

API Spec 5L, 44th Edition Specification for Line Pipe

Effective: October 1, 2008

ISO 3183:2007 (Modified) Steel Pipe for Pipeline Transportation Systems

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API Spec 5L, 44th Edition Specification for Line Pipe

An Overview

Background and History of Spec 5L

- API 5L initially issued in the 1920s
- Maintained by Subcommittee 5 / Task Group on Line Pipe
- Current 5L 44th edition is an adopted back ISO 3183 specification that contains both API and ISO requirements melded together to result in a single international standard.

Other API Pipeline Documents

(Upstream Subcommittee 5)

- RP 5L1 – Railroad Transportation of Line Pipe, 6th Ed (2002)
- RP 5L2 – Internal Coating of Line Pipe for Non-corrosive Gas Transmission Service, 4th Ed (Reaffirmed 2007)
- RP 5L3 – Conducting Drop-weight Teat Tests on Line Pipe, 3rd Ed (Reaffirmed 2003)
- RP 5L7 – Unprimed Internal Fusion Bonded Epoxy Coating of Line Pipe, 2nd Ed (Reaffirmed 2004)
- RP 5L8 – Field Inspection of New Line Pipe, 2nd Ed (Reaffirmed 2003)
- RP 5L9 – Recommended Practice for External Fusion Bonded Epoxy Coating of Line Pipe, 1st Ed (Reaffirmed 2004)
- Spec 5LC – Specification for CRA Line Pipe, 3rd Ed (Reaffirmed 2006)
- Spec 5LCP – Specification for Coiled Line Pipe, 2nd Ed (2006)
- Spec 5LD – Specification for CRA Clad or Lined Steel Pipe, 2nd Ed (1998)
- RP 5LW – Transportation of Line Pipe on Barges and Marine Vessels, 2nd Ed (2003)

API / ISO Adopt Back Process

- API and ISO Work Groups worked jointly to develop this harmonized 5L / ISO 3183 standard
- The best requirements of both standards were adopted
- First, a revised ISO 3183 was balloted and published.
- API then adopted back the ISO 3183 standard with a few national adoption requirements listed in Annex N and Annex O
- Therefore, the API spec 5L consists of 3183 plus (+) the requirements of Annex N and O

Spec 5 L Format

Spec 5 L format includes:

- 1. API 5L cover and forward placed on top of the ISO 3183 “Steel pipe for pipeline transportation systems -2nd edition”**
 - ISO 3183 is the basis or body of the 5L standard.
- 2. Notations in the margins of the 3183 standard showing where requirements in Annex N either supplement or replace those in the body**

Manufacturing to the Requirements of Spec 5L – Monogram Program

1. Manufacturer applies for Licensing under the Monogram Program
2. Manufacturer operates a quality management system to the requirements of API Spec Q1
3. Manufacturer is audited initially (and then once every 3 years thereafter) to the requirements of Spec Q1 and Spec 5L
4. License is granted once all requirements have been demonstrated

Scope of Spec 5L

- Seamless and welded pipe for pipeline transportation systems
 - Liquid and gas
 - Onshore and offshore
 - Transmission, distribution and utility systems
- 2 PSL (Product Specification Levels)
 - PSL 1 - Basic requirements
 - PSL 2 - Enhanced requirements including mandatory notch toughness, restricted strength ranges, carbon equivalents for improving weldability
- Plain or threaded pipe ends
- Suitable for welding

Products and Product Lines (cont'd)

API Spec 5L, Clause 9.12

Types of pipe ends included in 5L are:

- **Plain end pipe**
- **Belled end pipe**
- **Plain end pipe for special coupling**
- **Threaded end pipe**



Photo Courtesy of OSM Tubular Camrose

Products and Product Lines

API Spec 5L, Table 2

Seamless pipe

Welded pipe

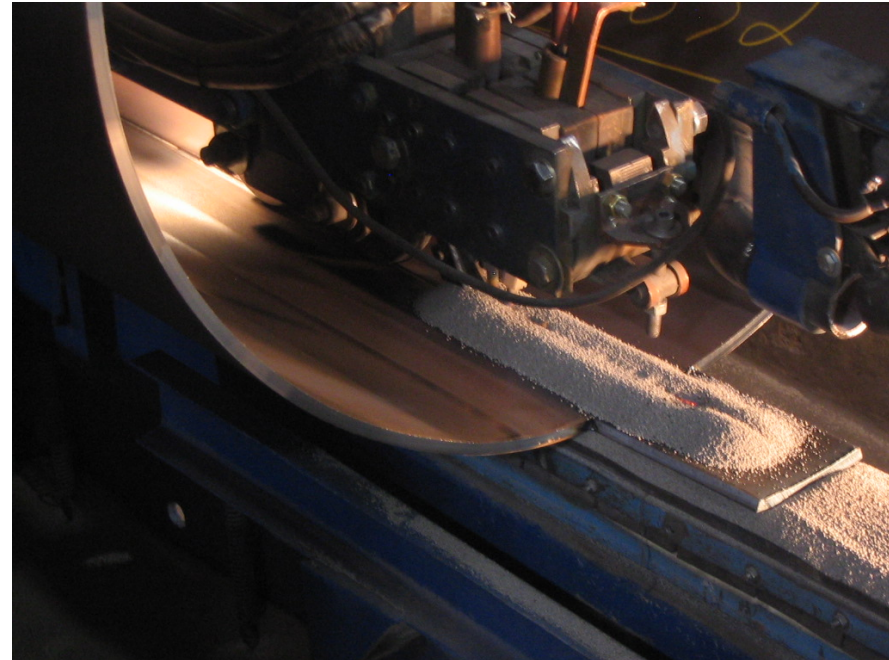
- **Continuous Weld (COWL)**
 - A single gas metal Arc pass
 - At least one SAW pass on inside and one on the outside
- **Submerged Arc Welded**
 - Longitudinal Seam (SAWL)
 - Helical (spiral) Seam (SAWH)
- **Electric Welded (EW)**
 - Low frequency (LFW, PSL 1 only)
 - High frequency (HFW)
- **Laser Welded (LW)**

SAWL Process



O-Press Exit

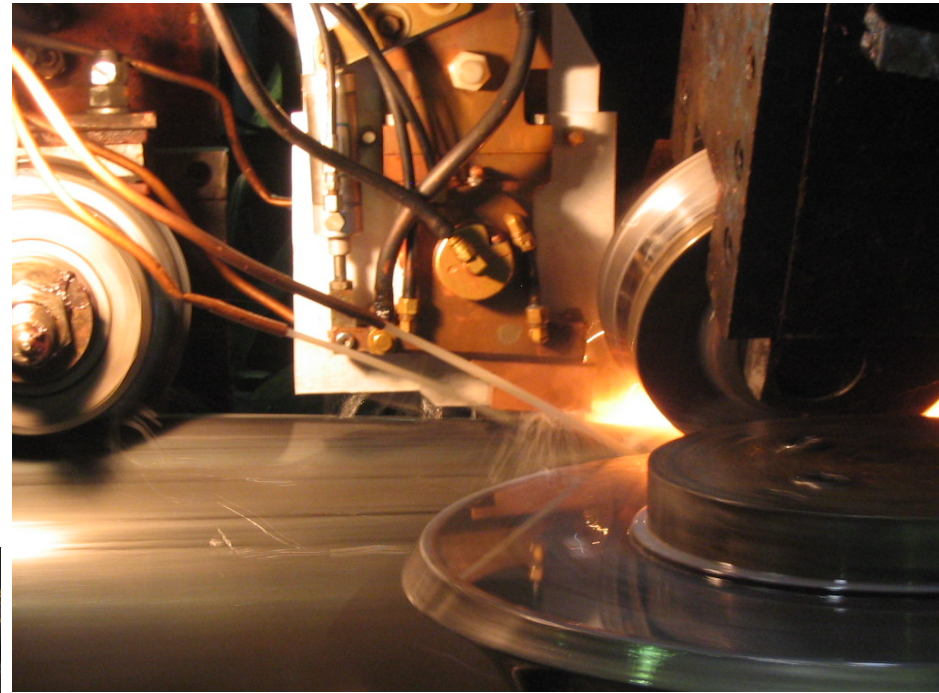
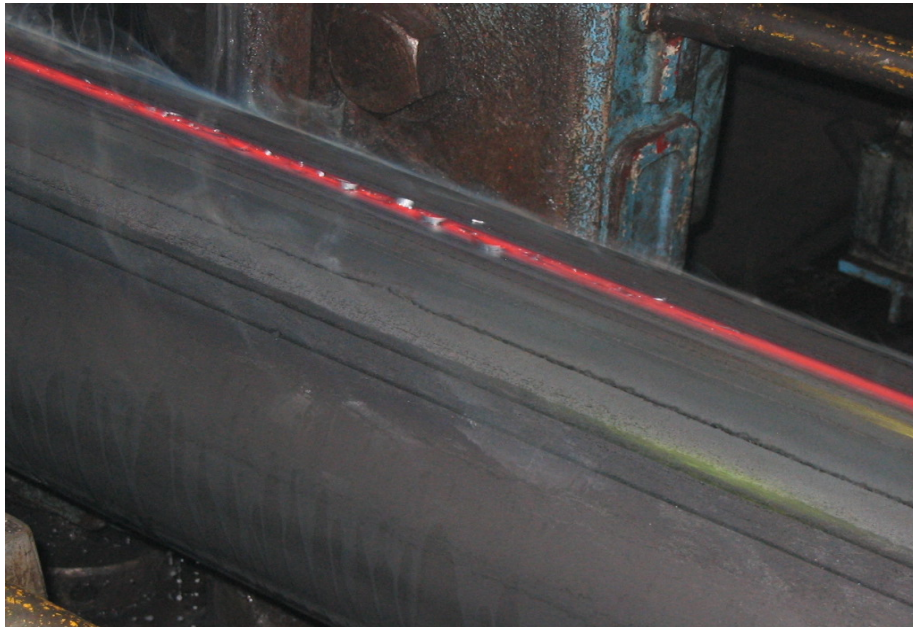
ID Welding



Photos Courtesy of OSM Tubular Camrose

EW Process

Hot Weld



Active Welder

Photos Courtesy of OSM Tubular Camrose

Cutoff and Grinding Pipe Ends



Photos Courtesy of OSM Tubular Camrose

Major Changes to the Current 44th from the 43rd Edition of API Spec 5L

- Current 44th edition includes:
 - **Harmonized API 5L and ISO 3183 technical requirements**
 - **Major changes in format vs the 43rd 5L edition**
 - **Addition of high strength X90-X120 pipe grades**
 - **Annexes which include requirements for sour and offshore service and for avoidance of ductile running shear fractures in gas transmission lines**

Major Changes to the Current 44th from the 43rd Edition of API Spec 5L

- Grade designations for PSL 2 contain a delivery condition, e.g, heat treatment of the pipe
- Chemical composition limits are more specific and tighter for many grades
- Maximum limits on yield and tensile strength
- Strength levels in US Customary units are converted from metric equivalents and are not rounded to the nearest thousand
 - **Conversion results in a slightly different value than in the past**
- Tighter pipe end diameter tolerances

Major Changes to the Current 44th from the 43rd Edition of API Spec 5L

**Annexes with specific manufacturing or
service requirements have been added**

- **Annex B:** (Normative) Qualified Manufacturing Procedures for PSL 2
- **Annex G:** (Normative) Requirements of Ductile Running Fracture Propagation for PSL 2
- **Annex H:** (Normative) Sour Service PSL 2 Pipe
- **Annex J:** (Normative) Offshore Service PSL 2 Pipe
- **Annex N:** (Normative) Identification of Deviations (National Adoption Annex)
- **Annex O:** (Informative) API Monogram Program (National Adoption Annex)

(Regional) Annex N – Deviations from ISO 3183 and API Spec 5L

1. Definition for “Sample” and “Test Piece” added
2. 6.2.1, Table 1 on Pipe/steel grades and delivery conditions – added restrictions for intermediate grades
3. 7.2 c) 34) – Alternate pipe length marking allowances, if agreed to by manufacturer and purchaser
4. 7.2 c) 56) - Changes in hardness testing as permitted in Annex H – PSL 2 pipe ordered for sour service
5. 7.2 c) 57) – Changes in hardness testing as permitted in Annex J – PSL 2 pipe ordered for offshore service
6. 10.2.11 - Reprocessing – allowances for failure to meet mechanical properties, manufacturer can heat treat entire lot and treat as new lot.

(Regional) Annex N – Deviations from ISO 3183 and API Spec 5L (cont'd)

7. 10.2.12 - New retesting requirements - allowances for failure to meet testing, manufacturer can heat treat entire lot and treat as new lot
8. Section 11 - Fifteen marking changes to accommodate the API Monogram program or reference to API Spec 5L
9. D.2.1.2 – Some allowable qualification test substitutions based on the 5L, 43rd Edition
10. D.3.1.1 – Only specific (cited) codes are acceptable for welder qualification
11. H.7.3.3.3 & J.8.3.2.3 c) Hardness test location changes

Ordering 5L Line Pipe (API Spec Q1, Section 7.4)

API Spec 5L, Section 7

1. Purchase order must first include general information, Clause 7.1
 - **Attributes such as pipe diameter, wall thickness, quantity, grade, PSL and applicability of individual annex requirements**

2. Purchase order must indicate which provisions of Clause 7.2 sub clauses actually apply
 - **Items subjected to mandatory agreements**
 - References provided in Clause 7.2.a
 - **Items that apply as prescribed unless otherwise agreed**
 - References provided in Clause 7.2.b

Ordering 5L Line Pipe (API Spec Q1, Section 7.4) cont'd

3. Purchase order should identify the applicability of all subclauses of Clause 7.2
 - **55 agreement clauses**
 - **These requirements can be project specific**
 - **Failure to specify will result in requirement not being met or default to the specific clause in the body**
 - **Many of these requirements are addressed in the Data Sheet attached to the Tender or Invitation to Bid documents**

Chemical Composition Requirements

API Spec 5L, Tables 4 (PSL 1) & 5 (PSL 2)

- More extensive requirements for PSL 2 than for PSL 1
- Tighter requirements on chemical alloying elements for PSL 2
- Mandatory CE (carbon equivalent) requirements for PSL 2 promotes better weldability

Pipe Grades

- Designation of grade is related to minimum yield strength
 - **SI / USC units**
- Yield strength ranges from:
 - **L175/A25 (25.4ksi) to L830/X120 (120.4ksi)**
- Requirements include minimum and maximum strengths
- Minimum strength requirement on weld seams
- Specification permits intermediate grades

Examples of Pipe Grades, PSL 2

API Spec 5L, Table 7 (abbreviated)

Pipe Grade	Yield Strength, ksi		Tensile Strength, ksi	
	Min	Max	Min	Max
USC / SI				
L245 / A25	35.5	65.3	60.2	110.2
L360 / X52	52.2	76.9	66.7	110.2
L415 / X60	60.2	81.9	75.4	110.2
L555 / X80	80.5	102.3	60.6	119.7
L690 / X100	100.1	121.8	110.2	143.6
L830 / X120	120.4	152.3	132.7	166.1

Product Specification Levels (PSL) Comparison

Some differences between PSL 1 and PSL 2

Attribute	PSL 1	PSL 2
Grade Range	A25 (L175) thru X70 (L485)	B (L245) thru X120 (L830)
Chemistry	C/Mn/P/S	C/Si/Mn/P/S/V/Nb/Ti/CE
End Condition	Plain, threaded or belled	Plain End
Seam Welding	All methods	Not COW or LW
EW Frequency	No minimum	70 KHz minimum
Yield Strength, min/max	Specified/None	Specified/Specified
Fracture toughness	If stipulated by customer	Mandatory minimums

Testing and Inspection Requirements (API Spec Q1, Section 8.2.4)

API Spec 5L, Tables 17 (PSL1) & 18 (PSL 2)

- Testing requirements include, type of test, lot size and frequency
- Tables include requirements for:
 - **Chemical analysis**
 - **Mechanical testing (tensile, bending, Charpy toughness, hardness)**
 - **Macro- and micro-scopic testing of welds**
 - **Hydrostatic testing**
 - **Visual and non-destructive testing**

Dimensional Comparison

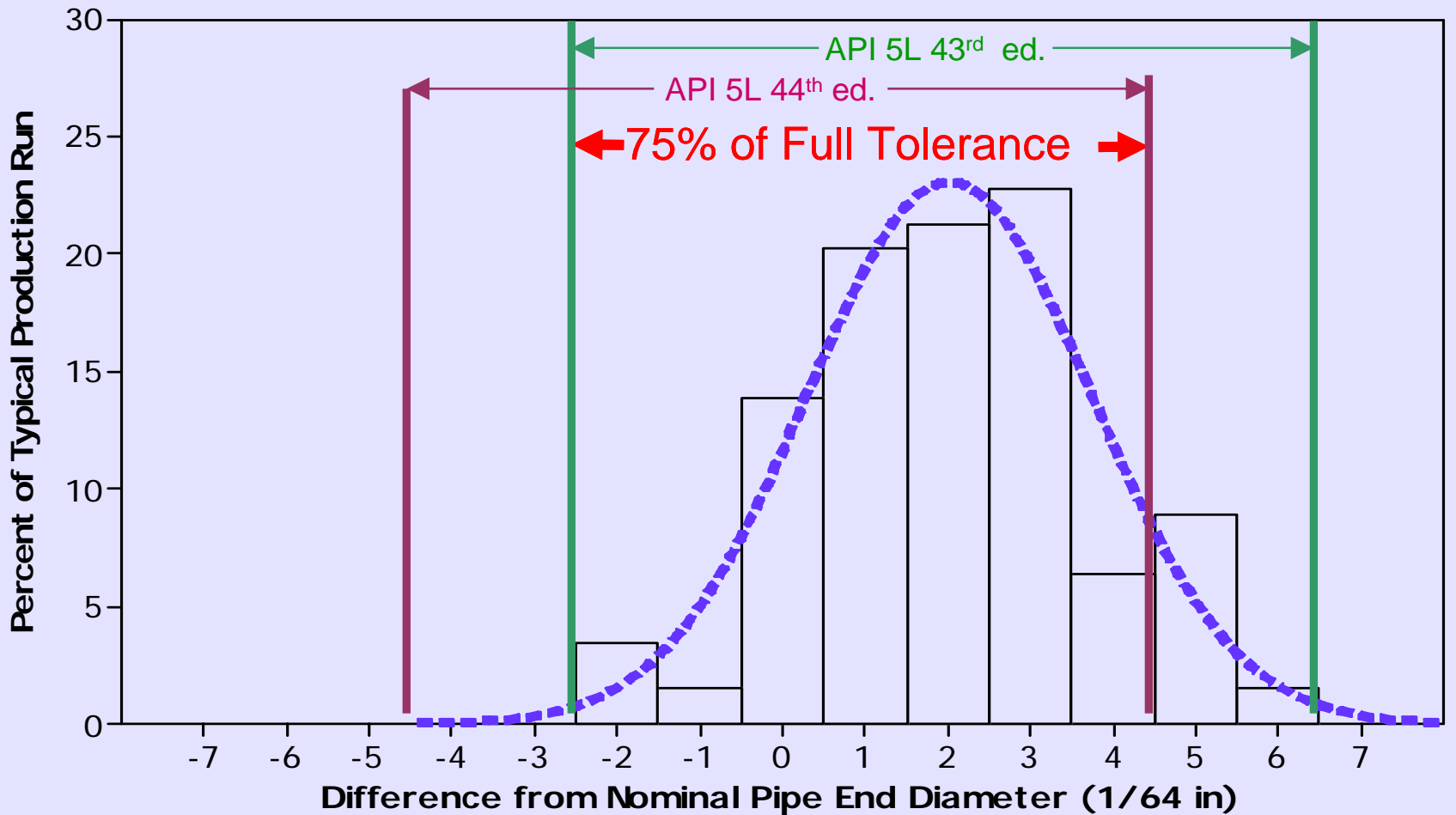
Parameter	Item	Measure	API 5L 43rd Edition						API 5L 44th Edition					
			Ref. Clause(s)	stat	criteria	unit	stat	criteria	units	Ref. Clause(s)	stat	criteria	unit	stat
Dimensions	1	Body OD (from nom.)	Table 7	min	-3.2 mm	max	6.4 mm	Table 10	min	-4.0 mm	max	4.0 mm		
	2	End OD (from nom)	Table 8	min	-0.8 mm	max	2.4 mm	Table 10	min	-1.6 mm	max	1.6 mm		
	3	End-end average diameter difference	Table 8	-	-	max	2.4 mm							
	4	End Diameter Out of round axis tolerance, spec OD	Table 8	min	-10.7 mm	max	10.7 mm							
	5	Out of round - end, max differential min & max OD	Table 8			max	12.7 mm	Table 10			max	10.5 mm		
	6	Out of round - body, max differential min & max OD						Table 10			max	15.0 mm		
Weight	7	Local wall thickness	Table 9	min	-1.0 mm	max	+2.5 mm	Table 11	min	-1.3 mm	max	1.3 mm		
	8	Weight, single lengths	Table 10	min	-3.5 %	max	10 %	9.14.1	min	-3.5 %	max	10 %		
	9	Weight, carload	Table 10	min	-1.75 %			9.14.3	min	-1.75 %				
	10	Weight, order items	Table 10	min	-1.75 %	-	-							
Length	11	Length	Table 11	min	8.53 m	max	25.91 m	Table 12	min	8.53 m	max	25.91 m		
	12	Length, avg	Table 11	min	21.34 m			Table 12	min	21.34 m				
Mill Joints	13	finished jointer length	Table 11	min	8.53 m	max	25.91 m							
	14	sub-joint Length	7.7	min	1.52 m	max	-	8.11.3	min	1.5 m				
	15	long seam offset	A.2	min	51 mm	max	203 mm	A.2.4	min	58 mm	max	200 mm		
	16	WPS/PQR & welder qualification	A.1					A.2.3			max	3.5 mm		
Defects	17	Weld Height - any point	A.2			max	3.2 mm	A.2.3			max	3.5 mm		
	18	Weld Height - overlap						A.2.3			max	3.5 mm		
	19	Radiography	A.4	min	100% Circ			A.4	min	100% circ				
	20	Dent depth in body without gouge	7.8.1			max	6.4 mm	9.10.5.2			max	6.4 mm		
	21	Dent depth in body with gouge	7.8.1			max	3.2 mm	9.10.5.2			max	3.2 mm		
	22	Dent length in body (without gouge)	7.8.1			max	50% OD	9.10.5.2			max	0.5 OD		
	23	Offset plate edges	7.8.2			max	1.6 mm	9.13.1			max	1.5 mm		
	24	Out of line weld bead	7.8.2			max	complete fusion per NDT	9.13.3			max	3.0 mm		
	25	ID and OD bead height	7.8.4	min	0 mm	max	3.2 mm	Table 16			max	3.5 mm		
	26	Hardspot hardness max	7.8.8			max	35 HRC	9.10.6			max	35 HRC		
Plain Ends	27	Hardspot dimensions - any direction	7.8.8			max	50.8 mm	9.10.6			max	50 mm		
	28	Cracks, sweats, leaks	7.8.9			max	0 mm							
	29	Laminations or inclusions in bevel face	7.8.10			max	6.4 mm	9.10.4			max	6.4 mm		
	30	Laminations in body, minor dimension (if assoc'd with 31)	7.8.10			max	19.0 mm							
	31	Laminations in body, area (if assoc'd with 30)	7.8.10			max	7742 mm ²							
	32	Arc Burns	7.8.11			max	0 mm				max	0 mm		
	33	Undercut depth (see clause), lesser of	7.8.12a	min	-12.5 %	max	0.8 mm	9.10.2			max	0 mm		
	34	Undercut length (see clause)	7.8.12a			max	6.4 mm	9.10.2			max	6.4 mm		
	35	Other defects depth -	7.8.14			min	12.5% t	9.10.7			max	0.125 t		
	36	Bevel Angle	7.9.3	min	30 deg	max	35 deg	9.12.5.2	min	30 deg	max	35 deg		
	37	Root face	7.9.3	min	0.8 mm	max	2.4 mm	9.12.5.2	min	0.8 mm	max	2.4 mm		
	38	Taper Angle	7.9.3			max	7 deg				max	7 deg		
	39	End Square	7.9.3			max	1.6 mm	9.12.1.4			max	1.6 mm		
40	ID flush-off distance/height	7.9.3	approx	101.6 mm	max	mm	9.13.2.2			max	0.5 mm			
41	local OOR						9.10.5.1			max	3.2 mm			
42	straightness	7.6			max	0.20% length	9.11.3.4			max	0.2% length			
43	straightness - local (in 1 m)						9.11.3.4			max	4.0 mm			

Where API 5L (44th ed) is less restrictive than API 5L (43rd ed)

12 API 5L (44th ed) is marginally more restrictive than API 5L (43rd ed) www.api.org

API 5L (44th ed) is more restrictive than API 5L (43rd ed)

Pipe End Diameter Tolerances



Graph Courtesy of OSM Tubular Camrose

Dimensional Requirements (cont'd)

API Spec 5L, Clauses 9.11 thru 9.14

Weldment tolerances and dimensions	
Weld detail	Table / figure
Max. permissible radial offset for SAW and COW pipes	14 / 4a & 4b
Maximum permissible groove for EW and LW	15
Maximum permissible weld bead height for SAW and COW pipe	16

Dimensional Verifications



Photos Courtesy of OSM Tubular Camrose

Mechanical Property Comparison

Parameter	Orient'n/ Location	Size	Specifics	API 5L 43rd Edition				API 5L 44th Edition (1116 ba)				
				Test Temp (C)	min spl	min test	min/max* Avg.	Max	Test Temp (C)	min spl	min test	Max
Chemistry	Heat	NA	Heat Chemical Composition	RT	See composition limits				RT	See composition limits		
	Product	NA	Product Chemical Composition	RT	See composition limits				RT	See composition limits		
Tensile	TPA	FS or RB	0.5% EUL YS (MPa)	RT	-	552	-	690	RT	-	555	705
	TPA	FS or RB	TS (MPa)	RT	-	621	-	827	RT	-	625	825
	TPA	FS or RB	Y:T	RT	-	-	-	0.93	RT	-	-	0.93
	TPA	FS or RB	Elong in 2" g.l. (%)	RT	-	21	-	-	RT	-	21	-
	TLW	Flat Strap	TS (MPa)	RT	-	621	-	827	RT	-	625	-
Charpy	TPA	full-equiv.	CVN En (J)	0	20	27	68	-	0	30	40	-
	TPA	full-equiv.	Ductility (%shr)	0	-	40	70	-	0	-	-	-
	TLW	full-equiv.	CVN En (J)	0	-	-	-	-	0	20	27	-
	TLW HAZ	full-equiv.	CVN En (J)	0	-	-	-	-	0	20	27	-
DWTT	TPA	full PN	DWTT Ductility (%shr)	0	-	40	60	-	0	-	-	-
Guided Bend	TLW	full	Guided Bend Crack - weld/HAZ (mm)	RT	-	-	-	3.2	RT	-	-	3.2
	TLW	full	Guided Bend Crack - edge (mm)	RT	-	-	-	6.4	RT	-	-	6.4
Hard spot	BM/HAZ/WM	full	Rockwell C Hardness (HRC)	RT	-	-	-	24	RT	-	-	24

Where:

- TPA Transverse pipe axis
- BM/HAZ/WM Base Metal/Heat affected zone/weld metal
- full-equiv full-sized equivalent
- full PN Full-sized Pressed Notch DWTT
- RT Room temperature
- AR As rolled
- FS Flattened strap specimen
- RB Round bar specimen
- RE Ring expansion
- Not specified

and where

- API 5L (44th ed) is less restrictive than API 5L (43rd ed)
- API 5L (44th ed) is identical to API 5L (43rd ed)
- API 5L (44th ed) is marginally more restrictive than API 5L (43rd ed)
- API 5L (44th ed) is more restrictive than API 5L (43rd ed)

Tensile Testing

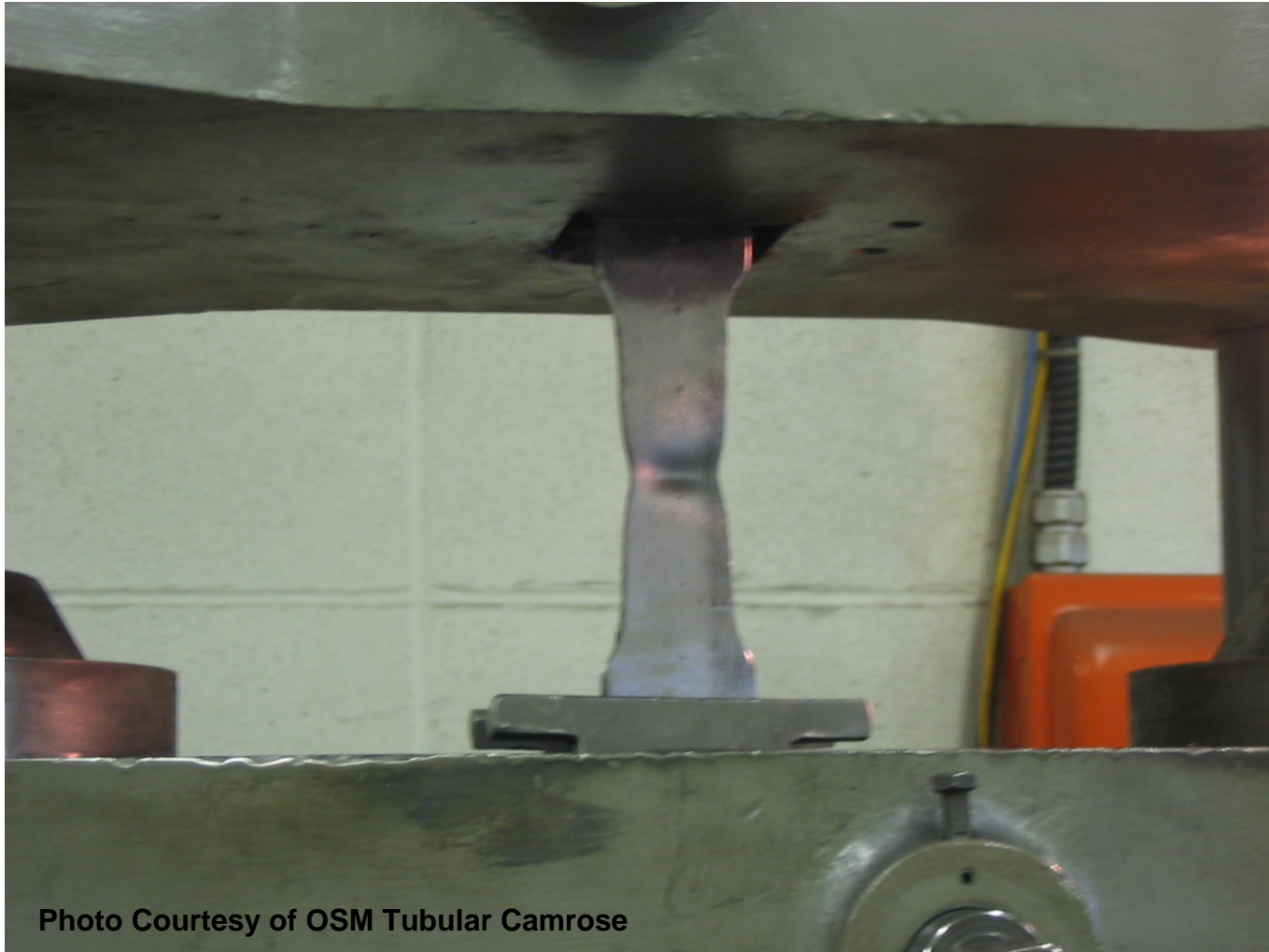


Photo Courtesy of OSM Tubular Camrose

Guided Bend Test



Photo Courtesy of OSM Tubular Camrose

Hardness Test



Photo Courtesy of OSM Tubular Camrose

Crush Test



Photo Courtesy of OSM Tubular Camrose

Surface Conditions, Imperfections and Defects

- Described in Clause 9.10
 - **Undercuts in seam welds**
 - **Arc burns**
 - **Laminations**
 - **Flat spots, peaks, dents and gouges**
 - **Hard spots**
 - **Other imperfections, such as gouges**
- Acceptance criteria are given to determine when these are considered a defect

Disposition of Pipe with Defects (API Spec Q1, Section 8.3)

- Defects and imperfections
 - **Defect, Clause 4.13** — an imperfection of a size or density greater than the acceptance criteria
 - **Imperfection, Clause 4.20** — a discontinuity or irregularity detectable by inspection
- Disposition of defects is addressed in section C
 - **Defects are treated in accordance with Clause C.2 and C.3**
 - Removed by grinding or repaired by welding if in a seam weld made with filler metal
 - A section containing the defect is removed by cutting
 - The pipe is rejected

Non-Destructive Inspection (NDI) Requirements

- Types of inspections required are based on the product form and the PSL level and include:
 - **Visual for defects and dimensions**
 - **Radiographic**
 - **Electromagnetic**
 - **Ultrasonic**
 - **Magnetic particle**
 - **Hydrotesting**

Non-Destructive Inspection (NDI) Requirements (cont'd)

Visual (API Spec 5L, Clauses 10.2.7 and 10.2.8)

- Visual Inspection
 - All pipe shall be 100% visually inspected over its entire length on its external surface and as much as is practical on the inside surface
- Qualifications of visual inspectors are identified
- Covered Inspections
 - OD
 - Out of roundness
 - Wall thickness
 - Flat spots in SAW and COW welded pipe

Non-Destructive Inspection (NDI) Requirements (cont'd)

Radiography (API Spec 5L , Annex E)

Radiographic Inspection of weld seams

- Clause E.4 and sub clauses
 - **Volumetric imperfections (Slag or Gas pockets) Acceptance criteria are given in Tables E.5 and E.6**
- Linear imperfections (cracks, lack of penetration or fusion) Acceptance criteria for are given in Tables E.8

Radiographic Inspection



Photo Courtesy of OSM Tubular Camrose

Non-Destructive Inspection (NDI) Requirements (cont'd)

Ultrasonic and Electromagnetic Inspection (API Spec 5L , Annex E)

- Acceptance criteria given in Clauses E.5.5 and E.5.6
- Disposition of pipes containing defects Clause E.10
 - **Remove defect by grinding**
 - **Repair by welding if permitted**
 - **Cut the section with defect out**
 - **Reject the pipe**
- Magnetic particle inspection Clause E.6
 - **If this method is employed for inspection of surface defects the entire length shall be inspected**

Electromagnetic Inspection



Photo Courtesy of OSM Tubular Camrose

Non-Destructive Inspection (NDI) Requirements (cont'd)

Hydrostatic Testing

- **Test requirements are given in Clause 10.2.6 and Table 26**
- **Table 26 lists the standard and alternative test pressures as a % of SMYS (specified minimum yield strength)**

Hydrotester SAW Line



Photo Courtesy of OSM Tubular Camrose

Hydrotester EW Line



Photo Courtesy of OSM Tubular Camrose

Marking (API Spec Q1, Section 7.5.3)

API Spec 5L, Section 11 and Annexes N and O

- Very prescriptive including the pipe attributes that must be marked on the pipe
 - *i.e.*, **Standard, diameter, wall thickness, grade, PSL, type of pipe (seamless or type of weld), annexes, and manufacturer**
- Provides specific examples on the marking sequence
 - **Both USC (US Customary) and SI units**
- Allows dual marking of Spec 5L and ISO 3183 if requirements of both specifications are met


Final Stencil Marking

Photo Courtesy of OSM Tubular Camrose



Monogramming (API Spec Q1, ANNEX A)

API Spec 5L, Annex O

- Application of the API Trademark  is permitted only by a licensee
- Provides specific examples on the marking sequence
 - **Both USC (US Customary) and SI units**
- In addition to annex allows marking of other standards if the requirements are met.
- Includes marking of couplings and small diameter pipe bundle tags

Retention of Records (API Spec Q1, Section 4.2.4)

API Spec 5L, Section 13

- Requires that records be retained for a minimum of 3 years (Spec Q1 requires a 5 year minimum retention)
- Section contains a list of the pertinent test and examination records
- Heat number
 - **Tensile/Guided Bend/Hydrotest, etc.**
 - **Nondestructive Inspections**
 - **Qualification for NDI Personnel**
 - **Welding WPS and PQRs**

Shipping

(API Spec Q1, Section 7.5.5)

API Spec 5L, Section 14 – Pipe loading

- **Manufacturer is responsible for properly loading the pipe**
- **Loading shall comply with jurisdictional rules, codes and standards**
 - API RP 5L1 is referenced for rail transport
 - API RP 5LW is referenced for marine transport by ship or barge.

Pipe Loading



Photo Courtesy
of OSM Tubular
Camrose

Transition from API 5L, 43rd Ed to 44th Ed

API modified their policy and extended the 6 month transition period to 12 months to allow manufacturers to switch their QA and manufacturing processes to the 44th edition requirements.

Published Date
October 1, 2007  **12 months** **Effective Date**
October 1, 2008

Industry Recommendation:

OPS/DOT harmonize the October 1, 2008 effective date with API for the 44th edition of 5L

Reasons for Extension of 5L Effective Date

Manufacturer Issues

- * Rewrite pipe tracking, marking and release computer systems;
- * Specify/purchase/manufacture new gauges;
- * Review/modify/purchase roll/die sets & marking systems; and
- * Modify mechanical & hydro testing equipment & software, and
- * Rewrite quality system documentation.

Operator Issues

- * Backlog/in-process orders starting on 43rd finishing 44th edition;
- * Mixed application of 43rd and 44th edition pipe; and
- * Inventory availability of new edition during transition.

Contact Information

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