1.0 SCOPE

This standard establishes the minimum requirements for the manufacture of high frequency welded (HFW) line pipe. This standard is applicable for pipe to be used in onshore crude oil, liquid, hydrocarbon or gas transmission, and storage pipelines. The pipe and unformed skelp/plate shall comply with DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) Rules, 49 CFR, and all PHMSA advisories and bulletins.

This standard is limited to the procurement of line pipe directly from a MANUFACTURER and shall not apply to pipe that has already been manufactured. The MANUFACTURER shall have a valid license to use the API Monogram for manufacturing of line pipe and the line pipe shall be monogrammed.

This standard shall be used in conjunction with 45th Edition of API 5L PSL2, dated July 1, 2013. The requirements identified here are intended to clarify, modify, and add additional requirements to the wording of API 5L and are numbered and titled to correspond to the numbered clauses of API 5L. Clauses in API 5L not mentioned remain unaltered, and are fully applicable. If only part of a clause in API 5L is altered by this standard, the remainder of any such clause shall remain applicable.

This standard shall be used for non-sour, liquid, two-phase (up to 6% ethane) gas, multiphase (gas, oil, and water) service installed in accordance to ASME B31.4 and ASME B31.8.

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

1.1 Information to be furnished at the Time of Bidding

The following information as applicable shall be furnished at Bid stage with respect to line pipe to be supplied.

- Name(s) of proposed MANUFACTURER(s)
- Authorization letter(s) from MANUFACTURER(s) where applicable.
- Authorization letter(s) from MANUFACTURER(s) of steel skelp, in case coil manufacturing facility is not an integral part of the Supplier's pipe mill.
- Record of similar supplies made earlier by the MANUFACTURER for both skelp and pipes, giving complete details of diameter, thickness, length, grade of skelp/pipe, service, year, name of project, name of client, and contact person.
- In particular, details of similar supplies made over the last five years shall be furnished, if requested

- Descriptive technical catalog(s) of the proposed MANUFACTURER(s).

- Copy of valid certificate of Authority to use API monogram as per clause 1.2 of this standard.

- A clause wise list of technical deviations, exceptions and clarifications, if any, from the requirements of this standard shall be furnished with the Inquiry. Deviations indicated anywhere else in the offer shall not be considered valid. In case of no deviations, Bidder shall write "NO DEVIATIONS".

2.0 CONFORMITY

2.1 Units of Measurement

Unless otherwise noted, UCS units shall be used. A dot (on the line) is used as the decimal separator.

2.3 Compliance to This Standard

The MANUFACTURER shall be certified to ISO 9001, ISO/TS 29001 or approved equivalent. The COMPANY shall have the right to conduct such audits, as COMPANY deems necessary to assess and ensure the effectiveness of MANUFACTURER's quality system. A quality plan shall be submitted with the technical tender.

The COMPANY normally requires Third Party Inspection during the manufacture, inspection and testing of the order, unless specifically omitted by the COMPANY. Third Party Inspectors shall be approved by the COMPANY as qualified to monitor product quality and processing at assigned locations within the manufacturing facility. 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, broadband, 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 standard. This may include a separate inspection area with adequate lighting The MANUFACTURER shall provide reasonable advance notice of when production, inspection or testing shall be performed or resumed.

A complete and detailed project-specific Manufacturing Procedure Specification (MPS) and Inspection and Test Plan (ITP) shall be prepared and submitted to

COMPANY for approval prior to start of production for steel and pipe. The MPS/ITP shall be representative of this standard and/or any technical exceptions/deviations agreed upon by COMPANY and MANUFACTURER. The details provided in the MPS/ITP are contractually binding on MANUFACTURER and changes after contract award require written COMPANY approval. If a change is proposed after manufacturing procedure qualification, permission shall be conditional on a repeat of the qualification test.

Absence of exception to this standard will be considered “qui tacet consentrie”.

The COMPANY may elect to monitor the MANUFACTURER’S (including steelmaking and rolling) operations to assure that the steel and pipe is manufactured in accordance with the approved MPS/ITP. Accordingly, COMPANY may have permanent representative(s) in the MANUFACTURER's facility throughout the production of the steel and pipe. The MANUFACTURER shall notify COMPANY a minimum of 14 days prior to start of production or of any impacts to production.

The COMPANY or its representative shall have the right to monitor and/or inspect the production or testing of the steel and pipe during any stage of manufacture in which the quality of the finished product may be affected. The COMPANY or its representative shall also have the right to perform inspection or testing of materials, such as plate, pipe and welding consumables, purchased by the MANUFACTURER.

All Mill monitoring tests and other testing will be made available to the COMPANY or its representative on request. All material and pipe rejections will be submitted to the COMPANY representative with reason for rejection and nomenclature of the defect. The COMPANY may make any investigation necessary to satisfy compliance to this standard and may reject any material that does not conform.

A Non-Conformance Report (NCR) may be initiated by the COMPANY, the MANUFATURER, or Third Party Inspection when there is a deviation from mill standard process(es), when a safety violation/concern is identified, and/or in the opinion of Third Party Inspection an issue is considered systemic. The intent of an NCR is to stop work and allow the MANUFACTURER to bring the process(es) back into conformance. Continuance of production shall be approved by the COMPANY once an NCR is initiated. The MANUFACTURER must provide a response with a corrective action within a reasonable amount of time. NCRs shall be closed out prior to the end of production.

3.0 NORMATIVE REFERENCES

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

If any conflicts exist between this standard and the codes, standards and federal regulations referenced, the more stringent requirements shall govern. Any conflict in standards shall be submitted in writing to the COMPANY for resolution. Applicable requirements in ASME B31.4 or ASME B31.8, if more stringent, shall supersede the requirements in this standard.

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

API RP 5L1, *Recommended Practice for Railroad Transportation of Line Pipe, Sixth Edition, December 2002*

API RP 5LW, *Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels, Second Edition, December 1996*

API 1104, Welding of Pipelines and Related Facilities, Twenty-First Edition, September 2013 (When applicable)

ASME B31.4[1], *Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids*

ASME B31.8, *Gas Transmission and Distribution Piping Systems*

ASME SEC IX, *BPVC Section IX – Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators*

ASTM A 577/A 577M, *Standard Specification for Ultrasonic Angle-Beam Examination of Steel Plates*

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

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*

4.0 TERMS AND DEFINITIONS

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

6.0 PIPE GRADE, STEEL GRADE AND DELIVERY CONDITION

6.2 Delivery Condition

All pipes shall be produced as PSL 2.

Pipes shall be provided with a surface quality compatible with subsequent application of a protective coating.

7.0 INFORMATION TO BE SUPPLIED BY THE PURCHASER

7.1 General Information

Additional Annex requirements will be specified in applicable sections.

7.2 Additional Information

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

8.0 MANUFACTURING

8.1 Process of Manufacture

The pipe shall be produced by the high frequency (conduction or induction) electric welding process. All HFW conduction welding shall be performed with a minimum welder frequency of 200 kHz. Welding parameters (power, current, frequency, voltage and travel speed) shall be established during the approved MPQT and shall not vary by more than ± 10% during production. Welding and seam annealing parameters should be monitored and recorded by an on-line computer system. Out-of-conformance sections of pipe shall be identified and marked for further disposition.

Skelp edge preparation for welding shall be by milling or machining. (A sheared edge that has been conditioned by pressure rolls may be acceptable, pending COMPANY approval.)

HFW pipes produced from partial width skelp product are acceptable only where the longitudinal slitting operation has not cut through any of the centered 30% width of the original slab width. The amount of edge removal from the original mill edge shall be a minimum of 2 mm per side for wall thickness < 0.500 in (12.7 mm) and a minimum of 3 mm per side for wall thickness ≥ 0.500 in (12.7 mm).

8.3 Starting Material

8.3.1 The pipe mill shall provide a list of proposed steel sources. The COMPANY retains the right to accept or reject specific steel sources prior to production. Acceptance may include requests for pre-qualification,

inspection, and/or testing of skelp/pipe. There should be a maximum of two unique skelp producers to be used on a production item.

8.3.2 The steel shall be made in a basic oxygen or electric arc furnace to a clean steel practice. All slab surfaces and edges shall be inspected. Mold powders that do not contribute carbon to hot steel surfaces during casting shall be utilized.

8.3.7 When the ambient temperature is < 20°F (-7°C), gas cutting and scarfing of slabs shall be performed with the slabs at temperature ≥ 248°F (120°C) to minimize the potential for thermal cracking.

8.3.8 Steel shall be produced as continuous cast. The steelmaker shall employ steelmaking and slab casting parameters and procedures to mitigate centerline segregation. For the production of skelp/plate, the steelmaker shall utilize a slab sulfur print/macro etch rating system to monitor centerline segregation, and maintain a maximum macro etch rating. When sulfur ≤ 0.005 %, a macro etch program shall be employed to monitor segregation. Cold acid etching is not suitable for revealing inclusions. The minimum sulfur print/macro etches inspection frequency for production heats shall be the start (first slab to be applied to the order) and end of each sequence for all strands. (Provided the next sequence is the same grade, the, a print/macro etch at the start of the sequence may cover the end of the previous sequence.) A failing sulfur print/macro etch requires testing of all heats in the production order prior to the failure until a passing test is encountered.

Slabs or skelp should be inspected using ammonium persulfate etchant. The etch time shall be ≥ 5 minutes and the solution shall be composed of 10 g $(NH_4)_2S_2O_8$ 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 sample orientation should be transverse covering the full width and cross section of the slab. The segregation images shall be rated using the Mannesmann type comparison rating chart (1 to 5 classification range) or equivalent). Acceptance levels shall be 2 maximum covering inclusions, alumina clouds, center cracks, center segregation and corner cracks.

Macro etch photographs and/or records and other mill control tests of the slab cross section shall be made available to the COMPANY for inspection at time of testing and shall be provided in the final documentation package.

8.3.9 Skelp/plate thickness shall be controlled by continuous gamma or X-ray devices. Skelp/plate rolling and accelerated cooling shall be adequately

instrumented to ensure proper control of furnace / rolling temperature, hold times, rolling reduction, and post-rolling cooling rate.

8.8 Treatment of Weld Seams in EW Pipe

8.8.2 PSL 2 HFW Pipe

The entire weld zone, including the heat-affected zone (HAZ) of HFW pipe, shall receive a normalizing heat treatment, with a minimum temperature of 870°C (1600°F) , to ensure complete austenitization and so that no untempered martensite remains. The seam annealed area shall be cooled at an appropriate rate to produce a refined grain microstructure (grain size 8 or finer). The weld area temperature shall be tracked automatically and recorded.

Full body heat treatment is an acceptable alternative to seam heat treatment provided that it can be accomplished without distortion or excessive scaling.

HFW weld seam portions not heat treated in accordance with the approved MPQT shall be identified and removed. Off-line heat treatment of the weld seam is not allowed.

8.9 Cold Sizing and Cold Expansion

8.9.2 The sizing ratio shall be ≤ 0.015.

8.11 Jointers

8.11.1 Jointers shall not be furnished.

8.12 Heat Treatment

All mechanical testing shall be performed after any heat treatment.

8.13 Traceability

8.13.2 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. The pipe tracking system should be computerized.

9.0 ACCEPTANCE CRITERIA

9.1 General

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

In case the occurrence of rejects – including, NDT, hydrotest, mechanical and chemical properties, workmanship, weld defects - results in higher than 25% downgrade/reject rate of pipes per heat, an investigation shall be agreed and will be carried out by the MANUFACTURER, reported to the COMPANY, and corrective action shall be taken. The COMPANY reserves the right to reject the test unit in question.

9.2 Chemical Composition

The requirements of Table 5 of this standard shall apply to all pipes. For residual elements not identified, API 5L limits shall apply. All elements identified in Table 5 (except as in Note [4]) shall be test reported for all production heats.

The MANUFACTURER shall advise whether any other elements are added that could affect hardenability and thus field weldability. Such element(s) added intentionally or expected deviations from this standard shall be stated in writing by the MANUFACTURER and subject to approval. The heat analysis shall not fall outside the requirements for chemical composition in the MPS approved for production.

Acceptable variation between heat and product analysis shall be as specified in Table C.

TABLE 5 *(modified)* — CHEMICAL COMPOSITION FOR PSL 2 PIPES WITH t ≤ 0.984 IN (25.0 MM)

Steel Grade	Mass Fraction, based on heat and product analyses % maximum										CE_{Pcm} max
	C	Si	Mn	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	0.20
X70M (L485M)	0.09	0.40	1.60	0.018	0.006	0.07	0.10	0.023	1,2.3,4,5,6	0.13	0.21

Additional Notes:

1 $0.010\% \leq Al_{total} \leq 0.050$.

2 $Ca \leqslant 0.004\%$.

3 When $S \leq 0.0015\%$, $Ca \leq 0.004\%$. When $S > 0.0015\%$, $0.008\% < Ca \leq 0.004\%$. Rare earth treatment is not allowed.

4 $B \leq 0.0005\%$. 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.

8 Nb + V + Ti ≤ 0.15

TABLE C — VARIATION IN PRODUCT ANALYSIS

Element	Allowable Variation of Product Analysis from Ladle Analysis
C	+ 0.02 %, - 0.03 %
Mn	± 0.20 %
V	± 0.02 %
Nb	± 0.02 %
If measured values are outside these tolerances, retests shall be performed on two additional pipes from the heat. Failure of the retests requires deviation request.	

9.3 Tensile properties

9.3.2 The maximum measured ultimate tensile strength shall be Specified Minimum Tensile Strength (SMTS) + 24 650 psi (170 MPa). The maximum measured $R_{t0.5}/R_m$ shall be 0.90

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).

9.3.3 Hardness tests

Vickers Hardness (VH 10) hardness tests shall meet the requirements of Table D of this standard.

TABLE D — HARDNESS REQUIREMENTS

Grade	Hardness (HV 10) – Base metal, weld metal and HAZ
	Non-Sour Service
≤ X65 (L450)	≤ 260
X70 (L485)	≤ 270

9.6 Flattening Test

For all combinations of pipe grade and specified wall thickness, there shall be no opening of the weld before the distance between the plates is less than 33% of the original outside diameter.

Flattening test shall be completed in the 0° and 90° position for each test location.

9.6.1 Reverse Bend Test

A specimen which fractures completely prior to the specified engagement of mandrel and specimen, or which reveals cracks or ruptures in the weld or heat affected zone longer than 0.16 inch (4 mm), shall be rejected. Cracks less than 0.24 inch (6 mm) long at the edges of the specimen shall not be cause for rejection.

9.8 CVN Impact Tests for PSL 2 Pipe

9.8.2 Pipe Body Tests

For liquid service, the minimum average CVN transverse energy (full size) shall be 30 ft-lbf (40 J) or the value provided in Table 8 of API 5L, whichever is greater.

For gas service, Table E of this standard shall apply. The minimum energy values apply to each test unit. The values in Table E are applicable for operating pressures up to 2175 psi (15 MPa) and for design factor up to 0.80.

9.8.2.1 Unless otherwise required, the Minimum Design Temperature (T_{min}) shall be +32°F (0°C). For liquid service pipe, where the primary concern is fracture initiation, CVN Test Temperature (T_{test}) shall be at T_{min}. For gas service, where the primary concern is fracture arrest, unless otherwise required, CVN test temperature (T_{test}) for pipelines shall be per Table F. below.

9.8.2.2 For all pipe, CVN % shear shall be measured and shall be as shown in Table G of this standard.

9.8.3 Pipe Weld and HAZ Tests

For liquid service, weld FL and HAZ minimum average CVN energy shall be 30 ft-lbf (40 J), unless otherwise specified.

For gas service, weld FL and HAZ minimum average CVN energy shall be 44 ft-lbf (60 J), unless otherwise specified.

9.8.4 Manufacture shall prepare transition temperature curves for 10% or two (2) of the heats of steel whichever is larger

TABLE E — PIPE BODY CVN ABSORBED ENERGY REQUIREMENTS, GAS TRANSMISSION

Grade	Minimum Transverse CVN Energy ft-lbf (J) (Full Size)		
	OD ≤ 24 (610) in(mm)	24 < OD ≤ 32 (813) in(mm)	32 < OD ≤ 44 (1118) in(mm)
B (L245)	30 (40)	30 (40)	30 (40)
X42 (L290)	30 (40)	32 (43)	38 (52)
X52 (L360)	37 (50)	45 (61)	55 (75)
X56 (L390)	42 (57)	51 (69)	63 (85)
X60 (L415)	47 (64)	57 (77)	70 (95)
X65 (L450)	54 (73)	66 (89)	80 (109)
X70 (L485)	60 (82)	74 (100)	91 (124)
X80 (L555)	76 (103)	93 (126)	114 (155)

TABLE F — CVN TEST TEMPERATURE AS FUNCTION OF MINIMUM DESIGN TEMPERATURE (T_{min})

Specified Wall Thickness	Liquid Pipelines and/or Blowdown Conditions Applied	Gas Pipelines where Blowdown Conditions Not Applied
$t \leq 0.787$ in (20 mm)	$T_{test} = T_{min}$	$T_{test} = T_{min} – 18°F$ (10°C)
0.787 in (20 mm) < $t \leq$ 1.575 in (40 mm)	$T_{test} = T_{min} – 18°F$ (10°C)	$T_{test} = T_{min} – 36°F$ (20°C)

TABLE G — CVN % SHEAR REQUIREMENTS

Sampling Location	Minimum average/single value % shear @ T_{test}
Pipe Body	85% minimum average (80% min. single value)
Weld FL	Not required
FL+0.079 in (2 mm),FL+0.197 in (5 mm)	60/50 %

9.9 DWT Test for PSL 2 Welded Pipe

Drop-Weight Tear (DWT) testing is required for pipe 20 in (508 mm) or larger in diameter, intended for gas or multiphase service. DWT testing may be requested for pipe diameter ≥ 16 in (406.4 mm). For pipes to be buried, the DWT test temperature shall be +14°F (-10°C). For above ground pipes, the DWT test temperature shall be at 0°F (-18°C) or T_{min} whichever is more stringent.

The DWT % shear shall be measured and the average shall be ≥ 85%, with a minimum of 80% for a single value.

9.10 Surface Conditions, Imperfections and Defects

9.10.1 General

9.10.1.1 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.

Ground areas shall blend smoothly into the surrounding pipe body. The remaining wall thickness in ground areas (other than cosmetic) shall be checked by ultrasonic thickness measurement device in general accordance with ISO 10893-12 to verify that it meets the minimum thickness.

Removal of wall thickness by grinding shall be limited to the following:

- Up to 5% of removed wall thickness, there is no restriction on maximum size of ground area.
- Between 5 and 7% of removed wall thickness, the maximum length of a ground area is 24 inches and maximum width is 3 inches.
- Between 7 and 8% of removed wall thickness, ground area is limited to a 3” diameter circle

9.10.3 Arc Burns

9.10.3.2 Contact marks on HFW pipe are surface discontinuities characteristic of the manufacturing process and are not considered arc burns. Contact marks shall be treated in accordance with section 9.10.7.

Arc burns shall be cut out as cylinders.

9.10.4 Laminations

Laminations on pipe end bevels that are open to the surface are not acceptable and the ends shall be re-beveled and re-inspected.

9.10.5 Geometric Deviations

9.10.5.2 Dents within the limits of this standard are acceptable on pipe with wall thickness ≤ 0.512 in (13 mm). Dents are not allowed on pipe sizes outside these limits. The maximum depth for all dents shall be 0.125 in (3.2 mm) as measured from the OD. Length of dent in any direction shall be ≤ 0.5D. Dents that contain sharp bottom gouges shall be removed as a cylinder. Dents that impact the weld shall not be allowed. Dents within 4 in (100 mm) of the pipe ends are not acceptable. There shall be no more than 2 dents per pipe length. 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.)

9.10.6 Hard Spots

The maximum hard spot hardness shall be the hardness given in Table D of this standard for the applicable grade. 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.

9.10.7 Other Surface Imperfections

For liquid service, in clauses a) and b), '0.0125*t*' shall be replaced by '0.08*t*'. Imperfections that contain sharp bottom (stress raiser) notches, grooves or gouges longer than 2 in (50 mm) shall be repaired by grinding or cut off.

For gas service, in clauses a) and b) '0.0125 *t*' shall be replaced by '0.04 *t*'. In limited areas (≤ 3 in (75 mm) in length), grinding may have a depth of 0.08 *t*, provided adjacent grinding is not closer than 20 in (500 mm). Imperfections that contain sharp bottom (stress raising) notches, grooves or gouges shall be repaired by grinding or cut off. The maximum

For pipes to be fusion bond coated, surface imperfections, regardless of depth judged to be detrimental to coating application include slivers, scabs, pitting, 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).

9.11 Dimensions, Mass and Tolerances

9.11.3 Tolerances for Diameter, Wall Thickness, Length and Straightness

The applicable tolerances are provided in Table 18 of this standard below. For dimensional tolerances, the pipe end includes a length of 6 in (150 mm) at each of the pipe extremities. Every 4 hours shall include start and end of the shift.

TABLE 18 *(modified)* — INSPECTION/TESTFREQUENCY FOR PSL 2 PIPE

Type of Inspection	Frequency of		Tolerance
	Inspection	Recording	
Wall thickness	100%	≥ every 4 hr	Plus tolerance per API 5L Table J.4 Minus tolerance -0t For areas of grinding refer to Section 9.10.1.1 of this standard for tolerances ;
Pipe end diameter	100%		API 5L Table J.3
Pipe body diameter	100%		
Pipe end out-of-roundness	100%		
Pipe body out-of-roundness	1 in every 10 pipe		
Geometric deviations (peaking and flats)	1 in every 10 pipe		0.005 *D* or 2.5 mm, whichever is less
Straightness (full length)	1 in every 20 pipe	≥ every 4 hr	0.15% pipe length
Straightness (pipe end)	1 in every 20 pipe	≥ every 4 hr	API 5L 9.11.3.4 b)
Pipe end out-of-squareness	1 in every 20 pipe	≥ every 4 hr	API 5L
Length	100%		Per PO requirement
Weight	100%		API 5L 9.14 and each pipe ≥ 98.25% nominal
Radial offset	1 in every 10 pipe	≥ every 4 hr	API 5L Section 9.13.1
Height of weld flash			API 5L Section 9.13.2.1
Full section seam anneal	Per frequency of macrographic / metallographic sampling		API 5L 8.8.2
Upset angle, flash trim, edge alignment, weld line width			Mill standard practice

Type of Inspection	Frequency of		Tolerance
	Inspection	Recording	
Type of Inspection	**Frequency of Inspection and Recording**		
Transverse Tensile Testing - pipe body and weld metal	One test per every 25 pipe per heat, QRL/TRLs at a minimum 2 tests per heat		
Longitudinal Tensile Testing	One test per every heat		
Hardness Testing	One test per 25 pipe per heat. One test per weld line per day.		
CVN Testing	Pipe body – one test per every 25 pipe per heat One test per every 12 pipe per heat, if heat contains less than 12 pieces.		
	Pipe weld and HAZ – one test per every 25 pipe per heat		
	Transition curve: 10% or 2 heats, whichever is greater		
DWTT	One set per heat. One curve for every 5 heats		
Flattening Testing	One set of tests per every 25 pipe per heat		
Reverse Bend Testing	One set of tests per every 25 pipe per heat		
Metallograhic Testing	One test per every heat or start/middle/end of operating shift, whichever is more stringent		
In cases where frequency is 2 or more tests per heat, tests will be taken from different pipe.			

9.11.3.3 Pipes are to be delivered in double random lengths per Table H of this standard, unless otherwise specified by the COMPANY.

9.11.3.4 a) The total deviation from a straight line over the entire pipe length shall be ≤ 0.15 % of the pipe length.

9.12 Finish of Pipe Ends

9.12.1.2 Pipes shall be bevelled for welding per API 5L Clause 9.12.5.2. Bevelled ends shall be smooth and free from any marks judged detrimental to subsequent welding or fit up operations. 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.

9.14 Tolerances for Mass

The weight of each pipe shall be recorded. The weight of each individual joint shall be equal to at least 98.25% of the nominal weight.

9.15 Weldability of PSL 2 Pipe

Unless otherwise specified, field weldability tests at the pipe mill are not required. Assuming that the chemistry and mechanical properties of this standard are met, the material is considered to be weldable under routine welding conditions. Lay contractors may require test pieces for field weld qualification in which case the pipe samples shall be within 0.02 carbon equivalent (P_{cm}) points of the maximum carbon equivalent to be supplied to the order.

If there is concern about field weldability, the COMPANY may request that the MANUFACTURER shall conduct field weldability trials using both a manual (stick) and a semi-automatic/automatic (GMAW) welding process utilizing welding procedures proposed and approved by COMPANY.

All welding parameters shall be recorded by an automatic data logging system. The welds produced shall meet all API 1104 testing and inspection requirement for welding procedure qualification and the hardness requirements of this standard. In addition a full set of heat affected zone CVN tests [fusion line, fusion line + 0.08 in (2 mm) and fusion line +0.20 in (5 mm) shall be taken. Hardness measurements shall also be taken through the girth weld/seam weld intersections when applicable.

10.0 INSPECTION

10.1 Types of Inspection and Inspection Documents

10.1.1.2 Approved Electronic Data Interface (EDI) documentation is required. The following paper and EDI documents shall be provided in the English language upon pipe delivery:

a) inspection certificates

b) pipe mill tally sheets

10.1.3 Inspection Documents for PSL 2 Pipe

10.1.3.1 Unless otherwise specified, one paper copy of Inspection Certificate 3.1 or 3.1.B and the final data book shall be issued to the COMPANY. Five (5) EDI copies of the data book shall also be issued. The Final Report (data book) shall follow the file structure provided in Annex Q of this standard. The final data book at a minimum shall include the following:

a) Latest revision of the purchase order

b) Approved and signed Manufacturing Procedure Standard,

c) NDT and inspection procedures (if not in MPS),

d) PPM notes minutes of meetings and correspondence,

e) Weld zone metallographic reports, including hardness,

f) Inspection ~~Mill~~ Certificates,

g) Certified Material Test Reports, signed by TPI. TPI shall be furnished with a preliminary copy for review. ,

h) Test results of all mechanical tests for individual specimens

i) Histograms for mechanical tests in graph form for CVN, Tensile Test, Hardness Test, DWTT, Chemistries, and dimensional measurements.

j) Pipe mill inspection reports, ie NDT and hydrotest reports, etc,

k) Welding Procedure Specification and Procedure Qualification Records

l) NDT operator certificates,

m) Copies of Equipment Calibration Certificates,

n) Packing and shipping reports, including weight and length.

o) Closed NCRs

10.1.3.2 The inspection certificate issued by the MANUFACTURER shall also include:

m) name of purchaser,

n) purchase order number,

o) mill order-item number,

p) quantity produced,

q) statement of compliance with this standard.

10.2 Specific Inspection

10.2.1 Inspection Frequency

10.2.1.2 Mechanical tests and dimensional inspection and recording frequencies are provided in Table 18 of this standard.

Measuring equipment requiring calibration or verification under the provisions of API 5L shall be verified at least at the start and end of the shift. Verification records shall be maintained.

10.2.2 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/plate approximate mid- length locations. Alternatively, historical data may be used to demonstrate process capability with respect to mechanical property variation.

10.2.3.2 Tensile straps, when used, shall be full thickness. Flattening of tensile coupons shall be performed in gradual, multiple steps.

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.

For production test pieces taken in the HAZ of HFW pipes, the notch shall be at one of the 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 5L.

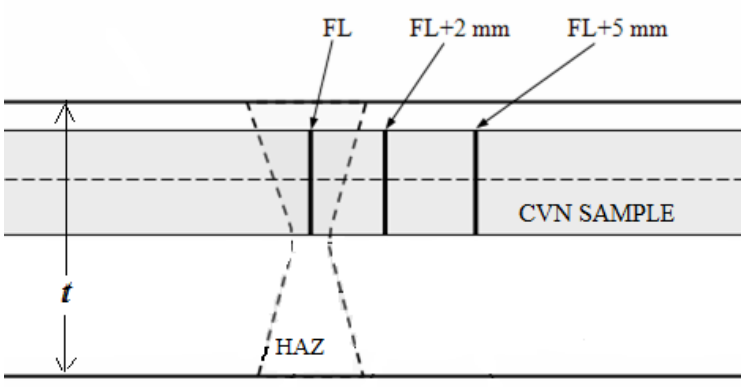

FIGURE 7 *(modified)* — LOCATION OF CVN TEST SPECIMENS

10.2.3.7 Flattening Test

The flattening test specimen shall be ≥ 4 in (100 mm) in length and shall be flattened cold. Each end-of-coil test location and start/stop shall be tested at the 6 o'clock position or 12 o'clock position and 3 o'clock or 9 o'clock position (ie test to be completed at 0° and 90°.

10.2.3.8 Reverse Bend Tests

The reverse bend test shall be executed with the same number of tests and retests as specified for the flattening test in API 5L Figure 6. The ring specimens shall be 4 inch to 4.5 in (100 mm to 115 mm) long. The reverse bend test shall be carried out with a mandrel, whose radius (R), or width (A) shall be calculated for any combination of diameter, wall thickness and grade with the formula, referred to in Figure 9 of API 5L, except the peaking factor shall be at 1.4.

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 heat or start, approximate middle and end of the operating shift.

The macrographic/metallographic inspection shall confirm that dimensional requirements of this standard are met, including edge alignment, weld line width, upset angle and evidence of effective seam annealing coverage, and that there is no evidence of significant centerline segregation.

10.2.5.3 Hardness Test

Vickers Hardness (VH 10) tests shall be conducted in accordance with Clause H.7.3.3, "Hardness Test," of API 5L. Indent locations shall conform to API 5L, Annex H, Figure H.1.c). Hardness shall conform to Table D of this standard.

10.2.6 Hydrostatic Test

10.2.6.1 The test pressure shall be held for at least 15 seconds. The pipe weld seam shall be clearly visible during the test.

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 week 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 should 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. In the event of individual pipe distortion, or failure to meet dimensional requirements, hydrostatic pressure may be reduced to 95% SMYS for individual pipes with COMPANY approval. Pressure is to be incrementally stepped down prior to reducing pressure to 95% SMYS. Hydraulic pumps shall not activate during the 15 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.

Any pipes that fail during the hydrostatic test shall be rejected and retained for investigation to determine cause. This information shall be provided to the 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. Test

pressure shall achieve a minimum of 100% SMYS with end load compensation. End loading shall not account for more than 5% of SMYS. End load compensation shall be noted on ITP or equivalent.

10.2.6.7 The specified wall thickness shall be used.

10.2.7 Visual Inspection

Visual inspection shall be conducted using a minimum light level of 150 foot candles.

The external surface shall be examined visually over the full length of each pipe. The inside surface of all pipes with OD > 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.. Illuminance shall be measured with a calibrated light meter. 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 Dimensional Testing

The diameter and out-of-roundness shall be measured and reported for five locations at 8 ft (2.4 m) intervals along one pipe per test unit.

10.2.8.1 For pipe diameter ≤ 20 in (508 mm) pipe body outside diameter measurement shall be by snap gauge, calipers or any instrument providing an actual measurement. For diameter > 20 in (508 mm) outside diameter measurement should be made by metal circumferential tape.

Pipe end diameter may be measured on ID or OD. Ring gauges or metal circumferential tape shall be used.

10.2.8.2 Pipe end out-of-roundness shall be based on inside diameter. Pipe end out-of-roundness shall be measured with Vernier calipers, rod gauge, or equivalent. Pipe body out-of-roundness shall be measured at approximate mid-length of pipe using calipers or equivalent.

10.2.8.5 The remaining wall thickness under areas ground for defect removal shall be measured ultrasonically in accordance with ASTM E 114. The accuracy of the instrument shall be at least

± 0.001 in (0.01 mm). The maximum element size should be ≤ 0.470 in (12 mm).

10.2.10 Non-Destructive Inspection

For liquid and gas transmission pipe, the requirements of Annex E of API 5L shall be applied..

10.2.12 Retesting

10.2.12.2 Any test having a YS between SMYS and SMYS + 1500 psi shall require two additional tests from the same unit. Both retests must meet SMYS to qualify the heat.

11.0 MARKING

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

11.1.3 The pipes shall also be marked with the following:

a. purchaser's purchase order number,

b. individual pipe number,

c. heat number,

d. CVN test requirement,

e. length (to nearest tenth)

f. weight

g. third party inspection company

11.1.5 A marking map shall be provided to the COMPANY for approval prior to production of pipe. The marking map shall include all information to be stenciled and locations of stencil placement. If agreed to, marking map shall also include placement of OD stickers along with information that is readable and/or information from barcode.

11.2 Pipe Markings

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 white paint 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.

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 ≥ 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.

11.2.7 A color code band shall be marked on inside surface of finished pipe for identification of pipes of same diameter but different wall thicknesses, as indicated in the Purchase Order. The color code band shall be 2 in (50 mm) wide and shall be marked at a distance of 12 in (300 mm) from the pipe ends. The COMPANY reserves the right to require external color code banding.11.2.8 The longitudinal seam shall be clearly marked with paint on the inside of the pipe at each end, to facilitate offsetting the weld seams during construction or hot bending.

12.0 COATINGS

12.1 Coatings and Linings

12.1.1 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 ID stenciled areas on each end.

12.2 Surface Sample Testing for FBE Application

12.2.1 As part of the MPQT, coating suitability testing may be requested.

12.2.2 The following test procedure shall be followed, if requested:

a) Cut three panels each 6 in x 6 in (150 mm x 150 mm) from each of the MPQT heats.

b) Send to coating applicator, clean surface to remove grease, oil and other contaminants, blast clean to SA 2 ½ finish in accordance with

SIS 05 5900 or equivalent and an appropriate (e.g. 1.5-3.5 mils) anchor pattern or coater recommendation.

b) Heat specimen to 460°F (240ºC) for 25 - 30 minutes.

c) Apply 12 mils of anti-corrosion FBE. Cure for 3 minutes at 460°F (240ºC). Samples shall be air cool samples to about 175°F (80°C).

e) Inspect for holidays with 1500 volts DC. There should not be any holidays.

f) Results of the test are to be approved by COMPANY.

13.0 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.

14.0 PIPE LOADING

Refer to ETC Engineering Standard 3.0511 Handling, Storage, and Shipping of Pipe, API RP 5L1, 6th Edition, July 2002 and API RP 5LW, 2nd Ed, Dec. 1996 for requirements. (API editions listed contain requirements believed to be more prudent than more recent editions.)

15.0 WARRANTY

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 5L and this standard and all benefits of warranty shall pass to the COMPANY.

The MANUFACTURER shall be liable for, and reimburse COMPANY for the total direct replacement costs of any pipe supplied to this standard which fails the field hydrostatic test up to 110% SMYS, due solely to material or manufacturing defects in the pipe. A copy of MANUFACTURER's warranty shall be included with the tender for COMPANY approval.

If the MANUFACTURER so desires, he will be advised at least two weeks in advance so that his representative may witness the hydrostatic test in field, however, the testing and leak (if any) finding and repair operation shall not be postponed because of absence of the MANUFACTURER’s Representative.

ANNEX B
(normative)

MANUFACTURING PROCEDURE QUALIFICATION FOR PSL2 PIPE

B.1 INTRODUCTION

Unless otherwise required, Manufacturing Procedure Qualification is required for pipes produced to this Standard. With COMPANY approval, small orders may be combined for purposes of the MPQT provided thinnest and thickest wall thicknesses are covered.

B.3 CHARACTERISTICS OF THE MANUFACTURING PROCEDURE STANDARD

As part of the technical bid, a generic Manufacturing Procedure Standard (MPS) shall be supplied and is acceptable if it provides sufficient detail for the COMPANY to determine process and procedure acceptability. A list of technical exceptions and clarification requests shall also be provided with the bid. The MANUFACTURER shall submit a project-specific MPS for COMPANY approval prior to production. References to other documents are acceptable to cover detailed activities. The QA Manual shall also be submitted.

The details provided in the MPS are contractually binding on MANUFACTURER and changes after contract award require written COMPANY approval. Note that all MPS items required by this standard are considered to be essential variables. Any significant change to these essential variables may require re-qualification and COMPANY approval of the MPS and procedures. Significant change is defined as any modification to any process that can materially affect the final chemical, mechanical, dimensional, internal or surface properties of the pipe. If a quality significant change is proposed after manufacturing procedure qualification, permission may be conditional on a repeat of the qualification test.

Specific essential variables and corresponding control limits are provided in Table B.1. The MPQT Control Limit values are indicative and will be determined for each MANUFACTURER pending a review of MPS documentation.

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;
2. Change in ladle analysis beyond ± 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

Essential Variable	Process Control Aim[1]	Process Control Limits[2]	Characteristic to be tested[2]	MPQT Control Limits[3]
Casting Super Heat	≤ 20°C	≤ 25°C	Slab macro-etch	≤ 30°C[4]
Casting Speed	≤ 1.4 m/min.	± 0.2 m/min.	Slab macro-etch	± 0.25 m/min.
Slab Reheat Temperature	± 20°C	± 30°C	Plate/Pipe: Tensile, CVN. Pipe: Tensile, CVN, DWTT.	± 40°C
Slab Thickness				-5%, +10%
Final Rolling Temperature	± 20°C	± 30°C		± 40°C
Coiling Temperature	± 40°C	± 45°C		± 50°C

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 units standard requirements.

(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 ≤ 55 °C and for MPQT control shall be ≤ 60 °C.

In addition to the information required by API 5L, the following documentation is required:

a) Steelmaking and Casting – for All Pipe:

2) also including degassing (where applicable), slag detection practices, size of tundish, tundish design (clean steel), shrouding practices, mold level control, mold type, casting machine maintenance practices (alignment, segment stability, roll gaps, nozzles), typical sequence size, cooling practices, slab inspection / scarfing practices;

8) including test frequency and photographs of macro etch rating system and the identification of maximum macro etch ratings for heats produced to the order;

9) procedures for control of radioactive substances in external scrap.

b) Pipe Manufacturing – for All Pipe:

3) end loading calculations, if applicable;

4) non-destructive inspection methods – including visual inspection and additional detail on UT inspection of the HFW seam weld as provided in Section g) below;

5) mechanical property testing procedures and methods and procedures for chemical analysis and use of calibration standards;

11) marking procedures.

c) Hot Rolling – for Welded Pipe:

2) including type of reheat furnace (e.g. walking beam), reheat fuel type, descaling practices, width, gauge and flatness control, in-process surface inspection;

3) applicable reheating, rolling (Finishing, Coiling) and cooling rate temperature aims, computer control level and practice;

6) sampling procedures for mechanical properties;

12) maximum strip cooling water temperature;

13) If skelp is sourced from outside producers, the MANUFACTURER shall include the skelp purchase protocol with the MPS.

e) Pipe Manufacture – for Welded Pipe:

6) when requested, statistical data covering chemical, mechanical and dimensional properties of equivalent/comparable grade and pipe size.

15. For HFW pipe, details of welding process, including description and tolerances for edge alignment, weld line width, evidence of seam annealing coverage and upset angle. Postweld heat treatment (PWHT) details, including proposed temperature range, time-at-temperature, and methods of temperature monitoring and control to ensure through-wall heat treatment.

h)

B.4 CHARACTERISTICS OF THE INSPECTION AND TEST PLAN

Prior to commencement of any fabrication work, the MANUFACTURER shall submit a job-specific ITP/MPS for COMPANY review and approval. The ITP format shall also include the following:

c) the associated procedure or standard reference governing the activity;

g) Identity of document to be used for recording inspection and test results;

i) monitor, witnessing, and/or hold points.

B.5 MANUFACTURING PROCEDURE QUALIFICATION TESTS

For small orders, MPQT may be waived by COMPANY if the MANUFACTURER can provide satisfactory statistical data indicating process capability with respect to chemical, mechanical and dimensional properties in conformance to this standard. Combining small orders – provided thickness range is covered – may be allowed. Otherwise, the following requirements shall be applicable.

B.5.1 The testing and inspection identified in Table 18, "Inspection frequency for PSL 2 pipe," of API 5L and this standard and the MPQT tests in Table B.1 below shall be applied prior to production and shall meet the requirements of this standard. The MANUFACTURER may elect to perform MPQT as first day production – in this instance, the subsequent production shall be at the MANUFACTURER's risk.

B.5.2 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 the 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 the COMPANY. Changes to the MPS shall be approved by the COMPANY.

MPQT shall be witnessed by the COMPANY and/or the third party certification authority. The MANUFACTURER may also be subject to a process audit in order to evaluate conformance to the MPS. All completed test samples shall be retained until disposal is approved by the COMPANY.

All MPQT pipes shall undergo all required NDT and full visual and dimensional checks as prescribed in this standard – including applicable MPS requirements - and API 5L. Recording frequency shall be 100%. Pictures of slab macro-etches on MPQT heats shall be provided. Destructive tests shall be carried out after final NDT, visual and dimensional controls.

The MPQT shall consider plate tensile property variation and plate-to-pipe strength correlation. 'Worst case' (defined as lowest pipe body transverse yield strength) pipes, based on the essential variable control limits in Table 4.1 should be tested. Although plate testing requirements are not specifically addressed by this standard, the organization producing the plate shall perform appropriate plate mechanical testing based on the requirements of the skelp protocol from the pipe mill. These tests should include at least tensile and CVN testing. The COMPANY reserves the right to witness plate testing. All plate test results shall be submitted to the COMPANY.

Following the completion of all the MPQ tests a final report, including test conditions and results shall be prepared by the MANUFACTURER for submission to the COMPANY.

TABLE B.2 — ADDITIONAL MANUFACTURING PROCEDURE QUALIFICATION TESTS

Item	Test Requirement	Acceptance Criteria
1.	Macro etch of slab/skelp representing head and tail of all strands to be used for production heats.	Table B.1 of this standard
2.	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 standard.	Section 9.8 of this standard at T_{test}
3.	Transverse CVN transition curves for pipe body, FL and HAZ; temperature range of +68°F (+20°C) to -60 (-50°C) (≥ 5 temperatures). One HAZ notch location shall be tested – the location that gives the lowest values when performing the tests in Item 2 of this table.	Section 9.8 of this standard at T_{test}
4.	~~A~~ged CVN transition curve for pipe body; temperature range of +68°F (+20°C) to -60 (-50°C) (≥ 5 temperatures). Prior to testing, samples shall be aged at 480°F (250°C) for one hour.	The transverse CVN energy shall meet Section 9.8 of this standard at T_{test}
5.	For pipe OD ≥ 16 in (406.4 mm), pipe body DWT transition curve. Minimum five sets of specimens to be tested at different temperatures including -40°F (-40°C) and T_{min}	Section 9.9 of API 5L and this standard at T_{min}
6.	MT or PT inspection of the OD weld seam. For HFW pipe, 100% of the OD weld zone of the two MPQT pipes shall be examined by MT or PT methods for transverse defects. If no transverse defects are found, then ultrasonic inspection of the weld seam for transverse imperfections during production is not required. If transverse defects are detected, inspection during production may be required, at the discretion of Company.	ISO 10893-5 acceptance level Table 3, M2
7.	At each pipe end and pipe middle, weld cross-sections shall be examined for full section heat treatment, edge alignment, flash trim, upset angle, weld line width, and microstructure - documented with photographs.	API 5L 8.8.2. mill standard practice
8.	Coating suitability testing – if required.	Section 12.2 of this standard

ANNEX C
(normative)

TREATMENT OF SURFACE IMPERFECTIONS AND DEFECTS

C.4 REPAIR OF DEFECTS BY WELDING

C.4.2 Weld repairs are not allowed on HFW pipe.

ANNEX E
(normative)

NON-DESTRUCTIVE INSPECTION FOR OTHER THAN SOUR SERVICE OR OFFSHORE SERVICE

E.1 QUALIFICATION OF PERSONNEL

E.1.1 Level III personnel shall be qualified and certified for the specific NDT method by a Certification Body in accordance with ISO 9712 or ASNT CP189. Personnel performing manual, semi-automated or automatic NDT and interpretation of test results shall be certified to Level 2 by a Certification Body in accordance with ISO 9712 or ASNTCP180 or by the certified MANUFACTURER Level III in the applicable method. MANUFACTURE appointed Level III personnel are not acceptable. Certification for visual inspection is also required.

The qualification and certification shall include training and demonstrated competency on the equipment and procedures of the producing pipe mill. Such personnel shall be requalified by examination for any method previously qualified, if they have not performed non-destructive testing in that method for a minimum of 40 hours for a period exceeding 6 months. A current list of qualified NDT (not including VT) personnel is to be presented to the COMPANY prior to using the personnel. The COMPANY shall reserve the right to reject any NDT operator who is not performing the work in compliance with the approved procedures.

All MUT operators shall demonstrate competence and have documented experience with the applicable MUT technique. The COMPANY reserves the right to qualify each operator for the specific applicable MUT technique with written and/or practical examinations.

E.1.2 Final non-destructive inspection shall be performed by Level 2 or 3 personnel.

E.2 STANDARD PRACTICE FOR INSPECTION

Ultrasonic equipment electronic signal suppression and damping shall not be used during calibration, sensitivity checking or production scanning.

All final automatic UT equipment shall incorporate a fully automatic monitoring and recording system to indicate the location of unacceptable imperfections and loss of coupling that encompasses an area greater than the allowable imperfection size. Alarms, lack of coupling or loss of signal transmission shall be accompanied by an audible alarm, and automatic or manual paint systems so that areas of the pipe that have valid alarms due to an imperfection and/or loss of coupling are clearly indicated on the pipe and seam tracking capabilities.

All ultrasonic probes shall be traceable to their manufacturer certification. For dynamic calibration and production scanning, the scanning speed of automatic systems shall be recorded and traceable to plate and pipes. Probe shoe or wear face surfaces shall have their radius conform to the diameter of the pipe surface to ensure intimate contact between the surface to be inspected and the transducer wear face.

E.3 METHODS OF INSPECTION

E.3.1 General

The required NDT methods of inspection for gas transmission pipe are given in Table E.9 and inspection shall be in accordance with Annex K of this standard. Liquid transmission pipe requirements shall be in accordance with API 5L Annex K.

TABLE E.9 — METHODS OF INSPECTION FOR GAS TRANSMISSION 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	100%
Laminar imperfections pipe body	UT	100%
Laminar imperfections adjacent to weld	UT	100%
Imperfections in weld	UT	100%
Surface imperfections in weld area	MT or PT	MPQT - Table B.2, Item 6
Imperfections in weld ends	RT	100%
Linear (non-laminar) imperfections at pipe ends[1]	UT	If specified
Residual magnetism	Gaussmeter	Every 4 hours
Notes: [1] The COMPANY may require inspection for vertical imperfections in pipe ends. In this case, UT inspection may be required in accordance with Section E3.1.4.3 of this standard.		

E.3.1.3 b) NDT of weld seams in cold expanded pipe shall take place after hydrostatic testing.

E.3.2 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.

E.3.2.1 Manual Angle Beam Ultrasonic Testing

Where AUT cannot inspect the pipe end welds at the required sensitivity levels or to 'prove up' weld suspect areas then a manual ultrasonic technique (MUT) in accordance with ASTM E 164 or ISO 17640 Level B shall be used with the same sensitivity and probe frequency (longitudinal and transverse) used to inspect the weld seam with AUT. The element size shall be equivalent to that used for AUT. Suspect areas shall be proved-up by MUT covering a length that is at least ± 4 in (100 mm) from the area with indications.

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

Scanning for longitudinal imperfections shall conform to ISO 17640 Fig. 1 (≥ 10% probe overlap and ≥ 10° swivelling motion). Maximum probe movement speed for angle beam inspection of welds shall be ≤ 2 in/sec (50 mm/sec).

The ultrasonic instrument shall have the ability to record, store, recall and display a distance-amplitude curve (DAC) electronically. The instrument shall meet the horizontal linearity, vertical linearity, resolution, sensitivity and accuracy of the calibrated gain control calibration requirements of EN 12668 or equivalent. Figure E 1 shall be used for probe angle selection based on determination of t/D ratios and skip distance calculations. The use of the highest probe angle shall be preferred for detection of longitudinal imperfections. The couplant used shall have a suitable viscosity or sufficient water flow to permit intimate contact between the probe wear face and the inspection surface.

The reference standard 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.

All sensitivity checks shall include beam angle, sound index point and distance linearity, and shall be documented on a report form by the UT Level II operator.

For wall thickness ≤ 0.625 in (16 mm) the screen range used should be 5 in (13 mm). For wall thickness > the screen range shall be 10 in (250 mm). The signal display shall be set to full wave rectified. Reject or noise suppression features shall be prohibited. The frequency of the instrument should be set as close as possible to match the frequency of the transducer.

The acceptance criteria are:

a) All maximized indications that exceed 100% of the DAC curve (scanning gain removed) are defects regardless of length.

b) 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.

c) 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.

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

e) 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° 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.

Where digital equipment permits exporting setup and/or measurement data, such data shall be exported in digital or paper (printed) format to be added to the inspection report.

For prove-up of suspect areas when $t > 0.787$ in (20 mm), inspection by two probe angles is required. The probe that produces the highest amplitude response shall be used for acceptance/rejection of the imperfection.

E.5 ULTRASONIC AND ELECTROMAGNETIC INSPECTION

E.5.1 Equipment

Inspection of the Weld Seam

For conventional weld seam inspection ultrasonic systems, the probe element size for detection of longitudinal imperfections shall be from 13 mm to 19 mm in diameter or equivalent area. Figure E.1, utilizing t/D (pipe wall thickness divided by pipe OD) ratio and skip distance calculations shall be used for probe angle selection (Note that the indicated angle is the rated probe angle, not the refracted angle) for longitudinal imperfection inspection – unless due to expected imperfection orientation specific to the MANUFACTURER other angles are more optimum. The refracted probe angle shall be chosen so that the angle of refraction in the weld is as perpendicular as possible to the weld groove in the applicable weld zone being inspected, i.e. this is considered to be the largest angle to the right of the pipe t/D calculation number. Tilting of probes shall not be used to alter the probe angle indicated by Figure E 1.

Angle beam UT transducer frequency and element size shall be selected so that inspection does not occur in the near field. The ratio of wall thickness to element size shall 2:1 maximum.

The probe wear face shall have a machined radius to provide intimate contact and coupling efficiency between the probe and the pipe surface.

The coupling signal should be set at 100% FSH. (Gain jacking of couplant monitor channels is not permitted.) Higher than 100% FSH shall not be allowed.. The coupling gate should be set with a negative logic at 20% FSH. Any area with a coupling alarm shall be treated as suspect – the suspect area shall be marked and either re-inspected when the correct coupling has been established with AUT or ‘proved-up’ with MUT.

The final AUT system shall accurately mark, record and identify the location of all alarm conditions on each pipe inspected. Alarm conditions (indications that exceed the acceptance level gate or a loss of coupling where the signal is below the coupling gate) shall be accompanied by both a visible and audible alarm that is easily recognized by the UT operator performing the inspection. The AUT system shall record the location and clearly paint the applicable suspect area adjacent to the weld zone location (± 1 in (25 mm) of the true location.

An electronic encoder based strip chart shall be employed with angle beam testing that clearly displays the inspection results of each probe independently (longitudinal, transverse and coupling verification) and the location of the alarmed indications. The results shall be saved in a file in a format that allows the data to be retrieved and displayed for verification that the complete weld length contains no indications above the acceptance level and no areas with a loss of coupling. An acceptable strip chart recording will have no alarm conditions except at the very ends of the pipe. Time based strip chart recorders do not meet the above requirements.

Wheeled angle beam ultrasonic inspection systems are not acceptable for weld seam angle beam inspection.

Phased array systems may be used pending COMPANY review and approval of procedures. Sensitivity for phased array systems shall be established with the same probe angle selection as for conventional systems in the paragraph above.

Guidelines for probe frequency for automatic angle beam inspection are provided in Table E.10, below:

TABLE E.10 — GUIDANCE FOR ANGLE BEAM PROBE FREQUENCY

Wall Thickness *t*	Frequency Range
$t \leq 0.500$ in (12.7 mm)	3.5 – 5 MHz
0.500 in (12.7 mm) $\leq t \leq$ 1.50 in (38 mm)	3 – 4 MHz

Guidelines for probe angle for automatic angle beam inspection for longitudinal imperfections are provided in Figure E.1 below *(from Electric Power Research Institute)*.

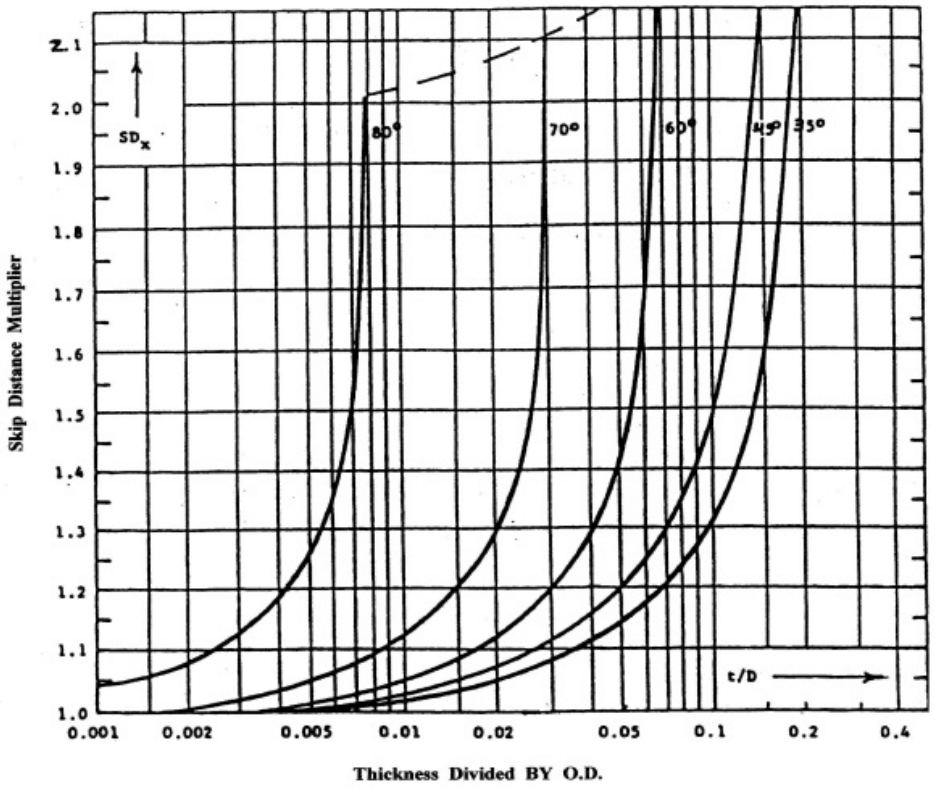

FIGURE E.1 — GUIDANCE FOR PROBE ANGLE – LONGITUDINAL IMPERFECTIONS

E.5.3 Instrument Standardization

All UT sensitivity checks shall be performed at the gain setting as used for production inspection. The sensitivity check is successful if all appropriate channels alarm, within the gate, on the required target reflector in the reference standard - without any alteration of any setting. All sensitivity checks are independent of each other.

E.5.3.5 System Calibration for Straight Beam Laminar Inspection

Through-transmission type probe systems should not be used for lamination detection. The 3 dB increase for test sensitivity in ISO 10893-09 Paragraph 7.5 shall not be allowed.

All probes shall be checked for perpendicularity by maximizing the signal from the back wall of the reference standard.

Static calibration and sensitivity verifications may be based on electronic means (e.g. DGS curves) for the plate body. For the plate longitudinal edges, static calibration may be based on electronic means, however sensitivity verification shall be based on a reference standard – the 6 mm flat bottomed hole (FBH) shall be used on the plate edges to verify each probe. A sensitivity verification is successful if all appropriate channels alarm, within the gate on the required target reflector in the reference standard – without alteration of settings.

For detection of laminar imperfections by manual and automatic systems, initially, the signal height from the backwall in the reference standard should be set from 60% to 90% of Full Screen Height (FSH) with the use of gain control. Reference to the backwall is necessary to verify signal perpendicularity and sound coupling during scanning. The gain should then be increased to set the signal from the respective edge or body reflector at 100 % FSH. Automatic equipment shall have a minimum of two independent gates so that the flaw gate shall be set with positive logic (≥ 50% FSH), and the backwall gate shall be set with negative logic (> 20% FSH). Loss of backwall – defined as backwall signal height < 20% FSH – greater in size than an acceptable imperfection shall be regarded as a rejectable condition. The signal from the reflector should have the flaw gate set at 80 % FSH with a positive logic set to alarm when any signal from the reflector is > 80 % FSH. Indications greater than primary reference level in the flaw gate are rejectable even if there is no loss of backwall.

Loss of coupling is considered to have occurred when the back wall drops below 20 % FSH. Loss of coupling is a suspect condition (and subject to prove up / sizing. Indications greater than the primary reference level, are considered defects even if there is not an associated loss of a signal height from the back-wall signal. (Guidance note: Setting the signal from the specified reflector at 80 % FSH requires a significant increase in gain which will result in the back wall signal being raised to more than 200 % FSH. If the signal from the back wall drops to below 20% FSH from > 200% FSH – loss of coupling is considered to have occurred.)

E.5.3.6 System Calibration for Angle Beam Weld Seam Inspection

The reference standard shall be from a project specific piece of pipe and will be of such a size as to allow a dynamic verification of sensitivity at production speeds (a coupon size piece of pipe is not acceptable as a reference standard).

Reflector(s) shall be placed at the ends of the reference standard to identify length of pipe on the end not inspected by UT probes. In order to identify length, all appropriate probes shall alarm on the reflector(s), both entering and exiting the reference standard.

For static calibration, the variation in sensitivity (measured in dB) between the probes in any pair shall be minimized. The level of dB required from each reference standard reflector to establish the sensitivity (acceptance level @ 80% FSH) shall be recorded for each probe. All instrument settings: distance from the weld center-line to the probe index point, range, gate width (start and finish points on the cathode ray tube), gate height and gate logic (alarm level percentage FSH) shall be recorded for each longitudinal, transverse and coupling) probe. The receiver shall be set to 'full-wave rectified'.

A sensitivity verification shall be performed in the dynamic mode at a speed not less than that used to inspect the production pipe. After each static calibration, the reference standard shall be passed through the ultrasonic testing equipment three (3) times at the operational scanning velocity. Scanning speed shall be recorded for all dynamic calibrations. If a change in gain is required in order to maintain the recorded percentage for the probes when aimed at their respective reference reflectors (used for sensitivity setting), these values shall be recorded as an average of the three (3) dynamic check results. This average gain, if any, shall be added to the primary gain for each probe during subsequent production testing.

The equipment shall be deemed to be in calibration if, for all three passes:

- the system produces readily distinguished and clearly identifiable indications from all the ID, OD and center weld reference reflectors – without any alteration in settings
- the response from any one of the respective reference reflectors (longitudinal or transverse) used to establish sensitivity during the dynamic check is at or above the acceptance level (80% FSH gate)

E.5.5 Acceptance Limits

E.5.5.2 Any pipe with an alarm condition (e.g. signal greater than 80 % FSH and within the gate) shall be considered a suspect pipe and proven-up by MUT in accordance with Section E.3.2.1 of this standard to ascertain the maximum amplitude has been achieved from the indication in the suspect area. (Note that 'prove-up' by running the suspect area through automatic UT does not meet the requirement for maximizing signal.)

E.6 MAGNETIC PARTICLE INSPECTION

E.6.2 Equipment

Magnetic particle inspection shall be performed dry or wet in accordance with ISO 10893-5 or ASTM E 709.. The inspection shall be performed with an active (continuous) field. Magnetic particle testing shall be performed with active (continuous) field, unless otherwise approved by the COMPANY.~~(Field strength~~

Manual magnetic particle testing shall be performed by AC yoke. Electromagnetic AC yokes shall have a minimum lifting force of 5 kg at maximum leg spread. Verification is required at the start of each operating shift.

Permanent magnets shall not be used.

E.7 RESIDUAL MAGNETISM

E.7.3 If other than Hall-effect measurement devices are used, the MANUFACTURER shall verify at least once per shift, that the measurements are within ± 2 Gs (0.2 mT) of Hall-effect gaussmeter readings. The accuracy of the gaussmeter shall be verified at least at the start of every shift that the gaussmeter is used.

E.7.6 The average of the four readings shall be ≤ 20 Gs (2 mT) with one reading as high as 25 Gs (2.5 mT) allowed.

E.10 DISPOSITION OF PIPE CONTAINING DEFECTS

Reported indications shall be classified as to the type of imperfection.

ANNEX G
(normative)

PSL 2 PIPE WITH RESISTANCE TO DUCTILE FRACTURE PROPAGATION

G.1 INTRODUCTION

This annex shall apply to gas service pipe applications where resistance to ductile fracture propagation in the pipe body is required.

G.6 GUIDANCE FOR DETERMINING CVN ABSORBED ENERGY VALUES IN BURIED ONSHORE GAS PIPELINES

G.6.1 The minimum CVN values provided in Table E of this standard exceed all minimum energy requirements stated in Annex G of API 5L. The values in Table E of this standard are valid for operating pressures up to 2175 psi (15 MPa) and design factor of 0.80.

ANNEX K
(normative)

NON-DESTRUCTIVE INSPECTION FOR PIPE ORDERED FOR SOUR SERVICE AND/OR OFFSHORE SERVICE

K.1 INTRODUCTION

Annex K of this standard shall be implemented for the manufacture of onshore gas transmission non-sour and sour service HFW line pipe.

K.2 GENERAL NON-DESTRUCTIVE INSPECTION REQUIREMENTS AND ACCEPTANCE CRITERIA

K.2.1 Laminar Imperfections at the Pipe Ends

K.2.1.1 Scanning sensitivity shall be based on a 0.25 in (6 mm) flat bottomed hole.

K.2.1.2 The +3 dB allowance in ISO 10893-08 and ISO 10893-09, Paragraphs 7.5 shall not be allowed.

Ultrasonic inspection of the pipe ends for laminations may be omitted provided inspection of the skelp body was performed to the same sensitivity and acceptance level as required for skelp edges.

K.2.1.3 If the girth welds will be inspected by automatic ultrasonic testing during installation, then ultrasonic inspection of the 4.0 in (100 mm) wide zone from each pipe end shall be performed.

K.2.1.4 Magnetic particle inspection of the end bevel face is required, except that if the pipe ends will be re-bevelled during pipe installation in the field, then end face inspection is not required. Wet fluorescent magnetic particle inspection should be used.

K.2.2 Suspect Pipe

Suspect areas shall be accepted or rejected using the same NDT method employed to find the original imperfection.

K.2.2.4 The removal of the defect shall be confirmed by MT or PT inspection. The dressed area shall then be re-examined by the original NDT method.

K.4 NON-DESTRUCTIVE INSPECTION OF HFW PIPE

K.4.1 Non-Destructive Inspection of the Weld Seam

The full length of the weld seam shall be ultrasonically inspection for longitudinal imperfections to ISO 10893-11 acceptance level U2H (1.6 mm through drilled hole).

The following requirements apply to final ultrasonic inspection:

For wall thickness ≤15.0 mm, a minimum of 4 separate transducers shall be used to examine the entire weld zone.

For wall thickness > 15.0 mm, a minimum of 6 separate transducers shall be used to examine the entire weld zone. At least one transducer on each side of the weld shall examine each of the OD, mid-wall, and ID areas of the weld zone.

The acceptance level shall be based on a 1.6 mm diameter through-drilled hole located on the fusion line. The weld seam not inspected (dead zone) by the automatic UT inspection system at the pipe ends shall be inspected by MUT for longitudinal imperfections, or cut back.

Longitudinal N5 OD and ID notches shall be placed parallel to the weld seam. The notches are to ensure that the sound beam is perpendicular to the weld seam and to indicate the edge of gate widths for probes inspecting the weld for longitudinal imperfections.

A side-drilled hole should be placed on the fusion line to establish the position of the fusion line for probe placement.

For angle beam inspection of weld seams, the primary reference level should be set at 80% FSH. Any areas of the pipe producing signals greater or equal to the primary reference level shall be considered suspect. For production scanning, the gain shall be increased by 2 dB to 6 dB to compensate for signal variation, difference between artificial reflectors and actual imperfections and equipment drift. For calibration / sensitivity verification and prove-up of suspect areas, the additional gain is not required.

Maximum drift of probes from the centerline of the weld shall be ± 0.25 in (6.0 mm). For inspection of weld zones, UT equipment should utilize an electronic weld seam tracking/centering system to ensure accuracy of probe locations. This drift shall be compensated for by extension of the leading and trailing edge of gate widths by an amount equivalent to the amount of drift. The sensitivity shall be verified by the appropriate reflectors at the gate extremities.

For angle beam scanning of the weld zone, the maximum number of legs of beam travel shall be 3 (1.5 skips) for detection of imperfections.

For angle beam inspection of weld seams, sound transmission shall be verified using the inspection probes in a paired cross-talk mode. Verification with close proximity straight beam transducers is not acceptable.

For angle beam inspection of the weld seam, the maximum speed of travel, when taking into account the alarm filter setting and the operational pulse repetition rate, shall be such that there will be at least 3 pulses on the applicable 0.063 in (1.6 mm) through drilled hole.

Loss of coupling shall be deemed to occur, and shall be considered an alarm condition if the signal from the coupling channel drops below 20 % FSH (gated).

Acceptance level ISO 10893-11, Table 2, Acceptance Level U2H (1.6 mm through drilled hole) shall be used for inspection for longitudinal imperfections of the weld.

Ultrasonic inspection for transverse imperfections is required of MT or PT identifies transverse defects during MPQT. The probes shall be positioned over the weld seam ('on-bead') with element diameter up to 20 mm and a 45° refracted angle, and shall examine the weld in both directions per Figure K.1 below.

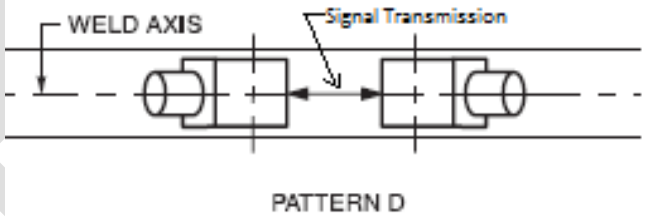

FIGURE K.1 — UT INSPECTION OF WELD SEAM - ON-BEAD PROBES

K.4.2 Laminar Imperfections in the Pipe Body

Automatic ultrasonic inspection shall be used to verify that the skelp/pipe body is free of laminar imperfections greater than those permitted by Table K.1, Acceptance Criteria for Laminar Imperfections," for 'sour' service. The coverage during inspection shall be 100% of the surface area if the direction of scanning is in the longitudinal direction or ≥ 50% of the surface area if the scanning direction is transverse.

Manual ultrasonic inspection pipe body for laminar imperfections shall be in accordance with ISO 10893-8 or ISO 10893-9. Sizing shall be performed in accordance with ISO 10893-8 or ISO 10893-9 Annex A. Maximum probe movement speed for MUT lamination inspection shall be ≤ 6 in/sec (150 mm/sec).

Manual ultrasonic prove up of the suspect areas reported during automated ultrasonic testing equipment shall cover a square of minimum 250 mm x 250 mm centered on the reported indication.

K.4.3 Laminar Imperfections on the Strip/Plate Edges or Areas Adjacent to the Weld Seam

The longitudinal strip/plate edges shall be ultrasonically inspected over a width of at least 2.0 in (50 mm). Sensitivity shall be based on a 0.25 in (6 mm) flat bottomed hole. Acceptance limits shall be as per standard 'sour' service condition in Table K.1 of API 5L.

Manual ultrasonic inspection of the pipe body for laminar imperfections shall be in accordance with ISO 10893-8 or ISO 10893-9. Sizing shall be performed in accordance with ISO 10893-8 or ISO 10893-9 Annex A. Maximum probe movement speed for MUT lamination inspection shall be ≤ 6 in/sec (150 mm/sec).

K.4.4 Supplementary Non-Destructive Inspection Operation

If specified, ultrasonic inspection of pipe ends for linear (non-laminar) imperfections shall be in general accordance with ASTM A 577 / A 577M. Maximum probe movement speed for MUT shall be ≤ 2 in/sec (50 mm/sec). (This inspection may be required for enhanced inspection of the pipe ends for cracks.)

Where the ends of the pipe have been cold sized, or the roundness corrected by jacking, the affected surface area of the OD seam weld shall be inspected for longitudinal imperfections by magnetic particle inspection in accordance with ISO 10893-5 or ASTM E 709, or liquid penetrant inspection according to ISO 10893-4. There shall be no linear indications greater than 0.118 in (3 mm) in length. This inspection shall be performed after hydrostatic testing.

ANNEX Q

Final Data Book Requirements

Q.1 FINAL DATA BOOK REQUIREMENTS

Q.1.1 Data book structure

The following documents, if applicable, shall be organized by tab for hard copies and folder for electronic copies following the structure below.

Doc Type	Description	Additional Requirements
100	**Material Certificates (MTRs)**	
	MTRs	Signed by TPI
200	**Steel Production**	
210	**Steel Project Documentation**	
	MPS/ITP	Signed by ET QA
	Unpriced Purchase Order	
	Production Schedule	
	Exceptions and Clarifications with mill and company responses	
	Material certificates	
220	**Steel Production Documentation**	
	Centerline Segregation test results with macro etch photos	
	Closed steel Non-conformance Reports (NCR)	
	List of material not applied to order	
300	**Pipe Production**	
	Purchase Order Reference list	
310	**Pipe Project Documentation**	
	Purchase Orders	
	PPM minutes	Final
	MPS/ITP	Signed by ET QA
	Exceptions and Clarifications with mill and company responses	
	Production Schedules	
	Weekly conference call minutes	
320	**Pipe Manufacturing/NDE Procedures**	
	Automatic Ultrasonic Testing	
	Manual Ultrasonic Testing	
	Skelp-Lamination Ultrasonic Testing	
	Radiographic Testing	

	Magnetic Particle Inspection	
330	**Pipe Equipment Calibration Certificates**	
	CVN Impact Tester	
	Hydrostatic Test Gauge	
	DWT Tester	
	Tensile Machine	
	Tensile Extensometer	
	Ultrasonic Equipment	
	Hardness Tester	
340	**Pipe NDT Operator Certificates**	
	Radiography Technicians	
	Ultrasonic Technicians	
350	**Pipe Mill Hydrostatic Test**	
	Hydrostatic Test Graphs	
	Hydrostatic Test Report	
360	**Pipe WPSs and PQRs**	
	Longitudinal Seam procedures	
	Mill Jointing procedures	
	Double Jointing procedures	
	Repair procedures	
370	**Pipe Histograms and Seam Rejection Report**	
	Tensile graph	
	Yield graph	
	Charpy Impact graph	
	Hardness graph	
	Chemistry graph	
	DWTT graph	
	Dimensional graph	
	Seam rejection report	
380	**Pipe Non-conformance Reports (NCR) or waivers**	
	Closed pipe NCRs with resolution and sign offs	
	Waivers	
390	**Pipe Production Reports**	
	UT	
	Xray	
	Final	
	Traceability	
400	**Coating**	
410	**Coating Project Documentation**	
	MPS/ITP	
	Exceptions and Clarifications with mill and company responses	

	Production Schedule	
420	**Coating Certificates**	
	Powder certificates	
	Equipment calibration certificates	
430	**Coating Non-conformance Reports (NCR) or waivers**	
	Closed coating NCRs with resolution and sign offs	
	Waivers	
440	**Coating Reports**	
	Lab results	
	Walk Through reports	
	Final bench reports	
500	**Pipe Mill Tally Sheets in Excel format**	
	Pipe mill tally sheets	