

DEP SPECIFICATION

**LINE PIPE FOR CRITICAL SERVICE
(AMENDMENTS/SUPPLEMENTS TO ISO 3183:2012 AND
API SPEC 5L 45th EDITION)**

DEP 31.40.20.37-Gen.

February 2013

DESIGN AND ENGINEERING PRACTICE

DEM1



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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the manufacture and supply of carbon and low-alloy steel line pipe for use in pipelines where the service has been evaluated by the Principal as being "Critical". Guidance on the evaluation of pipeline service criticality and line pipe selection is given in DEP 31.40.00.10-Gen.

This DEP applies to the following applications; see also (Part II, 1.2).

- a. All offshore pipelines;
- b. All onshore pipelines except those classified as "Line Pipe for Non Critical Service". Refer to Part II 1.2 for the definition of "Non Critical Service".
- c. All pipelines designed for sour service;
- d. All pipelines subject to high strain above normal elastic design limits (more than 0.3 %) in installation or service;
- e. All line pipe ordered with resistance to ductile fracture propagation.

This DEP is applicable only to grades L245 up to L555 (X80) as designated in ISO 3183:2012 and API SPEC 5L 45th Edition.

This DEP is based on ISO 3183:Third Edition 2012 and API SPEC 5L 45th Edition. Part III of this DEP amends, supplements and deletes various clauses of ISO 3183 and API SPEC 5L (PSL2). Part III follows the clause numbering of ISO 3183 and API SPEC 5L (PSL2) for easy reference.

All clauses of ISO 3183 and API SPEC 5L (PSL2) not modified by this DEP remain valid as written.

The amendments and supplements in this DEP apply equally to API SPEC 5L, 45th edition (PSL2), which contains the identical section numbers and content, with the exception of minor deviations listed in Annex M, N and O.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2011; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
Manufacturer	Term used in ISO 3183:2012 and API SPEC 5L 45 th Edition, which shall be taken to mean the Manufacturer/Supplier.
Purchaser	Term used in ISO 3183:2012 and API SPEC 5L 45 th Edition, which shall be taken to mean the Principal.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (Part IV).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2011, which was based on ISO 3183-2007 and API SPEC 5L 44th edition.

This update incorporates the updates from ISO 3183:2012 and API SPEC 5L 45th edition and feedback from users and pipe mills. Due to the numerous changes in overall scope and clause numbering, it is impractical to summarise the changes here.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://sww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

PART II GENERAL REQUIREMENTS

1.1 GENERAL

Part III of this DEP is written as amendments and supplements to ISO 3183:2012 and API SPEC 5L 45th edition. Wherever reference is made to ISO 3183:2012 and/or API SPEC 5L 45th edition, it shall be understood to mean ISO 3183:2012 and/or API SPEC 5L 45th edition as amended/supplemented by this DEP.

For ease of reference, the clause numbering of ISO 3183:2012 and API SPEC 5L 45th edition have been used throughout Part III of this DEP.

Clauses in ISO 3183:2012 and API SPEC 5L 45th edition, which are not mentioned in this DEP shall remain valid as written.

Tables and figures in this DEP not replacing the corresponding item in ISO 3183:2012 and API SPEC 5L 45th edition are numbered related to the DEP section they are contained in (e.g., Figure 10.2.5.3).

1.2 APPLICATION

Carbon steel line pipe SHALL [PS] be ordered using this DEP for the following applications:

- a. All offshore pipelines;
- b. All onshore pipelines except those classified as "Linepipe for Non Critical Service". Refer to the section below for the definition of "Non Critical Service".
- c. All pipelines designed for sour service;
- d. All pipelines subject to high strain above normal elastic design limits (more than 0.4 %) in installation or service;
- e. All line pipe ordered with resistance to ductile fracture propagation.

Line pipe for onshore applications not addressed above may be designated "Line Pipe for Non-Critical Service" (i.e., pipelines designed for non-sour service and where line pipe is not required to be resistant to ductile fracture propagation or high strain) and may be ordered in accordance with ISO 3183 or API SPEC 5L PSL2 without amendment.

To be classified as Line Pipe for Non-Critical Service all of the following conditions shall be satisfied:

- a. The maximum design pressure does not exceed 40 barg (580 psig); and,
- b. The pipeline has been designed with a design factor of 0.5 or lower; and,
- c. The pipeline is designed for the transportation of category A, B or C fluids (i.e. not for D and E fluids), refer to ISO 13623 Section 5, Table 1 for fluid definitions; and,
- d. The pipeline has a diameter of DN 250 (NPS 10) or less; and,
- e. The minimum pipeline design temperature is 0 °C (32 °F) or greater; and,
- f. The pipeline does not form part of a main transportation infrastructure.

Line pipe shall only be ordered in accordance with ISO 3183:2012 or API SPEC 5L 45th edition (PSL1) for non hydrocarbon, non toxic, low pressure, i.e., Category A fluids, (with a maximum design pressure of 20 Barg (2900 psig), and with a minimum design temperature greater than 0 °C (32 °F).

Use of SAWH line pipe should be considered for onshore applications where the diameter and wall thickness requirements are within the manufacturing range for SAWH line pipe (above 610 mm [24 in]), below this size HFW is generally used). SAWH line pipe shall not be used where:

- a. OD of the seam welds are at risk of corrosion due to water drop out, (SAWH pipe may be considered but requires analysis of the service conditions and potential for corrosion on a helical weld seam) or

- b. The use of reliability-based limit state design principles is required to confirm design or operational integrity, or in sour service.

Prior to order placement, the pipe mill and all sources of coil shall be evaluated technically and approved.

1.3 PRINCIPAL'S ACCESS AND ACTIVITIES

Principal's representatives shall be permitted to witness all chemical testing, mechanical testing, and equipment calibration, and to inspect all pipe. Sufficient notice (at least 14 days) shall be given of the time at which the production run is to begin.

The Principal's representatives shall have free entry at all times to all parts of the Manufacturer's works that will concern the manufacture, testing, inspection, quality control and shipping of the pipe ordered. This includes the steel mill and the pipe mill. The Manufacturer shall make available to the Principal, without charge, all reasonable facilities to inspect, measure, and test the pipe in all stages of production. For example, this includes ultrasonic equipment for wall thickness confirmation.

The Principal shall have the option to examine all materials rejected for any reason. The Principal's representative must be informed of any pipe fractures occurring during hydrostatic testing and of any test specimen failures to meet the requirements for any reason. All failed materials shall be retained until examined by the Principal's representative.

The Manufacturer shall allow the Principal to inspect each length of pipe after manufacture and testing are completed but prior to loading for shipment.

1.4 PIPE FOR INDUCTION BENDS

The general requirements of ISO 3183:2012 and API SPEC 5L 45th edition and this DEP apply to pipe intended for induction bending. However, the composition, mechanical properties and dimensions of such pipe shall be dictated by the dimensions and delivery condition of the completed bends, which shall be in accordance with ISO 15590-1 and DEP 31.40.20.33-Gen. The composition, mechanical properties and dimensions of this pipe shall therefore be by agreement between the Manufacturer and the Principal.

1.5 SMALL PIPE ORDER QUANTITIES

Where small quantities of pipe are required (less than a normal pipe mill order, e.g., for spools induction bend mother pipe, or risers), the options are to:

- a. Place an order with small volume pipe mills. A number of pipe mills, using bending roll or press forming, mainly SAWL can often provide small quantities of pipe.
- b. Consider pipe in stock.

However, these shall be produced by a Shell approved steel mill and pipe mill. Pipe from stock shall be evaluated and a gap analysis undertaken from actual production data and this DEP requirements. Pipe from stock will usually require supplementary tests (NDT and mechanical) to ensure compliance with the DEP.

PART III AMENDMENTS/SUPPLEMENTS TO ISO 3183:2012 and API SPEC 5L 45th EDITION

1 Scope

Amend first paragraph as follows:

This International Standard specifies requirements for the manufacture of product specification level PSL 2 of seamless and welded pipe for use in pipeline transportation systems in the petroleum and natural gas industries.

Add the following:

This DEP is applicable only to grades L245 (Grade B) up to and including L555 (X80) as designated in ISO 3183:2012 and API SPEC 5L 45th edition. Grades above L555 (X80) may be used when specifically approved by the Principal and testing requirements agreed on a project by project basis.

2 Conformance

2.3 Compliance to this International Standard

Replace this clause with the following:

The Manufacturer/Supplier SHALL [PS] maintain and operate a quality assurance system in accordance with ISO 9001 or an alternative standard approved by the Principal.

3 Normative references

Add the following:

See also (Part IV) of this DEP.

4 Terms and definitions

4.18 EW pipe

Replace this clause with the following:

Tubular pipe having one longitudinal weld seam produced by high frequency electric current with a frequency equal to or greater than 100 kHz.

4.36 Manufacturer

Add the following:

Where pipe manufacturing and/or heat treatment are subcontracted, the pipe mill and/or the processor shall also be considered to be the Manufacturer/Supplier.

5 Symbols and abbreviated terms

5.2 Abbreviated terms

Add the following:

AUT	automatic ultrasonic testing
FBE	fusion bonded epoxy
GMAW	gas metal arc welding
SCR	steel catenary riser
ToFD	time of flight diffraction

6 Pipe grade, steel grade and delivery condition

6.1 Pipe grade and steel grade

Delete this clause:

6.1.1

6.2 Delivery condition

Delete this clause:

6.2.1

Table 1 – Pipe Grades, steel grades and delivery conditions

Delete reference to PSL1 pipe grades.

Delete reference to PSL 2 Grades, L625M, L690M and L830M.

Add the following note:

NOTE: Pipes fabricated from thermomechanical rolled material may not be suitable for hot (induction) bending unless chemistry/strength is increased and/or specific post bend heat treatments are undertaken.

7 Information to be supplied by the purchaser

Add the following:

The complete information should be provided at the enquiry stage of the purchase order; however, requirements specifically addressed by this DEP need not be repeated.

Note: A standard line pipe order form is attached in Appendix 5 which should be used for initial technical enquiries with pipe mills.

7.1 General information

b) *Delete PSL1*

Add the following:

- i) Minimum design temperature (for determination of CVN, DWT and CTOD test temperature)
- j) Intended service, i.e., gas or oil or dual phase for determination of need for, resistance to ductile fracture propagation, sour service high strain, and deep water.

7.2 Additional information

Add the following:

a)

10) Diameter and out-of-roundness for pipes with $D/t > 75$

Information included in this DEP.

a)3), a)4), a)6), b)4), b) 6), b)7)

c)6) c)7), c)8), c)9), c)10), c)11), c)12), c)15), c)16), c)22), c)23), c)25), c)26), c)27), c)40), c)42), c)43), c)44), c)46), c)47), c)49), c)51), c)128)

Information not applicable to this DEP.

a)1), a)2), a)9)

b)2), b)3), b)5), b)8), b)11) b)12)

c)2), c)5), c)7), c)13), c)13), c)17), c)18), c)24), c)38), c)50), c)53), c)57), c)60)

8 Manufacturing

8.1 Process of manufacture

Replace this clause with the following:

Only PSL 2 pipe shall be supplied in accordance with this DEP.

Table 2 – Acceptable processes of manufacture and product specification levels

Delete references to PSL1 grades.

Delete, "Double-seam SAWL and Double-seam COWL"

Delete Note c.

Delete Note d and substitute: SAWH is applicable for 610 mm OD (24 inch) and above when specifically approved by the Principal.

Add Note g; "HFW pipe is generally limited to a maximum wall thickness of 20.6 mm (0.8 in). Thickness over 20.6 mm (0.8 in) may be considered after detailed evaluation, approval by the Principal shall be on a project by project basis."

Add Note h: "COW pipe is acceptable only with prior approval by the Principal of the welding processes used. GMAW is not an acceptable welding process."

Replace Table 3 with the following:

Table 3 – Acceptable manufacturing routes for PSL 2 pipe

Type of pipe	Starting material	Pipe forming	Pipe heat treatment	Delivery condition
Seamless	Ingot, bloom or billet	Normalising forming (NOTE 1)		N
		Hot forming	Normalising	N
			Quenching and tempering	Q
		Hot forming and cold finishing	Normalising	N
			Quenching and tempering	Q
HFW	Normalising rolled strip	Cold forming	Normalising weld area	N
	Thermomechanically rolled strip	Cold forming	Heat treating weld area	M
			Heat treating weld area and stress relieving (entire pipe)	M
	Hot rolled strip	Cold forming	Normalising (entire pipe)	N
			Quenching and tempering (entire pipe)	Q

Type of pipe	Starting material	Pipe forming	Pipe heat treatment	Delivery condition
SAW	Normalised or normalising rolled plate or strip	Cold forming		N
	Thermomechanically rolled plate or strip	Cold forming		M
	Quenched and tempered plate	Cold forming		Q
	As rolled, normalised, or normalising rolled plate or strip	Cold forming	Quenching and tempering (entire pipe)	Q
NOTE: The finishing temperature shall be greater than 780 °C (1435 °F). Pipe finished at a lower temperature than 780 °C (1435 °F), shall be subjected to a further normalising heat treatment.				

8.3 Starting materials

8.3.6 Add the following:

The abutting edges of strip or plate to be HFW welded shall be milled or machined. Rotary shearing shall not be considered as machining. Rotary shearing may be considered for specific purchase orders, with Principal prior approval, only for pipe of 8 mm (0.315 in) wall thickness or less, with a diameter of pipe of 273 mm (10 in) or less with a pipeline design temperature of not less than -10 °C.

Add new clause:

8.3.10 Centreline segregation of slabs, plate and coil.

A procedure for evaluation of centerline segregation shall be provided, with quality evaluation method and acceptance limits. This shall be approved by the Principal.

8.4 Tack welds

8.4.2 Tack welds shall be:

Add the following:

Made using a continuous single pass unless otherwise agreed with the Principal.

8.6 Weld seams in SAW pipe

Add the following:

The seam welding of SAWH pipe shall be carried out as a separate process from the forming operation (i.e. the welding speed shall be independent of the forming speed, this is referred to as a 2 step mills).

8.8 Treatment of weld seams in EW and LW pipes

Delete this clause:

8.8.1 PSL 1 EW Pipe

8.8.2 LW pipe and PSL 2 HFW pipe

Add the following:

See also Table 3 for acceptable heat treatment routes.

8.9 Cold sizing and cold expansion

8.9.2 *Replace this clause with the following:*

Cold expansion shall be performed by mechanical means only. The sizing ratio for cold-expanded pipe shall not be less than 0.008 or more than 0.015.

8.10 Coil/plate end welds

Replace this clause with the following:

Pipe containing strip end welds shall not be supplied.

8.11 Jointers

Replace this clause with the following:

Jointers shall not be supplied.

8.12 Heat treatment

Add the following:

In addition, the Manufacture shall supply the following information concerning the heat treatment facility for approval by the Purchaser:

- a. Type of furnace (e.g., batch, walking beam, etc.);
- b. Method of heating and fuel (if applicable);
- c. Number, position of thermocouples and controlled heating zones;
- d. Calibration frequency of the thermocouples
- e. Arrangement of pipes with furnace;
- f. Identification and control of individual pipes throughout the heat treatment cycle.

8.13 Traceability

Delete this clause:

8.13.1

9 Acceptance criteria

9.1 General

9.1.2 *Replace this clause with the following:*

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

9.2 Chemical composition

Delete this clause:

9.2.1

9.2.2 *Replace this clause with the following:*

Table J1 shall apply for all pipe grades and for pipe with $t \leq 35$ mm (1.38 in) (other than for sour service where Table H.1 shall apply) but shall not include Grades, L625M, L690M and L830M.

The chemical composition limits of pipe with $t > 35$ mm (1.38 in) shall be by agreement or as stated in the purchase order.

The Manufacturer/Supplier's target product analysis shall be shown in the Manufacturing Procedure Specification. A single value target of CE_{iiw} or CE_{pcm} shall be stated. The range of elements shall be such that the variation in the single value target CE_{iiw} does not exceed ± 0.03 units or CE_{pcm} does not exceed ± 0.02 units with the following additional restrictions:

C	0.03 (HFW and SAW) 0.04 (SMLS)
Mn	0.30
Si	0.25
Ni	0.10
Cu	0.10
V	0.03
Nb	0.02
Al	0.04
Ti	0.015
Mo	0.05
Cr	0.05

NOTE The above figures represent the total range and not a plus or minus tolerance.

No changes in the chemical composition (within the tolerances listed above) are permitted from the approved MPS composition. In particular no intentionally added elements shall be increased (beyond the limits above) or removed.

The chemical composition recorded for the pipes used in first-day production testing shall set the reference CE. Where any of the above elements is not intentionally added, the manufacturer may propose maximum values for approval by the Principal. In this case the above ranges shall not apply.

The chemical analysis and reporting in inspection documents shall include all elements covered by the requirements of Annex J Table J1.

Delete this clause:

9.2.3

Delete this table:

Table 4 – Chemical composition for PSL 1 pipe with $t \leq 25.0$ mm (0.984 in)

Replace this table with Annex J Table J1.

Table 5 — Chemical composition for PSL 2 pipe with $t \leq 25.0$ mm (0.984 in)

9.3 Tensile properties

Delete this clause:

9.3.1

Delete this table:

Table 6 — Requirements for the results of tensile tests for PSL 1 pipe

Replace this table with Annex J Table J2.

Table 7 — Requirements for the results of tensile tests for PSL 2 pipe

9.4 Hydrostatic test

Delete this clause:

9.4.2

9.6 Flattening test

Replace this clause with the following:

No cracks or breaks shall occur in either weld or parent metal during flattening of the test specimen to 50 % of the original OD. The specimen shall be further flattened to 1/3 of original OD without cracks or breaks other than in the weld.

9.8 CVN impact test for PSL2 pipe

9.8.2 Pipe body tests

9.8.2.1 Replace this clause with the following:

The minimum average (of a set of three test pieces) absorbed energy for each pipe body test shall be as given in Table 8, based upon full-size test pieces. The test temperature shall be lower than or equal to that specified in the table below.

Nominal wall thickness, t (mm)	Test Temperature (°C)	Maximum test temperature (°C)
$t \leq 20$	T_{min}	0
$20 < t \leq 30$	$T_{min} - 10$	0
$30 < t \leq 40$	$T_{min} - 20$	0
$40 < t$	To be advised by the Principal	
Nominal wall thickness, t (in)	Test Temperature (°F)	Maximum test temperature (°F)
$t \leq 0.80$	T_{min}	32
$0.80 < t \leq 1.2$	$T_{min} - 18$	32
$1.2 < t \leq 1.6$	$T_{min} - 36$	32
$1.6 < t$	To be advised by the Principal	

T_{min} is the minimum design temperature, which shall be specified in the purchase order. If no minimum design temperature is indicated, it shall be taken as 0 °C (32 °F).

9.8.3 Pipe weld and HAZ tests

Replace this clause with the following:

The absorbed energy requirements for weld and HAZ tests SHALL [PS] be as specified in Table 8 of this DEP.

If any specimen displays a value less than 60 % of the value in Table 8 (or a greater value if specified in the specific project requirements), the Manufacturer shall fully investigate the cause and advise the Principal.

For pipelines in rich gas service or CO₂ and pipelines subjected to high strain, the values in Table 8 may be increased on a project-by-project basis, This will be specified in project specifications when applicable. DEP 31.40.00.10-Gen., section 8.1.6 provides design information and requirements.

The test temperature shall be as specified for the pipe body.

Replace Table 8 with the following:

Table 8 – CVN absorbed energy requirements for PSL2 pipe

Grade	Full-size CVN absorbed energy Minimum average value (of the set) J	Full-size CVN absorbed energy Minimum average value (of the set) ft-lbf
	Pipe body, Weld and HAZ	
L245 (B)	40	30
L290 (X42)	40	30
L320 (X46)	40	30
L360 (X52)	40	30
L390 (X56)	40	30
L415 (X60)	45	34
L450 (X65)	45	34
L450 (X65) >1219 mm (48 in) to 1422 mm (56 in) OD	54	40
L450 (X65) >1422 mm (56 in) OD	68	50
L485 (X70)	54	40
L485 (X70) >1219 mm (48 in) to 1422 (56 in) OD	68	50
L485 (X70) >1422 mm (56 in) OD	81	60
L555 (X80)	54	40
L555 (X80) >1219 mm (48 in) to 1422 mm (56 in) OD	68	50
L555 (X80) >1422 mm (56 in) OD	81	60

9.9 DWT test for PSL2 welded pipe

9.9.1 Replace this clause with the following:

For each test (a set of two test pieces), the average shear fracture shall be $\geq 85\%$ with no individual specimen less than 50 % shear area. The test shall be performed at the minimum design temperature specified by the Principal in the purchase order. Where it is not possible to test a full thickness specimen, the test temperature shall be adjusted in accordance with API RP3.

9.10 Surface conditions, imperfections and defects

9.10.5 Geometric deviations

9.10.5.2 Replace this clause with the following:

For dents, the length in any direction shall not exceed 25 % of the pipe diameter.

All sharp gouges (with or without dent) of 1 mm (0.04 in) or greater depth shall be considered a defect.

Cold formed dents without sharp bottom gouges may be acceptable to a maximum depth of 3.2 mm (0.125 in).

Add new clause:

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 (e.g., FBE) coatings and multi-layer coatings where FBE forms the first layer.

Prior to manufacturing procedure qualification, the manufacturer shall submit, for approval by the Principal, acceptance criteria for the surface condition of all seamless pipe, together with historic evidence of the successful FBE coating of such pipe without excessive remedial work.

In the absence of such historic data, the Principal may require the blast cleaning and examination of three pipes during manufacturing procedure qualification and one pipe per 10 test units during production.

The pipes shall be selected at random and heated to a minimum of 70 °C (160 °F). The outside surface shall be blast cleaned to a surface finish of SA2½ and the pipe then reheated to 270 °C (520 °F). Each pipe shall be examined visually over its entire surface for imperfections: that could interfere with the FBE coating process.

If this pipe(s) is rejected then the remaining pipes from the test unit, and one pipe from each subsequent test unit, shall be blast cleaned and examined.

9.11 Dimensions, mass and tolerances

9.11.3.1 *Replace this clause with the following:*

The diameter and out of roundness tolerances of Annex J Table J3 as amended by this DEP, shall also apply to all pipe ordered for onshore service.

Replace this table with Annex J Table J3:

Table 10 – Tolerances for diameter and out-of-roundness

Modify Table J3 as follows:

The pipe end out of roundness tolerances for pipe of D't >75 shall be agreed with the Principal.

Delete footnote "c" of Table J3 and replace with:

Unless otherwise agreed by the Principal pipe with $D \geq 219.1$ mm (8.63 in), the diameter tolerance and out-of-roundness shall be determined using the measured inside diameter. Table J OOR tolerance for OD shall also be maintained.

Add footnote "e" to Table J3:

Pipe end rectification can be applied to achieve diameter and OOR tolerance, subject to review and approval of the rectification procedure by the Principal.

9.11.3.2 *Replace this clause with the following:*

The tolerances for wall thickness shall be as given in Annex J Table J4.

Replace Table 12 with the following:

Table 12 – Tolerance for random length pipe

Random length designation m	Minimum length m	Minimum average length for each order item m	Maximum length m
12	9	11.5	13.70
15	12	14.25	16.70
18	15	17.0	19.80
Random length designation ft	Minimum length ft	Minimum average length for each order item ft	Maximum length ft
40	30	38	45
50	40	47	55
60	50	56	65

9.11.3.4 *Amend this clause as follows:*

- a. The total deviation from a straight line, over the entire pipe length, shall be $\leq 0.15\%$ of the pipe length, as shown in Figure 1.
- b. The local deviation from a straight line at each end of 1 m (4 ft) section shall be ≤ 3.0 mm (0.12 in) as shown in Figure 2.

9.12 **Finish of pipe ends**

9.12.1 **General**

Delete this clause:

9.12.1.1

Delete this clause:

9.12.2 **Threaded ends (PSL1 only)**

Delete this clause:

9.12.3 **Belled ends (PSL1 only)**

9.13 Tolerances for the weld seam

9.13.1 Radial offset of strip/plate edges

Replace Table 14 with the following:

Table 14 — Maximum permissible radial offset for SAW and COW pipes

Specified wall thickness, T mm	Maximum radial offset mm
$T \leq 10$	1.0
$10 < T \leq 20$	0.1 T
$T > 20$	2.0
Specified wall thickness, T in	Maximum radial offset in
$T \leq 0.4$	0.04
$0.4 < T \leq 0.8$	0.1 T
$T > 0.8$	0.08

9.13.2.2

b) Add the following:

For SAWH weld beads, the weld cap profile shall exhibit minimal or no concavity. For SAW and COW, the cap profile shall be approved by the Principal at MPS stage. For SAWH a sample acceptable weld cross section macro shall be retained as a standard sample of acceptable cap profile.

Selection item e)

The outside weld bead shall be removed by grinding for a distance of at least 150 mm (6 in) from pipe end for all pipe ordered.

NOTE: Removal of the outside weld bead is required wherever AUT is intended to be performed on girth welds during pipeline installation.

9.14 Tolerances for mass

9.14.1 Replace items a), b) and c) with the following:

For all pipes: +10.0 %, -3.5 %

9.14.3 Replace items a) and b) with the following:

For all grades: -1.75 %

9.15 Weldability of PSL2 pipe

Add the following:

For all offshore pipelines and for other pipelines where specified in the purchase order, weldability trials shall be carried out. The material shall be as qualified in the manufacturing procedure qualification (Annex B), within the limits specified in (B.5). The requirements for weldability testing are given in (Appendix 2).

10 Inspection

10.1 Types of inspection and inspection documents

Delete this clause:

10.1.2 Inspection documents for PSL1 pipe

10.2 Specific inspection

10.2.1 Inspection frequency

Delete this clause:

10.2.1.1

Delete this table:

Table 17 — Inspection frequency for PSL 1 pipe

Replace Table 18 with the following:

Table 18 – Inspection frequency for PSL 2 pipe

Type of inspection	Type of pipe	Frequency of inspection
Heat analysis	All pipe	One analysis per heat of steel
Product analysis	SMLS, HFW, SAW COW	Two analyses per heat of steel (taken from separate pipes)
Tensile testing of the pipe body	SMLS, HFW, SAW COW	Two tests per test unit ^(c) of pipe with the same cold expansion ratio ^(a) . One test for heats less than 100 tonnes (110 tons), but at least one test per 200 pipes. For pipe of D > 323.9 mm (12.75 in), at least one test per 100 pipes.
Tensile testing of longitudinal or helical weld	HFW, SAW, COW	Two tests per test unit of pipe with the same cold expansion ratio ^{(a),(b)} . One test for heats less than 100 tonnes (110 tons) but at least one test per 200 pipes. For pipe of D > 323.9 mm (12.75 in), at least one test per 100 pipes.
CVN impact testing of pipe body	SMLS, HFW, SAW COW	Two tests per test unit of pipe with the same cold expansion ratio ^(a) . One test for heats less than 100 tonnes (110 tons). For test temperature of -10 °C (14 °F) or below, one test for each 100 pipes.
CVN impact testing of longitudinal weld	HFW	At least once per shift. Whenever the pipe diameter or thickness changes. At least once per five coils. For test temperature of below -10 °C (14 °F), one test for each 100 pipes.
CVN impact of longitudinal or helical weld	SAW, COW	Two tests each for weld, fusion line, FL+2, FL+5 locations per test unit of pipe with the same cold expansion ratio ^{(a),(b)} . One test for heats less than 100 tonnes (110 tons). For test temperature below -10 °C (14 °F), one test for each 100 pipes.

Type of inspection	Type of pipe	Frequency of inspection
DWT testing of the pipe body of welded pipe with $D \geq 406.4$ mm (16 in) Applicable to gas pipelines only.	HFW, SAW, COW	Once per test unit with the same cold expansion ratio (a)
Guided-bend testing of the longitudinal or helical seam weld of welded pipe	HFW, SAW, COW	At least one test for not less than 50 lengths of pipe with the same cold expansion ratio (a). except for HFW pipe one test per 100 lengths of pipe with the same cold expansion ratio (a).
Flattening test of welded pipe	HFW	As shown in Figure 6, but applicable to all pipe diameters.
Hardness test on body and seam weld	SMLS, HFW, SAW, COW	One test per test unit (c)
Hardness testing of hard spots in cold-formed welded pipe	HFW, SAW, COW	Any hard spot
CTOD testing	SMLS, HFW, SAW, COW, (e)	Once; for manufacturing procedure qualification only. For HFW applicable for L450 (X65) and above and 16 mm (0.63 in) wall thickness and above.
Hydrostatic testing	SMLS, HFW, SAW, COW	Each pipe
Metallographic testing of the longitudinal or helical seam weld of welded pipe	SAW, COW, SAWH	At least once per shift or when pipe diameter or thickness is changed
Metallographic testing of the longitudinal seam weld of welded pipe	HFW	Manufacturing procedure qualification test: Each pipe Production: At least once per shift. Whenever the pipe diameter or thickness changes. At least once per five coils. Whenever significant excursions in the operating heat treatment conditions are encountered.
Grit blasting and visual examination of outer surface (if required by the Principal)	SMLS	(a) Manufacturing procedure qualification test: Three pipes (b) Production TBA
Visual inspection	SMLS, HFW, SAW, COW	Each pipe
Pipe diameter and out of roundness	SMLS, HFW, SAW, COW	One pipe out of every 20 pipes, but not less than once per 4 hour operating shift or whenever any change in pipe diameter or wall thickness occurs.
Wall thickness measurement	SMLS, HFW, SAW, COW	Each pipe (see 10.2.8.5)

Type of inspection	Type of pipe	Frequency of inspection
Other dimensional (scope to be agreed with the Principal)	SMLS, HFW, SAW, COW	At least once per 4 hour operating shift (3x per 12 hour shift, start middle and end of shift) or if required by the purchase orders, one pipe out of every 20 pipes.
Weighing of pipe with $D < 141.3$ mm (5.563 in)	SMLS, HFW, SAW, COW	Each pipe or each lot, with the choice being at the discretion of the manufacturer
Weighing of pipe with $D \geq 141.3$ mm (5.563 in)	SMLS, HFW, SAW, COW	Each pipe
Length	SMLS, SAW, COW, HFW	Each length of pipe shall be measured except that pipe made in lengths that are uniform within 30 mm (0.1 ft) need not be individually measured, provided the accuracy of lengths is verified at least once per 4 hour operating shift or once every 20 pipes whichever is the greater.
Non-destructive testing	SMLS, HFW, SAW, COW	Each pipe in accordance with (Annex E).
NOTES: a) The cold-expansion ratio is designated by the manufacturer and is derived using the designated before expansion outside diameter or circumference and the after expansion outside diameter or circumference. An increase or decrease in the cold-expansion ratio of more than 0.002 requires the creation of a new test piece. b) In addition, pipe produced by each welding machine shall be tested at least once per week. c) Test unit is as defined in 4.62. d) Test piece is as defined in 4.61. e) Mandatory for offshore service, and onshore service for high strain design pipelines and where specified in the purchase order. For HFW applicable to L450 (X65) and above 16 mm (0.63 in) wt and when specified in the purchase order.		

Delete this table:

Table 19 — Number, orientation and location of test pieces per sample for mechanical tests for PSL 1 pipe

Replace Table 20 with the following:

Table 20 – Number, orientation and locations of test pieces per sample for mechanical tests

Type of pipe	Sample location	Type of test	Number, orientation, and location of test pieces per sample ^(a)		
			Specified outside diameter <i>D</i> in mm and (in)		
			< 219.1 (8.63)	219.1 (8.63) to < 406.4 (16)	≥ 406.4 (16)
SMLS, cold expanded and not cold-expanded [see Fig 5 a]	Pipe body	Tensile	1L ^(b)	1T ^(c) & 1L	1T ^(c) & 1L
		CVN	3T ^(e) & 1L	3T ^(e) & 1L	3T ^(e) & 1L
		Hardness	1T	1T	1T
HFW [see Figure 5 b]	Pipe body	Tensile	1L90 ^(b)	1T180 ^(c) & 1L	1T180 ^(c) & 1L
		CVN	3T90 & 1L	3T90 & 1L	3T90 & 1L
		DWT	—	—	2T90
	Seam weld	Tensile	—	1W	1W

Type of pipe	Sample location	Type of test	Number, orientation, and location of test pieces per sample ^(a)		
			Specified outside diameter <i>D</i> in mm and (in)		
			< 219.1 (8.63)	219.1 (8.63) to < 406.4 (16)	≥ 406.4 (16)
		CVN	3W	3W	3W
		Hardness	1T	1T	1T
	Pipe body and weld	Flattening	As shown in Figure 6 for all pipe sizes		
SAWL or COWL [see Figure 5 b]	Pipe body	Tensile	1L90 ^(b)	1T180 ^(c) & 1L	1T180 ^(c) & 1L
		CVN	3T90 ^(f) & 1L	3T90 ^(f) & 1L	3T90 ^(f) & 1L
		DWT	—	—	2T90
	Seam weld	Tensile	—	1W	1W
		CVN	3W and 9HAZ ^(g)	3W and 9HAZ ^(g)	3W and 9HAZ ^(g)
		Guided-bend	2W ^(d)	2W ^(d)	2W ^(d)
		Hardness	1T	1T	1T
SAWH or COWH [see Figure 5 c]	Pipe body	Tensile	1L ^(b)	1T ^(c) & 1L	1T ^(c) & 1L
		CVN	3T & 1L	3T & 1L	3T & 1L
		DWT	—	—	2T
	Seam weld	Tensile	—	1W	1W
		CVN	3W and 9HAZ	3W and 9HAZ	3W and 9HAZ
		Guided-bend	2W ^(d)	2W ^(d)	2W ^(d)
		Hardness	1T	1T	1T
NOTES: a) See Figure 5 for an explanation of the symbols used to designate orientation and location.					
b) Full-section longitudinal test pieces may be used at the option of the Manufacturer.					
c) If agreed, annular test pieces may be used for the determination of transverse yield strength by the hydraulic ring expansion test in accordance with ASTM A370.					
d) For pipe with t > 19.0 mm (0.75 in), the test pieces may be machined to provide a rectangular cross-section having a thickness of 18.0 mm (0.71 in).					
e) TBA for wall thicknesses>25.4 mm (1 in).					
f) Additional 3T specimens for wall thicknesses > 25.4 m (1 in).					
g) Additional 3W and 9HAZ specimens for wall thicknesses >25.4 mm (1 in).					

10.2.3 Samples and test pieces for mechanical tests

10.2.3.3 Test pieces for the CVN impact test

Amend fourth paragraph as follows:

For test pieces taken in the HAZ of SAW pipes, the axis of the notch shall be positioned at the fusion line, fusion line + 2 mm (0.08 in) and fusion line + 5 mm (0.2 in). The upper surface of the specimens shall be within 2 mm (0.08 in) of the outer surface of the pipe. See Figure 7. For SAW pipe of wall thickness greater than 25.4 mm (1 in), four additional sets of impact specimens, from weld centre line, fusion line, fusion line +2 mm (0.08 in) and fusion line +5 mm (0.2 in), as shown in Figure 7 but with the lower surface of the specimen within 2 mm (0.08 in) of the inner surface of the pipe.

In the fifth paragraph replace "as close as practicable" with "within 0.25 mm".

Add the following:

For test pieces taken from seamless pipes the specimens axis shall be aligned with the mid-thickness of the pipe.

The impact testing of seamless pipe with wall thickness equal to or greater than 25.4 mm (1 in) shall be as specified in the Purchase Order.

Flattening of coupons prior to removal of specimens is not permitted.

Amend Figure 7 as follows:

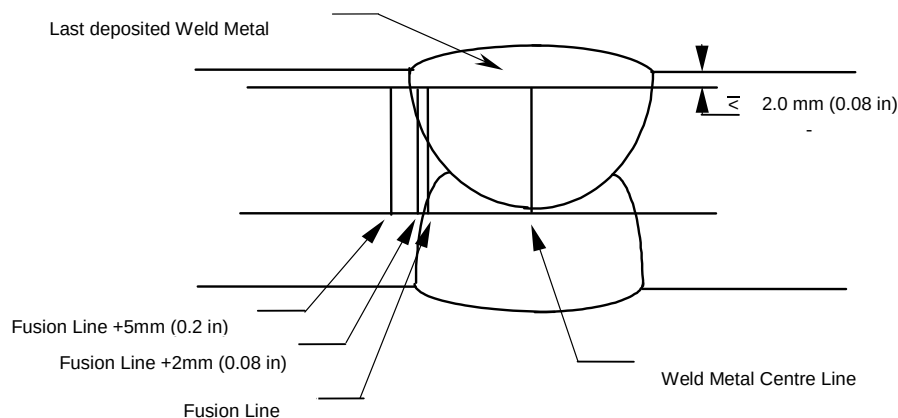


Figure 7 – Location of Charpy test specimens for weld and HAZ tests

Add new clause:

10.2.3.8 Test pieces for CTOD test

Test pieces shall be taken from the weld metal, the HAZ and the parent metal and shall be prepared in accordance with ISO 12135, or BS 7448-2. Test specimens shall be Bx2B through thickness notched specimens. For weld metal test, the notch axis shall be located on the weld centre line. For HAZ specimens, the notch axis located so as to sample the fusion line. The central 50 % portion of the specimen shall sample the HAZ and the outer portions shall sample weld metal.