	-	226.3 HV 0.5	97.7 HRB	63.6 µm	64.4 µm	
81	-	218.7 HV 0.5	96.5 HRB	65.1 µm	65.1 µm	
82	-	207.8 HV 0.5	94.6 HRB	67.6 µm	66.0 µm	
83	-	186.1 HV 0.5	90.2 HRB	70.4 µm	70.7 µm	
84	-	203.9 HV 0.5	93.8 HRB	67.5 µm	67.3 µm	
85	-	203.5 HV 0.5	93.7 HRB	68.7 µm	66.4 µm	
86	-	188.9 HV 0.5	90.8 HRB	70.0 µm	70.2 µm	
87	-	209.8 HV 0.5	95.0 HRB	66.7 µm	66.2 µm	
88	-	210.6 HV 0.5	95.1 HRB	66.9 µm	65.9 µm	
89	-	211.5 HV 0.5	95.3 HRB	65.1 µm	67.3 µm	
90	-	221.0 HV 0.5	96.8 HRB	65.6 µm	63.9 µm	
91	-	200.6 HV 0.5	93.1 HRB	65.9 µm	70.1 µm	
92	-	256.3 HV 0.5	-	59.5 µm	60.8 µm	
93	-	202.5 HV 0.5	93.5 HRB	67.4 µm	67.9 µm	
94	-	189.8 HV 0.5	91.0 HRB	68.7 µm	71.1 µm	
95	-	200.0 HV 0.5	93.0 HRB	67.6 µm	68.6 µm	
96	-	197.8 HV 0.5	92.6 HRB	67.4 µm	69.5 µm	
97	-	201.6 HV 0.5	93.3 HRB	68.0 µm	67.6 µm	
98	-	Deleted	-	-	-	
99	-	202.5 HV 0.5	93.5 HRB	67.4 µm	67.9 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
100	-	210.3 HV 0.5	95.1 HRB	67.1 µm	65.7 µm	
101	-	195.1 HV 0.5	92.0 HRB	69.9 µm	67.9 µm	
102	-	187.3 HV 0.5	90.5 HRB	70.6 µm	70.2 µm	
103	-	181.5 HV 0.5	89.3 HRB	70.9 µm	72.1 µm	
104	-	184.0 HV 0.5	89.8 HRB	70.9 µm	71.1 µm	
105	-	196.0 HV 0.5	92.2 HRB	69.0 µm	68.6 µm	
106	-	193.3 HV 0.5	91.7 HRB	68.7 µm	69.8 µm	
107	-	184.3 HV 0.5	89.9 HRB	72.0 µm	69.8 µm	
108	-	184.8 HV 0.5	90.0 HRB	69.9 µm	71.8 µm	
109	-	190.6 HV 0.5	91.1 HRB	69.3 µm	70.2 µm	
110	-	173.7 HV 0.5	87.4 HRB	73.1 µm	73.0 µm	
111	-	179.1 HV 0.5	88.8 HRB	72.4 µm	71.4 µm	
112	-	196.0 HV 0.5	92.2 HRB	68.0 µm	69.5 µm	
113	-	184.8 HV 0.5	90.0 HRB	69.9 µm	71.8 µm	
114	-	183.0 HV 0.5	89.6 HRB	71.8 µm	70.6 µm	
115	-	182.4 HV 0.5	89.5 HRB	71.2 µm	71.4 µm	
116	-	240.6 HV 0.5	-	62.1 µm	62.0 µm	
117	-	229.7 HV 0.5	98.3 HRB	62.2 µm	64.8 µm	
118	-	228.2 HV 0.5	98.0 HRB	64.0 µm	63.4 µm	
119	-	222.3 HV 0.5	97.1 HRB	63.7 µm	65.4 µm	
120	-	211.4 HV 0.5	95.2 HRB	66.1 µm	66.4 µm	
121	-	190.5 HV 0.5	91.1 HRB	69.1 µm	70.5 µm	
122	-	184.1 HV 0.5	89.8 HRB	72.4 µm	69.5 µm	
123	-	191.8 HV 0.5	91.4 HRB	68.7 µm	70.4 µm	
124	-	203.2 HV 0.5	93.6 HRB	65.2 µm	69.9 µm	
125	-	190.1 HV 0.5	91.0 HRB	68.5 µm	71.2 µm	
126	-	192.4 HV 0.5	91.5 HRB	70.6 µm	68.3 µm	
127	-	210.1 HV 0.5	95.0 HRB	64.9 µm	67.9 µm	
128	-	207.3 HV 0.5	94.5 HRB	66.6 µm	67.2 µm	
129	-	198.0 HV 0.5	92.6 HRB	67.4 µm	69.5 µm	
130	-	197.8 HV 0.5	92.6 HRB	68.6 µm	68.3 µm	
131	-	192.5 HV 0.5	91.5 HRB	72.1 µm	66.7 µm	
132	-	204.7 HV 0.5	93.9 HRB	67.9 µm	66.7 µm	
133	-	203.6 HV 0.5	93.7 HRB	67.7 µm	67.2 µm	
134	-	217.1 HV 0.5	96.2 HRB	66.7 µm	64.0 µm	
135	-	193.3 HV 0.5	91.7 HRB	68.2 µm	70.4 µm	
136	-	210.7 HV 0.5	95.1 HRB	65.0 µm	67.7 µm	
137	-	249.8 HV 0.5	-	60.6 µm	61.2 µm	
138	-	273.1 HV 0.5	-	59.0 µm	57.5 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
139	-	187.3 HV 0.5	90.5 HRB	71.8 µm	68.9 µm	
140	-	185.6 HV 0.5	90.1 HRB	69.0 µm	72.4 µm	
141	-	193.3 HV 0.5	91.7 HRB	67.4 µm	71.1 µm	
142	-	Deleted	-	-	-	
143	-	195.1 HV 0.5	92.0 HRB	69.0 µm	68.9 µm	
144	-	183.5 HV 0.5	89.7 HRB	70.2 µm	71.9 µm	
145	-	192.5 HV 0.5	91.5 HRB	68.7 µm	70.2 µm	
146	-	196.9 HV 0.5	92.4 HRB	67.7 µm	69.5 µm	
147	-	208.3 HV 0.5	94.7 HRB	68.0 µm	65.4 µm	
148	-	186.5 HV 0.5	90.3 HRB	70.2 µm	70.8 µm	
149	-	198.6 HV 0.5	92.7 HRB	67.4 µm	69.2 µm	
150	-	180.7 HV 0.5	89.1 HRB	71.8 µm	71.4 µm	
151	-	177.2 HV 0.5	88.3 HRB	72.8 µm	71.9 µm	
152	-	185.7 HV 0.5	90.1 HRB	70.5 µm	70.8 µm	
153	-	189.8 HV 0.5	91.0 HRB	69.3 µm	70.5 µm	
154	-	169.6 HV 0.5	86.2 HRB	74.0 µm	73.9 µm	
155	-	179.9 HV 0.5	89.0 HRB	71.8 µm	71.8 µm	
156	-	168.6 HV 0.5	85.9 HRB	74.3 µm	74.0 µm	
157	-	168.4 HV 0.5	85.8 HRB	74.1 µm	74.3 µm	
158	-	170.0 HV 0.5	86.3 HRB	73.7 µm	74.0 µm	
159	-	216.6 HV 0.5	96.1 HRB	65.4 µm	65.4 µm	
160	-	208.0 HV 0.5	94.6 HRB	67.7 µm	65.9 µm	
161	-	204.5 HV 0.5	93.9 HRB	67.4 µm	67.3 µm	
162	-	189.3 HV 0.5	90.9 HRB	68.5 µm	71.4 µm	
163	-	189.7 HV 0.5	90.9 HRB	68.1 µm	71.8 µm	
164	-	186.1 HV 0.5	90.2 HRB	72.1 µm	69.1 µm	
165	-	183.7 HV 0.5	89.7 HRB	67.9 µm	74.1 µm	
166	-	199.2 HV 0.5	92.8 HRB	69.0 µm	67.4 µm	
167	-	185.0 HV 0.5	90.0 HRB	70.2 µm	71.4 µm	
168	-	196.5 HV 0.5	92.3 HRB	66.2 µm	71.2 µm	
169	-	201.0 HV 0.5	93.2 HRB	66.9 µm	68.9 µm	
170	-	182.9 HV 0.5	89.6 HRB	70.6 µm	71.9 µm	
171	-	205.7 HV 0.5	94.1 HRB	66.3 µm	68.0 µm	
172	-	201.8 HV 0.5	93.4 HRB	67.0 µm	68.6 µm	
173	-	208.5 HV 0.5	94.7 HRB	65.8 µm	67.5 µm	
174	-	202.7 HV 0.5	93.5 HRB	66.5 µm	68.8 µm	
175	-	197.4 HV 0.5	92.5 HRB	67.9 µm	69.1 µm	
176	-	204.3 HV 0.5	93.9 HRB	66.1 µm	68.6 µm	
177	-	202.6 HV 0.5	93.5 HRB	66.8 µm	68.5 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
178	-	211.0 HV 0.5	95.2 HRB	65.9 µm	66.7 µm	
179	-	195.4 HV 0.5	92.1 HRB	68.3 µm	69.5 µm	
180	-	197.5 HV 0.5	92.5 HRB	67.6 µm	69.5 µm	
181	-	217.9 HV 0.5	96.3 HRB	66.1 µm	64.3 µm	
182	-	217.8 HV 0.5	96.3 HRB	66.1 µm	64.4 µm	
183	-	228.9 HV 0.5	98.2 HRB	62.2 µm	65.1 µm	
184	-	240.2 HV 0.5	-	61.9 µm	62.3 µm	
185	-	254.0 HV 0.5	-	59.8 µm	61.0 µm	
186	-	271.4 HV 0.5	-	59.4 µm	57.5 µm	
187	-	280.7 HV 0.5	-	57.8 µm	57.1 µm	
188	-	206.5 HV 0.5	94.3 HRB	66.1 µm	67.9 µm	
189	-	173.5 HV 0.5	87.4 HRB	72.9 µm	73.3 µm	
190	-	177.6 HV 0.5	88.4 HRB	71.8 µm	72.7 µm	
191	-	174.7 HV 0.5	87.7 HRB	73.1 µm	72.6 µm	
192	-	177.4 HV 0.5	88.3 HRB	71.6 µm	73.0 µm	
193	-	184.7 HV 0.5	89.9 HRB	71.1 µm	70.6 µm	
194	-	178.3 HV 0.5	88.6 HRB	71.8 µm	72.4 µm	
195	-	176.0 HV 0.5	88.0 HRB	71.8 µm	73.3 µm	
196	-	179.1 HV 0.5	88.8 HRB	70.6 µm	73.3 µm	
197	-	196.9 HV 0.5	92.4 HRB	68.7 µm	68.6 µm	
198	-	176.8 HV 0.5	88.2 HRB	72.8 µm	72.1 µm	
199	-	172.9 HV 0.5	87.2 HRB	73.2 µm	73.2 µm	
200	-	175.2 HV 0.5	87.8 HRB	71.8 µm	73.7 µm	
201	-	182.7 HV 0.5	89.5 HRB	69.0 µm	73.4 µm	
202	-	201.0 HV 0.5	93.2 HRB	68.0 µm	67.9 µm	
203	-	185.4 HV 0.5	90.1 HRB	69.3 µm	72.2 µm	
204	-	198.6 HV 0.5	92.7 HRB	69.3 µm	67.4 µm	
205	-	196.5 HV 0.5	92.3 HRB	67.7 µm	69.7 µm	
206	-	177.4 HV 0.5	88.3 HRB	72.4 µm	72.3 µm	
207	-	188.4 HV 0.5	90.7 HRB	69.9 µm	70.4 µm	
208	-	185.6 HV 0.5	90.1 HRB	69.6 µm	71.7 µm	
209	-	187.6 HV 0.5	90.5 HRB	69.6 µm	71.0 µm	
210	-	185.6 HV 0.5	90.1 HRB	69.3 µm	72.1 µm	
211	-	207.4 HV 0.5	94.5 HRB	66.3 µm	67.4 µm	
212	-	187.4 HV 0.5	90.5 HRB	71.2 µm	69.4 µm	
213	-	182.6 HV 0.5	89.5 HRB	71.3 µm	71.3 µm	
214	-	184.2 HV 0.5	89.8 HRB	71.7 µm	70.2 µm	
215	-	206.8 HV 0.5	94.4 HRB	65.9 µm	68.1 µm	
216	-	209.3 HV 0.5	94.9 HRB	66.4 µm	66.7 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
217	-	211.5 HV 0.5	95.2 HRB	66.4 µm	66.0 µm	
218	-	212.4 HV 0.5	95.4 HRB	65.3 µm	66.9 µm	
219	-	209.1 HV 0.5	94.8 HRB	65.3 µm	67.8 µm	
220	-	222.0 HV 0.5	97.0 HRB	64.7 µm	64.6 µm	
221	-	206.7 HV 0.5	94.3 HRB	66.1 µm	67.9 µm	
222	-	218.9 HV 0.5	96.5 HRB	65.9 µm	64.3 µm	
223	-	208.1 HV 0.5	94.6 HRB	67.9 µm	65.6 µm	
224	-	211.6 HV 0.5	95.3 HRB	66.1 µm	66.3 µm	
225	-	198.9 HV 0.5	92.8 HRB	68.7 µm	67.9 µm	
226	-	208.4 HV 0.5	94.7 HRB	68.5 µm	64.9 µm	
227	-	212.4 HV 0.5	95.4 HRB	65.5 µm	66.6 µm	
228	-	214.4 HV 0.5	95.7 HRB	65.6 µm	65.9 µm	
229	-	215.2 HV 0.5	95.9 HRB	65.3 µm	65.9 µm	
230	-	213.0 HV 0.5	95.5 HRB	65.7 µm	66.2 µm	
231	-	226.0 HV 0.5	97.7 HRB	64.5 µm	63.6 µm	
232	-	196.0 HV 0.5	92.2 HRB	68.7 µm	68.9 µm	
233	-	192.1 HV 0.5	91.4 HRB	70.2 µm	68.7 µm	
234	-	173.0 HV 0.5	87.2 HRB	72.8 µm	73.7 µm	
235	-	170.5 HV 0.5	86.5 HRB	73.7 µm	73.8 µm	
236	-	178.2 HV 0.5	88.6 HRB	72.1 µm	72.1 µm	
237	-	166.4 HV 0.5	85.4 HRB	72.4 µm	76.8 µm	
238	-	173.0 HV 0.5	87.2 HRB	72.8 µm	73.7 µm	
239	-	171.3 HV 0.5	86.8 HRB	73.2 µm	74.0 µm	
240	-	170.6 HV 0.5	86.5 HRB	74.1 µm	73.3 µm	
241	-	172.2 HV 0.5	87.1 HRB	73.1 µm	73.7 µm	
242	-	167.0 HV 0.5	85.5 HRB	74.0 µm	75.0 µm	
243	-	167.6 HV 0.5	85.7 HRB	75.4 µm	73.3 µm	
244	-	188.9 HV 0.5	90.8 HRB	69.6 µm	70.5 µm	
245	-	185.0 HV 0.5	90.0 HRB	70.9 µm	70.7 µm	
246	-	200.2 HV 0.5	93.0 HRB	68.7 µm	67.4 µm	
247	-	188.8 HV 0.5	90.8 HRB	70.4 µm	69.8 µm	
248	-	202.3 HV 0.5	93.5 HRB	67.9 µm	67.5 µm	
249	-	188.9 HV 0.5	90.8 HRB	70.7 µm	69.4 µm	
250	-	169.7 HV 0.5	86.2 HRB	73.3 µm	74.5 µm	
251	-	177.8 HV 0.5	88.4 HRB	67.8 µm	76.6 µm	
252	-	195.9 HV 0.5	92.2 HRB	69.1 µm	68.5 µm	
253	-	202.5 HV 0.5	93.5 HRB	66.7 µm	68.7 µm	
254	-	190.7 HV 0.5	91.1 HRB	67.7 µm	71.7 µm	
255	-	192.1 HV 0.5	91.4 HRB	70.9 µm	68.1 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
256	-	172.5 HV 0.5	87.1 HRB	71.8 µm	74.9 µm	
257	-	193.2 HV 0.5	91.6 HRB	69.3 µm	69.3 µm	
258	-	185.2 HV 0.5	90.0 HRB	70.6 µm	70.9 µm	
259	-	211.4 HV 0.5	95.2 HRB	66.1 µm	66.4 µm	
260	-	205.3 HV 0.5	94.1 HRB	67.8 µm	66.6 µm	
261	-	219.1 HV 0.5	96.5 HRB	65.2 µm	64.9 µm	
262	-	202.4 HV 0.5	93.5 HRB	67.2 µm	68.2 µm	
263	-	204.7 HV 0.5	93.9 HRB	67.8 µm	66.8 µm	
264	-	249.6 HV 0.5	-	59.6 µm	62.3 µm	
265	-	224.3 HV 0.5	97.4 HRB	64.5 µm	64.1 µm	
266	-	205.0 HV 0.5	94.0 HRB	65.0 µm	69.5 µm	
267	-	210.9 HV 0.5	95.1 HRB	67.0 µm	65.6 µm	
268	-	204.5 HV 0.5	93.9 HRB	65.2 µm	69.5 µm	
269	-	203.0 HV 0.5	93.6 HRB	65.2 µm	69.9 µm	
270	-	211.9 HV 0.5	95.3 HRB	66.3 µm	66.0 µm	
271	-	217.0 HV 0.5	96.2 HRB	65.9 µm	64.8 µm	
272	-	208.9 HV 0.5	94.8 HRB	66.2 µm	67.1 µm	
273	-	210.3 HV 0.5	95.0 HRB	63.9 µm	69.0 µm	
274	-	219.9 HV 0.5	96.7 HRB	64.4 µm	65.4 µm	
275	-	216.7 HV 0.5	96.1 HRB	67.1 µm	63.7 µm	
276	-	214.3 HV 0.5	95.7 HRB	64.9 µm	66.7 µm	
277	-	188.1 HV 0.5	90.6 HRB	69.1 µm	71.3 µm	
278	-	184.7 HV 0.5	89.9 HRB	71.3 µm	70.4 µm	
279	-	181.3 HV 0.5	89.3 HRB	71.3 µm	71.8 µm	
280	-	174.6 HV 0.5	87.6 HRB	74.7 µm	71.0 µm	
281	-	169.7 HV 0.5	86.2 HRB	71.4 µm	76.4 µm	
282	-	169.4 HV 0.5	86.1 HRB	74.6 µm	73.3 µm	
283	-	171.5 HV 0.5	86.8 HRB	74.5 µm	72.6 µm	
284	-	168.2 HV 0.5	85.8 HRB	74.6 µm	73.9 µm	
285	-	169.3 HV 0.5	86.1 HRB	73.4 µm	74.6 µm	
286	-	182.3 HV 0.5	89.5 HRB	70.9 µm	71.7 µm	
287	-	179.6 HV 0.5	88.9 HRB	71.9 µm	71.8 µm	
288	-	181.5 HV 0.5	89.3 HRB	71.5 µm	71.4 µm	
289	-	190.6 HV 0.5	91.1 HRB	69.2 µm	70.3 µm	
290	-	186.4 HV 0.5	90.3 HRB	70.3 µm	70.8 µm	
291	-	185.9 HV 0.5	90.2 HRB	69.7 µm	71.5 µm	
292	-	185.7 HV 0.5	90.1 HRB	69.3 µm	72.0 µm	
293	-	179.4 HV 0.5	88.8 HRB	71.9 µm	71.9 µm	
294	-	183.1 HV 0.5	89.6 HRB	69.6 µm	72.7 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
295	-	201.0 HV 0.5	93.2 HRB	68.6 µm	67.2 µm	
296	-	194.4 HV 0.5	91.9 HRB	68.3 µm	69.8 µm	
297	-	191.5 HV 0.5	91.3 HRB	68.7 µm	70.5 µm	
298	-	188.9 HV 0.5	90.8 HRB	68.7 µm	71.4 µm	
299	-	190.7 HV 0.5	91.1 HRB	69.3 µm	70.2 µm	
300	-	187.4 HV 0.5	90.5 HRB	68.1 µm	72.6 µm	
301	-	193.1 HV 0.5	91.6 HRB	68.4 µm	70.2 µm	
302	-	186.4 HV 0.5	90.3 HRB	71.6 µm	69.5 µm	
303	-	187.4 HV 0.5	90.5 HRB	69.6 µm	71.1 µm	
304	-	193.2 HV 0.5	91.6 HRB	68.0 µm	70.5 µm	
305	-	188.0 HV 0.5	90.6 HRB	68.7 µm	71.8 µm	
306	-	187.0 HV 0.5	90.4 HRB	70.1 µm	70.7 µm	
307	-	190.1 HV 0.5	91.0 HRB	70.5 µm	69.2 µm	
308	-	186.5 HV 0.5	90.3 HRB	69.5 µm	71.6 µm	
309	-	189.7 HV 0.5	90.9 HRB	68.2 µm	71.7 µm	
310	-	201.1 HV 0.5	93.2 HRB	67.0 µm	68.8 µm	
311	-	195.6 HV 0.5	92.1 HRB	68.6 µm	69.1 µm	
312	-	195.8 HV 0.5	92.2 HRB	67.8 µm	69.8 µm	
313	-	190.0 HV 0.5	91.0 HRB	68.6 µm	71.1 µm	
314	-	204.8 HV 0.5	94.0 HRB	66.5 µm	68.1 µm	
315	-	187.1 HV 0.5	90.4 HRB	69.7 µm	71.1 µm	
316	-	192.1 HV 0.5	91.4 HRB	67.9 µm	71.0 µm	
317	-	190.0 HV 0.5	91.0 HRB	70.9 µm	68.8 µm	
318	-	192.5 HV 0.5	91.5 HRB	70.2 µm	68.6 µm	
319	-	186.6 HV 0.5	90.3 HRB	69.2 µm	71.8 µm	
320	-	195.6 HV 0.5	92.1 HRB	68.3 µm	69.4 µm	
321	-	191.4 HV 0.5	91.3 HRB	70.1 µm	69.1 µm	
322	-	181.7 HV 0.5	89.3 HRB	71.0 µm	71.9 µm	
323	-	183.5 HV 0.5	89.7 HRB	71.5 µm	70.6 µm	
324	-	188.1 HV 0.5	90.6 HRB	70.2 µm	70.2 µm	
325	-	179.0 HV 0.5	88.8 HRB	72.1 µm	71.8 µm	
326	-	182.6 HV 0.5	89.5 HRB	71.1 µm	71.4 µm	
327	-	182.4 HV 0.5	89.5 HRB	71.5 µm	71.1 µm	
328	-	180.9 HV 0.5	89.2 HRB	71.4 µm	71.8 µm	
329	-	181.8 HV 0.5	89.4 HRB	71.4 µm	71.4 µm	
330	-	193.8 HV 0.5	91.8 HRB	68.4 µm	69.9 µm	
331	-	193.0 HV 0.5	91.6 HRB	70.0 µm	68.6 µm	
332	-	189.3 HV 0.5	90.9 HRB	69.8 µm	70.2 µm	
333	-	193.8 HV 0.5	91.8 HRB	68.1 µm	70.2 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
334	-	185.6 HV 0.5	90.1 HRB	70.3 µm	71.1 µm	
335	-	183.8 HV 0.5	89.8 HRB	70.8 µm	71.3 µm	
336	-	186.4 HV 0.5	90.3 HRB	70.7 µm	70.3 µm	
337	-	189.2 HV 0.5	90.8 HRB	70.1 µm	69.9 µm	
338	-	178.9 HV 0.5	88.7 HRB	69.8 µm	74.2 µm	
339	-	193.2 HV 0.5	91.6 HRB	67.8 µm	70.7 µm	
340	-	175.9 HV 0.5	88.0 HRB	72.0 µm	73.2 µm	
341	-	184.5 HV 0.5	89.9 HRB	70.2 µm	71.6 µm	
342	-	199.4 HV 0.5	92.9 HRB	67.1 µm	69.2 µm	
343	-	193.6 HV 0.5	91.7 HRB	69.3 µm	69.1 µm	
344	-	186.9 HV 0.5	90.4 HRB	70.7 µm	70.2 µm	
345	-	184.5 HV 0.5	89.9 HRB	71.2 µm	70.6 µm	
346	-	182.4 HV 0.5	89.5 HRB	70.5 µm	72.1 µm	
347	-	187.5 HV 0.5	90.5 HRB	70.0 µm	70.7 µm	
348	-	191.3 HV 0.5	91.3 HRB	68.9 µm	70.3 µm	
349	-	181.7 HV 0.5	89.3 HRB	71.1 µm	71.8 µm	
350	-	199.1 HV 0.5	92.8 HRB	67.1 µm	69.4 µm	
351	-	200.1 HV 0.5	93.0 HRB	67.9 µm	68.2 µm	
352	-	192.3 HV 0.5	91.5 HRB	68.5 µm	70.4 µm	
353	-	194.3 HV 0.5	91.9 HRB	68.2 µm	70.0 µm	
354	-	181.2 HV 0.5	89.2 HRB	70.2 µm	72.9 µm	
355	-	197.3 HV 0.5	92.5 HRB	69.0 µm	68.2 µm	
356	-	192.1 HV 0.5	91.4 HRB	69.0 µm	70.0 µm	
357	-	187.8 HV 0.5	90.6 HRB	70.0 µm	70.6 µm	
358	-	189.9 HV 0.5	91.0 HRB	68.2 µm	71.6 µm	
359	-	195.4 HV 0.5	92.1 HRB	68.0 µm	69.7 µm	
360	-	188.1 HV 0.5	90.6 HRB	70.2 µm	70.2 µm	
361	-	199.0 HV 0.5	92.8 HRB	67.1 µm	69.4 µm	
362	-	190.7 HV 0.5	91.1 HRB	69.7 µm	69.7 µm	
363	-	192.4 HV 0.5	91.5 HRB	68.8 µm	70.0 µm	
364	-	196.6 HV 0.5	92.3 HRB	68.3 µm	69.0 µm	
365	-	181.2 HV 0.5	89.2 HRB	72.8 µm	70.3 µm	
366	-	183.8 HV 0.5	89.8 HRB	70.9 µm	71.1 µm	
367	-	177.9 HV 0.5	88.5 HRB	73.6 µm	70.8 µm	
368	-	193.2 HV 0.5	91.6 HRB	69.4 µm	69.1 µm	
369	-	183.6 HV 0.5	89.7 HRB	71.5 µm	70.6 µm	
370	-	181.6 HV 0.5	89.3 HRB	71.8 µm	71.1 µm	
371	-	181.5 HV 0.5	89.3 HRB	70.9 µm	72.1 µm	
372	-	178.6 HV 0.5	88.7 HRB	72.2 µm	71.9 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
373	-	177.6 HV 0.5	88.4 HRB	72.8 µm	71.8 µm	
374	-	192.6 HV 0.5	91.5 HRB	67.9 µm	70.9 µm	
375	-	177.9 HV 0.5	88.5 HRB	73.1 µm	71.3 µm	
376	-	183.7 HV 0.5	89.7 HRB	70.6 µm	71.5 µm	
377	-	182.3 HV 0.5	89.5 HRB	71.8 µm	70.8 µm	
378	-	182.8 HV 0.5	89.6 HRB	71.8 µm	70.6 µm	
379	-	192.4 HV 0.5	91.5 HRB	67.9 µm	70.9 µm	
380	-	198.9 HV 0.5	92.8 HRB	70.0 µm	66.6 µm	
381	-	193.3 HV 0.5	91.7 HRB	69.2 µm	69.3 µm	
382	-	185.1 HV 0.5	90.0 HRB	70.1 µm	71.4 µm	
383	-	191.8 HV 0.5	91.4 HRB	67.7 µm	71.4 µm	
384	-	199.7 HV 0.5	92.9 HRB	68.2 µm	68.1 µm	
385	-	193.7 HV 0.5	91.7 HRB	68.9 µm	69.4 µm	
386	-	190.6 HV 0.5	91.1 HRB	68.1 µm	71.4 µm	
387	-	174.9 HV 0.5	87.7 HRB	71.5 µm	74.1 µm	
388	-	186.5 HV 0.5	90.3 HRB	70.0 µm	71.1 µm	
389	-	195.2 HV 0.5	92.0 HRB	68.5 µm	69.3 µm	
390	-	191.0 HV 0.5	91.2 HRB	68.7 µm	70.7 µm	
391	-	184.6 HV 0.5	89.9 HRB	70.4 µm	71.3 µm	
392	-	188.3 HV 0.5	90.7 HRB	70.1 µm	70.2 µm	
393	-	183.7 HV 0.5	89.7 HRB	70.6 µm	71.5 µm	
394	-	182.6 HV 0.5	89.5 HRB	70.4 µm	72.1 µm	
395	-	180.6 HV 0.5	89.1 HRB	71.3 µm	72.0 µm	
396	-	190.2 HV 0.5	91.0 HRB	67.6 µm	72.1 µm	
397	-	186.8 HV 0.5	90.4 HRB	69.3 µm	71.6 µm	
398	-	187.8 HV 0.5	90.6 HRB	68.2 µm	72.4 µm	
399	-	185.4 HV 0.5	90.1 HRB	70.6 µm	70.8 µm	
400	-	184.4 HV 0.5	89.9 HRB	69.3 µm	72.5 µm	
401	-	191.2 HV 0.5	91.2 HRB	68.3 µm	70.9 µm	
402	-	190.7 HV 0.5	91.1 HRB	67.6 µm	71.8 µm	
403	-	192.2 HV 0.5	91.4 HRB	68.7 µm	70.2 µm	
404	-	196.8 HV 0.5	92.4 HRB	67.4 µm	69.8 µm	
405	-	185.8 HV 0.5	90.2 HRB	69.6 µm	71.7 µm	
406	-	185.4 HV 0.5	90.1 HRB	70.6 µm	70.9 µm	
407	-	186.2 HV 0.5	90.2 HRB	70.8 µm	70.3 µm	
408	-	188.0 HV 0.5	90.6 HRB	70.2 µm	70.3 µm	
409	-	172.0 HV 0.5	87.0 HRB	72.6 µm	74.2 µm	
410	-	190.6 HV 0.5	91.1 HRB	69.3 µm	70.2 µm	
411	-	187.3 HV 0.5	90.5 HRB	69.9 µm	70.8 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
412	-	186.1 HV 0.5	90.2 HRB	70.2 µm	70.9 µm	
413	-	185.6 HV 0.5	90.1 HRB	70.2 µm	71.1 µm	
414	-	178.8 HV 0.5	88.7 HRB	71.3 µm	72.8 µm	
415	-	187.1 HV 0.5	90.4 HRB	70.6 µm	70.2 µm	
416	-	176.9 HV 0.5	88.2 HRB	71.5 µm	73.3 µm	
417	-	188.1 HV 0.5	90.6 HRB	69.9 µm	70.5 µm	
418	-	177.8 HV 0.5	88.5 HRB	72.3 µm	72.1 µm	
419	-	172.0 HV 0.5	87.0 HRB	73.4 µm	73.4 µm	
420	-	196.9 HV 0.5	92.4 HRB	68.9 µm	68.3 µm	
421	-	188.1 HV 0.5	90.6 HRB	70.6 µm	69.8 µm	
422	-	182.8 HV 0.5	89.6 HRB	71.9 µm	70.6 µm	
423	-	190.5 HV 0.5	91.1 HRB	69.6 µm	70.0 µm	
424	-	184.2 HV 0.5	89.8 HRB	70.6 µm	71.3 µm	
425	-	185.4 HV 0.5	90.1 HRB	69.7 µm	71.8 µm	
426	-	197.2 HV 0.5	92.4 HRB	68.2 µm	68.9 µm	
427	-	191.6 HV 0.5	91.3 HRB	69.7 µm	69.4 µm	
428	-	200.8 HV 0.5	93.2 HRB	67.1 µm	68.8 µm	
429	-	171.8 HV 0.5	86.9 HRB	77.1 µm	69.8 µm	
430	-	185.7 HV 0.5	90.1 HRB	68.5 µm	72.8 µm	
431	-	193.5 HV 0.5	91.7 HRB	69.4 µm	69.0 µm	
432	-	188.7 HV 0.5	90.7 HRB	68.5 µm	71.7 µm	
433	-	195.1 HV 0.5	92.0 HRB	69.6 µm	68.3 µm	
434	-	185.6 HV 0.5	90.1 HRB	69.6 µm	71.8 µm	
435	-	188.4 HV 0.5	90.7 HRB	70.8 µm	69.5 µm	
436	-	190.4 HV 0.5	91.1 HRB	70.6 µm	68.9 µm	
437	-	170.8 HV 0.5	86.6 HRB	77.5 µm	69.8 µm	
438	-	182.1 HV 0.5	89.4 HRB	72.6 µm	70.1 µm	
439	-	183.1 HV 0.5	89.6 HRB	71.5 µm	70.9 µm	
440	-	189.2 HV 0.5	90.8 HRB	69.5 µm	70.6 µm	
441	-	186.7 HV 0.5	90.3 HRB	70.4 µm	70.6 µm	
442	-	179.9 HV 0.5	89.0 HRB	69.3 µm	74.3 µm	
443	-	181.0 HV 0.5	89.2 HRB	70.1 µm	73.0 µm	
444	-	178.7 HV 0.5	88.7 HRB	70.3 µm	73.8 µm	
445	-	188.6 HV 0.5	90.7 HRB	69.1 µm	71.1 µm	
446	-	182.4 HV 0.5	89.5 HRB	68.8 µm	73.8 µm	
447	-	188.7 HV 0.5	90.7 HRB	68.6 µm	71.6 µm	
448	-	183.4 HV 0.5	89.7 HRB	71.1 µm	71.1 µm	
449	-	191.7 HV 0.5	91.3 HRB	68.9 µm	70.2 µm	
450	-	183.0 HV 0.5	89.6 HRB	69.7 µm	72.6 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
451	-	183.3 HV 0.5	89.7 HRB	71.6 µm	70.6 µm	
452	-	206.1 HV 0.5	94.2 HRB	67.5 µm	66.6 µm	
453	-	181.6 HV 0.5	89.3 HRB	70.5 µm	72.4 µm	
454	-	174.7 HV 0.5	87.7 HRB	72.4 µm	73.3 µm	
455	-	174.9 HV 0.5	87.7 HRB	72.1 µm	73.5 µm	
456	-	169.1 HV 0.5	86.0 HRB	73.9 µm	74.2 µm	
457	-	178.7 HV 0.5	88.7 HRB	71.4 µm	72.7 µm	
458	-	191.1 HV 0.5	91.2 HRB	69.0 µm	70.3 µm	
459	-	194.1 HV 0.5	91.8 HRB	68.6 µm	69.6 µm	
460	-	181.4 HV 0.5	89.3 HRB	71.0 µm	72.0 µm	
461	-	176.9 HV 0.5	88.2 HRB	73.5 µm	71.2 µm	
462	-	172.1 HV 0.5	87.0 HRB	72.6 µm	74.2 µm	
463	-	173.6 HV 0.5	87.4 HRB	72.7 µm	73.4 µm	
464	-	189.7 HV 0.5	90.9 HRB	70.1 µm	69.7 µm	
465	-	194.4 HV 0.5	91.9 HRB	69.0 µm	69.2 µm	
466	-	200.7 HV 0.5	93.1 HRB	67.4 µm	68.6 µm	
467	-	186.4 HV 0.5	90.3 HRB	70.6 µm	70.5 µm	
468	-	197.4 HV 0.5	92.5 HRB	70.1 µm	67.0 µm	
469	-	194.2 HV 0.5	91.8 HRB	68.4 µm	69.8 µm	
470	-	187.2 HV 0.5	90.4 HRB	70.4 µm	70.3 µm	
471	-	188.8 HV 0.5	90.8 HRB	69.1 µm	71.0 µm	
472	-	199.1 HV 0.5	92.8 HRB	68.0 µm	68.4 µm	
473	-	194.8 HV 0.5	92.0 HRB	67.4 µm	70.6 µm	
474	-	187.9 HV 0.5	90.6 HRB	70.5 µm	70.0 µm	
475	-	186.6 HV 0.5	90.3 HRB	69.7 µm	71.2 µm	
476	-	174.4 HV 0.5	87.6 HRB	73.2 µm	72.6 µm	
477	-	180.1 HV 0.5	89.0 HRB	70.1 µm	73.4 µm	
478	-	191.9 HV 0.5	91.4 HRB	68.6 µm	70.4 µm	
479	-	193.9 HV 0.5	91.8 HRB	66.3 µm	72.0 µm	
480	-	181.6 HV 0.5	89.3 HRB	71.2 µm	71.7 µm	
481	-	189.0 HV 0.5	90.8 HRB	69.5 µm	70.6 µm	
482	-	180.6 HV 0.5	89.1 HRB	70.3 µm	73.0 µm	
483	-	191.0 HV 0.5	91.2 HRB	67.7 µm	71.6 µm	
484	-	179.9 HV 0.5	89.0 HRB	70.9 µm	72.7 µm	
485	-	185.1 HV 0.5	90.0 HRB	69.1 µm	72.5 µm	
486	-	182.7 HV 0.5	89.5 HRB	71.1 µm	71.4 µm	
487	-	173.5 HV 0.5	87.4 HRB	69.0 µm	77.2 µm	
488	-	182.8 HV 0.5	89.6 HRB	69.0 µm	73.4 µm	
489	-	181.5 HV 0.5	89.3 HRB	71.4 µm	71.6 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
490	-	182.7 HV 0.5	89.5 HRB	70.7 µm	71.8 µm	
491	-	194.5 HV 0.5	91.9 HRB	67.3 µm	70.8 µm	
492	-	186.1 HV 0.5	90.2 HRB	68.4 µm	72.7 µm	
493	-	178.2 HV 0.5	88.6 HRB	70.1 µm	74.2 µm	
494	-	191.9 HV 0.5	91.4 HRB	68.9 µm	70.1 µm	
495	-	185.2 HV 0.5	90.0 HRB	70.2 µm	71.3 µm	
496	-	187.3 HV 0.5	90.5 HRB	70.8 µm	69.9 µm	
497	-	180.1 HV 0.5	89.0 HRB	71.6 µm	71.9 µm	
498	-	188.9 HV 0.5	90.8 HRB	70.0 µm	70.2 µm	
499	-	191.6 HV 0.5	91.3 HRB	69.1 µm	70.0 µm	
500	-	182.3 HV 0.5	89.5 HRB	71.8 µm	70.8 µm	
501	-	179.8 HV 0.5	89.0 HRB	72.3 µm	71.3 µm	
502	-	180.0 HV 0.5	89.0 HRB	72.0 µm	71.5 µm	
503	-	170.5 HV 0.5	86.5 HRB	73.9 µm	73.6 µm	
504	-	176.0 HV 0.5	88.0 HRB	71.6 µm	73.5 µm	
505	-	176.5 HV 0.5	88.1 HRB	72.1 µm	72.9 µm	
506	-	177.8 HV 0.5	88.4 HRB	71.8 µm	72.6 µm	
507	-	180.5 HV 0.5	89.1 HRB	71.4 µm	72.0 µm	
508	-	206.4 HV 0.5	94.3 HRB	66.4 µm	67.6 µm	
509	-	205.5 HV 0.5	94.1 HRB	67.0 µm	67.3 µm	
510	-	194.1 HV 0.5	91.8 HRB	70.6 µm	67.7 µm	
511	-	189.9 HV 0.5	91.0 HRB	70.0 µm	69.8 µm	
512	-	185.4 HV 0.5	90.1 HRB	70.2 µm	71.2 µm	
513	-	184.9 HV 0.5	90.0 HRB	69.8 µm	71.8 µm	
514	-	177.7 HV 0.5	88.4 HRB	71.5 µm	73.0 µm	
515	-	183.7 HV 0.5	89.7 HRB	68.1 µm	74.0 µm	
516	-	185.3 HV 0.5	90.1 HRB	70.7 µm	70.8 µm	
517	-	190.3 HV 0.5	91.1 HRB	69.4 µm	70.2 µm	
518	-	188.2 HV 0.5	90.6 HRB	67.5 µm	72.9 µm	
519	-	193.1 HV 0.5	91.6 HRB	68.6 µm	70.0 µm	
520	-	183.8 HV 0.5	89.8 HRB	67.9 µm	74.2 µm	
521	-	196.5 HV 0.5	92.3 HRB	68.8 µm	68.6 µm	
522	-	206.0 HV 0.5	94.2 HRB	68.0 µm	66.2 µm	
523	-	196.2 HV 0.5	92.2 HRB	68.3 µm	69.2 µm	
524	-	191.0 HV 0.5	91.2 HRB	69.0 µm	70.4 µm	
525	-	188.6 HV 0.5	90.7 HRB	68.5 µm	71.8 µm	
526	-	188.8 HV 0.5	90.8 HRB	70.6 µm	69.6 µm	
527	-	188.1 HV 0.5	90.6 HRB	68.7 µm	71.7 µm	
528	-	191.5 HV 0.5	91.3 HRB	68.0 µm	71.1 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
529	-	188.9 HV 0.5	90.8 HRB	69.6 µm	70.5 µm	
530	-	198.6 HV 0.5	92.7 HRB	67.4 µm	69.2 µm	
531	-	189.5 HV 0.5	90.9 HRB	69.6 µm	70.3 µm	
532	-	191.9 HV 0.5	91.4 HRB	67.6 µm	71.4 µm	
533	-	185.2 HV 0.5	90.0 HRB	70.8 µm	70.7 µm	
534	-	186.7 HV 0.5	90.3 HRB	69.0 µm	72.0 µm	
535	-	190.2 HV 0.5	91.0 HRB	68.6 µm	71.1 µm	
536	-	188.4 HV 0.5	90.7 HRB	69.2 µm	71.1 µm	
537	-	188.1 HV 0.5	90.6 HRB	68.1 µm	72.4 µm	
538	-	183.5 HV 0.5	89.7 HRB	70.7 µm	71.5 µm	
539	-	196.8 HV 0.5	92.4 HRB	68.1 µm	69.2 µm	
540	-	210.5 HV 0.5	95.1 HRB	65.6 µm	67.1 µm	
541	-	184.2 HV 0.5	89.8 HRB	72.7 µm	69.2 µm	
542	-	186.1 HV 0.5	90.2 HRB	70.1 µm	71.1 µm	
543	-	190.0 HV 0.5	91.0 HRB	70.2 µm	69.5 µm	
544	-	183.3 HV 0.5	89.7 HRB	71.0 µm	71.2 µm	
545	-	190.0 HV 0.5	91.0 HRB	68.9 µm	70.8 µm	
546	-	193.3 HV 0.5	91.7 HRB	68.6 µm	69.9 µm	
547	-	185.3 HV 0.5	90.1 HRB	70.4 µm	71.1 µm	
548	-	185.5 HV 0.5	90.1 HRB	70.9 µm	70.5 µm	
549	-	193.9 HV 0.5	91.8 HRB	70.0 µm	68.3 µm	
550	-	188.7 HV 0.5	90.7 HRB	69.8 µm	70.4 µm	
551	-	195.1 HV 0.5	92.0 HRB	68.8 µm	69.0 µm	
552	-	210.8 HV 0.5	95.1 HRB	66.2 µm	66.5 µm	
553	-	199.1 HV 0.5	92.8 HRB	67.7 µm	68.8 µm	
554	-	193.7 HV 0.5	91.7 HRB	68.5 µm	69.8 µm	
555	-	195.6 HV 0.5	92.1 HRB	69.0 µm	68.7 µm	
556	-	192.7 HV 0.5	91.5 HRB	67.4 µm	71.4 µm	
557	-	194.0 HV 0.5	91.8 HRB	67.8 µm	70.5 µm	
558	-	197.8 HV 0.5	92.6 HRB	68.7 µm	68.2 µm	
559	-	191.4 HV 0.5	91.3 HRB	67.7 µm	71.5 µm	
560	-	191.2 HV 0.5	91.2 HRB	68.9 µm	70.4 µm	
561	-	189.3 HV 0.5	90.9 HRB	68.6 µm	71.4 µm	
562	-	199.0 HV 0.5	92.8 HRB	68.2 µm	68.3 µm	
563	-	191.0 HV 0.5	91.2 HRB	70.2 µm	69.1 µm	
564	-	198.2 HV 0.5	92.6 HRB	66.3 µm	70.5 µm	
565	-	189.2 HV 0.5	90.8 HRB	68.9 µm	71.2 µm	
566	-	195.4 HV 0.5	92.1 HRB	66.9 µm	70.9 µm	
567	-	189.9 HV 0.5	91.0 HRB	69.7 µm	70.0 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
568	-	195.8 HV 0.5	92.2 HRB	67.1 µm	70.6 µm	
569	-	196.3 HV 0.5	92.3 HRB	69.0 µm	68.5 µm	
570	-	190.8 HV 0.5	91.2 HRB	69.6 µm	69.8 µm	
571	-	194.9 HV 0.5	92.0 HRB	68.3 µm	69.6 µm	
572	-	190.8 HV 0.5	91.2 HRB	69.6 µm	69.8 µm	
573	-	187.5 HV 0.5	90.5 HRB	68.6 µm	72.1 µm	
574	-	185.6 HV 0.5	90.1 HRB	68.2 µm	73.1 µm	
575	-	194.8 HV 0.5	92.0 HRB	69.8 µm	68.2 µm	
576	-	191.8 HV 0.5	91.4 HRB	68.6 µm	70.5 µm	
577	-	202.9 HV 0.5	93.6 HRB	66.2 µm	69.0 µm	
578	-	194.6 HV 0.5	91.9 HRB	68.3 µm	69.8 µm	
579	-	184.8 HV 0.5	90.0 HRB	69.6 µm	72.1 µm	
580	-	198.3 HV 0.5	92.7 HRB	67.7 µm	69.1 µm	
581	-	198.4 HV 0.5	92.7 HRB	67.3 µm	69.4 µm	
582	-	193.6 HV 0.5	91.7 HRB	67.5 µm	71.0 µm	
583	-	200.3 HV 0.5	93.1 HRB	66.8 µm	69.2 µm	
584	-	222.3 HV 0.5	97.0 HRB	64.3 µm	64.8 µm	
585	-	242.8 HV 0.5	-	62.4 µm	61.2 µm	
586	-	193.5 HV 0.5	91.7 HRB	69.0 µm	69.5 µm	
587	-	187.5 HV 0.5	90.5 HRB	70.2 µm	70.4 µm	
588	-	188.2 HV 0.5	90.6 HRB	69.8 µm	70.6 µm	
589	-	186.1 HV 0.5	90.2 HRB	69.4 µm	71.8 µm	
590	-	197.9 HV 0.5	92.6 HRB	68.3 µm	68.6 µm	
591	-	204.6 HV 0.5	93.9 HRB	67.8 µm	66.8 µm	
592	-	194.5 HV 0.5	91.9 HRB	69.3 µm	68.7 µm	
593	-	195.4 HV 0.5	92.1 HRB	69.7 µm	68.1 µm	
594	-	189.7 HV 0.5	90.9 HRB	69.8 µm	70.0 µm	
595	-	201.1 HV 0.5	93.2 HRB	69.5 µm	66.3 µm	
596	-	207.7 HV 0.5	94.5 HRB	67.6 µm	66.0 µm	
597	-	192.0 HV 0.5	91.4 HRB	67.0 µm	72.0 µm	
598	-	198.5 HV 0.5	92.7 HRB	68.7 µm	67.9 µm	
599	-	201.6 HV 0.5	93.3 HRB	66.0 µm	69.6 µm	
600	-	195.1 HV 0.5	92.0 HRB	67.8 µm	70.0 µm	
601	-	196.9 HV 0.5	92.4 HRB	69.4 µm	67.9 µm	
602	-	190.0 HV 0.5	91.0 HRB	69.6 µm	70.2 µm	
603	-	185.7 HV 0.5	90.1 HRB	68.6 µm	72.8 µm	
604	-	188.9 HV 0.5	90.8 HRB	69.7 µm	70.5 µm	
605	-	186.6 HV 0.5	90.3 HRB	69.6 µm	71.4 µm	
606	-	183.3 HV 0.5	89.7 HRB	68.2 µm	74.0 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
607	-	200.7 HV 0.5	93.1 HRB	67.9 µm	68.0 µm	
608	-	204.9 HV 0.5	94.0 HRB	66.7 µm	67.8 µm	
609	-	199.8 HV 0.5	93.0 HRB	67.1 µm	69.1 µm	
610	-	189.2 HV 0.5	90.8 HRB	68.0 µm	72.0 µm	
611	-	189.1 HV 0.5	90.8 HRB	69.2 µm	70.8 µm	
612	-	195.5 HV 0.5	92.1 HRB	69.4 µm	68.4 µm	
613	-	195.4 HV 0.5	92.1 HRB	68.1 µm	69.7 µm	
614	-	193.9 HV 0.5	91.8 HRB	69.3 µm	69.0 µm	
615	-	187.7 HV 0.5	90.5 HRB	69.8 µm	70.7 µm	
616	-	192.8 HV 0.5	91.6 HRB	68.4 µm	70.2 µm	
617	-	188.1 HV 0.5	90.6 HRB	71.5 µm	68.9 µm	
618	-	199.9 HV 0.5	93.0 HRB	68.2 µm	68.1 µm	
619	-	188.9 HV 0.5	90.8 HRB	70.1 µm	70.0 µm	
620	-	201.8 HV 0.5	93.4 HRB	67.3 µm	68.3 µm	
621	-	198.4 HV 0.5	92.7 HRB	67.6 µm	69.1 µm	
622	-	195.7 HV 0.5	92.1 HRB	68.5 µm	69.2 µm	
623	-	194.4 HV 0.5	91.9 HRB	70.5 µm	67.7 µm	
624	-	194.9 HV 0.5	92.0 HRB	67.9 µm	70.1 µm	
625	-	196.9 HV 0.5	92.4 HRB	68.0 µm	69.2 µm	
626	-	196.6 HV 0.5	92.3 HRB	70.4 µm	67.0 µm	
627	-	183.2 HV 0.5	89.6 HRB	71.4 µm	70.9 µm	
628	-	213.9 HV 0.5	95.6 HRB	64.3 µm	67.3 µm	
629	-	219.1 HV 0.5	96.5 HRB	65.4 µm	64.7 µm	
630	-	238.1 HV 0.5	99.7 HRB	62.2 µm	62.7 µm	
631	-	183.8 HV 0.5	89.8 HRB	73.2 µm	68.9 µm	
632	-	188.7 HV 0.5	90.7 HRB	70.0 µm	70.2 µm	
633	-	181.1 HV 0.5	89.2 HRB	70.4 µm	72.7 µm	
634	-	187.3 HV 0.5	90.5 HRB	70.6 µm	70.1 µm	
635	-	189.9 HV 0.5	91.0 HRB	67.6 µm	72.1 µm	
636	-	194.6 HV 0.5	91.9 HRB	68.7 µm	69.3 µm	
637	-	197.3 HV 0.5	92.5 HRB	68.7 µm	68.4 µm	
638	-	197.9 HV 0.5	92.6 HRB	69.3 µm	67.6 µm	
639	-	204.6 HV 0.5	93.9 HRB	69.3 µm	65.3 µm	
640	-	236.2 HV 0.5	99.4 HRB	62.7 µm	62.6 µm	
641	-	215.1 HV 0.5	95.9 HRB	65.2 µm	66.1 µm	
642	-	202.2 HV 0.5	93.4 HRB	65.8 µm	69.6 µm	
643	-	210.0 HV 0.5	95.0 HRB	66.4 µm	66.5 µm	
644	-	202.9 HV 0.5	93.6 HRB	66.5 µm	68.7 µm	
645	-	217.9 HV 0.5	96.3 HRB	64.4 µm	66.0 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
646	-	211.7 HV 0.5	95.3 HRB	65.7 µm	66.7 µm	
647	-	210.9 HV 0.5	95.1 HRB	67.4 µm	65.2 µm	
648	-	205.3 HV 0.5	94.1 HRB	66.1 µm	68.3 µm	
649	-	208.7 HV 0.5	94.7 HRB	66.0 µm	67.3 µm	
650	-	221.6 HV 0.5	96.9 HRB	63.9 µm	65.5 µm	
651	-	211.6 HV 0.5	95.3 HRB	65.3 µm	67.1 µm	
652	-	207.6 HV 0.5	94.5 HRB	67.9 µm	65.7 µm	
653	-	214.6 HV 0.5	95.8 HRB	67.4 µm	64.1 µm	
654	-	201.6 HV 0.5	93.3 HRB	65.8 µm	69.8 µm	
655	-	214.1 HV 0.5	95.7 HRB	63.8 µm	67.8 µm	
656	-	220.2 HV 0.5	96.7 HRB	63.3 µm	66.5 µm	
657	-	217.8 HV 0.5	96.3 HRB	63.7 µm	66.8 µm	
658	-	220.6 HV 0.5	96.8 HRB	64.9 µm	64.8 µm	
659	-	210.1 HV 0.5	95.0 HRB	66.4 µm	66.4 µm	
660	-	233.4 HV 0.5	98.9 HRB	65.1 µm	60.9 µm	
661	-	215.8 HV 0.5	96.0 HRB	65.4 µm	65.6 µm	
662	-	201.9 HV 0.5	93.4 HRB	70.4 µm	65.1 µm	
663	-	217.4 HV 0.5	96.2 HRB	64.7 µm	65.9 µm	
664	-	217.5 HV 0.5	96.3 HRB	64.8 µm	65.7 µm	
665	-	210.6 HV 0.5	95.1 HRB	65.7 µm	67.0 µm	
666	-	218.7 HV 0.5	96.4 HRB	64.5 µm	65.7 µm	
667	-	218.1 HV 0.5	96.3 HRB	64.6 µm	65.8 µm	
668	-	212.5 HV 0.5	95.4 HRB	65.5 µm	66.6 µm	
669	-	219.7 HV 0.5	96.6 HRB	64.4 µm	65.5 µm	
670	-	217.2 HV 0.5	96.2 HRB	65.2 µm	65.5 µm	
671	-	212.2 HV 0.5	95.4 HRB	64.1 µm	68.1 µm	
672	-	223.2 HV 0.5	97.2 HRB	63.4 µm	65.5 µm	
673	-	242.7 HV 0.5	-	61.3 µm	62.3 µm	
674	-	255.7 HV 0.5	-	60.3 µm	60.1 µm	
675	-	268.3 HV 0.5	-	58.9 µm	58.7 µm	
676	-	206.2 HV 0.5	94.2 HRB	66.6 µm	67.5 µm	
677	-	192.3 HV 0.5	91.5 HRB	69.2 µm	69.7 µm	
678	-	192.2 HV 0.5	91.4 HRB	69.4 µm	69.5 µm	
679	-	186.9 HV 0.5	90.4 HRB	70.3 µm	70.5 µm	
680	-	190.4 HV 0.5	91.1 HRB	70.0 µm	69.5 µm	
681	-	192.5 HV 0.5	91.5 HRB	69.9 µm	68.9 µm	
682	-	213.1 HV 0.5	95.5 HRB	65.5 µm	66.4 µm	
683	-	216.1 HV 0.5	96.0 HRB	65.4 µm	65.6 µm	
684	-	218.2 HV 0.5	96.4 HRB	65.4 µm	65.0 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
685	-	209.5 HV 0.5	94.9 HRB	65.5 µm	67.6 µm	
686	-	206.3 HV 0.5	94.3 HRB	66.1 µm	68.0 µm	
687	-	206.2 HV 0.5	94.2 HRB	66.1 µm	68.0 µm	
688	-	199.2 HV 0.5	92.8 HRB	66.5 µm	70.0 µm	
689	-	207.7 HV 0.5	94.5 HRB	68.1 µm	65.5 µm	
690	-	208.5 HV 0.5	94.7 HRB	65.6 µm	67.8 µm	
691	-	207.9 HV 0.5	94.6 HRB	65.6 µm	67.9 µm	
692	-	226.8 HV 0.5	97.8 HRB	65.0 µm	62.9 µm	
693	-	207.1 HV 0.5	94.4 HRB	67.2 µm	66.6 µm	
694	-	204.6 HV 0.5	93.9 HRB	66.1 µm	68.5 µm	
695	-	188.0 HV 0.5	90.6 HRB	70.5 µm	70.0 µm	
696	-	207.8 HV 0.5	94.6 HRB	67.4 µm	66.2 µm	
697	-	198.8 HV 0.5	92.8 HRB	66.6 µm	70.0 µm	
698	-	217.6 HV 0.5	96.3 HRB	64.4 µm	66.1 µm	
699	-	212.8 HV 0.5	95.5 HRB	66.4 µm	65.6 µm	
700	-	205.4 HV 0.5	94.1 HRB	67.5 µm	66.8 µm	
701	-	194.5 HV 0.5	91.9 HRB	69.3 µm	68.8 µm	
702	-	208.0 HV 0.5	94.6 HRB	66.7 µm	66.8 µm	
703	-	208.8 HV 0.5	94.8 HRB	65.5 µm	67.8 µm	
704	-	209.4 HV 0.5	94.9 HRB	65.5 µm	67.5 µm	
705	-	208.3 HV 0.5	94.7 HRB	66.5 µm	67.0 µm	
706	-	205.9 HV 0.5	94.2 HRB	66.0 µm	68.2 µm	
707	-	207.5 HV 0.5	94.5 HRB	66.3 µm	67.4 µm	
708	-	200.2 HV 0.5	93.0 HRB	68.0 µm	68.1 µm	
709	-	198.8 HV 0.5	92.8 HRB	69.9 µm	66.7 µm	
710	-	199.4 HV 0.5	92.9 HRB	68.2 µm	68.1 µm	
711	-	199.2 HV 0.5	92.8 HRB	68.3 µm	68.2 µm	
712	-	211.3 HV 0.5	95.2 HRB	65.6 µm	66.8 µm	
713	-	209.9 HV 0.5	95.0 HRB	66.0 µm	66.9 µm	
714	-	207.1 HV 0.5	94.4 HRB	64.8 µm	69.0 µm	
715	-	204.9 HV 0.5	94.0 HRB	66.9 µm	67.7 µm	
716	-	215.9 HV 0.5	96.0 HRB	66.5 µm	64.6 µm	
717	-	211.2 HV 0.5	95.2 HRB	67.3 µm	65.2 µm	
718	-	229.7 HV 0.5	98.3 HRB	62.4 µm	64.7 µm	
719	-	242.1 HV 0.5	-	61.9 µm	61.9 µm	
720	-	246.2 HV 0.5	-	61.9 µm	60.9 µm	
721	-	215.7 HV 0.5	95.9 HRB	65.7 µm	65.4 µm	
722	-	214.5 HV 0.5	95.7 HRB	65.1 µm	66.4 µm	
723	-	192.7 HV 0.5	91.5 HRB	69.3 µm	69.5 µm	

Date: 05-24-2023
Tester: Admin
Program: Hardness Map

Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
724	-	195.2 HV 0.5	92.0 HRB	68.5 µm	69.3 µm	
725	-	208.8 HV 0.5	94.8 HRB	66.6 µm	66.7 µm	
726	-	210.5 HV 0.5	95.1 HRB	65.9 µm	66.9 µm	
727	-	208.9 HV 0.5	94.8 HRB	66.5 µm	66.8 µm	
728	-	203.2 HV 0.5	93.6 HRB	67.6 µm	67.5 µm	
729	-	196.2 HV 0.5	92.2 HRB	67.1 µm	70.4 µm	
730	-	210.0 HV 0.5	95.0 HRB	67.0 µm	65.8 µm	
731	-	206.9 HV 0.5	94.4 HRB	67.8 µm	66.1 µm	
732	-	201.5 HV 0.5	93.3 HRB	68.0 µm	67.6 µm	
733	-	204.5 HV 0.5	93.9 HRB	66.7 µm	67.9 µm	
734	-	210.2 HV 0.5	95.0 HRB	66.9 µm	65.9 µm	
735	-	205.4 HV 0.5	94.1 HRB	67.3 µm	67.1 µm	
736	-	200.6 HV 0.5	93.1 HRB	69.2 µm	66.8 µm	
737	-	207.1 HV 0.5	94.4 HRB	67.1 µm	66.7 µm	
738	-	217.7 HV 0.5	96.3 HRB	65.5 µm	65.1 µm	
739	-	201.0 HV 0.5	93.2 HRB	68.3 µm	67.5 µm	
740	-	199.3 HV 0.5	92.9 HRB	67.5 µm	69.0 µm	
741	-	203.4 HV 0.5	93.7 HRB	66.8 µm	68.3 µm	
742	-	210.7 HV 0.5	95.1 HRB	64.7 µm	68.0 µm	
743	-	208.6 HV 0.5	94.7 HRB	65.9 µm	67.5 µm	
744	-	210.2 HV 0.5	95.0 HRB	67.4 µm	65.4 µm	
745	-	199.6 HV 0.5	92.9 HRB	65.8 µm	70.5 µm	
746	-	216.9 HV 0.5	96.2 HRB	66.0 µm	64.7 µm	
747	-	200.1 HV 0.5	93.0 HRB	66.1 µm	70.0 µm	
748	-	203.4 HV 0.5	93.7 HRB	65.3 µm	69.7 µm	
749	-	206.7 HV 0.5	94.3 HRB	66.5 µm	67.4 µm	
750	-	218.1 HV 0.5	96.4 HRB	64.9 µm	65.5 µm	
751	-	219.7 HV 0.5	96.6 HRB	64.4 µm	65.5 µm	
752	-	244.7 HV 0.5	-	60.5 µm	62.6 µm	
753	-	234.7 HV 0.5	99.1 HRB	63.8 µm	61.9 µm	
754	-	234.8 HV 0.5	99.1 HRB	62.5 µm	63.2 µm	
755	-	213.6 HV 0.5	95.6 HRB	66.5 µm	65.3 µm	
756	-	207.5 HV 0.5	94.5 HRB	65.4 µm	68.3 µm	
757	-	214.4 HV 0.5	95.7 HRB	65.4 µm	66.1 µm	
758	-	214.4 HV 0.5	95.7 HRB	66.4 µm	65.1 µm	
759	-	215.6 HV 0.5	95.9 HRB	64.9 µm	66.3 µm	
760	-	209.5 HV 0.5	94.9 HRB	66.5 µm	66.5 µm	
761	-	207.9 HV 0.5	94.6 HRB	66.0 µm	67.5 µm	
762	-	211.1 HV 0.5	95.2 HRB	65.6 µm	67.0 µm	

Date: 05-24-2023
Tester: Admin
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Point	Distance	Hardness	Converted	Diagonal X	Diagonal Y	Comments
763	-	212.9 HV 0.5	95.5 HRB	65.3 µm	66.6 µm	
764	-	211.2 HV 0.5	95.2 HRB	65.8 µm	66.7 µm	
765	-	214.6 HV 0.5	95.8 HRB	65.2 µm	66.3 µm	
766	-	221.0 HV 0.5	96.8 HRB	64.5 µm	65.1 µm	
767	-	204.9 HV 0.5	94.0 HRB	67.3 µm	67.2 µm	
768	-	211.8 HV 0.5	95.3 HRB	66.5 µm	65.8 µm	
769	-	211.9 HV 0.5	95.3 HRB	66.0 µm	66.3 µm	
770	-	213.7 HV 0.5	95.6 HRB	65.5 µm	66.2 µm	
771	-	218.2 HV 0.5	96.4 HRB	65.5 µm	64.9 µm	
772	-	213.5 HV 0.5	95.6 HRB	65.5 µm	66.3 µm	
773	-	214.8 HV 0.5	95.8 HRB	66.1 µm	65.3 µm	
774	-	214.6 HV 0.5	95.8 HRB	64.8 µm	66.7 µm	
775	-	203.1 HV 0.5	93.6 HRB	68.0 µm	67.2 µm	
776	-	219.8 HV 0.5	96.6 HRB	65.3 µm	64.6 µm	
777	-	221.3 HV 0.5	96.9 HRB	63.9 µm	65.5 µm	
778	-	212.6 HV 0.5	95.4 HRB	63.8 µm	68.3 µm	
779	-	236.7 HV 0.5	99.4 HRB	62.3 µm	62.8 µm	
780	-	227.4 HV 0.5	97.9 HRB	63.3 µm	64.4 µm	
781	-	249.1 HV 0.5	-	61.6 µm	60.4 µm	