GTI ENERGY

SAGE

STATISTICS, ANALYTICS, AND GIS IN ENERGY CONFERENCE

August 13-14, 2025 | Des Plaines, Illinois

AI for a Digital Thread and Asset Traceability

Alicia Farag

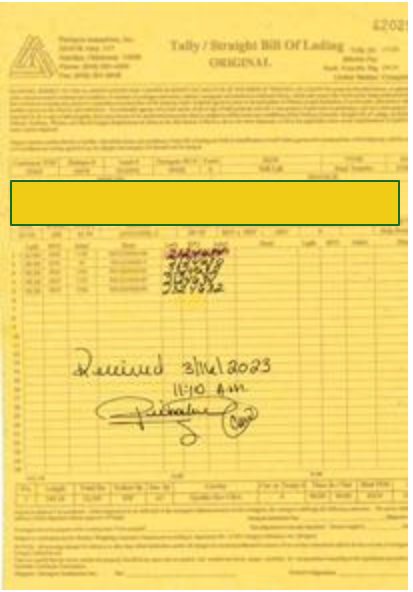
Locusview

The Big Idea

AI can accelerate the adoption of a Digital Thread that enables the flow of data from suppliers into a utility's system of record without requiring IT transformations by using AI agents with industry standards and ontologies to convert unstructured analog data into structured digital datasets

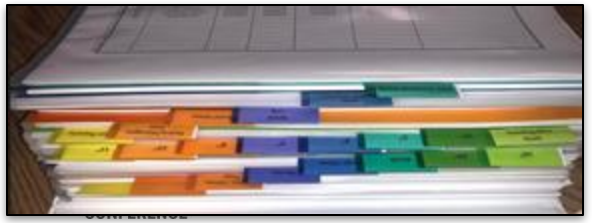
Digital Thread

- Utilities need high quality accurate asset data in systems of record
  - Existing use cases - engineering, compliance, operations
  - New use cases - AI, analytics, augmented reality, drones



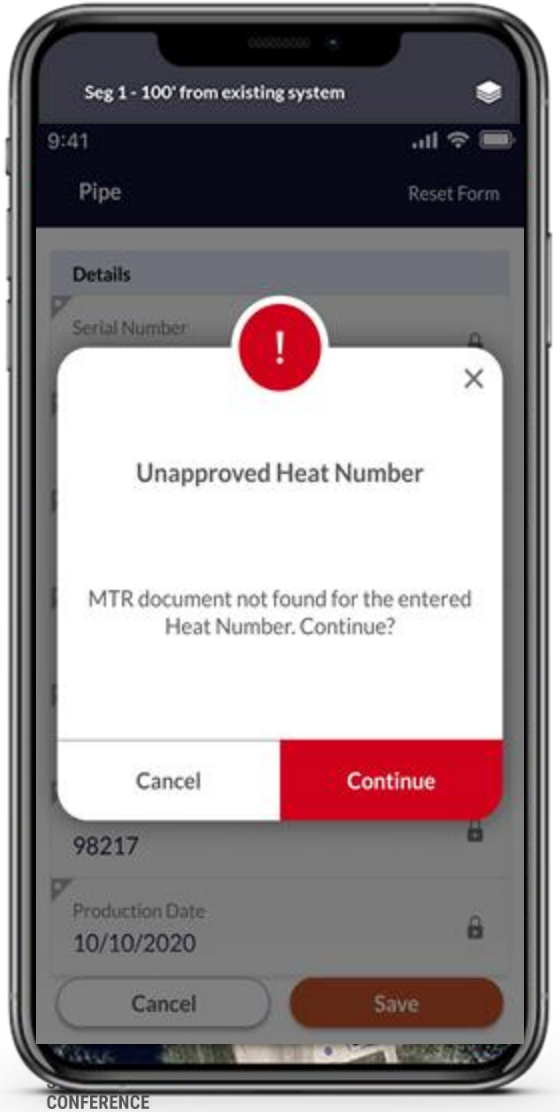
- Current workflows often involve manual interpretation and transcription, especially when receiving data from third parties

- We need a Digital Thread that enables the flow of data from suppliers to utilities in a digital, standardized format



Digital Thread Asset Traceability Use Cases

- MTR verification during intake
  - *"We waste so much time chasing MTRs"*
- Weld procedure verification
- Pressure test verification
- MAOP and TVC verification during project close-out
  - *"We spend days combing through MTRs"*
- Ensuring fabrications were constructed according to standards and specifications
  - *"This is where most of our verification problems are"*
- Getting certification and test data into systems of record
- Linking inspection results to the correct asset
- Addressing recalls and systemic performance issues

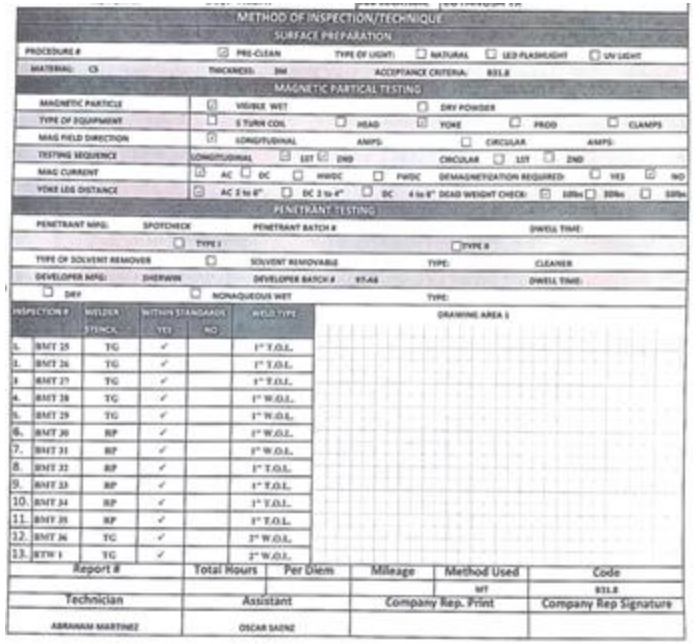


Unstructured ➡ Structured Data

- Many workflows between utilities and suppliers (service providers and manufacturers) still transfer analog data in an unstructured format
  - Spec sheets, test reports, fabrication reports, quality inspection reports, as-built drawings, print lines, nameplates
  - Variable formats and terminology

- Unstructured data requires human interpretation, transcription, and manual data entry into systems of record

- AI can convert unstructured data into structured data



Industry Standard Data Models

- An AI-enabled Digital Thread needs industry standard data models!
- Some standards describe data models in general terms with a list of mandatory requirements, but do not provide a real data model
- API 5L and RP 5MT
  - API 5L provides a list of required attributes in an MTR
  - API 5MT provides a digital data model for MTRs
  - MTR ontology for AI

10.1.3 Inspection Documents for PSL 2 Pipe

10.1.3.1 The manufacturer shall issue an Inspection Certificate 3.1.B in accordance with ISO 10474:1991 or an Inspection Certificate 3.1 in accordance with EN 10204:2004. Alternatively, if specified in the purchase order, an Inspection Certificate 3.1.A or 3.1.C in accordance with ISO 10474:1991 or an Inspection Certificate 3.2 in accordance with EN 10204:2004 shall be issued.

10.1.3.2 The following information, as applicable, shall be provided for each order item:

a) specified outside diameter, specified wall thickness, pipe grade, PSL, type of pipe, and the delivery condition;

b) chemical composition (heat and product) and carbon equivalent (product analysis and acceptance criterion);

c) tensile test results and the type, size, location, and orientation of the test pieces;

d) CVN impact test results; the size, orientation, and location of the test pieces; the test temperature; and the acceptance criteria for the specific test piece sizes used;

e) for welded pipe, DWT test results (individual and average test results for each test);

f) specified minimum hydrostatic test pressure and specified test duration;

g) for welded pipe, the method of nondestructive weld inspection (radiological, ultrasonic, or electromagnetic) used and the type and size of reference indicator or IQI used;

h) for SMLS p
particle) use

i) for HFW pip

j) for pipe with
Annexes M

k) name and l

Table A.1—Essential Data Elements to Provide Electronically

No.	Data type	Information/Guidance and Restrictions [b]	Data Format	e-label	API 5L [a] References
1	Z number	Test unit and/or data linking pipe to the appropriate MTR inspection document	Text or number	ZZZZ	3.1.60 11.2.1 j)
2	Pipe number	Unique identifier j (also see NOTE 1)	Text or number	PNUM	—
3	Serial number	Unique identifier of the final shipped joint/bundle j,k	Text or number	SNUM	—
4	Heat number	State the heat number	Text or number	HNUM	—
5	MTR number/identifier	State the related MTR number(s) or identifier(s) as they appear on the MTR	Text or number	MTRN	—
6	Date of certification	The date that appears on the hard-copy MTR	Default spreadsheet date format b (e.g. "MM/DD/YYYY")	DOCE	—
7	Facility name for pipe manufacturer m	Actual name of the manufacturer's facility that produced the pipe, as detailed on the facility's certificate or other appropriate documentation (if any) issued to them recognizing conformance to API 5L	Text	FNPM	10.1.3.2 k)
8	Facility address for pipe manufacturer m	Actual physical address/location of the manufacturer's facility that produced the pipe, as detailed on the facility's certificate or other appropriate documentation (if any) issued to them recognizing conformance to API 5L	Text	FAPM	10.1.3.2 k)
9	Facility name for plate/coil manufacturer	Actual name of the facility that produced the coil/plate	Text	FNPC	10.1.3.2 k)
10	Facility address for plate/coil manufacturer	Actual physical address/location of the facility that produced the coil/plate	Text	FAPC	10.1.3.2 k)
11	Facility name for steelmaking	Actual name of the facility that produced the steel (in liquid form)	Text	FNSM	10.1.3.2 k)

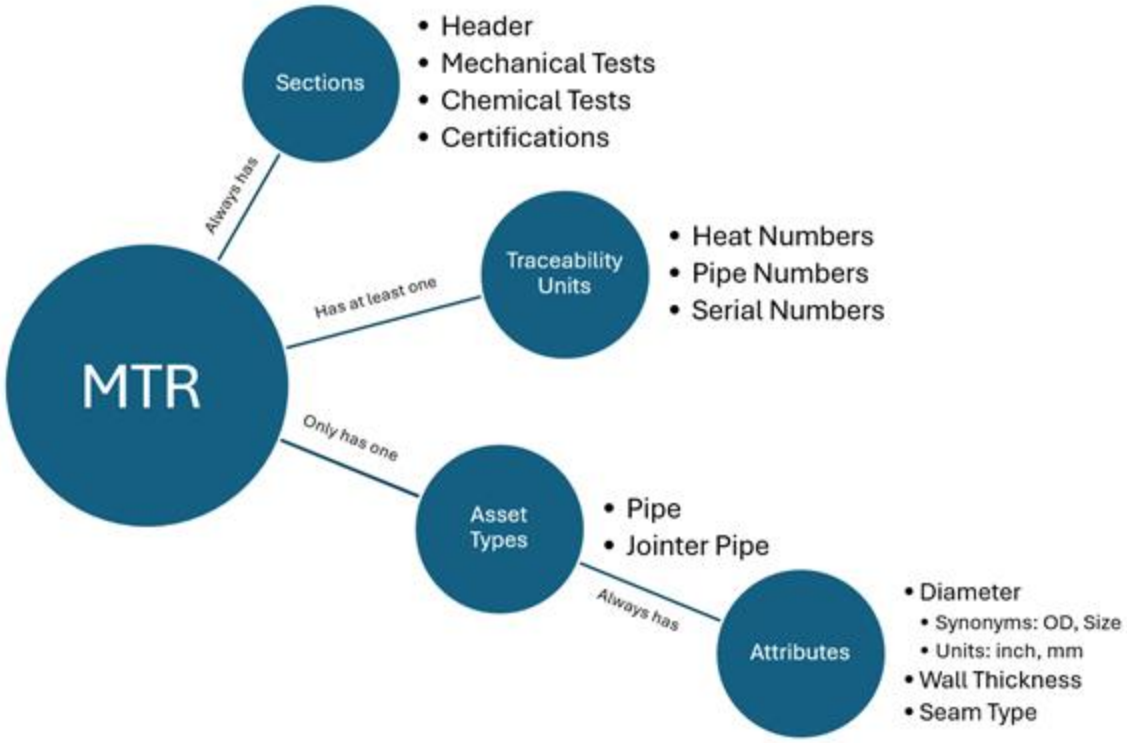
Probabilistic vs Deterministic

- LLMs are probabilistic - resulting in hallucinations and unpredictable output
- An ontology constrains an LLM's behavior by anchoring it to verifiable structures and rules
  - *wall thickness is always a number, usually measured in inches or mm, but sometimes described as a schedule*
- LLMs with an ontology can use structured relationships to produce answers instead of "guessing"
- LLMs with an ontology are more deterministic, predictable, and auditable

Ontologies and Knowledge Graphs

- Ontology
  - Formal, structured representation of knowledge within a domain - vocabulary, concepts, and relationships
  - Provides a common vocabulary and enables semantic mapping (Outside Diameter = Pipe OD = OD = Size)
  - Acts as the “schema” that AI uses to interpret, organize and reason with unstructured data

- Knowledge Graph
  - Specific implementation of an ontology using data from various sources

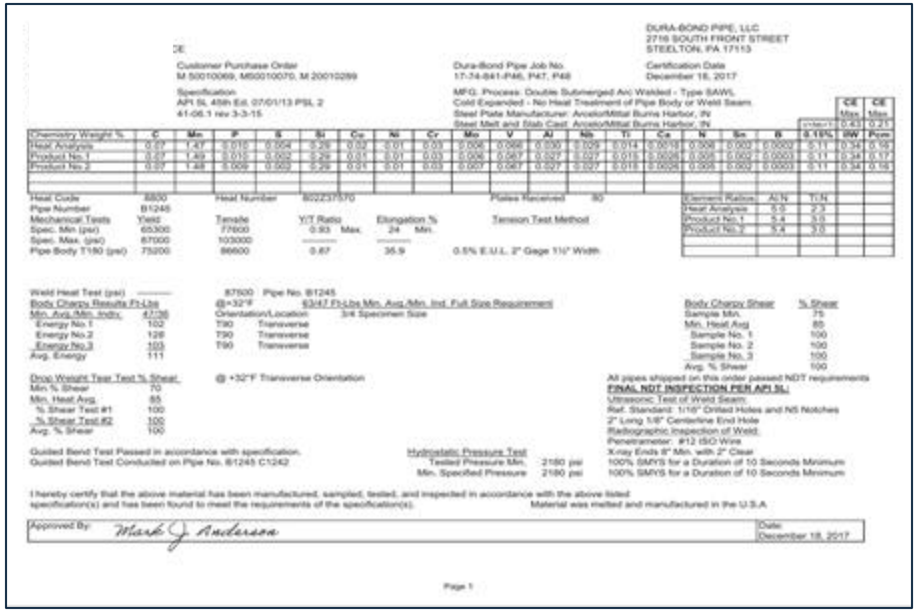


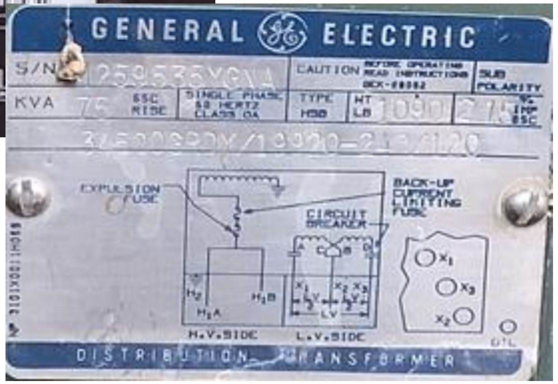
MTR Example

- Ontology provides an industry standard dictionary of MTR terms and relationships
  - Pipe has a diameter and a material grade
  - Diameter = OD = Outside Diameter = Size
- Knowledge Graph links heat numbers to materials in an engineering drawing
  - Heat number 123456 is linked to pipe #12 in engineering drawing 5
- Computer Vision extracts data from an MTR
  - Heat numbers, chemical composition, mechanical tests, manufacturer data
- Trained AI makes sense of human language within the MTR
  - Understands that “passed test on 2/5” means that the pipe passed the hydrostatic pressure test on February 5, 2024
- Trained AI converts industry jargon into defined data attributes
  - Convert a product description “5L 16.000 0.500 82.85# X52 HFW/ERW” into specific attributes

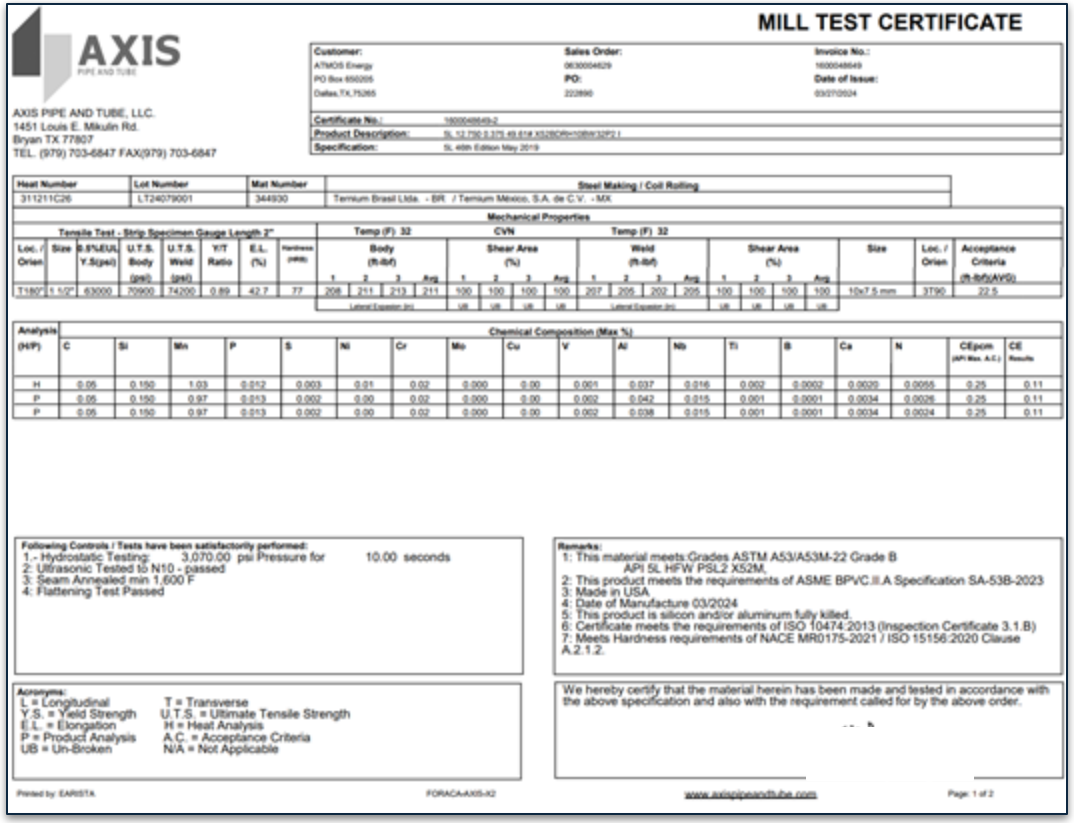
Locusview R&D

- Converting traditional test reports into digital datasets
  - MTRs into API 5MT compliant datasets
  - Certificates of Compliance
  - Assembly/fabrication closing packets
- Extracting key attributes from images
  - Nameplates
  - Fabrication reports
  - Pressure test charts
  - Digital interfaces


DURA-BOND PIPE, LLC
2716 SOUTH FRONT STREET
STEELTON, PA 17113
Customer Purchase Order
Dura-Bond Pipe Job No.
Certification Date
December 18, 2017
Specification
Heat Analysis
Product No.1
Product No.2
Heat Code
Pipe Number
Mechanical Tests
Approved By



Optical Character Recognition (OCR)



AXIS

MILL TEST CERTIFICATE

AXIS PIPE AND TUBE, LLC.
1451 Louis E. Mikulin Rd.
Bryan TX 77807
TEL. (979) 703-6847 FAX(979) 703-6847

Customer:	Sales Order:	Invoice No.:
ATMOS Energy	0630004629	1600048649
PO Box 650205	PO:	Date of Issue:
Dallas,TX,75265	222890	03/27/2024

Certificate No.: 1600048649-2
Product Description: 5L 12.750 0.375 49.61# X52BDRH108W32P2 I
Specification: 5L 46th Edition May 2019

Heat Number	Lot Number	Mat Number	Steel Making / Coil Rolling
311211C26	LT24079001	344930	Ternium Brasil Ltda. - BR / Ternium México, S.A. de C.V. - MX

Mechanical Properties

Tensile Test - Strip Specimen Gauge Length 2"

Loc. / Orien	Size	0.5%EUL Y.S.(psi)	U.T.S. Body (psi)	U.T.S. Weld (psi)	Y/T Ratio	E.L. (%)	Hardness (HRB)	Temp (F) 32 Body (ft-lbf) 1	2	3	Avg	CVN Shear Area (%) 1	2	3	Avg	Temp (F) 32 Weld (ft-lbf) 1	2	3	Avg	Shear Area (%) 1	2	3	Avg	Size	Loc. / Orien	Acceptance Criteria (ft-lbf)(AVG)
T180°	1 1/2"	63000	70900	74200	0.89	42.7	77	208	211	213	211	100	100	100	100	207	205	202	205	100	100	100	100	10x7.5 mm	3T90	22.5
								Lateral Expansion (in)				UB	UB	UB	UB	Lateral Expansion (in)				UB	UB	UB	UB			

Chemical Composition (Max %)

Analysis (H/P)	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	V	Al	Nb	Ti	B	Ca	N	CEpcm (API Max. A.C.)	CE Results
H	0.05	0.150	1.03	0.012	0.003	0.01	0.02	0.000	0.00	0.001	0.037	0.016	0.002	0.0002	0.0020	0.0055	0.25	0.11
P	0.05	0.150	0.97	0.013	0.002	0.00	0.02	0.000	0.00	0.002	0.042	0.015	0.001	0.0001	0.0034	0.0026	0.25	0.11
P	0.05	0.150	0.97	0.013	0.002	0.00	0.02	0.000	0.00	0.002	0.038	0.015	0.001	0.0001	0.0034	0.0024	0.25	0.11

Following Controls / Tests have been satisfactorily performed:
1.- Hydrostatic Testing: 3,070.00 psi Pressure for 10.00 seconds
2: Ultrasonic Tested to N10 - passed
3: Seam Annealed min 1,600 F
4: Flattening Test Passed

Remarks:
1: This material meets Grades ASTM A53/A53M-22 Grade B
API 5L HFW PSL2 X52M,
2: This product meets the requirements of ASME BPVC.III.A Specification SA-53B-2023
3: Made in USA
4: Date of Manufacture 03/2024
5: This product is silicon and/or aluminum fully killed.
6: Certificate meets the requirements of ISO 10474:2013 (Inspection Certificate 3.1.B)
7: Meets Hardness requirements of NACE MR0175-2021 / ISO 15156:2020 Clause A.2.1.2.

Acronyms:
L = Longitudinal T = Transverse
Y.S. = Yield Strength U.T.S. = Ultimate Tensile Strength
E.L. = Elongation H = Heat Analysis
P = Product Analysis A.C. = Acceptance Criteria
UB = Un-Broken N/A = Not Applicable

We hereby certify that the material herein has been made and tested in accordance with the above specification and also with the requirement called for by the above order.

Printed by: EARISTA FORACA-AXIS-X2 www.axispipeandtube.com Page: 1 of 2

OCR

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MILL TEST CERTIFICATE AXIS Customer: Sales Order: Invoice No.: ATMOS Energy 0630004629 1600048649 PIPE AND TUBE PO Box
650205 PO: Date of Issue: llas,TX,75265 222890 03/27/2024 AXIS PIPE AND TUBE, LLC.
"Certificate No.:" is found in a cell (row 1, column 1) in table 1.
"1600048649-2" is found in a cell (row 1, column 2) in table 1.
1451 Louis E. Mikulin Rd.
"Product Description:" is found in a cell (row 2, column 1) in table 1.
"5L 12.750 0.375 49.61# X52BDRH108W32P2" is found in a cell (row 2, column 2) in table 1.
Bryan TX 77807
"Specification:" is found in a cell (row 3, column 1) in table 1.
"5L 46th Edition May 2019" is found in a cell (row 3, column 2) in table 1.
TEL. (979) 703-6847 FAX(979) 703-6847
"Heat Number" is found in a cell (row 1, column 1) in table 2.
"Lot Number" is found in a cell (row 1, column 2) in table 2.
"Mat Number" is found in a cell (row 1, column 3) in table 2.
"Steel Making / Coil Rolling" is found in a cell (row 1, column 4) in table 2.
"311211C26" is found in a cell (row 2, column 1) in table 2.
"LT24079001" is found in a cell (row 2, column 2) in table 2.
"344930" is found in a cell (row 2, column 3) in table 2.
"Ternium Brasil Ltda. - BR / Ternium México, S.A. de C.V. - MX" is found in a cell (row 2, column 4) in table 2.
"Mechanical" belongs to "Mechanical Properties" and is found in a cell (row 1, column 15) in table 3.
"Properties" belongs to "Mechanical Properties" and is found in a cell (row 1, column 16) in table 3.
"Tensile" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 2) in table
3.
"Test" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 3) in table 3.
"-" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 3) in table 3.
"Strip" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 4) in table 3.
"Specimen" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 5) in table
3.
"Gauge" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 6) in table 3.
"Length" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 7) in table
3.
"2"" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 7) in table 3.
"Temp" belongs to "Temp (F) 32" and is found in a cell (row 2, column 10) in table 3.
"(F)" belongs to "Temp (F) 32" and is found in a cell (row 2, column 11) in table 3.
"32" belongs to "Temp (F) 32" and is found in a cell (row 2, column 11) in table 3.
"CVN" is found in a cell (row 2, column 14) in table 3.
"Temp" belongs to "Temp (F) 32" and is found in a cell (row 2, column 18) in table 3.
"(F)" belongs to "Temp (F) 32" and is found in a cell (row 2, column 19) in table 3.
"32" belongs to "Temp (F) 32" and is found in a cell (row 2, column 19) in table 3.
"Loc. /" is found in a cell (row 3, column 1) in table 3.
"Size" is found in a cell (row 3, column 2) in table 3.
"0.5%EUL" is found in a cell (row 3, column 3) in table 3.
"U.T.S." is found in a cell (row 3, column 4) in table 3.
"U.T.S." is found in a cell (row 3, column 5) in table 3.
"Y/T" is found in a cell (row 3, column 6) in table 3.
"E.L." is found in a cell (row 3, column 7) in table 3.
"Hardness" is found in a cell (row 3, column 8) in table 3.
"Body" is found in a cell (row 3, column 11) in table 3.
"Shear" belongs to "Shear Area" and is found in a cell (row 3, column 14) in table 3.
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GTI ENERGY

Trained AI Model

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"1600048649-2" is found in a cell (row 1, column 2) in table 1.
1451 Louis E. Mikulin Rd.
"Product Description:" is found in a cell (row 2, column 1) in table 1.
"SL 12.750 0.375 49.61# X52BDRH10BW32P2" is found in a cell (row 2, column 2) in table 1.
Bryan TX 77807
"Specification:" is found in a cell (row 3, column 1) in table 1.
"SL 46th Edition May 2019" is found in a cell (row 3, column 2) in table 1.
TEL. (979) 703-6847 FAX(979) 703-6847
"Heat Number" is found in a cell (row 1, column 1) in table 2.
"Lot Number" is found in a cell (row 1, column 2) in table 2.
"Mat Number" is found in a cell (row 1, column 3) in table 2.
"Steel Making / Coil Rolling" is found in a cell (row 1, column 4) in table 2.
"311211C26" is found in a cell (row 2, column 1) in table 2.
"LT24079001" is found in a cell (row 2, column 2) in table 2.
"344930" is found in a cell (row 2, column 3) in table 2.
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"Strip" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 4) in table 3.
"Specimen" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 5) in table
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"Gauge" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 6) in table 3.
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"2"" belongs to "Tensile Test - Strip Specimen Gauge Length 2"" and is found in a cell (row 2, column 7) in table 3.
"Temp" belongs to "Temp (F) 32" and is found in a cell (row 2, column 10) in table 3.
"(F)" belongs to "Temp (F) 32" and is found in a cell (row 2, column 11) in table 3.
"32" belongs to "Temp (F) 32" and is found in a cell (row 2, column 11) in table 3.
"CVN" is found in a cell (row 2, column 14) in table 3.
"Temp" belongs to "Temp (F) 32" and is found in a cell (row 2, column 18) in table 3.
"(F)" belongs to "Temp (F) 32" and is found in a cell (row 2, column 19) in table 3.
"32" belongs to "Temp (F) 32" and is found in a cell (row 2, column 19) in table 3.
"Loc. /" is found in a cell (row 3, column 1) in table 3.
"Size" is found in a cell (row 3, column 2) in table 3.
"0.5%EUL" is found in a cell (row 3, column 3) in table 3.
"U.T.S." is found in a cell (row 3, column 4) in table 3.
"U.T.S." is found in a cell (row 3, column 5) in table 3.
"Y/T" is found in a cell (row 3, column 6) in table 3.
"E.L." is found in a cell (row 3, column 7) in table 3.
"Hardness" is found in a cell (row 3, column 8) in table 3.
"Body" is found in a cell (row 3, column 11) in table 3.
"Shear" belongs to "Shear Area" and is found in a cell (row 3, column 14) in table 3.
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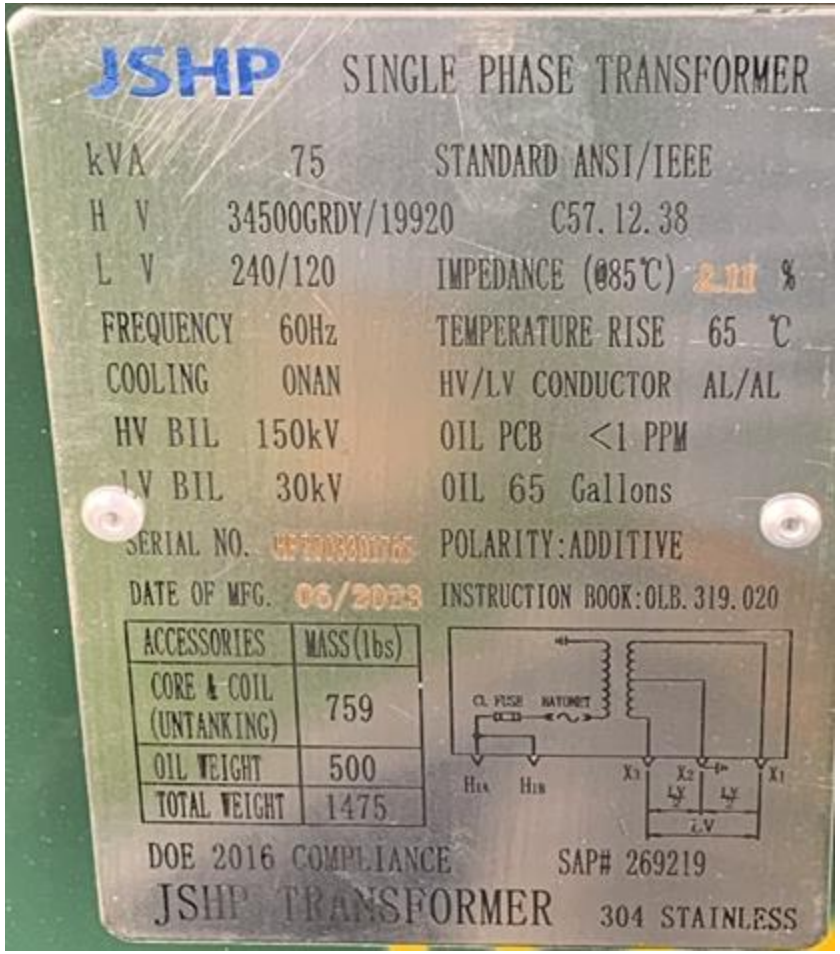
NER

Heat Number	311231C26	311211C26	
Date of Certification	03/27/2024	03/27/2024	
Facility Name for Pipe Manufacturer	AXIS PIPE AND TUBE, LLC.	AXIS PIPE AND TUBE, LLC.	
Facility Address for Pipe Manufacturer	1451 Louis E. Mikulin Rd.Bryan TX 77807	1451 Louis E. Mikulin Rd. Brya	
Facility Name for Plate/Coil Manufacturer	Ternium M\u00e9xico, S.A. de C.V.	Ternium M\u00e9xico, S.A. de	
Facility Address for Plate/Coil Manufacturer	MX	MX	
CVN Average Shear Area Percent	97	100	
Certified Hydrostatic Test Pressure Value	3,070.00	3,070.00	
Certified Hydrostatic Test Pressure Value Units	psi	psi	
Certified Hydrostatic Test Pressure Value Duration (seconds)	10.00	10.00	
NDT Statement	We hereby certify that the material herein ha	the above sp	We hereby certif
Carbon (C)	0.05	0.05	
Manganese (Mn)	1.02	0.97	0.97
Copper (Cu)	0,01	0,01	1
Customer Purchase Order	222890	222890	
Tensile Test Type	Strip Specimen	Strip Specime	Strip Specimen
Hardness Test Type	HRB	HRB	
Chemistry Test Type	H	P	H

Optical Character Recognition (OCR)



OCR

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JSHP SINGLE PHASE TRANSFORMER kVA 75 STANDARD ANSI/IEEE HV
34500GRDY/19920 C57.12. 38 LV 240/120 IMPEDANCE (085°C) 2.11
% FREQUENCY 60Hz TEMPERATURE RISE 65 °C COOLING ONAN HV/LV
CONDUCTOR AL/AL HV BIL 150kV OIL PCB <1 PPM AV BIL 30kV OIL
65 Gallons SERIAL NO. HPT00330176E POLARITY : ADDITIVE DATE
OF MFG. 06/2023 INSTRUCTION BOOK:OLB. 319.020 ACCESSORIES
MASS (Ibs) CORE & COIL (UNTANKING) 759 CL FUSE BAYONET OIL
WEIGHT 500 X3 X2 X1 TOTAL WEIGHT 1475 HIA HIB LV DOE 2016
COMPLIANCE SAP# 269219 JSHP TRANSFORMER 304 STAINLESS
```

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Trained AI Model

JSHP SINGLE PHASE TRANSFORMER kVA 75 STANDARD ANSI/IEEE HV 34500GRDY/19920 C57.12. 38 LV 240/120 IMPEDANCE (085°C) 2.11 % FREQUENCY 60Hz TEMPERATURE RISE 65 °C COOLING ONAN HV/LV CONDUCTOR AL/AL HV BIL 150kV OIL PCB <1 PPM AV BIL 30kV OIL 65 Gallons SERIAL NO. HPT00330176E POLARITY : ADDITIVE DATE OF MFG. 06/2023 INSTRUCTION BOOK:OLB. 319.020 ACCESSORIES MASS (Ibs) CORE & COIL (UNTANKING) 759 CL FUSE BAYONET OIL WEIGHT 500 X3 X2 X1 TOTAL WEIGHT 1475 HIA HIB LV DOE 2016 COMPLIANCE SAP# 269219 JSHP TRANSFORMER 304 STAINLESS

NER

Manufacturer
Entity value: JSHP
Confidence: 100.00%

Number_of_Phases
Entity value: SINGLE PHASE
Confidence: 100.00%

Frequency
Entity value: 60Hz
Confidence: 100.00%

Temperature_Rise
Entity value: 65 °C
Confidence: 100.00%

PCB_lessthan_1PPM_Statement
Entity value: OIL PCB <1 PPM
Confidence: 100.00%

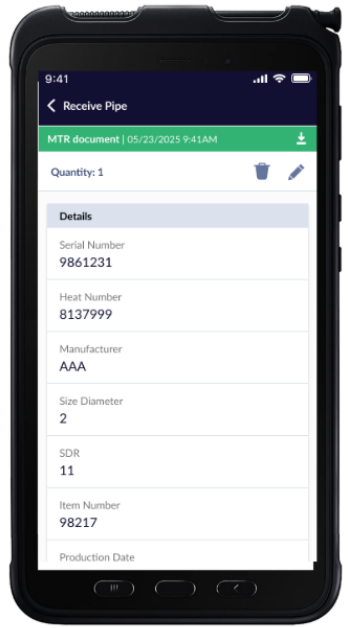
LV_BIL_Rating
Entity value: 30kV
Confidence: 100.00%

CoreandCoil_Weight
Entity value: 759
Confidence: 100.00%

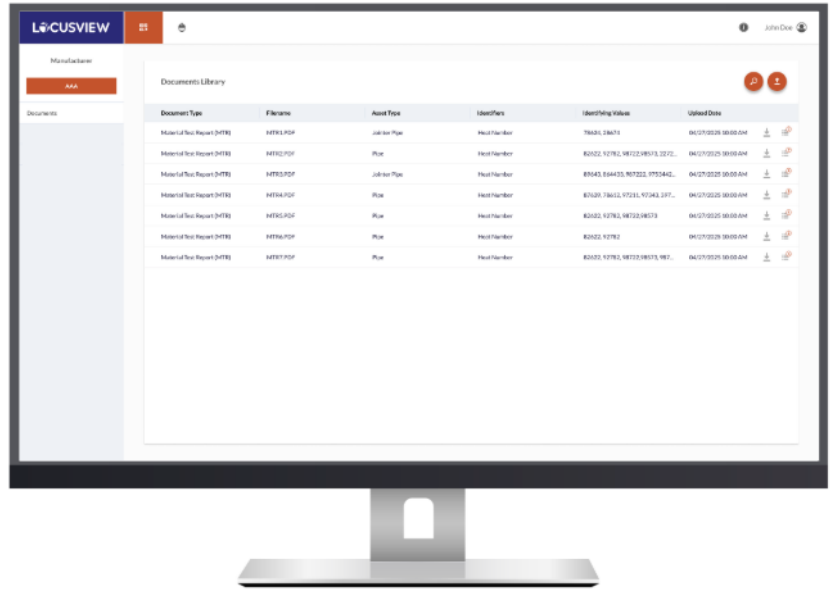
Liquid_Weight
Entity value: 500
Confidence: 91.00%

Implementation

- Software Releases
  - Q3 2025 – TRACE for MTR/COC upload and real-time verification
  - Q4 2025 – AI data extraction (basic traceability attributes for field verification)
  - Q1 2026 – AI data extraction (full dataset for automated compliance verification)

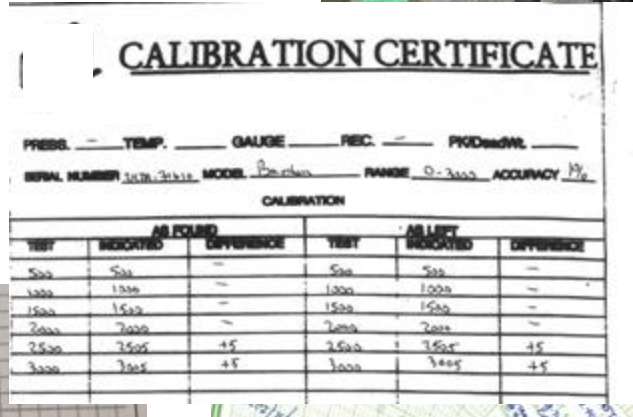


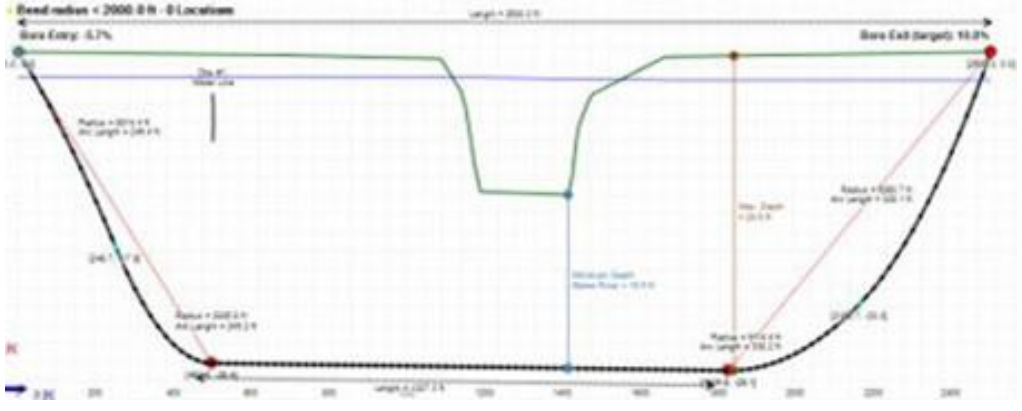
- Implementation
  - Q4 2025 – pilot project
  - Q2 2026 – production implementation

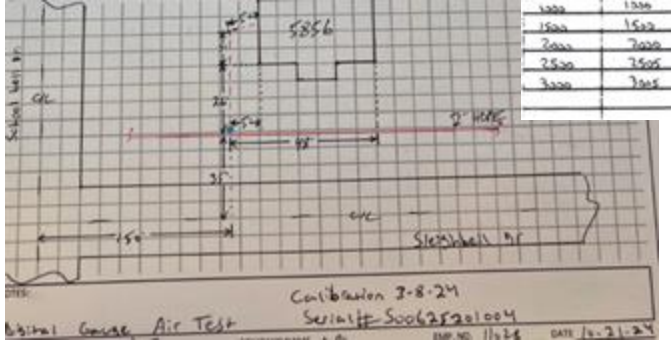


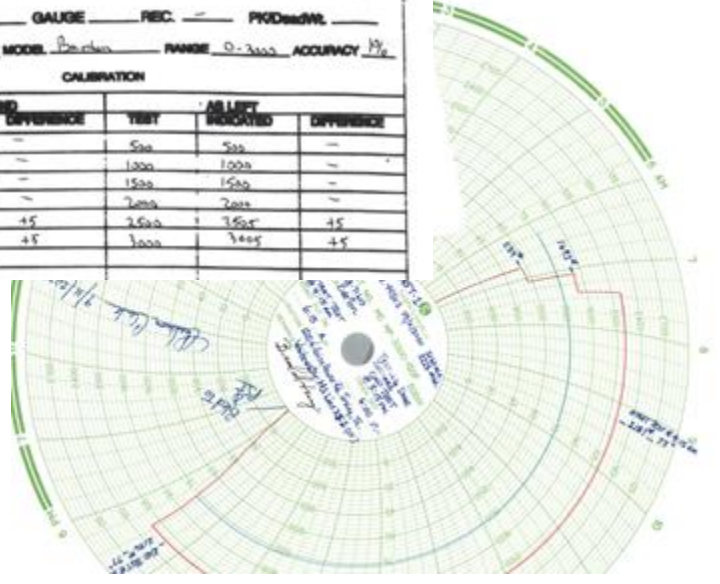
Other Use Cases

- Converting legacy sketches, notes, and forms into digital datasets that can be consumed by systems of record and analytical tools
- Converting sensor data from fusion machines, bore profiles, and pressure tests
- Extract dimension lines from pictures







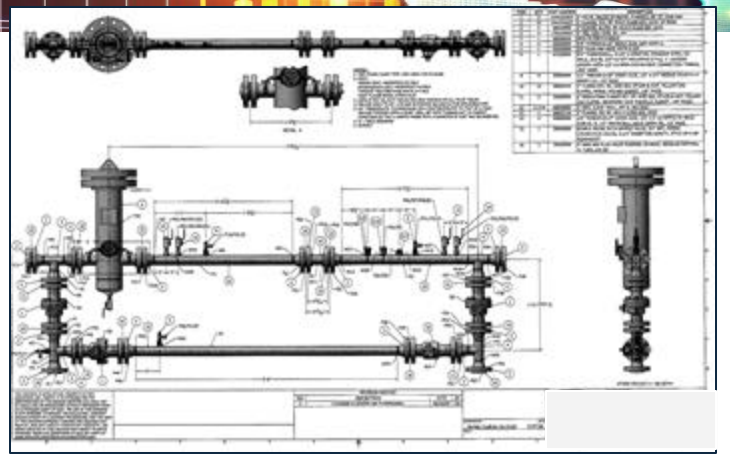


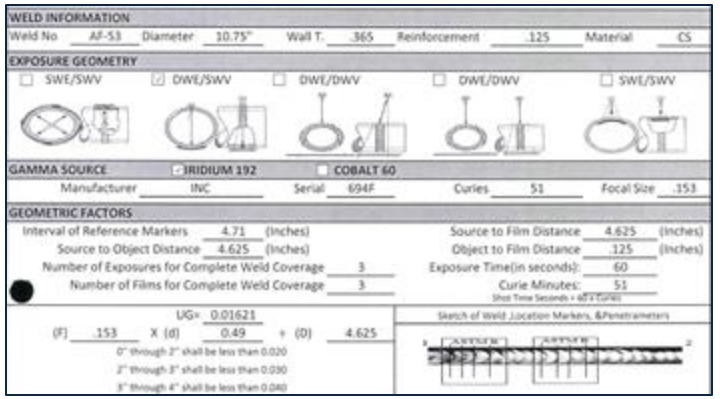
Now possible . . .

- AI is able to cost-effectively create niche agents to solve industry specific problems like linking COCs and NDT records to an engineering drawing

- Reduce the burden of implementation on suppliers and utilities by using AI to create agents to automate compliance with industry standards

- But, AI tools must be integrated into an end-to-end workflow with integrations to upstream and downstream systems





Summary

- Utilities need to have high quality asset data in systems of record for existing use cases as well as future use cases
- A Digital Thread enables the flow of data from supplies into utility's systems of record without manual data transfer
- AI can accelerate the Digital Thread by converting unstructured data into structured data, even for niche use cases
- Industry standard data models, together with ontologies and knowledge graphs, can improve the accuracy and reliability of AI agents
- AI can reduce the burden of implementing the Digital Thread for both suppliers and utilities
- AI must be integrated into end-to-end workflows to truly provide value