

Line pipe Specification: Clauses in addition to API 5L/ISO 3183

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Introduction

This Specification, prepared by the EEMUA Materials Technology Committee, is an addendum to API 5L 45th Edition 2012 / ISO 3183 3rd Edition 2012 for line pipe up to and including Grade L555 / X80. It details the changes and modifications to API 5L / ISO 3183 generally specified by EEMUA members for line pipe to be employed for oil and gas transmission and distribution, both on land and sub sea. However, deviations to this Specification may be agreed in writing between the Purchaser and the Manufacturer for specific projects.

The numbering employed in this Specification corresponds directly to that in the API / ISO documents. Changes and modifications to API / ISO are identified as **Add**, **Modify to read**, or **Delete**. Paragraphs within API / ISO that are not revised by this Specification remain applicable.

It should be noted that Annex E of this Specification applies to all pipe and that Annex K relates only to pipe ordered for sour service. Two additional Annexes AA and BB have been added dealing with "Line pipe subjected to high strain" and "NDT procedures" respectively. A third Annex CC provides a Modular Pipeline Data Sheet.

1. Scope Modify to Read

This EEMUA Specification provides the requirements for seamless and welded line pipe, up to and including Grade L555 (X80), manufactured to product specification level PSL 2.

This Specification may also be applied to mother pipe intended for induction bending.

This Specification is not applicable to cast pipe.

2. Conformity

2.3 Compliance to this Specification Modify to read

1. Vendor, steel maker, plate / strip mill, and pipe mill shall operate a QMS in accordance with ISO 9001, or an alternative standard agreed by the Purchaser, which ensures that requirements of this Specification can be met reliably and consistently.
2. Vendor QMS shall include provision for the QA of raw materials, intermediate products, pipe manufacture, and final inspections.
3. Measuring and testing equipment shall be calibrated and certified as part of the QMS.
4. The effectiveness of the QMS shall be subject to monitoring by the Purchaser and may be audited following an agreed period of notice.

3. Normative references

The following bulleted list of documents are the normative references of this Specification. These documents are conditional elements of this Specification, required for the application of the document.

- API 5L1 – Railroad Transportation of Line Pipe
- API RP 5LT – Recommended Practice for Truck Transportation of Line Pipe
- API RP 5LW – Transportation of Line Pipe on Barges and Marine Vessels
- ASTM E29 2013 – Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- ASTM E140 Standard Hardness Conversion Tables for Metals. Relationship among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness and Leeb Hardness
- DNV OS F101 – Offshore standard: Submarine pipeline systems
- EFC 16 – Materials Requirements for Carbon and Low Alloy Steels for H₂S – Containing Environments in Oil and Gas Production
- EN ISO 9001 – Quality management systems – Requirements
- EN ISO 15156-2 Petroleum and natural gas industries – Materials for use in H₂S – containing environments in oil and gas production – Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons

4. Terms and definitions

4.14 EW pipe Modify to Read

Tubular product having one longitudinal seam produced by high frequency electric-welding.

4.18 HFW pipe Modify to Read

EW pipe produced with a welding current frequency equal to or greater than 150kHz.

4.36 Manufacturer Modify to Read

A pipe mill accepting a Purchase Order or contract to supply line pipe (in which case, Manufacturer and Vendor are the same entity). The duties of a Manufacturer may include responsibility for technical and quality matters relating to steelmaking and sourcing of plate from which the pipe is manufactured.

4.46 Pipe mill Modify to Read

The company responsible for manufacturing, testing, finishing, and supplying line pipe and the facilities at which these activities are conducted.

4.56 Seamless pipe Modify to Read

Pipe without a welded seam that was produced by a hot forming process without the application of any cold finishing or cold sizing unless agreed by the Purchaser.

Add

4.68 Calibration

A term that is interchangeable with instrument standardisation as defined in 4.29.

4.69 Consumable batch

A single heat of filler wire, a single blend of flux, or for covered electrodes or cored wire, the combination of a single heat of cored wire with a single dry blend of flux cover or core.

4.70 JCOE

Manufacturing process wherein pipe is made by forming and welding steel plate by bending it into a J shape, bending it into a C shape, bending it into an O shape, arc welding the abutting edges and expanding to control dimensions.

4.71 Manufacturing procedure specification

A document prepared by the Manufacturer defining each stage of the manufacturing, inspection, and testing processes and the control parameters or acceptance criteria that apply to each activity. The minimum contents of the MPS are as defined in Annex B.

4.72 Plate mill

The company rolling and / or heat treating steel plate from slab for supply to the pipe mill and the premises where these activities are carried out.

4.73 Purchaser's Inspection Engineer

The Purchaser's representative, based at the manufacturing facility during strip / billet / plate and pipe production, responsible for monitoring the Vendor's compliance with the approved production and quality management procedures.

4.74 Quality assurance

The planned and systematic actions necessary to ensure quality and provide confidence that a product or service meets the specified requirements of the Purchase Order.

4.75 Quality management system

The organisation structure, responsibilities, activities, resources, and events that together provide organised procedures and methods of implementation to ensure the capability of an organisation to comply with quality requirements.

4.76 Quality manual

A document setting out general quality policies, procedures, and practices of an organisation.

4.77 Quality plan

A document prepared by the Manufacturer or Vendor that sets out the specific quality practices, resources, and activities relevant to a particular contract or order.

4.78 Steel mill

The company manufacturing, refining, and casting steel to slab / billet for subsequent plate / strip manufacture and the premises where these activities are carried out.

4.79 Strip mill

The company rolling and / or heat treating steel coil from slab for supply to the pipe mill and the premises where these activities are carried out.

4.80 UOE

Manufacturing process wherein pipe is made by forming and welding steel plate by bending it into a U shape, bending it into an O shape, arc welding the abutting edges and expanding to control dimensions.

4.81 Vendor

A trading house or steel merchant acting on behalf of the Manufacturer or pipe mill, to which an enquiry has been issued or to which a Purchase Order or contract to supply line pipe has been awarded.

5. Symbols and abbreviated terms

5.2 Abbreviated terms

Add

AC	Alternating current
AUT	Automatic ultrasonic inspection
DC	Direct current
EMI	Electromagnetic inspection
FBE	Fusion bonded epoxy
FL	Fusion line
ID	Internal diameter
MDT	Minimum design temperature
MPS	Manufacturing procedure specification
MPQT	Manufacturing procedure qualification test
MUT	Manual ultrasonic testing
OD	Outside diameter
PWHT	Post weld heat treatment
QA	Quality assurance
QMS	Quality management system
QP	Quality plan
RT	X-ray inspection
SMLS	Seamless pipe
SMYS	Specified minimum yield stress
VT	Visual inspection

6. Pipe grade, steel grade and delivery condition

6.1 Pipe grade and steel grade

6.1.1 Clause deleted

6.1.2 Add

Only PSL 2 pipe shall be supplied.

6.2 Delivery condition Add

NOTE: Pipes manufactured in accordance with this Specification may be used as mother pipe for the production of induction bends. However, the steel processing and heat treatment, chemical analysis, mechanical properties and / or wall thickness of the main pipe order may not be suitable for induction bending. The specific requirements for the mother pipe should be agreed by the Purchaser, pipe mill and bend Manufacturer.

7. Information to be supplied by the purchaser

Add

The information provided in the Purchase Order shall be as defined in API 5L / ISO 3183, except as modified by the requirements of this Specification.

8. Manufacture

8.1 Process of manufacture Modify to read

1. HFW pipe shall not be manufactured by the use of cold forming subsequently followed by the use of thermo-mechanical forming.
2. HFW pipe shall be limited to a maximum wall thickness of 20.6mm (0.8in).
3. SAWL and SAWH pipe shall be supplied in the Q, N or M delivery condition, being cold formed without further heat treatment.
4. SAWL pipe shall be manufactured by the UOE, JCOE or roll bending process and shall have a single longitudinal weld seam.
5. SAWH pipe shall be limited to ≥ 610 mm OD (24in).

8.3 Starting material

8.3.2 Modify to Read

1. Steel shall not be made by the open hearth process.
2. Steel shall be fully killed and vacuum degassed. Vendors may offer alternative treatments to vacuum degassing, subject to the agreement of the Purchaser.
3. If the steel is not cast and processed to form pipe in an integrated facility, the name and location of each manufacturing plant involved shall be declared in the bid.
4. Slabs for plate or strip rolling and, blooms and billets for pipe rolling shall be produced by a continuous casting process that shall, as appropriate, include precautions to minimise the occurrence of centreline segregation. Other casting processes (e.g. ingot casting) may be offered subject to the agreement of the Purchaser.
5. A procedure for the evaluation of centerline segregation of slabs, plate and / or strip shall be provided and include the quality evaluation method and acceptance limits. This procedure shall be agreed with the Purchaser.
6. The surfaces of slab, blooms and billets / ingots shall be inspected visually for defects and, if necessary, scarfing shall be carried out to produce an acceptable surface for subsequent processing.
7. Unless full body UT of the completed pipe is employed, each coil or plate used for pipe manufacture shall be subjected to VT and UT in accordance with Annex E or Annex K, as appropriate, to ensure freedom from flaws and unacceptable laminations and/or major clusters of inclusions.

8. The Purchaser shall be notified if the Manufacturer intends to use either slit coil or slit slabs for pipe production and the Manufacturer shall provide evidence, additional to item 5 above, that an adequate procedure for the control of "edge" quality is in place. This procedure shall be agreed with the Purchaser.

8.3.6 Add

Prior to welding, the longitudinal edges of strip to be used for HFW pipe shall be machined to remove a minimum of 3mm (0.12 in) from each edge. The use of rotary shearing shall be agreed by the Purchaser.

8.5 Weld seams in COW pipe Modify to Read

1. Combination GMAW / SAW pipe may be offered, subject to the GMAW element consisting of a single root pass only, applied after forming, and followed by SAW from inside and outside surfaces.
2. The GMAW weld shall be completely re-melted by subsequent SAW.

8.6 Weld seams in SAW pipe

Add

8.6.1 Water injection lines

If the line pipe application is shown on the Purchase Order / data sheet as unlined water injection, welding consumables for all weld passes in SAWL or SAWH pipe shall have a nickel content of 0.7% to 1%, unless agreed otherwise with the Purchaser.

8.6.2 SAWH pipe

SAWH pipe shall be manufactured by either:

- a two step process in which the pipe forming and seam welding are undertaken as individual processes on separate production lines, or
- a single in line mill providing an essentially smooth product feed such that the welding travel speed does not fluctuate by more than $\pm 2\%$.

8.6.3 Control of welding consumables and batch testing

1. A satisfactory system for the control, issue, use, and systematic recording of welding consumables used for the production of pipe shall be demonstrated via the MPS and QP. Effective QA to ensure consistent quality of incoming welding consumables shall also be demonstrated.
2. Welding consumables having an ASME II classification with the suffix G or ISO classification with suffix Z, shall be of a consistent and nominally identical chemical composition.
3. The use of welding consumables not classified in accordance with ASME / ISO shall be subject to the agreement of the Purchaser.
4. All welding consumables shall deposit weld metal having a maximum of 5ml/100g diffusible hydrogen.

5. SAW fluxes that add alloying elements to the weld deposit shall not be permitted.
6. Batch testing of welding consumables and weld metal analysis shall ensure control within the range specified in the MPS (see Annex B).

8.8 Modify title to Read Treatment of weld seams in EW pipes

8.8.1 Delete

8.8.2 Modify title to Read PSL 2 HFW pipe

8.9 Cold sizing and cold expansion

Add

8.9.4

Seamless pipe shall not be cold expanded, cold sized or cold finished without the agreement of the Purchaser.

8.10 Coil / plate end welds Modify to Read

Pipe containing coil / plate end welds shall not be supplied.

8.11 Jointers

8.11.1 Modify to Read

Jointers shall not be supplied.

8.12 Heat treatment Add

Weld seam and full pipe body heat treatment procedures shall be agreed by the Purchaser. For furnace heat treatment the following information concerning the heat treatment facility shall be supplied:

1. Type of furnace (e.g. batch, walking beam, etc.).
2. Method of heating and fuel (if applicable).
3. Number, position of thermocouples / pyrometers and heating zones.
4. Calibration frequency of the thermocouples .
5. Arrangement of pipes within furnace .
6. Details of quenching parameters, as applicable.
7. Identification and control of individual pipes throughout the heat treatment cycle.

9. Acceptance criteria

9.1 General

9.1.2 Modify to Read

Pipe manufactured to a specific higher grade shall not be substituted for pipe ordered as a lower grade.

9.2 Chemical composition

9.2.2 / 9.2.3 Modify to Read

Chemical analysis shall also comply with the modified Table 5.

Table 5 (modified) Chemical composition for PSL 2 pipe

Element	Weight	Element	Weight
C (a)	0.12% max	Nb+V	0.10% max
Si	0.05% – 0.40%	Al	0.015% – 0.055%
Mn (b)	0.80% – 1.65%	Ca	0.006% max
P	0.018% max	As	0.03% max
S	0.005% max	Sb	0.01% max
V	0.08% max	Sn	0.01% max
Nb	0.05% max	Pb	0.01% max
Ti	0.04% max	Bi	0.01% max
Cu	0.35% max	B	0.0005% max
Cr	0.25% max	N	0.010% max
Mo	0.25% max	Al:N	2:1 min
Ni	0.35% max		
(a) For seamless pipe grades, C content may be increased in accordance with Table H1. The maximum C content for seamless L555 / X80 shall be 0.16%. (b) For each reduction of 0.01% below the specified maximum for C, an increase of 0.05% above the specified maximum for Mn is permissible, up to a maximum increase of 0.20%.			

Notes:

1. Scrap feedstock shall be checked for radioactivity. Maximum activity shall be 0.5 μ Sv/h.
2. The Purchaser shall be advised of any deviations from the limits placed on heat and product analyses in the MPS, and further qualification of a modified MPS may be required if the Purchaser considers the deviations significant.
3. If any part of the product analysis fails to comply with the limits in the Purchaser agreed MPS either the whole heat shall be rejected, or each pipe shall be fully analysed, and those failing to comply with the requirements shall be rejected.

9.2.4 Add

The maximum carbon equivalent, CE_{PCM} , based on product analysis shall be as follows:

- Grades up to and including L485 / X70 0.21
- Grade L555 / X80 0.22
- Maximum variation of CE_{PCM} on any given order +0.01 / - 0.02

9.2.5 Add

The maximum carbon equivalent, CE_{IIW} , based on product analysis shall be in accordance with Table H1 or 0.40%, whichever is the less. The maximum variation of CE_{IIW} on any given order shall be +0.01 / -0.02.

9.3 Tensile properties**9.3.2 Add**

1. The maximum allowable $R_{t0.5}$ shall not exceed the specified minimum value in Table 7 by more than 150MPa (21,700psi).
2. Tensile elongation shall be recorded and shall not be less than 22% for strip tensiles and 18% for round bar specimens.

Add**9.3.3**

The Purchaser shall specify the need for the determination of additional tensile properties at other than room temperature.

9.4 Hydrostatic test**9.4.1 Modify to Read**

Each pipe shall withstand the hydrostatic test without showing visible deformation or leakage through the weld seam or pipe body.

9.6 Flattening test Modify to Read

For all grades and thicknesses, flattening shall continue to 33% of the original OD without cracks or breaks occurring in the pipe or the weld.

9.8 CVN impact test for PSL 2 pipe

9.8.2 Pipe body tests Modify to Read

1. The minimum CVN impact requirements for each set of full size tests shall be 45J (34ft-lb) minimum average, 34J (25ft-lb) minimum individual, for all grades / ODs unless a higher requirement is specified in Table 8. The minimum shear area for each test shall be 75%.
2. The impact test temperature shall be based on wall thickness as detailed below.

Table 8A Impact test temperatures

Specified nominal pipe wall thickness (t)		Test temperature
mm	in	
$t \leq 20$	$t \leq 0.8$	-10°C (14°F) or MTD whichever is lower
$20 < t \leq 30$	$0.8 < t \leq 1.2$	MTD -10°C (14°F) or -10°C (14°F) whichever is the lower
$30 < t \leq 40$	$1.2 < t \leq 1.6$	MTD -20°C (-4°F) or -10°C (14°F) whichever is the lower
$t > 40$	$t > 1.6$	To be specified by the Purchaser

9.8.3 Pipe weld and HAZ tests Modify to Read

The requirements defined in 9.8.1 and 9.8.2, with the exception of the minimum shear area, shall also apply to impact testing of weld metal and HAZ. However, for impact test temperatures $\leq -30^{\circ}\text{C}$ (-22°F) and / or thicknesses $>40\text{mm}$ (1.6 in) the CVN impact values and / or the need for supplementary CTOD fracture toughness tests shall be agreed between the Purchaser and Manufacturer.

9.9 DWT test for PSL 2 pipe Modify to Read

DWT tests shall be carried out on pipe for gas service only. For each test (a set of two test pieces) the average shear fracture shall be $\geq 85\%$. The test shall be performed at the MDT. Where it is not possible to test a full thickness specimen, the test temperature shall be adjusted in accordance with API RP 5L3.

9.10 Surface conditions, imperfections and defects

9.10.1 General

9.10.1.2 Add

If cracks or leaks are detected, their location shall be clearly marked and the pipe length set aside for inspection or investigation by the Purchaser.

9.10.4 Laminations Modify to Read

1. Pipe bevels containing any size of lamination or other discontinuities shall be cut back until imperfections detectable by fluorescent MT or UT have been removed.
2. Acceptance criteria for laminations in the plate or strip for pipe manufacture shall be as defined in Annex E or Annex K as appropriate.

9.10.5 Geometric deviations

9.10.5.1 Modify to Read

Geometric deviations in the pipe body or across the longitudinal seam shall not exceed 1.5mm (0.06in) from the design form, as measured over an arc of not greater than 200mm (8in).

9.10.5.2 Modify to Read

Dents shall not be allowed.

Add

9.10.5.3 Surface condition—seamless pipe

The external surface of all seamless pipes shall be free from scabs, laps, shells, slivers, burrs, metallurgical tears and sharp edged discontinuities that may interfere with the application of thin film coatings (e.g. FBE) and multi-layer coatings where FBE forms the first layer.

9.10.6 Hard spots Modify to Read

1. The test method and procedure used to determine the extent of any hard spots shall be subject to agreement with the Purchaser.
2. Any hard spot, in any area of the pipe, larger than 50mm (2in) in any direction, shall be considered to be a defect if the hardness exceeds the limits in 10.2.4.8 or the equivalent in other hardness scales. Hardness conversions shall be in accordance with ASTM E140.
3. Pipes that contain unacceptable hard spots shall be treated in accordance with Annex C, C.3 b) or C.3 c).

9.10.7 Other surface imperfections Add

Sharp edged imperfections, regardless of depth, shall be considered as defects.

9.11 Dimensions, mass and tolerances

9.11.1 Dimensions

9.11.1.2 Modify to Read

The pipe shall be delivered with the OD and wall thickness specified in the Purchase Order.

9.11.1.3 Modify to Read

Pipe lengths shall be in accordance with the length requirements of 9.11.3.3 unless specified otherwise in the Purchase Order.

9.11.3 Tolerances for diameter, wall thickness, length and straightness

9.11.3.1 Modify to Read

1. OD shall be measured using a circumferential (pi) tape. Out-of-roundness shall be determined by direct measurement.
2. Tolerances for OD of pipe body shall be in accordance with Annex J, Table J3 modified in accordance with the following,

Seamless pipe:

- i. Unless restricted otherwise by API / ISO, the maximum positive OD tolerance shall be 3.2mm (0.125in) for all pipe sizes.
- ii. Along the entire length of the pipe, the maximum OD, measured at any point, shall not exceed the minimum OD, measured by the same technique at the same point, by more than 1% or 4.0mm (0.16in), whichever is less.

Welded pipe:

- i. Unless restricted otherwise by API / ISO, the OD tolerance shall be plus 2.5mm (0.1in), minus 1.5mm (0.06in) for all pipe sizes.
- ii. Peaking of the pipe body at the weld or on the pipe body shall not deviate by more than 1.5mm (0.06in) from the design form, as measured over an arc of not greater than 200mm (8in).

3. Tolerances for pipe ends

Seamless pipe:

- i. The tolerance on the ID within 100mm (4in) of the pipe ends shall be $\pm 1.5\text{mm}$ ($\pm 0.06\text{in}$).
- ii. The internal out-of-roundness within 100mm (4in) of the pipe end shall not exceed 3.0mm (0.12in) or 0.75% of the nominal ID, whichever is less.

Welded pipe:

- i. The tolerance on the ID within 100mm (4in) of the pipe ends shall be $\pm 1.5\text{mm}$ ($\pm 0.06\text{in}$).
- ii. The internal out-of-roundness within 100mm (4in) of the pipe end shall not exceed 7.5mm (0.30in) or 0.75% of the nominal ID, whichever is less.

Table 10 Delete

9.11.3.2 Modify to Read

Wall thickness tolerances shall be as follows:

Seamless pipe:

Nominal wall thickness $\leq 25\text{mm}$ (1.0in) $\pm 12.5\%$

Nominal wall thickness $> 25\text{mm}$ (1.0in) $\pm 10\%$

(with a max positive tolerance of 3.2mm (0.125in) and a maximum negative tolerance of 3.0mm (0.12in).