

**SUMMIT CARBON SOLUTIONS, LLC**  
**PETITION FOR HAZARDOUS LIQUID PIPELINE PERMIT**  
**Docket No. HLP-2021-0001**  
**EXHIBIT C ADDENDUM 1**  
**PROJECT SPECIFICATION FOR LINE PIPE**




# **Project Specification for Line Pipe**

**Specification Number: 2/18/2022, Rev 3.0**


**Project Name: Midwest Carbon Express**

Rev. No.	Date	Revision	Prepared By	Checked By	Approved By
			Mark Hereth		
1	12/10/2021	Section 9.2 Max Yield Strength			L Meredith
2	02/02/2022	Various sections of the spec. updated	Daniel Guzman and Harsh Mehta		Daniel Guzman
3	02/18/2022	Update to CVN and DWTT requirement	Daniel Guzman and Harsh Mehta		Daniel Guzman

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## 1 Scope

This standard covers the general requirements for the manufacture of HIGH FREQUENCY ELECTRICAL RESISTANCE Welded (HF-ERW) line pipe larger than 3.0 in (76 mm) and up to 24" (610 mm) in diameter to be purchased directly from the MANUFACTURER. These specifications is applicable for pipe to be used in onshore hazardous gas, dense phase CO<sub>2</sub>, liquids, etc. transmission, and storage pipelines. The pipe and unformed skelp/plate shall comply with DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) Rules, 49 CFR Part 192 and 195, and all PHMSA advisories and bulletins.

This specification shall be used in conjunction with API SPEC 5L<sup>1</sup>. The requirements identified here are intended to clarify, modify, and add additional requirements to the wording of API SPEC 5L and are numbered and titled to correspond to the numbered clauses of API SPEC 5L. Clauses in API SPEC 5L not mentioned remain unaltered and are fully applicable. If only part of a clause in API SPEC 5L is altered by this specification, the remainder of any such clause shall remain applicable.

Clauses, tables and figures additional to API SPEC 5L are identified by the phrase "*(added)*". Added tables and figures in the main body of the specification have alpha designations to distinguish them from tables and figures in API SPEC 5L. In the annexes of this specification the numbering system of tables has been extended. API SPEC 5L tables and figures modified in this specification are identified by the phrase "*(modified)*".

Third-party inspectors shall be given access to all facilities, that includes steel, pipe, coating, loadout and staging yards.


This specification shall be used for hazardous gas and liquids in accordance with ASME B31.4 and ASME B31.8.

Requirements which are more restrictive than API SPEC 5L or this specification shall be provided in the Request for Quote (RFQ).

This Specification covers pipe Grades from Grade B to Grade X70, inclusive, for pipelines that operate up to:

- A maximum design factor of 72% SMYS.
- A maximum internal pressure of 15 MPa (2183 psi).
- The design temperatures from -5°C (23°F) to 49°C (120°F).
- The minimum design temperature (MDT) is -5°C (23°F).

<sup>1</sup> This specification uses API Specification 5L, "Specification for Line Pipe," 46<sup>th</sup> Edition, April 2018. The version incorporated by reference by PHMSA at 49 CFR 195.3 is the 45<sup>th</sup> edition, effective July 1, 2013. PHMSA has exercised enforcement discretion in allowing use of the 46<sup>th</sup> edition.

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## 2 Conformity

### 2.1 Units of measurement

Unless otherwise noted, UCS units shall be used.

### 2.3 Compliance to this International Standard

The manufacturer shall be certified to ISO 9001, ISO/TS 29001 or approved equivalent. Mills producing steel, plate, coil, skelp, and/or rolling of pipe shall have an internal quality management program structured to detecting and eliminating defects and inclusions that could affect the pipe quality.

Third Party Inspection (TPI) is required during the manufacture, inspection and testing of the order, unless specifically omitted by Company. The inspector representing the Company shall have unrestricted access, at all times while work on the contract is being performed, to all parts of the manufacturer's works that concern the manufacture and inspection of the ordered pipe including casting, rolling and other processes – provided there is no unnecessary interference with the operation of the works. Suitable office space, fax and telephone access shall be provided. The inspector may require checking of instruments, gauges, or other equipment if justifiable cause exists. The manufacturer shall afford the inspector all reasonable facilities, including reasonably dry and clean pipe, to satisfy the inspector that the pipe is being manufactured in accordance with this specification. The manufacturer shall provide reasonable notice of when production, inspection or testing shall be performed.

The purchaser may make any investigation necessary to satisfy compliance to this specification and may reject any material that does not conform.

## 3 Normative References

This Section lists the codes, standards, specifications, and publications that shall be used with this document. Unless otherwise specified herein, use the latest edition.


If any conflicts exist between this specification and the codes, standards and federal regulations referenced, the more stringent requirements shall govern. Any conflict in specifications shall be submitted in writing to Company for resolution. Appropriate requirements in ASME B31.4, if more stringent, shall supersede the requirements in this specification.

All normative references in API SPEC 5L are applicable to this specification. In addition, the following references shall apply.

API Specification 5L, *Specification for Line Pipe*, 46<sup>th</sup> Edition, April 2018.

API RP 5L1, *Recommended Practice for Railroad Transportation of Line Pipe*, Seventh Edition, September 2009

API RP 5LW, *Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels*, Third Edition, September 2009.

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API RP 5LT, *Recommended Practice for Truck Transportation of Line Pipe*, First Edition, March 12, 2012

ASME B31.4<sup>1</sup>, *Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids*, October 2006

ASME BPVC Section IX – *Welding, Brazing and Fusing Qualifications*, 2021.

ASTM A 578/A 578M, *Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications*, November 1, 2017

ISO 12737, *Fracture Mechanics Toughness Tests*

ISO 9712, *Non-Destructive Testing - Qualification and Certification of NDT Personnel - General Principles*

DOT Title 49 CFR Part 192, *Department of Transportation Code of Federal regulations, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards*

DOT Title 49 CFR Part 195, *Department of Transportation Code of Federal regulations, Transportation of Hazardous Liquids by Pipelines*

DNV RP F104, *Design and Operation of Carbon Dioxide Pipelines*, February 2021, Amended September 2021

ISO 5178, *Destructive Tests on Welds in Metallic Materials - Longitudinal Tensile Test on Weld Metal in Fusion Welded Joints*

ISO 9001, *Quality Management Systems – Requirements*

ISO 17640, *Non-Destructive Testing of Welds - Ultrasonic Testing of Welded Joints*

ISO/TS 29001, *Petroleum, petrochemical, and natural gas industries — Sector-specific quality management systems — Requirements for product and service supply organizations*

## 4 Terms and definitions


All terms and definitions in API SPEC 5L are applicable to this specification. The following additional definitions shall be applicable.

### **Company (User/Purchaser/SUMMIT CARBON SOLUTIONS)**

pipeline company who purchases the pipe for ultimate use

### **Distributor**

merchant who buys pipe from a mill for his own stock for resale to other distributors or to users

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### **EW**

process of forming a seam by electric resistance welding, wherein the edges to be welded are mechanically pressed together and the heat for welding is generated by the resistance to flow of electric current applied by induction or conduction.

### **HFW**

EW pipe produced with a welding current frequency equal to or greater than 70 kHz.

### **Inspector**

qualified third party Inspector, usually representing the original purchaser, who observes manufacture and/or inspection of pipe at the mill and whose certification is included in the essential documentation of pipe manufactured to this specification

### **Joint**

single piece of pipe of acceptable length

### **MPS**

Manufacturing Procedure Specification

### **Normative**

Indicates a mandatory requirement

### **Shall**

used to indicate that a provision is mandatory

### **Should**


Used to indicate that a provision, although non-mandatory, is recommended as good practice. Approval is required from Company to deviate from the provision.

## **5 Symbols and abbreviated terms**

### **5.2 Abbreviated terms**

All symbols and abbreviated terms in API SPEC 5L are applicable. In addition, the following shall apply.

FL	Fusion Line
ID	Inside Diameter
ITP	Inspection & Test Plan
KSI	Kilo-pound per square inch
MUT	Manual Ultrasonic Test
MPQT	Manufacturing Procedure Qualification Test
OD	Outside Diameter
PQR	Procedure Qualification Records

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PSL	Product Specification Level
RFQ	Request for Quote
SMTS	Specified Minimum Tensile Strength
SMYS	Specified Minimum Yield Strength
T <sub>min</sub>	Minimum Design Temperature
T <sub>test</sub>	Test Temperature

**NOTE:** Section numbers in this specification correspond with corresponding section in API 5L.

## **6 Pipe grade, steel grade and delivery condition**

### **6.2 Delivery condition**

All pipes shall be produced as PSL 2 for maximum pressure and maximum and minimum operating temperature. Pipes shall be provided with a surface quality compatible with subsequent application of a protective coating.

## **7 Information to be supplied by the purchaser**

### **7.1 General information**

The pipe shall be HFW as specified in the Request for Quote (RFQ). The pipe shall be PSL 2. Annexes A and D of API SPEC 5L, Forty-Sixth Edition shall be applied to all line pipe applications. Annexes B and C of this specification shall be applied to all line pipe applications.

### **7.2 Additional information**

The applicable provisions are identified in the appropriate clauses of this specification.

## **8 Manufacturing**


### **8.1 Process of manufacture**

As per API 5L

### **8.3 Starting material**

**8.3.1** Unless otherwise agreed, coil and plate used for the manufacture of welded pipe shall be rolled from continuously (strand) cast or pressure cast slabs. For HFW pipe, the abutting edges of the coil or plate should be sheared, milled, or machined shortly before welding.



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**8.3.6 (added)** The producers of slab/skelp/plate used for the production of pipe require Company approval. The approval process may include pre-qualification, production, inspection, or testing of skelp/pipe.

**8.3.7 (added)** When niobium  $\geq 0.020$  % and when the ambient temperature  $\leq 40^{\circ}\text{F}$  ( $5^{\circ}\text{C}$ ), gas cutting and scarfing of slabs shall be performed with the slabs at temperature  $\geq 248^{\circ}\text{F}$  ( $120^{\circ}\text{C}$ ) to minimize the potential for thermal cracking.

**8.3.8 (added)** Steel shall be micro-alloyed, fine grain, fully killed, and produced as continuous cast with calcium treatment. The steelmaker shall employ steelmaking and slab casting parameters and procedures to mitigate centerline segregation. For the production of skelp/plate or coil, the steelmaker shall utilize a macro etch rating system or other equivalent method on the first or second slab of each sequence to monitor centerline segregation, and maintain a maximum macro etch rating. A macro etch program shall be employed to monitor segregation.

Slabs or skelp shall be inspected using ammonium persulfate etchant. The etch time shall be  $\geq 5$  minutes and the solution shall be composed of 10 g  $(\text{NH}_4)_2\text{S}_2\text{O}_8$  in 100 ml of distilled water. (If the test is performed on skelp, a 20 % aqueous solution may be used for a reduced time period that duplicates the results of the five-minute etch.) The segregation images shall be rated using the Mannesmann type comparison rating chart (1 to 5 classification range) or equivalent). Acceptance levels shall be per Table A.

**Table A (added) — Macro etch rating by grade and application**

Grade	Acceptance Level	Concerns
$\leq \text{X70 (L485)}$	$\leq 2$	Lamination; Weldability; Centerline cracking; De-lamination during bending; Centerline hardness; C, Mn, S, and P segregation

**8.3.9 (added)** Skelp thickness shall be controlled by continuous gamma or X-ray devices. Skelp rolling, and accelerated cooling shall be adequately instrumented to ensure proper control of furnace / rolling temperature, rolling reduction, and post-rolling cooling rate.


**8.9.2. (added) Cold sizing and cold expansion**

HFW pipe shall not be cold expanded. The cold sizing ratio shall be  $\leq 1.0$  %.

During expansion / sizing, contact of the expansion / compression device, or of any jacking device used to correct pipe end dimensions, with the inside and outside weld beads shall not be permitted. Correction of a pipe out-of-round condition using a maximum of one additional cycle through the expander / sizer is acceptable.

**8.11 Joints**

**8.11.1** Joints shall not be furnished for HFW pipe.

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## 8.12 Heat treatment

All mechanical testing shall be performed after any heat treatment.

## 8.13 Traceability

**8.13.2** *(added)* During production, a unique serial number, shall be applied to each joint of pipe before the first inspection point, including mill control inspection points, and prior to removal of any test samples. The serial number shall follow the pipe during production, final inspection, and shipping.

# 9 Acceptance criteria

## 9.1 General


*(added)* All failing chemical or mechanical tests shall be immediately reported to the purchaser's inspector.

The Manufacturer shall investigate and present Company with a root cause analysis of each failure due to:

- Chemical Composition
- Mechanical Tests
- Hydrostatic Tests

## 9.2 Chemical composition

The requirements of PSL 2 apply shall apply to all pipes, except as noted below in Table B. All elements identified in Table 5 as well as cobalt, zirconium and oxygen<sub>total</sub> shall be test reported for all production heats.


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**Table B (added) - Modifications to API SPEC 5L Table 5**

Steel Grade	Mass Fraction, based on heat and product analyses % maximum										CE <sub>Pcm</sub> max
	C <sup>b</sup>	Si	Mn <sup>b</sup>	P	S	V	Nb	Ti	Other	Nb+V+Ti	
Welded pipes											
X42M (L290M)	0.13	0.40	1.30	0.020	0.010	0.05	0.05	0.023	1,2,4,5, 6	0.06	0.19
X46M (L320M)	0.12	0.40	1.30	0.020	0.010	0.05	0.05	0.023	1,2,4,5, 6	0.07	0.19
X52M (L360M)	0.12	0.40	1.40	0.020	0.010	0.05	0.05	0.023	1,2,4,5, 6	0.08	0.20
X56M (L390M)	0.12	0.40	1.40	0.020	0.008	0.05	0.05	0.023	1,2,4,5, 6	0.09	0.20
X60M (L415M)	0.10	0.40	1.60	0.020	0.006	0.06	0.05	0.023	1,2,4,5, 6	0.10	0.20
X65M (L450M)	0.10	0.40	1.60	0.020	0.006	0.06	0.08	0.023	1,3,4,5,6	0.12	≥0.14 and ≤0.20
X70M (L485M)	0.09	0.40	1.70	0.018	0.006	0.07	0.10	0.023	1,2,3,4,5,6	0.13	≥0.14 and ≤0.21
X80M (L555M)	0.08	0.40	1.85	0.018	0.005	0.08	0.10	0.023	1,2,3,4,5,6	0.15	0.23
Notes:											
<i>italics</i> Indicates that limits in API 5L Table 5 are applicable.											
Except as noted below, all footnotes in Table 5 of API 5L are applicable.											
b              Only one (1) Mn increase of 0.05 % is allowed.											
Additional Notes:											
1              0.010% ≥ Al <sub>total</sub> ≤ 0.050.											
2              Ca ≤ 0.004%.											
3              When S ≤ 0.0015%, Ca ≤ 0.004%. When S > 0.0015%, 0.008% < Ca ≤ 0.004%. Rare earth treatment is not allowed.											
4              B ≤ 0.0005%. Deliberate additions of B and N are not permitted.											
5              Mo + Cu + Cr + Ni ≤ 0.80%											
6              Al:N > 2:1											
7              Levels of tramp elements shall not exceed: 0.02% As; 0.01% Bi; 0.01% Pb; 0.01% Sb; 0.015% Sn. These levels shall be established during MPQT, and analysis is not required during production.											

## 9.3 Tensile properties

**9.3.2 (added)** If the heat yield strength measured on two consecutive pipes is less than 2000 psi (13.5 MPa) above the minimum specified value, additional tension test shall be performed at locations selected by the COMPANY or third-party inspector (TPI). On orders where the number of heats > 20, the average measured yield strength on a pipe order shall be at least two standard deviations higher than the Specified Minimum Yield Strength (SMYS).

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The maximum measured  $R_{t0.5}/R_m$  (yield to tensile ratio) shall be 0.90 – except that for grades > X65 (450 MPa), when tensile testing is performed with round bar specimens, the maximum measured  $R_{t0.5}/R_m$  shall be 0.93.

For grades X-60 and below, pipe body longitudinal tensile tests are required (at the same frequency as transverse) with results being for informational purposes only.

For Grade X-65 and above, pipe body longitudinal Tensile tests shall be performed at the same frequency as transverse tensile tests. For longitudinal tensile tests, the maximum yield strength shall not exceed the minimum transverse yield strength test requirements plus 17400 psi (120 MPa) of API 5L. For longitudinal tensile tests, the maximum tensile strength shall not exceed the minimum transverse tensile strength test requirements plus 17400 psi (120 MPa) of API 5L. The maximum measured  $R_{t0.5}/R_m$  shall be 0.90 in the longitudinal direction.

### 9.3.3 Hardness tests *(added)*

Vickers Hardness (VH 10) tests shall be conducted on the metallographic cross sections required in Table 18 of this specification in accordance with Clause H.7.3.3, "Hardness Test," of API SPEC 5L. Hardness shall conform to Table C of this specification.

**Table C *(added)* — Hardness**


Grade	Hardness (HV 10) – Base metal, weld metal and HAZ
All Grades	≤ 248, 260, 260

## 9.8 CVN impact tests for PSL 2 pipe

The minimum CVN transverse energy (full size) shall be as shown in Table D.1.1 for the pipe body and D.1.2 for pipe FL, FL + 2mm and FL + 5mm. The temperature for testing shall be at minimum design temperature which is 23°F (-5°C). In addition to MPQT a set of 7 tests shall be performed on a range of test temperatures that will allow the data to be graphed to determine the Ductile-Brittle Transition Temperature per starting material supplier, grade, diameter, wall thickness, alloy design, and rolling practice combination. A graph shall be prepared, and the transition temperature identified. This documentation shall be included in the report package for the order. The mill shall report if the sample breaks or does not break.

All the Charpy Energy requirements are based on Full Size Specimens. As the size of the Charpy specimen is reduced due to small WT the Charpy requirement shall be scaled accordingly.

If the Parent pipe CVN Requirements cannot be met, the pipe mill is to submit the “best effort” CVN test result commitment on this requirement for 23°F (-5°C) and also submit data for 32°F (0°C) if the CVN results drastically increase.

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**Table D.1.1 (added) — CVN energy requirements – Pipe body**

Pipe OD size (Inches)	Set Average (Joules)	Individual (Joules)
4 and 6	120	80
All other pipe sizes	150	120

**Table D.1.2 (added) — CVN energy requirements – FL|FL+2mm|FL+5mm**

Pipe OD size (Inches)	Set Average (Joules)	Individual (Joules)
All other pipe sizes	60	45

**9.8.2.2** For all pipe, CVN % shear shall be as shown in Table D.2.

**Table D.2 (added) — CVN % shear requirements**

Sampling Location	Minimum average/single value % shear @ T <sub>test</sub>
Base Material	The results of the Charpy impact test must indicate at least 85% average shear area on each set with a minimum of 75% shear area for any single test.
FL	Report for information only
FL+0.079 in (2 mm), FL+0.197 in (5 mm)	The results of the Charpy impact test must indicate at least 75% average shear area on each set with a minimum of 60% shear area for any single test.

## **9.9 DWT test for PSL 2 welded pipe**


Drop-Weight Tear (DWT) testing is required for pipes of all sizes. The DWT test temperature shall be at minimum design temperature which is 23°F (-5°C).

For pipe 16 in (406.4 mm) and larger in diameter the DWT test acceptance criteria shall be a minimum of 85% average and minimum 75% for individual shear area on each test and API 5L Annex G.

## **9.10 Surface conditions, imperfections, and defects**

### **9.10.1 General**

**9.10.1.1** Repair of surface defects shall be performed prior to hydrostatic testing. If surface imperfections appear over a large area (i.e., > 10 % of pipe surface) in excess of what is considered a workmanlike finish, the surface imperfections shall be cause for rejection of the pipe, even if the individual imperfections would be permissible. Areas of cosmetic grinding shall not be included in the 10% total surface area.

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### 9.10.3 Arc burns

9.10.3.2 Arc burns are not acceptable and shall be removed as a cylinder.

### 9.10.5 Geometric deviations

9.10.5.2 Dents within the limits of this specification are acceptable on pipe with wall thickness  $\leq 0.512$  in (13 mm). Dents are not allowed on pipe sizes outside these limits. For dents, the length in any direction shall be  $\leq 0.25 D$ . The maximum depth for all dents shall be 0.125 in (3.2 mm). Dents that contain sharp bottom gouges shall be removed as a cylinder. Dents that impact the weld shall not be allowed. Removal of dents by re-expansion, jacking out, or hammering is not allowed. A dent is classified as a depression caused by mechanical damage that produces a localized alteration in the curvature of the OD and ID surface without reducing wall thickness. Dents within 4 in (100 mm) of the pipe ends are not acceptable.

### 9.10.6 Hard spots

The maximum hard spot hardness shall be 260 Hv10 – Vickers (25.1 HRC). Surface hardness testing of potential hard spots detected by visual inspection shall be performed, depending on the method used, according to ASTM A 956, A 1038, E 110, ASTM A370, ISO 6506, ISO 6507 or ISO 6508. Hard spots outside the hardness limits for the applicable grade larger than 2 in (50 mm) in any direction and within 4 in (100 mm) of the pipe ends regardless of size shall be classified as defects and will be rejected.

### 9.10.7 (added) Other surface imperfections

For pipes to be fusion bond coated, surface imperfections, regardless of depth judged to be detrimental to coating application include slivers, scabs, laps and gouges that have sharp edges or undercutting. These imperfections potentially affect the flow of coating into the imperfection and should be removed. There should be no slivers or other sharp-edged imperfections that protrude above the pipe surface by more than 0.012 in (0.3 mm). The average number of these imperfections shall be  $\leq 0.7$  per 10.8 square ft (1.0 square m) (i.e., maximum of 7 imperfections for 100.8 ft<sup>2</sup> (10 m<sup>2</sup>) of pipe surface).

## 9.11 Dimensions, mass and tolerances

### 9.11.3 Tolerances for diameter, wall thickness, length and straightness


9.11.3.1 (added) The dimensional tolerances for diameter shall be:

Pipe except for pipe ends	0.005D but maximum of 4 mm (0.160 in.)
Pipe end	+/- 2 mm (0.079 in.)

The dimensional tolerances for pipe end out-of-roundness shall be:

Pipe except for pipe ends	0.01D but maximum of 10 mm (0.4 in.)
Pipe end	0.0075D but maximum of 8 mm (0.3 in.)

9.11.3.2 (added) The wall thickness tolerance for shall be  $+0.15t$  and  $-0.05 t$ .

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**9.11.3.3** Pipes are to be delivered in lengths per Table E of this specification, unless otherwise specified by the Company in the Purchase Order.

**Table E (added) — Average length requirements**

<b>Application</b>	<b>Double Random Length (4" – 6")</b>	<b>Triple Random Length (8" - 12")</b>	<b>Quad Random Length (16" – 24")</b>
Onshore	42 ft (12.8 m)	57 ft (17.4 m)	76 ft (23.2 m)

**9.11.3.4** The total deviation from a straight line over the entire pipe length shall be  $\leq 0.15$  % of the pipe length.

## **9.12 Finish of pipe ends**

**9.12.1.2** Pipes shall be beveled for welding per API SPEC 5L Clause 9.12.5.2.

Beveled ends shall be smooth and free from objectionable marks. Re-machining is required to correct out-of-tolerance bevels. Grinding shall not be allowed. Filing to remove burrs is acceptable provide the land face is not affected.

### **9.12.6 (added) End Squareness**

As per API SPEC 5L (End Squareness Added to 46<sup>th</sup> Edition)

## **9.15 Weldability of PSL 2 pipe**

Unless otherwise specified, no weldability tests at the pipe mill are required. Assuming that the chemistry and mechanical properties of this specification are met, the material is considered to be weldable.


## **10 Inspection**

All inspection, measurement, and test equipment used for pipe acceptance shall be controlled, verified, and calibrated.

### **10.1.1.2 Types of inspection and inspection documents**

Approved Electronic Data Interface (EDI) documentation is acceptable. The following documents shall be provided in the English language.

- Manufacturing Procedure Specification,
- Mill Certificates,
- Certified Material Test reports,
- Inspection reports, including hydrotest reports,
- Copies of Equipment Calibration Certificates,
- Packing and Shipping reports.

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**10.1.3.1 Inspection documents for PSL 2 pipe**

All documents shall be legible and submitted in electronic format, along with copies of Inspection Certificate 3.1 or 3.1.B shall be issued to the purchaser.

**10.1.3.2** The inspection certificate issued by the manufacturer shall also include:


- Name of purchaser,
- Purchase order number,
- Mill order number,
- Quantity produced,
- Statement of compliance with this specification.

**10.1.3.3** The inspection certificate issued by the manufacturer shall also include:

- Purchase order
- Manufacturing Procedure Specification
- NDT and inspection procedures (if not in MPS)
- Automatic seam UT charts
- Minutes of meetings and correspondence
- Weld zone metallographic reports, including hardness
- Inspection Mill Certificates
- Inspection reports, including NDT and hydrotest reports
- NDT operator certificates
- Double/triple joint tracking
- Tracking sheet for each pipe's acceptance through each station
- Copies of Equipment Calibration Certificates
- Packing and shipping reports, including weight and length

The Manufacturer's documents shall be labeled in imperial units and all documents shall have acceptance criteria. If metric units are used, the imperial units shall be provided adjacent to the metric units. All the testing documents shall be in Microsoft excel and/or searchable PDFs.



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## 10.2 Specific inspection

### 10.2.1 Inspection frequency

The following clarifications shall apply to Table 18, "Inspection Frequency for PSL 1 Pipe," of API SPEC 5L. All dimensional inspections listed in Table 18 of API SPEC 5L and Table 18 of this specification shall be measured and recorded at least 3 times per 8 hour working shift—at approximately the start, middle, and end of the shift.

**Table F – API 5L Table 18 (*modified*) — Inspection frequency for PSL 2 pipe**

<b>Type of Inspection</b>	<b>Frequency of Inspection</b>
Pipe end diameter	Each pipe
Pipe end out-of-roundness	Each pipe
Charpy testing of the HFW seam	Minimum of one per test unit of pipe with same cold expansion ratio
Height of ID/OD weld beads	Minimum 3 pipes per 8-hour shift
Pipe end peaking at weld seam	Minimum 3 pipes per 8-hour shift

At a minimum, a Vickers (Hv10) hardness test shall be performed on a cross section of the weld seam of one (1) pipe from each heat plus one (1) pipe from each line per day

### 10.2.2 (*added*) Samples and test pieces for product analysis

For single coil heats lots, product analysis samples shall be taken from the coil end and from the approximate center lap of the coil.

### 10.2.3 Samples and test pieces for mechanical tests


#### 10.2.3.1 General

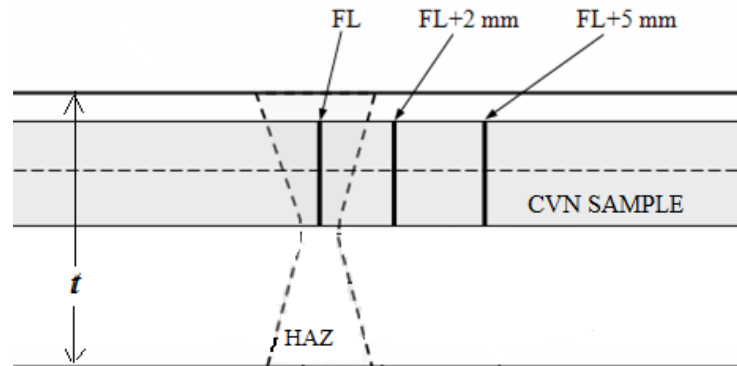
Samples for mechanical tests shall be taken randomly from pipe locations that correspond to opposite skelp/plate ends and skelp approximate mid- length locations if pipes are produced from cut-to-length multiple lengths.

#### 10.2.3.3 Test pieces for the CVN impact test

The axis of all pipe body CVN test specimens shall be near to the center of the wall thickness. Required longitudinal CVN energy shall be  $\geq 1.5$  times transverse CVN energy.

For production test pieces taken in the HAZ, the notch shall be at one of the fusions lines (FL), FL+0.079 in (2 mm) or FL+0.197 in (5 mm) locations, whichever location has the lowest impact toughness values obtained in the Manufacturing Procedure Qualification Tests (MPQT). Sample locations are as shown in Modified Figure 7 (below) of API SPEC 5L. FL line notch location shall traverse 50 % weld metal and 50 % HAZ.

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**Figure 7 (modified) – Location of Charpy Test Specimens**

#### 10.2.5 Macrographic and metallographic tests

The weld sections selected for macrographic/metallographic inspection testing shall be taken at the more stringent of once per test unit or start, approximate middle and end of the operating shift

The macrographic/metallographic inspection shall confirm that dimensional requirements of this specification are met and that there is no evidence of significant centerline segregation. The frequency of sampling and hardness value recording shall be per Table G below.

**Table G (added) — Frequency of macrographic/metallographic Inspection**


Type of Pipe	Sampling Frequency
All Pipe	Whenever lengths of pipe are outside of MPS weld parameter tolerances

#### 10.2.6 Hydrostatic test

**10.2.6.1** The test pressure shall be held for at least 20 seconds.

**10.2.6.2** The hydrostatic testing master gauge shall be calibrated against a dead weight tester before the start of the production order, at the end of production order and at least once per month during production. The working pressure gauge and the pressure chart shall be verified against the master gauge at the start of each working shift and at the approximate middle of the shift. Pressure gauges used during the hydrostatic test shall have a range that is between 1.5 to 3 times the maximum test pressure. All hydrostatic pressure tests shall be chart recorded and traceable. The working pressure gauge and chart shall be calibrated after any expansion or hydrostatic test failure.

**10.2.6.5** All pipes shall be hydrostatically tested to a pressure that will produce a hoop stress of at least 100 % SMYS. Hydraulic pumps shall not activate during the 20-second test duration. Hydrostatic testing shall be carried out on each pipe prior to final visual and final non-destructive inspection, except that cutting to length, beveling or correction to pipe end out-of-roundness may take place after hydrostatic testing.

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Any pipes that fail during expansion or hydrostatic test shall be rejected and retained for investigation to determine cause and TPI shall be notified immediately. This information shall be provided to Company.

**10.2.6.6** End load compensation for hydrostatic test pressure may be implemented provided there is Company approval of manufacturer calculations for the compensation.

**10.2.6.7** A distortion occurrence will be considered a failure. In the event of a failure, the MANUFACTURER shall investigate and report back to the COMPANY the cause of any distortion. In no event shall the test pressure be less than 95% SMYS or less than 15 seconds with decrements starting at 2.5% increments.

### **10.2.7 Visual inspection**

The external surface shall be examined visually over the full length of each pipe. The inside surface of all pipes with OD  $\geq$  20 in (508 mm) shall be visually inspected. For pipe OD < 20 in (508 mm), the inside surface of the pipe shall be visually inspected at the pipe ends as far inside the pipe length as practical. All end bevels shall be visually inspected.

Pipes shall not come into contact with materials that contain low melting metals such as copper, zinc, or tin.

### **10.2.8.2. Dimensional testing**

Pipe end out-of-roundness shall be measured with calipers, rod gauge, or equivalent. Pipe body out-of-roundness shall be measured at approximate mid-length of pipe.

### **10.2.12 Retesting**

**10.2.12.2** In addition to the retest criteria for failed samples, if the yield strength for the initial tensile test specimen, representing a test unit of pipe, is less than SMYS + 1500 psi (10 MPa), then two additional retests of different pipe from the same test unit are required. The test unit passes only if all three tests are above the SMYS.

## **11 Marking**


**11.1.1** The pipes shall be monogrammed in accordance with API Spec 5L, Annex O.

**11.1.3** The pipes shall also be marked with the purchaser's purchase order number, individual pipe number, heat number and CVN test requirement.

### **11.2 Pipe markings**

**11.2.1** Pipe markings shall additionally include the following:

- a) Third Party Inspection mark.
- b) Bar coding shall be applied when specified by the Company. The format of the barcode, the location, the data requirements, etc. shall be as agreed upon between the manufacture and the Company.

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**11.2.2** The required markings shall be placed on both ends of the pipe. If due to logistical or safety reasons full stencil marking of both ends is not possible then it is acceptable for one end to have the traceable pipe identity legibly hand marked with a permanent marker on the inside surface of the pipe. For pipe with  $D < 12.75$  in (323.9 mm) continuous stenciling is acceptable with required information not included in the continuous stencil marked on the outside surface of the pipe.

- a) Pipe size  $D \leq 1.900$  in (48.3 mm) is not applicable.
- b) For pipe with  $1.900$  in (48.3 mm)  $< D < 16$  in (406.4 mm), where possible, markings shall be placed on the inside surface of the pipe.
- c) For pipe with  $D \geq 16$  in (406.4 mm), the required markings shall be paint stenciled on the inside surface of the pipe at least 300 mm from each pipe end.

**11.2.3** Die stamping shall not be permitted, except on the pipe end bevel face with low stress stamps.

## 12 Coatings

Pipe shall be furnished bare with no loose mill scale, foreign matter, oil, or varnish. A light coat of clear varnish shall be sprayed only over the stenciled areas on each end.

## 13 Retention of records

Records of the inspections indicated in Section 13 shall be maintained for at least 7 years. In addition, repair welder qualification records shall be maintained.


## 14 Pipe loading

All recommendations in API RP 5L1, 7<sup>th</sup> Edition, September 2009 and API RP 5LW, 3<sup>rd</sup> Ed, September 2009 shall be mandatory.

### 14.1. Pipe handling (*added*)

Pipe shall be lifted using end hooks, vacuum lifts, straps (slings), or front loaders.

- a) End hooks shall be lined with a cushioning material such as rubber or a non-ferrous metallic material such as aluminum. For TRL and QRL lifting shall be accomplished utilizing straps or vacuum lifts.
- b) Lifting straps shall be made of non-abrasive material such as nylon webbing.
- c) The forks of forklifts shall be lined with rubber or other Company-approved material.
- d) Spreader bars (or Company-approved equivalent) shall be certified and shall maintain a minimum angle of 60° between the pipe and the strap/sling/hook.
- e) All pipes shall be picked up clear of the ground without dragging. Pipes shall not be subjected to impact or jarring.

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Bare pipe in outside storage shall be stacked off the ground on berms covered with plastic sheeting material, or on timbers with a minimum 6 in (150 mm) wide bearing surface. The berms or timbers shall be of sufficient height to prevent the pipe ends from coming into contact with the ground and to keep the pipe clear of any localized surface water. The timbers shall be equipped with wedges or a similar device to prevent the pipe from falling off the stack.

Manufacturer and/or distributor shall provide calculations of proposed pipe joint stacking height and support systems for Company approval. Calculations shall demonstrate that the pipe is not loaded beyond 72 % of its SMYS and that the pipe coating will not be damaged by stacking.

All pipes shall be stacked at an angle ( $\geq 3^\circ$ ) to ensure adequate water drainage from the pipe interior.

Pipes should not be shot blasted prior to long-term storage due to the increased potential for detrimental surface rusting and pitting. Pipe in long-term storage should be inspected at least every 6 months to determine corrosion damage and traceability. If the pipe surfaces appear to be deteriorating at an abnormal rate, then protective measures should be taken. Protective measures include washing to remove salt contamination, shot blasting and painting with a thin layer of red oxide primer, or moving to controlled storage. All pipes without identification shall be immediately rejected and removed from storage for disposition. The purchaser shall be notified.

## **14.2 Pipe shipment (*added*)**

### **14.2.1 General**

Pipe shall be protected during loading, transit, and storage in order to preclude all contamination by oil, grease, salt water, or other chemicals which could adversely affect coating adhesion. A positive reaction with potassium ferricyanide indicating paper is considered proof of chemical contamination, and mandates phosphoric acid pretreatment of all pipes. Such pretreatment shall consist of preheating the pipe to at least 120°F (49°C), followed by phosphoric acid solution wash, and a high-pressure rinse with clean water. Where other contamination is found, the pipe shall be inspected and segregated at the destination and all affected pipes shall be cleaned by detergent wash.

Prior to shipping, manufacturer shall remove all paper or plastic stickers from the pipe ID.


All pipe bolsters and supports shall be padded and shall have bearing surfaces adequate to keep bearing loads on pipes and coatings within acceptable limits. Manufacturer shall demonstrate bearing load calculations if Company so requests.

Dunnage shall be hardwood or dense fir. Nail-heads on dunnage shall be adequately countersunk to avoid transit damage to pipe.

All foreign substances such as dirt and debris shall be removed from inside the pipes before stock piling or shipping. Pipes shall be blown out during load-out at the discretion of Company.

All cables, or other equipment used for fastening loads shall be padded to avoid metal-to-metal contact with the pipe.

All dimensional tolerances and pipe surface conditions as specified in this specification and in API SPEC 5L shall apply to the pipe condition as received by Company at the shipping destination.

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Discovery of any transit fatigue cracking shall be grounds for rejection of the entire load, until absence of cracking on the balance of the load is proven.

Where steel-to-steel contact has fretted the pipe surface, magnetic particle or dye penetrant inspection shall be performed to ensure absence of cracking.

A loading diagram shall be furnished for methods of transportation proposed for the pipe.

Shipping damage caused by improper loading shall be considered mill damage.

#### **14.2.2 Shipping by rail**

Pipe shall be loaded on or in rail cars in accordance with all provisions of API RP 5L1, 7<sup>th</sup> Edition, September 2009, regardless of  $D/t$  ratio. End gates lined with wood to a minimum nominal thickness of 1.0 in (25 mm) shall be provided in gondola cars and bulkhead flat cars.

The static load stress used in computing the number of bearing strips required shall be determined in accordance with API RP 5L1.

Rail cars shall be clean and inspected by the inspector prior to loading. The inspector shall be given reasonable notice prior to loading and shipping so that each rail car can be inspected prior to loading, and again before it is released to the railroad.

Skids shall be placed directly on car bottom, not on residual debris. Skid height shall be at least 1.0 in (25 mm) higher than any foreign material or integral projections on car bottom. Skids shall not be stacked, and skid height shall not exceed skid width.

#### **14.2.3 Shipping by truck**

Shipping by truck shall be in general accordance with API RP 5LT, 1<sup>st</sup> Edition, March 2012. Low-boy (step bed) or pole trailers shall not be used.

Metallic uprights on trucks/trailers shall be completely padded with a minimum 0.126 in (3.2 mm) thickness of PVC or equivalent.

Dunnage shall be arranged to avoid contact between pipe and nails and/or staples. Skids shall not be stacked, and skid height shall not exceed skid width.


Nonmetallic hold down straps shall be used. Chains are prohibited. Steel strapping may be used for belly banding, providing straps are free of burrs.

#### **14.2.4 Shipment by barge and marine vessel**

Pipe shall be loaded per API RP 5LW, 3<sup>rd</sup> Edition, September 2009, with mandatory wood bearing strips and side wood bearing strips. All API RP 5LW requirements shall apply to all pipes, regardless of actual  $D/t$  ratio. The maximum load stress shall be  $\leq 80\%$  SMYS.

Barges and vessels, loading and unloading are subject to inspection by the inspector. A licensed marine surveyor shall also approve marine equipment and procedures.

Pipe shall not be shipped on deck on oceangoing vessels and shall not be exposed to salt water or salt-water spray during transportation. Testing for salt contamination and treatment may be

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required by the Company. For transoceanic shipping, when permitted, ship's log shall be made available to Company for review when the pipe is unloaded.

No pipe end shall overhang any underlying pipe end by more than 3.3 ft (1.0 m).

Over-stowage shall not be permitted.


Lashing shall be padded to preclude metal-to-metal contact with the pipe.

## **15 Warranty (*added*)**

The Manufacturer shall warrant for 2 years after receipt, any pipe that fails during testing due to a manufacturing defect, when testing in the field up to 105% of SMYS. The warranty shall cover all costs related to finding, cutting out and replacing the defective section of pipe.

The manufacturer shall supply a copy of his warranty with other documentation required by the original purchaser. This warranty will cover manufacturing defects as defined in API SPEC 5L and this specification and all benefits of warranty shall pass to the Company.



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## Annex B (normative)

### Manufacturing procedure qualification for PSL 2 pipe

#### B.1 Introduction

Manufacturing Procedure Qualification is required for pipes produced to this Specification.


#### B.2 Characteristics of the manufacturing procedure

As part of the technical bid, a generic MPS is acceptable if it provides sufficient detail for Company to determine process and procedure acceptability. Pipe manufacturer to assure third party inspection (TPI) has access to all steel slabs/coil/plate facilities for this project. Company (SUMMIT CARBON) and its representatives shall be invited to pre-award and pre-production technical meetings for steel slabs/coil/plate manufacturing once steel sources have been chosen and approved. Steel sources: Potential approved steel manufacturers are to be submitted at time of bidding. When a selection is made for the steel source for this purchase it must be submitted to the Company along with the coil/plate MPS for review and approval by Company. The manufacturer shall submit a job specific MPS for Company approval prior to production.

a) The MPS shall include the following:

1. Process flow diagram,
2. Steel and skelp producer,
3. Company and Representatives will be invited to pre-award/pre-production meetings for steel slab/coil/plate manufacturing.
4. Company and Representatives will be granted access to the steel slab/coil/plate facilities for inspection and audits.
5. Data set to include all actual manufacturing parameters and internal procedures for the specific alloy designs being used will be available for review and audit at steel slab/coil/plate manufacturing facilities.
6. Aim chemical composition and tolerances for each element,
7. Steelmaking and casting techniques, including transition slab practice,
8. Ladle treatments including degassing,
9. Slab caster centerline segregation mitigation and monitoring procedures, including test frequency and photographs of macro etch rating system and the identification of maximum macro etch ratings for heats produced to the order,
10. Slabs reheat temperature and soak time, start and stop temperatures for finishing mill and accelerated cooling. Allowable variations for these parameters,
11. Hydrogen control procedures for skelp > 0.787 in (20 mm) thick,
12. End cropping process and procedures,



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13. Pipe manufacturing process,
  14. Procedures for run-on and run-off weld tabs,
  15. Slab/skelp/pipe identification and traceability procedures,
  16. Procedures for weld wire and flux storage and handling, including moisture control,
  17. Welding Procedure Specification and Welding Procedure Qualification Record for welding,
  18. If required, post weld heat treatment details including proposed temperature range, time-at-temperature and methods of temperature monitoring and control to ensure through wall heat treatment,
  19. Methods of weld defect removal and repair welding procedures,
  20. Method for cold expansion/sizing/pipe end dimensional correction.
  21. Aim sizing ratio,
  22. Hydrostatic test procedures, including calibration/verification,
  23. Dimensional control procedures, including corrective 'jacking' for out-of-roundness,
  24. NDT procedures, including for skelp,
  25. Mechanical tests - sampling and testing procedures,
  26. Procedures for testing or reworking material that does not conform to MPS process tolerances,
  27. Calibration intervals for instruments and equipment used in processing, measuring and testing,
  28. Marking, handling, loading, and shipping procedures.
- b) Re-qualification of the MPS shall be required if any of the essential variables below are exceeded:
1. Any change in steel supplier or type of steelmaking/casting,
  2. Changes beyond the allowable variation for rolling and accelerated cooling processes,
  3. Change in ladle analysis beyond  $\pm 0.03 \text{ CE}_{\text{Pcm}}$  and/or  $+ 0.02 \text{ \% carbon}$ ,
  4. Change in type of pipe forming.

MPQT Control Limit values are indicative and will be determined for each MANUFACTURER pending a review of MPS documentation.

All records pertaining these essential variables shall be made available to the Company or Third-Party inspector during production. Types of records include macro etched surfaces and scanned images, rolling traces for each coil/plate, dimensional charts, and operational procedures.

Re-qualification of the MPS may be required if any of the essential variable tolerances in Table B.1 below are exceeded. In addition, the flowing conditions shall require re-qualification:

1. Any change in steel supplier or type of steelmaking/casting.

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2. Change in ladle analysis beyond  $\pm 0.03$  CE Pcm and/or  $+ 0.02$  % carbon.
3. Change in type of pipe forming.

**Table B.1 – Control Limits for Manufacturing Essential Variable**

<b>Essential Variable</b>	<b>Process Control Aim<sup>(1)</sup></b>	<b>Process Control Limits<sup>(2)</sup></b>	<b>Characteristic to be tested<sup>(2)</sup></b>	<b>MPQT Control Limits<sup>(3)</sup></b>
Casting Super Heat	$+12^{\circ}\text{C}$ (21.6°F) to $+28^{\circ}\text{C}$ (50.4°F)	$+10^{\circ}\text{C}$ (18°F) to $+30^{\circ}\text{C}$ (54°F)	Slab macro-etch	$+10^{\circ}\text{C}$ (18°F) to $+30^{\circ}\text{C}$ (54°F)
Casting Speed	$\leq 1.0$ m/min. ( $\leq 39.37$ in./min.)	$\pm 0.20$ m/min. ( $\pm 7.87$ in./min.)	Slab macro-etch	$\pm 0.20$ m/min. ( $\pm 7.87$ in./min.)
Slab Reheat Temperature	$\pm 20^{\circ}\text{C}$ (36°F)	$\pm 30^{\circ}\text{C}$ (°54)	Plate/Skelp/Pipe: Tensile, CVN, DWTT.	$\pm 40^{\circ}\text{C}$ (72°F)
Slab Thickness				-5%, +10%
Final Rolling Temperature	$\pm 20^{\circ}\text{C}$ (36°F)	$\pm 30^{\circ}\text{C}$ (°54)		$\pm 40^{\circ}\text{C}$ (72°F)
Coiling Temperature	$\pm 25^{\circ}\text{C}$ (45°F)	$\pm 30^{\circ}\text{C}$ (°54)		$\pm 50^{\circ}\text{C}$ (90°F)

**Notes:**

- (1) The aim values and tolerances are considered to be representative of good mill practice to achieve consistent and reproducible quality and mechanical test results.
- (2) Heats / coils / pipes outside these limits shall be segregated from the order. Additional testing is required to confirm that the non-conforming unit's specification requirements. Testing shall be conducted on material from the location violating Table B.1 Process control limits.
- (3) Heats / coils / pipes outside of these limits may require a new MPQT qualification. COMPANY review and approval are required.
- (4) For vertical casters (No bending / unbending of the strands) the superheat for process control shall be  $\leq 55^{\circ}\text{C}$  (99°F) and for MPQT control shall be  $\leq 60^{\circ}\text{C}$  (108°F).
- (5) The ACC max cooling rate shall be  $50^{\circ}\text{C}$  (90°F) per second.

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### B.3 Manufacturing procedure qualification tests (MPQT)

**B.3.1** The testing and inspection identified in Table 18, "Inspection frequency for PSL 2 pipe," of API SPEC 5L and this specification and the MPQT tests in Table B.1 below shall be applied as First Day production testing and shall meet the requirements of this specification.

**B.3.2** In order to qualify the proposed manufacturing procedure, two pipes from each pipe size, wall thickness and grade representing two separate heats will be selected by Company for MPQ testing. Sufficient notice (at least 14 days) shall be given of the time when the production run is to begin. For small quantity orders, the qualification of the manufacturing procedure for pipe with similar wall thicknesses may be combined provided the procedure is otherwise identical – the order with greater wall thickness shall be tested. No pipes on this order shall be accepted until the MPQT results are approved by Company. Changes to the MPS shall be approved by Company.

**Table B.1 (added) — Additional manufacturing procedure qualification tests**

Item	Test Requirement	Acceptance Criteria
1.	Macro etch of slab/skelp representing head, middle and tail of all strands to be used for production heats.	Table B of this specification
2.	Chemical analysis of weld metal.	$\leq CE_{Pcm}$ maximum of ordered grade + 0.03.
3.	All weld metal tensile test (longitudinal) per ISO 5178. For WT > 0.984 in (25 mm), test both OD and ID welds.	$R_{0.5t} > SMYS$ . $R_m > SMTS$ . Elongation $\geq 18\%$ .
4.	Transverse CVN tests - pipe body, weld centerline. FL, FL+0.079 in (2 mm) and FL+ 0.197 in (5 mm) at $T_{test}$ – per Figure 7 of this specification.	Section 9.8 of this Specification.
5.	Transverse CVN transition curves for pipe body, weld centerline and HAZ; temperature range of +68°F (+20°C) to -60 (-50°C) ( $\geq 5$ temperatures). One HAZ notch location shall be tested – the location that gives the lowest values when performing the tests in Item 4 of this table. For $D \geq 12.75$ in (323.9 mm), pipe body DWT transition curve may be used to replace pipe body CVN transition curve.	To document transition temperature. CVN: Section 9.8 of this specification at $T_{test}$ .  DWT: Section 9.9 of API SPEC 5L and this specification at $T_{min}$ .
6.	For pipe with wall thickness > 0.512 in (13 mm), CTOD of weld metal at $T_{min}$ . – minimum of three 'NP' samples in accordance with BSI BS 7448. Sample size should be B x 2B, with B dimension as close to t as possible.	CTOD $\geq 0.0059$ in (0.15 mm).
7.	Cross section macro specimen, documented with a photo, from the weld at a position 6 in (150 mm) from each pipe end, polished and etched to disclose weld geometry.	Section 9.13 of API 5L and this specification.
8.	Surface imperfections in weld area. The full length of the	ISO 10893-5 acceptance


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<b>Item</b>	<b>Test Requirement</b>	<b>Acceptance Criteria</b>
	helical weld shall be inspected for longitudinal and transverse imperfections by MT in accordance with ISO 10893-5 or ASTM E 709.	level Table 3, M2

### **B.5 Inspection and test plan (ITP) (*added*)**

Prior to commencement of any fabrication work, the manufacturer shall submit a job-specific ITP for Company review and approval. The ITP format shall include the following:

1. The specific activity and associated procedure or specification reference governing the activity,
2. Acceptance criteria,
3. Responsible organization performing the activity,
4. Verifying document to be used for recording inspection and test results,
5. Manufacturer shall show designated monitor, witness, test and hold points in manufacturing process,
6. Provisions for Company to designate third party monitor, witness, and hold points,
7. Company participation for each activity to be completed by Company.

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## ANNEX E

(normative)

### NON-DESTRUCTIVE INSPECTION

The required NDT methods of inspection for pipe are given in Table E.1.

**Table E.1 – Methods of Inspection for Pipe**

Testing Required	Method	Inspection Frequency
Visual inspection	VT	100%
Imperfections in pipe end weld dead zone	MUT	100%
Laminar imperfections pipe ends	UT	100%
Laminar imperfections pipe end bevel face	MT & MUT	100%
Laminar imperfections pipe body	UT	100%
Laminar imperfections adjacent to weld	UT	100%
Imperfections in weld	UT	100%
Linear (non-laminar) imperfections at pipe ends <sup>1</sup>	UT	If specified
Residual magnetism	Gaussmeter	Every 4 hours
<b>Notes:</b> <sup>1</sup> The COMPANY may require inspection for vertical imperfections in pipe ends.		


#### Pipe End Inspection – Welded Pipe

The weld at pipe ends not covered by automatic UT shall be inspected by semi-automatic or manual UT for longitudinal imperfections to the same acceptance level as the automatic inspection.

#### Non-destructive Inspection – Skelp Inspection

All skelps used for the manufacture of pipe shall be ultrasonically examined for laminations over a minimum width of 1 in. along the entire length of all surfaces to be welded. Acceptance limits shall be as per standard “Sour” service condition in Table K.1 of API SPEC 5L.

Sensitivity shall be based on a 0.25 in (6 mm) flat bottomed hole

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The body of the skelp shall be ultrasonically examined using a scanning technique that covers at least 80% of the surface area. Single indications that exceed an area covered by a 1/4-in. maximum diameter circle or multiple or clustered indications that exceed an area covered by a 2-in. maximum diameter circle shall be rejected.

Full-body pipe ultrasonic examination is an acceptable substitute for skelp ultrasonic examination. The Manufacturer shall include the ultrasonic testing method to be used and the scanning details in the vendor quote. The Company shall approve the ultrasonic inspection procedure.


#### **Non-destructive Inspection – HF-ERW Weld Inspection**

The full length of the weld shall be ultrasonically inspected after expansion and hydrostatic testing. The weld shall be inspected for both longitudinal and transverse defects.

The reference standard and calibration for non-destructive inspection shall be in accordance with *this specification's table E2*

**TABLE E2: REFERENCE REFLECTORS:**

Reflector Number	Reflector	Location
1	N5	Shall be on the pipe end in the weld on both ends in the ID and the OD to detect dead zones of the AUT machines
2	N5 OD longitudinal notch	On the weld, 2 inches from reflector number 1, both pipe ends
3	N5 ID longitudinal notch	On the weld, 2 inches from reflector number 2, both pipe ends
4	N5 OD longitudinal notch	On the right side of the weld, 2 inches from reflector number 3, both pipe ends
5	N5 ID longitudinal notch	On the right side of the weld, 2 inches from reflector number 4, both pipe ends
6	N5 OD longitudinal notch	On the left side of the weld, 2 inches from reflector number 5, both pipe ends
7	N5 ID longitudinal notch	On the left side of the weld, 2 inches from reflector number 6, both pipe ends

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Imperfections exceeding the acceptable threshold shall be marked in the tracking system and a spray paint shall be applied adjacent to the indication.

The Suspect areas shall be proved-up by MUT covering a length that is at least  $\pm 6$  in (155 mm) from the area with indications from both sides of the weld and the probe shall be swiveled by 5°-10° during the inspection.

The reference standard of Manual UT shall be the same grade, pipe size, heat treat condition and have equivalent attenuation. The reference standard shall have a 0.063 in (1.6 mm) diameter through wall drilled hole located in the center of the weld to establish the sensitivity level using a distance-amplitude curve (DAC).

The DAC curve for longitudinal indications should be established with a minimum of two points. Point #1 is from the maximized signal from the 1.6 mm diameter TDH located on the ID weld crown surface in leg # 1 and is set at 80% FSH. Point #2 is from the signal from the 1.6 mm diameter TDH located on the OD weld crown surface in leg #2. This DAC curve is the primary reference or acceptance level. The DAC curve for transverse indications is established in the same manner with the 45° 'on-bead' probe parallel to the long seam weld axis.

For production and prove-up scanning, gain shall be  $\geq 6$  dB over the primary reference level. Acceptance of suspect areas shall be based on the established primary reference level.

**The acceptance criteria are:**


All maximized indications that exceed 100% of the DAC curve are defects regardless of length.

All maximized indications that are greater than 50% of the DAC curve and exhibit signal characteristics of a 'crack' (including but not limited to amplitude, shape of signal envelope, location in the weld and walking during scanning) are defects regardless of length.

All maximized indications that are below established sensitivity level established during calibration of the DAC curve (scanning gain is removed) and do not exhibit signal characteristics of a 'crack' are acceptable regardless of length.

All indications that are open to the surface are defects regardless of displayed amplitude (FSH position) or length.

Indications exceeding 50% of the DAC curve shall be further investigated and the amplitude maximized using probes with another approved refracted angle (e.g., If an indication is displayed and maximized on the CRT at 80 % of the DAC curve with a 70°

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probe then the indication is also tested with a 60° probe for evaluation and vice versa). All maximized indications exceeding 50% of DAC curve are unacceptable.

Reference calibration material shall be the same as production material, following shall constitute change of reference calibration material:

- Change in steel supplier
- Change in material's attenuation properties

The change in calibration reference material shall require all the documentation as mentioned in this specification.

#### **Non-destructive Inspection – Pipe End Inspection**

The ends of each pipe shall be ultrasonically inspected for laminations and inclusions over a width of at least 1 in. around the circumference of the pipe after beveling.

Any defect with a circumferential dimension that exceeds 1/4 in. shall be rejected. If a cut-off is required, the inspection shall be repeated. The Company shall approve the ultrasonic testing procedure.

If the automatic ultrasonic weld inspection does not cover the pipe-ends, then the ends +2 inches shall be inspected by manual ultrasonic testing unit and the MUT shall be calibrated as stated in this specification section.