

Section 1: Scope

The Technical Delivery conditions (TDC) applies for procurement of steel round bars as per PSL2 requirement of ISO 3183:2012. The size, length & quantity of the round bars shall be as per the Enquiry / Purchase Order (PO).

Section 2: Material

a) Steel Grades : L245R or BR, L245N or BN, L290R or X42R, L290N or X42N, L320N or X 46N, L360N or X52N, L390N or X56N, L415N or X60N.

b) Addl. Requirement : As listed below (supplementary to Specification)

c) All the Testing/Acceptance standards referred in this TDC shall be of latest revision as on the date of Enquiry/Purchase Order, whichever is earlier, unless specified other wise.

d) The supplying steel and/or rolling mill(s) shall have a documented quality management system like ISO 9001, API Spec Q1 etc.

Section 3: Chemical composition and process of manufacture

The steel shall be made to a clean steel practice, using

- basic oxygen process,
- electric furnace process, or
- open hearth process only in combination with a ladle refining process.

The steel shall be fully killed, Vacuum de-gassed and made according to fine grain practice.

Chemical composition and carbon equivalent shall be as per Table 1 given below:

TABLE 1: CHEMICAL COMPOSITION (Percentage by Weight)

Steel Grade (Steel Name)	Mass Fraction, Based on Heat and Product Analysis ^z % Maximum									Carbon Equivalent ^a % max	
	C ^b	Si	Mn ^b	P	S	V	Nb	Ti	Other	CE _{IW}	CE _{PCM}
L245R or BR	0.24	0.40	1.20	0.025	0.015	c	c	0.04	e, l	0.43	0.25
L290 R or X42R	0.24	0.40	1.20	0.025	0.015	0.06	0.05	0.04	e, l	0.43	0.25
L245N or BN	0.24	0.40	1.20	0.025	0.015	c	c	0.04	e, l	0.43	0.25
L290N or X42N	0.24	0.40	1.20	0.025	0.015	0.06	0.05	0.04	e, l	0.43	0.25
L320N or X46N	0.24	0.40	1.40	0.025	0.015	0.07	0.05	0.04	d, e, l	0.43	0.25
L360N or X52N	0.24	0.45	1.40	0.025	0.015	0.10	0.05	0.04	d, e, l	0.43	0.25
L390N or X56N	0.24	0.45	1.40	0.025	0.015	0.10	0.05	0.04	d, e, l	0.43	0.25
L415N or X60N	0.24	0.45	1.40	0.025	0.015	0.10	0.05	0.04	g, h, l	0.48	0.25

Notes to Table 1:

a - Based on product analysis, the CE_{IW} limits apply if carbon mass fraction, C > 0.12% and CE_{PCM} limits apply if carbon mass fraction, C ≤ 0.12%.

Carbon Equivalents shall be calculated using the following equations:

$$CE_{IW} = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

$$CE_{PCM} = C + Si/30 + Mn/20 + Cu/20 + Ni/60 + Cr/20 + Mo/15 + V/10 + 5B$$

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 of 1.65 % for grades ≥ L245 or B, but ≤ L360 or X52; up to a maximum of 1.75 % for grades > L360 or X52 but ≤ L415 or X60;



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c - Nb + V $\leq$ 0.06%.

d - Nb + V + Ti $\leq$ 0.15%;

e - Cu $\leq$ 0.50%, Ni $\leq$ 0.30%, Cr $\leq$ 0.30%, Mo $\leq$ 0.15%.

g - Nb + V + Ti $\leq$ 0.15%

h - Cu $\leq$ 0.50%, Ni $\leq$ 0.50%, Cr $\leq$ 0.50%, Mo $\leq$ 0.50%.

I - No intentional addition of B permitted & residual B $\leq$ 0.001%

z - Samples shall be taken, and test pieces prepared, in accordance with ISO 14284 or ASTM E1806.

Section 4: Dimensions and tolerances

(a) Diameter : 200mm. + 4 mm - 2 mm; Ovality : < 4.0 mm.

(b) Straightness : Permissible deviation is 2.5 mm / meter to 25 mm on the entire length of the bars, whichever is less

(c) End Surface : 3.0 mm from the perpendicular

Section 5: Supply Condition

As Cast / As Rolled / As Forged:

The round bars shall be supplied without any heat treatment. In every despatch schedule, the lot Quantity shall be preferably 30 MT per Heat Number or Full quantity of Suppliers furnace melting capacity. Each consignment of despatches shall have the quantity bulked Heat Number wise.

Section 6: Finish and Repair

Free from mill scales and defects like laps, seams, folds, cracks, undue segregation, piping etc. Repairs by welding is not permitted. The Surface defects can be removed mechanically, subject to meeting minimum diameter with BHEL's approval.

Section 7: Non Destructive Testing

Ultrasonic Test shall be carried out for rolled or forged round bars as per ASTM A 388 & acceptance criteria shall be as per ASME section VIII division 2 clause 3.3.4

Section 8: Macro and Micro Examination

Section 8.1 Macro Etch Test

One sample of complete cross-section of a Round bar for each Heat Number shall be examined in accordance with ASTM E 381. The reference plates shall be as follows.

- a) For the Round bars made by Concast Method (Plate - II & III) and
- b) For the Round bars made by Rolled/Forged Method (Plate I & II).
- c) The Macro structure shall be better than or equal to C2 R2 S2 of ASTM E381 (Plate I & II)

2) Injurious defects of any category like Surface cracks, Pipe/centre void, Star crack, centre unsoundness, dark centre, Pin holes, White bands, Chill structure, and Dendritic structure (strong) are not allowed.

3) Photo of Macrograph shall be provided along with Test Certificates per Heat Number.

Section 8.2 Micro examination for rolled/forged Round bars:

The Specimen for testing shall be taken on longitudinal plane, midway between the centre and surface of the material. The 'Inclusion content of the steel,' measured as per ASTM E 45 shall not exceed the following table 2:

Table 2

Classification							
Type 'A'		Type 'B'		Type 'C'		Type 'D'	
Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
2	1	2	1	2	1	2	1

Section 9: Mechanical Tests

9.1 Round bars supplied shall meet the mechanical properties as per Table 3.

TABLE 3: Mechanical Tests

Pipe Grade	Yield Strength in MPa R _{t0.5}		Tensile Strength in MPa R _m		% Elongation (A _f) (on 50mm)
	Min	Max	Min	Max	Min
L245R or BR L245N or BN	245	450	415	655	23
L290R or X42R L290N or X42N	290	495	415	655	23
L320N or X46N	320	525	435	655	22
L360N or X52N	360	530	460	760	21
L390N or X56N	390	545	490	760	20
L415N or X60N	415	565	520	760	19

9.2 The mechanical testing shall be in accordance with ASTM A370.

9.3 In order to ensure the same, simulation tests shall be carried out on samples as per clauses 9.4. to 9.8.1.

9.4 For grades L245R or BR, L290R or X42R

One sample per heat shall be tested in as cast / as rolled / as forged condition to ensure the mechanical properties satisfy the requirements as per Table 3.

9.5 For grades L245N or BN, L290N or X42N, L320N or X46N, L360N or X52N, L390N or X56N & L415N or X60N.

One sample per heat shall be subjected to Normalising heat treatment with cooling in still air and tested for ensuring the mechanical properties satisfy the requirements as per Table 3. If normalising heat treatment is carried out in multiple batches with one or more heats, one sample per heat per heat treatment batch shall be selected for mechanical testing.

9.6 In case the test results of the tested sample do not confirm with the requirements of Table 3, two additional samples (from the same location) as per clause 9.4 or 9.5 as applicable shall be tested. The test results of both the additional samples shall confirm with the requirements of Table 3. The round

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bars shall be rejected if the test results of any one of the additional samples do not confirm with the requirements of Table 3.

9.7 The test specimen shall be selected midway between the centre and surface of the material.

9.8 Impact test shall be carried out as per ASTM A370. The minimum average (of a set of three test pieces per heat for grades specified in clause 9.4 or per heat/heat treatment batch for grades specified in clause 9.5) absorbed energy for each test piece shall be minimum 27 Joules, based on full-size test pieces and a test temperature of 0 °C (32 °F).

9.8.1 In case the minimum average absorbed energy values of the tested pieces do not confirm with the requirement as per clause 9.8, three additional test pieces from the same test location as per clause 9.4 or 9.5 as applicable shall be tested. The test results of all the three test pieces shall confirm with the minimum average absorbed energy value. The product shall be rejected if the specified requirements are not met.

9.9 The acceptance of the round bar shall be based on the periodic audit check performed at BHEL for the requirements of this TDC.

Section 10: Marking

On each bar, following details to be hard Stamped using 10 mm (min) letter punch & bordered with white paint on one end face and Paint Stencilled / affixed as sticker on the other face. Heat number shall be paint stencilled on both the faces:

- 1) BHEL Order Number
- 2) Supplier Reference
- 3) Specification
- 4) Heat Number
- 5) Weight
- 6) Inspector's Seal

Longitudinal Colour coding adjacent to each other to be done for entire length of each bar with white strip in combination with colours specified in the Table 4:

Table 4

Material Grade	Colour
L245R or BR	Red
L245N or BN	Green
L290R or X42R	Yellow
L290N or X42N	Violet
L320N or X46N	Orange
L360N or X 52N	Blue
L390N or X56N	Black
L415N or X60N	Brown

Section 11: Inspection and certification

All tests specified to be carried out by the supplier and the test results to be furnished on the Test Certificate of the type 3.1 or 3.2 as per ISO 10474 and shall contain the following information in English language only:

Manufacturer's Test Certificate (MTC) Shall essentially contain:

- BHEL Order No., TDC No. & Test Certificate number, Size & Quantity - Heat Number wise.
- Specification, Grade and ISO 3183:2012, Heat Number, supply condition, Steel making process, de-oxidation process and grain refining practice.
- Chemical composition ranges, including each element intentionally added – Ladle, product analysis, applicable Carbon Equivalent values and values as per notes, of Table 1.
- Mechanical Test values, Impact test values, NDE results with reference and acceptance standards as applicable.
- Heat Treatment parameters (temperature, time and cooling medium) on test samples as applicable.
- Colour Coding
- Macro Etch Test results
- Micro examination test results for rolled round bars.
- Confirmation to round bar Dimension & Tolerance.

Section 12: End Use

Manufacture of hot and cold finished seamless steel ISO 3183 PSL 2 Line Pipes of thickness less than 25mm and Outside Diameter less than or equal to 133 mm in the rolled or normalised condition.

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Prepared	Reviewed			Approved

Records of Revision

Rev. No.	Date	Details of Revision
00	24.05.2019	New Bloom TDC for PSL 2 requirement of ISO 3183:2012