MASSACHUSETTS MATERIALS TECHNOLOGIES LLC

Massachusetts Materials Technologies LLC
8 Erie Dr, Unit A
Natick, MA 01760
617-502-5636
www.ByMMT.com

Preliminary Material Verification Report

This Preliminary Report provides nondestructive results using the Hardness, Strength, & Ductility (HSD) process that is performed in compliance with Title 49 CFR §192.607

Preliminary results are intended to provide timely feedback based on an initial review of data collected, including geometry, location, tensile grade, and seam characteristics. The results are subject to change in a Final Material Verification Report that also includes the sample chemistry, microstructure grain size, test images, and individual HSD test reports.

PRELIMINARY PROJECT SUMMARY

Operator: Energy Company	**NDE Services:** MMT	**MMT Project ID:** MMT22000
Testing Dates: April 12th, 2022	**No. of Test Sites:** 1	**No. of Samples:** 1

PRELIMINARY SAMPLE OVERVIEW

Sample ID	Sample Type	Dig ID	Line ID	Approximate Street Address	GPS Coordinates
Sample A	In-Service Pipe Joint	Dig 1	Line AB	123 Pipe St, Pipe Town, MA 01760	12.345678, -87.654321

PRELIMINARY MATERIAL VERIFICATION RESULTS SUMMARY

Sample ID	Physical Properties			Measured NDE Strength		Conservative NDE Strength		API 5L Tensile Grade				
	OD (inch)	WT (inch)	Seam Type	Yield (ksi)	UTS (ksi)	Yield (ksi)	UTS (ksi)	Expected Grade	Conservative Grade		Expected Requirement Check	
									Yield	UTS	Yield	UTS
Sample A	16	0.250	LF-ERW	60.7	76.1	57.0	73.8	X46	X56	X56	Verified	Verified

Nondestructive evaluation (NDE) strength properties are reported as the average measured yield and UTS, as well as the conservative properties calculated by reducing the measured values by the HSD measurement uncertainty at an 80% confidence level for preliminary strength models which is 3.7 ksi for yield and 2.3 ksi for UTS. A conservative API 5L tensile grade is determined by comparing the conservative strength to the minimum requirements for PSL 1 materials, with the sample conforming to all grades up to what is reported. If an expected grade is provided, the strength requirements are checked with the measured values and uncertainty. An expected grade of "N/A" indicates that this information was not available when the report was issued. Additional information and remarks are provided under the detailed results and justification.

Contact the MMT reporting group (reporting@bymmt.com) if preliminary data does not reflect records or expectations.

Prepared by: John Smith
John Smith

Reviewed by: Jane Johnson
Jane Johnson

Issued: April 14, 2022

MASSACHUSETTS MATERIALS TECHNOLOGIES LLC

Massachusetts Materials Technologies LLC
8 Erie Dr, Unit A
Natick, MA 01760
617-502-5636
www.ByMMT.com

PRELIMINARY DETAILED RESULTS AND JUSTIFICATION

Sample geometry: The outer diameter (OD) and wall thickness (WT) are nominal values provided by the operator and verified during field examination.

Seam type determination: Sample A was an electric resistance welded (ERW) seam that was classified as low frequency (LF). Additional details and justification of the seam type designation will be provided in a subsequent Final Material Verification Report.

Measured NDE strength properties: Measured strength properties are reported as the average 0.5% total elongation under load (EUL) yield and ultimate tensile strength (UTS) based on subset values from multiple HSD test on the same sample.

Conservative NDE strength properties: Procedural requirements in §192.607(d)(2) specifies that nondestructive methods for grade verification must conservatively account for measurement inaccuracy and uncertainty. The HSD process for preliminary strength estimates considers HSD base metal tests and sample manufacturing process with an associated measurement uncertainty at varying confidence levels shown in the table below[1], with MMT recommending an 80% confidence level[2]. These measurement uncertainties are subtracted from the measured values to establish conservative lower bound strength properties.

Confidence Level (%)	Yield Uncertainty (ksi)	UTS Uncertainty (ksi)
70	2.3	1.4
80	3.7	2.3
90	5.6	3.5
95	7.2	4.6

API 5L tensile grade: A conservative grade is determined by comparing the conservative strength properties at the specified confidence level to the tensile requirements for API 5L PSL 1 materials for yield and UTS, which are both referenced in 192.607(b)(2). The API 5L grade requirements are minimum values, so the sample conforms to all grades up to what is reported. If an expected grade is provided, the measured strength and measurement uncertainty are compared to the grade requirement to assess conformance using the criterion in the table below. Note that these criteria are based on the NDE strength results and measurement uncertainty at the desired confidence level and may require further analysis and review to substantiate the outcome.

Expected Grade Requirement Check	Criterion	Description
Verified	Measured - Uncertainty ≥ API 5L Grade Minimum	Measured strength exceeds the expected grade requirement at specified confidence level.
Not Verified	Measured + Uncertainty ≤ API 5L Grade Minimum	Measured strength is more conservative than expected grade at specified confidence level
Inconclusive	Measured - Uncertainty < API 5L Grade Minimum	Measured strength is within the uncertainty of the grade requirement at the specified confidence level
	Measured + Uncertainty > API 5L Grade Minimum	

[1] Tabulated HSD measurement uncertainty is applicable to preliminary model results reported as of July 15, 2021.

[2] Palkovic et al., A statistical approach to material verification of expected grade through opportunistic measurements, PPIM, 2020.

MASSACHUSETTS MATERIALS TECHNOLOGIES LLC

Massachusetts Materials Technologies LLC
8 Erie Dr, Unit A
Natick, MA 01760
617-502-5636
www.ByMMT.com

PRELIMINARY UT WALL THICKNESS RESULTS

Ultrasonic Testing (UT) wall thickness measurements: Informational ultrasonic thickness measurements that were taken to evaluate average material removal during surface preparation and the wall thickness around the circumference of the pipe body are provided below.

Sample ID	Nominal wall thickness (inch)[1]	Average initial wall thickness (inch)	Average wall after testing (inch)	Percent change in initial wall thickness (%)[2]	Percent change in nominal wall thickness (%)[3]
Sample A	0.250	0.263	0.245	-6.8	-2.0

[1] As identified by Energy Company
[2] Change in initial wall thickness = (Average wall thickness after testing-Average initial wall thickness) / Average initial wall thickness
[3] Change in nominal wall thickness = (Average wall thickness after testing-Nominal wall thickness) / Nominal wall thickness

Sample ID	Average UT circumferential wall thickness measurements (inch)											
	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00
Sample A	0.260	0.263	0.264	0.264	0.264	0.262	0.262	0.258	0.263	0.260	0.260	0.263