Draft Indian Standard

Specification for Carbon Steel Seamless Pipe for High Temperature Services

1. SCOPE

1.1 This specification details the requirements for seamless carbon steel pipe designed for high-temperature service, available in sizes ranging from NB 6 to NB 900 (10.29 to 914 mm) as nominated in Annexure 1(Normative) of this specification. Other Dimension of pipe may be supply subjected to agreement between manufacturer and purchaser to compliance of other requirements. The pipe is suitable for bending, flanging, and similar forming operations, as well as for welding. For welding applications, it is assumed that an appropriate welding procedure matching the steel grade and intended service will be employed of steel and intended use or service will be utilized.

1.2 Supplementary requirements are intended for applications requiring a higher quality standard. These optional requirements mandate additional testing to ensure the pipe meets superior performance criteria. If a purchaser desires these supplementary requirements, they must specify this in the purchase order.

2. REFERENCE STANDARD

- **IS 10543:** Method for dry powder magnetic particle testing
- **IS 12147 :** Recommended practice for wet magnetic particle examination
- **IS 15435:** Recommended practice for measuring thickness using ultrasonic method
- **IS 6394:** Ultrasonic testing of seamless metallic tubular products by contact and immersion methods - Code of practice
- **IS 6398 (Part 2):** Non-Destructive Testing of Steel Tubes Part 2 Automated Eddy Current Testing of Seamless and Welded (Except Submerged Arc Welded) Steel Tubes for the Detection of imperfections
- **IS 13805:** General standard for qualification and certification of non -Destructive testing personnel – Specification
- **IS 11655 :** Procedure for stray flux testing of ferrous magnetic seamless steel tubular products
- **IS 12260:** Metallic Materials - Tube - Ring - Expanding test
- **IS 1500 (Part 1):** Metallic materials - Brinell hardness test: Part 1 test method
- **IS 1586 (Part 1):** Metallic materials - Rockwell hardness test: Part 1 test method
- **IS 1599 :** Metallic materials Bend test
- **IS 1608 (Part 1) :** Metallic materials - Tensile testing - Part 1 : Method of test at room temperature
- **IS 1608 (Part 1) :** Metallic materials - Tensile testing - Part 2 : Method of test at Elevated temperature
- **IS 1757(Part 1) :** Metallic Materials — Charpy Pendulum Impact Test Part 1 Test Method
- **IS 2328 :** Metallic materials - Tube - Flattening test
- **IS 2329 :** Metallic materials - Tube (In Full Section) - Bend test
- **IS 2330:** Metallic Materials - Tube - Flanging Test
- **IS 2335:** Metallic Materials - Tube - Drift expanding test
- **IS 130165 :** Steel Products -Macroetch Testing, Inspection And Rating-Specification
- **IS 4748 :** Steel - Micrographic determination of the apparent grain size
- **IS 228:** Methods For Chemical Analysis of Steels

3. DESIGNATION

Pipe covered by this standard shall be designated by their nominal bore and wall thickness schedule or Outer diameter and Wall thickness (see Annexure 1). They shall be further graded as A, B or C depending on the yield strength & chemical composition of the material (see Table 1 & 2).

4. TERMINOLOGY

4.1 Nominal Bore (N.B)--A size reference denoting the approximate bore of the Pipe . For each size of Pipe, the outside diameter is fix therefore, the actual bore of each size of tube will vary according to the thickness.

4.2 Seamless Pipe -- A pipe with no welding seam. It is made of a single piece of metal without any joints.

4.3 **Wall Thickness Scheduled (WTS):** A size reference denoting the designation of the Pipe Thickness.

5. ORDERING INFORMATION

5.1 The following information items should be considered for inclusion in the purchase order, as applicable::

2.1.1 Material Specification (including year-date),
2.1.2 Quantity (meters, or number),
2.1.3 Type of material (seamless carbon steel pipe),
2.1.4 Grade (A,B,C)
2.1.5 Manufacture Method (hot-finished or cold Finished),
2.1.6 Size Details NB and wall thickness schedule or both; outside diameter and nominal wall thickness; or inside diameter and nominal wall thickness,

2.1.7 Different outside diameter tolerance pipe ,
2.1.8 Pipe Inside diameter tolerance, over 250 mm
2.1.9 Length Type (specific or random, Single Random or Double Random)
2.1.10 Supplementary requirements S1 to S9
2.1.11 Test report required
2.1.12 End Application of material,
2.1.13 Special requirements of Hydrostatic test

6. MATERIALS PROCESS

6.1 The steel used for seamless pipe can be produced through by any one process like open-hearth or electric furnace, or basic oxygen.

6.2 When different grades of steel are sequentially strand cast should be identify the resulting transition material.

6.3 For pipe NB 40 (48.30 mm) and under, it shall be acceptable to deliver hot finished or cold finish.

6.4 Unless not specified, pipes with a nominal pipe size NB 50 (60.30 mm) and larger shall be supplied as hot finished. If mutually agreed upon by the manufacturer and purchaser, cold-finished pipes may be provided.

7. HEAT TREATMENT

7.1 Hot Finished pipes do not require heat treatment. However, if hot-finished pipes are heat treated, they must be treated at a temperature of 650 °C or higher.

7.2 Cold-Finished pipe must be heat treated after the final cold pass at a temperature of 650 °C or higher.

8. CHEMICAL COMPOSITION

8.1 Heat Analysis

8.1.1 The Ladle/Heat analysis of material shall conform chemical composition prescribed in Table 1 and the chemical analysis shall be in accordance with Test Methods IS 228.

8.2 Product Analysis:

8.2.1 At the purchaser's request, the manufacturer shall perform analyses on two pipes from each Heat of finished pipe.
The product analysis of the material shall not deviate from the specified composition by more than the permissible deviation for each element given in Table 1. Samples for chemical analysis shall be taken in accordance with IS 228.

8.2.2 If the initial product analysis test fails, two additional pipes shall be retested. Both retests for the elements in question must meet the specification requirements; otherwise, all remaining material from the heat shall be rejected. Alternatively, at the producer's discretion, each pipe may be individually tested for acceptance. Pipes that do not meet the specification requirements shall be rejected.

Table 1: Chemical Requirements
(*Clause 8.1 & 8.2*)

	Composition, %		
	Grade A	Grade B	Grade C
Carbon, max	0.25[A]	0.30[B]	0.35[B]
Manganese	0.27–0.93	0.29–1.06	0.29–1.06
Phosphorus, max	0.035	0.035	0.035

Sulfur, max	0.035	0.035	0.035
Silicon, min	0.10	0.10	0.10
Chromium, max[C]	0.40	0.40	0.40
Copper, max[C]	0.40	0.40	0.40
Molybdenum, max[C]	0.15	0.15	0.15
Nickel, max[C]	0.40	0.40	0.40
Vanadium, max[C]	0.08	0.08	0.08

9. MECHANICAL PROPERTIES

9.1 Tensile Requirements:

9.1.1 For yield strength corresponding to a permanent offset of 0.2 % of the gage length or to an extension of 0.5 % of the gage length under load, the tensile strength, and the elongation in 50 mm shall be determined, and the tension test results shall conform to the applicable tensile property requirements given in Table 2.

Table 2: Tensile Requirements
(*Clause 3 & 9.1*)

	Grade A		Grade B		Grade C	
Tensile strength, min, [MPa]	330		415		485	
Yield strength, min,[MPa]	205		240		275	
	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
Elongation 50 mm, min, %:						
Basic minimum elongation transverse strip tests, and for all small sizes tested in full section,	35	25	30	16.5	30	16.5
When standard round 50-mm gauge length test specimen is used	28	20	22	12	20	12
For longitudinal strip tests,	*A*		*A*		*A*	
For transverse strip tests, a deduction for each 0.8mm decrease in wall thickness below 7.9 mm from the basic minimum elongation		1.25		1.00		1.00

[A] The minimum elongation in 2 in. [50 mm] shall be determined by the following equation:

$$e = 1940A^{0.2}/U^{0.9}$$

where:
e = minimum elongation in 50 mm, %, rounded to the nearest 0.5 %,
A = cross-sectional area of the tension test specimen, mm2, based upon specified outside diameter or nominal specimen width and specified wall thickness, rounded to the nearest 1 mm2. (If the area thus calculated is equal to or greater than 500 mm2, then the value 500 mm2 shall be used..

U = specified tensile strength, [MPa].

9.2 Bend Test

9.2.1 For pipes with a nominal pipe size NB 50 (60.30 mm) or smaller, a sufficient length of pipe must be able to be cold bent through 90° around a cylindrical mandrel with a diameter of twelve times the specified outside diameter of the pipe, without any cracks developing at any point.

9.2.2 If ordered for close coiling, the pipe must be able to be cold bent through 180° around a cylindrical mandrel with a diameter of eight times the specified outside diameter of the pipe, without failure.

9.2.3 For pipes with a diameter exceeding 635 mm and a diameter-to-wall thickness ratio of 7.0 or less (where this ratio is defined as the specified outside diameter divided by the nominal wall thickness), a bend test shall be conducted. The bend test specimens must be bent at room temperature through 180°, with the inside diameter of the bend being 25 mm, without any cracking on the outside portion of the bend.

9.3 Flattening Test

While testing is not mandatory for seamless pipes, they must be capable of meeting the flattening test requirements specified in Supplementary Requirement S3, if tested.

10. HYDROSTATIC TESTS

10.1 Except as allowed by 10.2 or 10.3 each length of pipe shall be subjected to the hydrostatic test without leakage through the pipe wall.

10.2 As an alternative to the hydrostatic test, at the manufacturer's option or as specified in the purchase order, the full body of each pipe may be tested using nondestructive testing methods.

10.3 Where specified in the purchase order, pipes may be supplied without the hydrostatic test and without the nondestructive test. In this case, each length provided must be marked with the letters "NH.".

10.4 If the hydrostatic test and nondestructive test are omitted, and the lengths are marked with "NH," the certification must clearly state "Not Hydrostatically Tested" where required. Additionally, the letters "NH" should be added to the product specification number and material grade specified on the certification.

10.5 The hydrostatic test shall be applied, without leakage through the pipe body.

Each length of pipe shall be tested by the manufacturer to a hydrostatic pressure which will produce in the pipe wall a stress not less than 40 % of the minimum specified Ultimate strength for carbon and ferritic alloy steel pipe. The test pressure or stress shall be determined by the following equation:

$$P = 2St/D \text{ or } S = PD/2t$$

where:

P = hydrostatic test pressure in MPa,

S = Ultimate pipe wall stress in MPa,

t = Specified Thickness in mm

D = Specified outside diameter in mm

The hydrostatic test pressure determined by the equation shall be rounded to the nearest 0.5 MPa for pressures below 7 MPa, and to the nearest 1 MPa for 7 MPa and above. The hydrostatic test may be performed prior to cutting to final length, or prior to upsetting, swaging, expanding, bending, or other forming operations.

10.6 The minimum hydrostatic test pressure required to satisfy the requirements specified need not exceed 17 MPa for pipe NB 80 (88.90 mm) or smaller, or 19 MPa for pipe larger than NB 80 (88.90 mm); however, the manufacturer has the option of using higher test pressures. For all sizes pipe, the hydrostatic test pressure shall be maintained for at least 5 s.

10.7 On the agreement of manufacturer, a minimum hydrostatic test pressure in excess of the requirements of 10.5 or 10.6, or both, may be stated on the order

10.8 The hydrostatic test may not adequately inspect the end portion of the pipe. The length of pipe that cannot be tested shall be determined by the manufacturer and reported to the purchaser if specified in the purchase order.

11. NON-DESTRUCTIVE TEST

As an alternative to the hydrostatic test, the manufacturer may choose to conduct a nondestructive electric test on the full body of each seamless pipe or if agreed between manufacturer and purchaser, In these instances, each supplied length must be marked with the letters "NDE.

The test methods outlined in this section may not be able to inspect the end portions of pipes, a phenomenon

referred to as "end effect." The manufacturer shall determine the length of this end effect and report it to the purchaser if specified in the purchase order or part off that untested portion.

Each tube shall be tested by ultrasonic method or by leakage flux system or by Eddy Current Testing. The tubes shall be free from any harmful internal and external surface defects such as seams, cracks, lamination and any other injurious defect.

11.1 Ultrasonic Testing-- Ultrasonic Test shall be perform accordance to Specification IS 6394.The ultrasonic testing shall be perform according to Specification mentioned in this specification can detect the presence and location of significant longitudinally or circumferentially oriented imperfections.
The calibration reference notches shall be chosen at the manufacturer's discretion and may consist of any one of the three common notch shapes outlined in the referenced IS6394 specification. The depth of the notch shall not exceed 12.5% of the specified wall thickness of the pipe 0.1 mm, whichever is greater.

11.2 Stray Flux Testing-- Stray Flux Testing to be performed accordance to specification IS 11655. This specification only requires longitudinal calibration for flux testing.
The depth of the notch must not exceed 12.5% of the specified wall thickness 0.3 mm, whichever is greater. The length of the notch should not surpass 25 mm, and the width of the notch must be less than or equal to its depth.

11.3 Eddy Current Testing-- The eddy current examination referenced in this specification is capable of detecting significant discontinuities, particularly those of the short, abrupt type. Eddy current Testing method shall be accordance to Specification IS 6398. Notch drill hole dimension not specified in this specification shall be according to IS 6398
For eddy current testing, the calibration pipe shall include, at the manufacturer's discretion, one of the following calibration standards to establish a minimum sensitivity level for rejection.
11.3.1 Drilled Hole—The calibration pipe shall contain three holes spaced 120° apart or four holes spaced 90° apart, sufficiently separated longitudinally to ensure separately distinguishable responses. The holes shall be drilled radially and completely through the pipe wall, care being taken to avoid distortion of the pipe while drilling. Dependent upon the nominal pipe size, the calibration pipe shall contain the following hole

Pipe size	Drill hole size (mm)
21.3 and below	1.0
Above 21.3 to 42.2	1.4
Above 42.2 to 60.30	1.8
Above 60.3 to 141.3	2.2
Above 141.30	2.7

11.3.2 Transverse or Longitudinal Notch— A notch 0.8 mm or less in width shall be machined in a radial plane parallel to the pipe axis on the outside surface of the pipe, to a depth not more than 12.5% of the specified wall thickness or 0.3 mm, whichever is greater.

12. PERMISSIBLE VARIATIONS IN WEIGHT (MASS) , STRAIGHTNESS AND DIMENSIONS

12.1 Weight (Mass) -- The mass of any length of pipe shall not differ by more than 10% above or 3.5% below the specified value. Unless otherwise agreed upon by the manufacturer and the purchaser, pipe with a nominal pipe size NB 100 (114.30 mm) and smaller may be weighed in convenient lots, while pipes larger than NB 100 (114.30 mm) must be weighed individually

12.2 Straightness –Pipe shall be reasonably straight.Unless otherwise agreed to between the purchaser and the manufacturer, tubes shall not deviate from straightness by more than 1 mm in any 600 mm length.

12.3 Standard Weights

A Standard weight has been defined in annexure 1.The calculated weight per unit length, based upon a specified wall thickness, shall be determined by the following equation:
W = c (D-t)t
where: C = 0.0246615 W = weight, kg/m,
D = specified outside diameter, mm],
t = specified minimum wall thickness, mm

12.4 Diameter: Thin-wall pipes often display ovality (out-of-roundness) during final annealing, straightening, or

both. The diameter tolerances do not adequately account for the additional ovality expected in these pipes and apply only to the average of the maximum and minimum outside diameter readings in any cross-section. However, for thin-wall pipes, the difference between the maximum and minimum outside diameter readings (ovality) in any cross-section must not exceed 1.5% of the specified outside diameter.

12.4.1 Excluding for pipe ordered as special outside diameter tolerance pipe or as inside diameter tolerance pipe, variations in outside diameter shall not exceed those given in Table 3

12.4.2 For pipe over 250 mm OD ordered as special outside diameter tolerance pipe, the outside diameter shall not vary more than 1 % over or 1 % under the specified outside diameter.

12.4.3 For pipe over 250 mm ID ordered as inside diameter tolerance pipe, the inside diameter shall not vary more than 1 % over or 1 % under the specified inside diameter.

12.5 **Thickness**— The minimum wall thickness at any point must not be less than 12.5% below the specified wall thickness.

Table 3: Variations in Outside Diameter

(*Clause 12.4.1*)

NB Size	Permissible variation in outside diameter	
	Over	Under
	mm	**mm**
[6 to 40, incl],	0.4	0.4
Over [40 to 100], incl	0.8	0.8
Over [100 to 200]incl	1.6	0.8
Over [200 to 450]incl	2.4	0.8
Over [450 to 650]incl	3.2	0.8
Over [650 to 850]incl	4	0.8

13. END FINISH

13.1 The pipe shall be supplied according to the following practices, unless otherwise specified.

13.1.1 NB 40 and Smaller—All walls shall be either plain-end square cut, or plain-end beveled at the option of the manufacturer. Other end finish also acceptable between purchaser and manufacturer.

13.1.2 NB 50 and Larger—All wall shall be plain-end-beveled. Other end finish also acceptable between purchaser and manufacturer.

13.1.3 Plain-end beveled pipe shall having a bevel angle of 30°, + 5° or - 0°, as measured from a line drawn perpendicular to the axis of the pipe with a root face of 1.60 ± 0.8 mm. Other bevel angles may be specified by agreement between the purchaser and the manufacturer.

14. LENGTH

14.1.1 Pipe lengths shall conform to the following standard practices:

a) The lengths must be specified in the order, and No jointers are acceptable unless otherwise specified

b) If specific lengths are not required, pipe may be ordered in single random lengths or double random lengths, provided they meet the following requirements:

1) Single random lengths shall be 4 to 7 meter in length,

2) Double random lengths shall have be 7 to 14 meter with a minimum average length of 10.7 meter.

14 WORKMANSHIP

14.1 The pipe should be free from harmful defects, such as pits, deep draw lines, heavy roller marks, lamination, cracks etc. Superficial defects on outside diameter may be dressed provided that the remaining wall thickness is within the permissible limits.

14.2 Surface imperfections that penetrate more than 12.5% of the specified wall thickness or affect the minimum wall thickness shall be deemed defects. Pipe with defects shall be subject to one or more of the following actions:

14.2.1 The defect shall be eliminated through grinding, as long as the remaining wall thickness meets the specified limits.

14.2.2 The section of pipe with the defect must be cut off within the specified length requirements or discarded.

14.3 To ensure a workmanlike finish and a basis for assessing conformance to surface standards, the pipe manufacturer may grind away the following non-injurious imperfections.

14.3.1-Mechanical marks and abrasions—such as cable marks, dinges, guide marks, roll marks, ball scratches, scores, and die marks—and pits, any of which imperfections are deeper than 1.6 mm.

14.3.2- Visual imperfections commonly referred to as scabs, seams, laps, tears, or slivers found by exploration deeper than 5 % of the nominal wall thickness.

14.4 At the purchaser's discretion, pipe may be rejected if repaired surface defects are not scattered but instead cover a significant area, surpassing acceptable standards for a workmanlike finish. The disposition of such pipe shall be decided through mutual agreement between the manufacturer and the purchaser

14.5 To remove imperfections and defects through grinding, it is essential to maintain a smooth, curved surface, ensuring that the wall thickness does not fall below the limits set by this specification. It is allowed to decrease the outside diameter at the grinding location by the amount that has been removed.

14.6 Wall thickness measurements must be taken using a mechanical caliper or a properly calibrated nondestructive testing device with suitable accuracy. In case of a disagreement, measurements obtained with the mechanical caliper will be considered authoritative.

14.7 Weld repair shall be permitted only subject to the approval of the purchaser

14.8 The finished pipe shall be reasonably straight.

15 SAMPLING

15.6 For product analysis and tensile tests a lot is the number of lengths of the same size and wall thickness from any one heat of steel of 400 lengths or fraction thereof, of each size below and of 200 lengths or fraction thereof of each size NB 150 and over.

15.7 For bend tests, a "lot" refers to a group of lengths of the same size and wall thickness from a single heat of steel, consisting of 400 lengths or any fraction thereof for each size.

15.8 For flattening tests, a lot is the number of lengths of the same size and wall thickness from any one heat of steel of 400 lengths or fraction thereof of each size over NB 50 below NB 150 and of 200 lengths or fraction thereof, of each size NB 150 and over.

16 NUMBER OF TESTS

16.6 The tensile requirements outlined in Section 9 shall be determined on one length of pipe from each lot.

16.7 For pipe NB 50 and under, the bend test outline clause 9 shall be made on one pipe from each lot.

16.8 The bend test, as required by 9.2, shall be made on one end of 5 % of the pipe from each lot. For small lots, at least one pipe shall be tested.

16.9 If any test specimen exhibits flaws or defective machining, it is permissible to discard it and replace it with another specimen.

17 RETESTS

Should any one of the test pieces first selected fail to pass any of the tests specified, two further samples shall be selected for testing inrespect of each failure from the same lot. Should the test pieces from both these additional samples pass, the material represented by the test samples shall be deemed to comply with the requirement of that particular test. Should the test pieces from either of these additional samples fail, the material represented by the test samples shall be deemed as not complying with the standard or the manufacturer may select to test individually the remaining lengths in the lot for the test failed to comply in the preceding tests.

18 TEST SPECIMENS AND TEST METHODS

18.1 NB 200 (219.10 mm) and larger, specimens cut either longitudinally or transversely shall be oriented for the tension test. For sizes smaller than NB 200 (219.10 mm) only longitudinal orientation to be used.

18.2 For round tension test specimens used on pipe wall thicknesses exceeding 25.4 mm, the midpoint of the longitudinal axis should be located halfway between the pipe's inner and outer surfaces..

18.3 Test specimens for the bend test outlined in Section 9.2, as well as for flattening tests test outlined in Section 9.2 must be sections cut from a pipe. Specimens for flattening tests should have smooth ends and be free of burrs, unless they are made from crop ends.

18.4 All tests shall be performed after the heat treatments permitted at room temperature.

19 CERTIFICATION

19.1 Upon request, the manufacturer or supplier shall provide the purchaser with a certificate of compliance stating that the material has been manufactured, sampled, tested, and inspected in accordance with this specification (including

the year and date) and has been found to meet the specified requirements. The manufacturer or supplier must provide the purchaser with a chemical analysis

19.8 **BIS Certification Marking**

The product(s) conforming to the requirements of
this standard may be certified as per the conformity assessment schemes under the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations framed there under, and the product(s) may be marked with the Standard Mark.

20 PRODUCT MARKING

20.1 Each tube shall be suitably marked with the manufacturers name or trade-mark, grade of the Pipe .Marking must include the heat number, details specified in Table 4 and an additional "S" symbol if any supplementary requirements are applicable. It should also state the length, outside diameter (OD) ±1% if the pipe is ordered with a special OD tolerance, inside diameter (ID) ±1% if ordered with a special ID tolerance, the wall thickness schedule number, nominal wall thickness and weight. For sizes larger than NB 100 the weight must be included. Length should be marked in meters to two decimal places, or other agreed markings. For sizes NB 40, 32, 25, and 20, each length may be labeled with the required information on a tag.

Table 4: Marking of Seamless Pipe

(*Clause 20.1*)

Hydro	NDE	Marking
Yes	No	Test Pressure
No	Yes	NDE
No	No	NH
Yes	Yes	Test Pressure/NDE

20.2 When a subsequent processor cuts pipe sections into shorter lengths for resale, they must transfer complete identifying information—including the manufacturer's name or brand—to each unmarked cut length or to metal tags securely attached to bundles of unmarked small diameter pipe. The same material designation must be included in the transferred information, along with the processor's name, trademark, or brand.

20.3 Any additional information on option of the manufacturer or specified in the purchase order.

20.4 **Bar Coding—** In addition to the requirements, barcoding is an acceptable method for supplementary identification. The purchaser may specify a particular barcoding system to be used in the order.

21 OILING AND PAINTING

All tubes shall, unless otherwise specified, be varnished or oiled externally.

22 INSPECTION

Unless the order specifies otherwise, the manufacturer is responsible for meeting all inspection and testing requirements outlined in this document. The purchaser retains the right to conduct any inspections and tests ensure the pipe meets the required specifications.

23 BUNDLING AND PACKING

Where tubes are to be bundled for transport, they shall unless otherwise specified, be packed in accordance with IS 4740**.**

SUPPLEMENTARY REQUIREMENTS

(*Clause* 1.2)

Supplementary requirements will apply only if specified in the purchase order. The purchaser has the option to request a different frequency of testing or analysis than what is stated in the supplementary requirements. Additionally, any modifications to retest and retreatment provisions can be agreed upon between the purchaser and the manufacturer. This flexibility allows for customization based on specific project needs.

S1. Product Analysis

S1.1 Product analysis must be conducted on each length of pipe. If any individual length does not meet the specified chemical composition requirements, it shall be rejected. This ensures that all supplied pipe conforms to the necessary standards for quality and performance

S2. Transverse Tension Test

S2.1 A transverse tension test is required on a specimen taken from one or both ends of each pipe NB 200 and larger if specified in the supplementary requirements. The purchaser must also specify the number of tests per pipe. If any specimen fails to meet the required tensile properties (including tensile strength, yield strength, and elongation), that specific length will be rejected, although retreatment and satisfactory retesting may be permitted. This process ensures that the mechanical integrity of the pipe meets the necessary standards for high-temperature service..

S3. Flattening Test, S (For pipe over NB 50)

S3.1 A section of pipes not less than 63.5 mm in length shall be flattened cold between parallel plates until the opposite walls of the pipe meet. Flattening tests shall be in accordance with accordance with IS 2328. except that in the formula used to calculate the "H" value, the following "e" constants shall be used:

0.08 for Grade A
0.07 for Grades B and C

S3.2 When testing low D-to-t ratio tubular, cracks on the inside surface at the six and twelve o'clock positions shall not be grounds for rejection if the D-to-t ratio is less than ten, due to the unreasonably high strain imposed by the geometry.

S3.3 The flattening test will be conducted on one length of pipe from each lot of 400 lengths, or any fraction thereof, for sizes greater than NB 50 and below NB 150. For sizes NB 150 and above, the test will be performed on one length from each lot of 200 lengths, or any fraction thereof.

S3.4 If the crop end of a finished pipe fails the flattening test, one retest is allowed from the failed end. The pipe must be normalized either before or after the initial test, but it may undergo a maximum of two normalizing treatments.

S4. Flattening Test, Enhanced

S4.1 The flattening test, must be conducted on a specimen taken from one or both ends of each pipe, with crop ends permissible for this purpose. If this supplementary requirement is specified, the purchaser must indicate the number of tests to be performed per pipe .If any specimen fails the flattening test due to insufficient ductility before completing the first step, that particular pipe will be rejected, though retreatment and a satisfactory retest may be permitted. If a specimen fails due to a lack of soundness, the entire length of the pipe may be rejected, but reconsideration for acceptance is possible if subsequent retesting shows the remaining length is sound. This process ensures the pipe maintains both ductility and structural integrity for high-temperature applications.

S5. Metal Structure and Etching Test

S5.1 Test should be conducted on a cross-section taken from one or both ends of each pipe, and the results must show that the material is sound and reasonably uniform, free from any harmful laminations, cracks, or other defects. If this supplementary requirement is agreed and specified in Purchase order, the purchaser should specify the number of tests required per lot. For any defects, re-sampling to be done and on acceptance the affected length of the pipe will be rejected . However, the remaining pipe of lot will be accepted. if re-test pipe also fail ,it may be salvaged by removing the defective end, provided subsequent retests confirm that the rest of the material is sound and uniform. This process ensures the pipe's integrity and quality for its intended use.

S6. Carbon Equivalent

S6.1 The steel shall comply a carbon equivalent (CE) of 0.50 Maximum as calculated by the following formula:

$$CE = \%C + \frac{\%Cr+\%Mo+\%V}{5} + \frac{\%Ni+\%Cu}{15}$$

S6.2 Other CE may be agreed upon between the purchaser and the producer.

S6.3 The CE must be reported on the test reports.

S7. Heat Treated Test Specimens

S7.1When these supplementary requirements mentioned in purchase order manufacturer shall conduct a tensile test on a test specimen taken from each heat of steel supplied. This specimen must have been either stress relieved at 675°C or normalized at 900°C, according to the purchaser's specifications. Alternatively, other stress relief or annealing temperatures appropriate for the specific steel analysis may be established through mutual agreement between the purchaser and manufacturer. The outcomes of this tensile test must comply with the criteria outlined in Table 2.

S8. Internal Cleanliness–Government Orders

S8.1 When this supplementary requirements mentioned in purchase order, the inside surface of hot-finished ferritic steel pipes and tubes must be produced in a scale-free condition that meets the visual standard outlined in SSPC-SP6. Cleaning must follow a documented procedure proven to be effective, and this procedure should be readily accessible for audit purposes to ensure compliance and maintain quality control during manufacturing.

S9. Requirements for Carbon Steel Pipe for Hydrofluoric Acid Alkylation Service

S9.1 The carbon equivalent (CE), based on heat analysis, must not exceed 0.43% for specified wall thicknesses of 25.4 mm or less, and 0.45% for wall thicknesses greater than 25.4 mm.

S9.2 The carbon equivalent (CE) to be calculated using the following formula

$$CE = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

S9.3 Mass percent, of heat analysis vanadium content shall not be more than 0.02 %, the niobium content shall not be more than 0.02 %, and the sum of the vanadium and niobium contents shall be maximum 0.03 %.

S9.4 On the basis of heat analysis in mass percent, the addition of the nickel and copper contents shall not be more than 0.15 %.

S9.5 On the basis of heat analysis in mass percent, the minimum carbon content shall be 0.18 %.

S9.6 Each pipe shall be mark with the word "HF" to indicate compliance with the supplementary requirements.

ANNEXURE 1

(*Clause* 1.1 & 3)

NB	WTS No.	Outside Diameter, (mm)	Wall Thickness, (mm)	Plain End Weight (Mass), kg/m
6	10	10.29	1.24	0.28
6	30	10.29	1.45	0.32
6	40	10.29	1.73	0.37
6	80	10.29	2.41	0.47
6	160	10.29	3.15	0.55
8	10	13.72	1.65	0.49
8	30	13.72	1.85	0.54
8	40	13.72	2.24	0.63
8	80	13.72	3.02	0.80
8	160	13.72	3.68	0.91
10	10	17.14	1.65	0.63
10	30	17.14	1.85	0.70
10	40	17.14	2.31	0.84
10	80	17.14	3.20	1.10
10	160	17.14	4.01	1.30
15	5	21.34	1.65	0.80
15	10	21.34	2.11	1.00
15	30	21.34	2.41	1.13
15	40	21.34	2.77	1.27
15	80	21.34	3.73	1.62
15	160	21.34	4.78	1.95
20	5	26.67	1.65	1.02
20	10	26.67	2.11	1.28
20	30	26.67	2.41	1.44
20	40	26.67	2.87	1.68
20	80	26.67	3.91	2.19
20	160	26.67	5.56	2.89
25	5	33.40	1.65	1.29
25	10	33.40	2.77	2.09
25	30	33.40	2.9	2.18
25	40	33.40	3.38	2.50
25	80	33.40	4.55	3.24
25	160	33.40	6.35	4.24
32	5	42.16	1.65	1.65
32	10	42.16	2.77	2.69
32	30	42.16	2.97	2.87
32	40	42.16	3.56	3.39
32	80	42.16	4.85	4.46
32	160	42.16	6.35	5.61
40	5	48.26	1.65	1.90
40	10	48.26	2.77	3.11
40	30	48.26	3.18	3.54
40	40	48.26	3.68	4.05

ANNEXURE 1

(*Clause* 1.1 & 3)

NB	WTS No.	Outside Diameter, (mm)	Wall Thickness, (mm)	Plain End Weight (Mass), kg/m
40	80	48.26	5.08	5.41
40	160	48.26	7.14	7.24
50	5	60.32	1.65	2.39
50	10	60.32	2.77	3.93
50	30	60.32	3.18	4.48
50	40	60.32	3.91	5.44
50	80	60.32	5.54	7.48
50	160	60.32	8.74	11.12
65	5	73.02	2.11	3.69
65	10	73.02	3.05	5.26
65	30	73.02	4.78	8.04
65	40	73.02	5.16	8.64
65	80	73.02	7.01	11.41
65	160	73.02	9.52	14.91
80	5	88.90	2.11	4.52
80	10	88.90	3.05	6.46
80	30	88.90	4.78	9.92
80	40	88.90	5.49	11.29
80	80	88.90	7.62	15.27
80	160	88.90	11.13	21.35
90	5	101.60	2.11	5.18
90	10	101.60	3.05	7.41
90	30	101.60	4.78	11.41
90	40	101.60	5.74	13.57
90	80	101.60	8.08	18.64
100	5	114.30	2.11	5.84
100	10	114.30	3.05	8.37
100	30	114.30	4.78	12.91
100	40	114.30	6.02	16.08
100	80	114.30	8.56	22.32
100	120	114.30	11.13	28.32
100	160	114.30	13.49	33.54
125	5	141.30	2.77	9.46
125	10	141.30	3.40	11.56
125	40	141.30	6.55	21.77
125	80	141.30	9.52	30.94
125	120	141.30	12.70	40.28
125	160	141.30	15.88	49.12
150	5	168.28	2.77	11.31
150	10	168.28	3.40	13.83
150	40	168.28	7.11	28.26
150	80	168.28	10.97	42.56
150	120	168.28	14.27	54.2
150	160	168.28	18.26	67.56
200	5	219.08	2.77	14.78

NB	WTS No.	Outside Diameter, (mm)	Wall Thickness, (mm)	Plain End Weight (Mass), kg/m
200	10	219.08	3.76	19.97

ANNEXURE 1

(*Clause* 1.1 & 3)

NB	WTS No.	Outside Diameter, (mm)	Wall Thickness, (mm)	Plain End Weight (Mass), kg/m
200	20	219.08	6.35	33.31
200	30	219.08	7.04	36.81
200	40	219.08	8.18	42.55
200	60	219.08	10.31	53.08
200	80	219.08	12.70	64.64
200	100	219.08	15.09	75.91
200	120	219.08	18.26	90.43
200	140	219.08	20.62	100.92
200	160	219.08	23.01	111.26
250	5	273.0	3.40	22.61
250	10	273.0	4.19	27.78
250	20	273.0	6.35	41.76
250	30	273.0	7.80	51.01
250	40	273.0	9.27	60.29
250	60	273.0	12.70	81.53
250	80	273.0	15.09	95.98
250	100	273.0	18.26	114.71
250	120	273.0	21.44	133.01
250	140	273.0	25.40	155.10
250	160	273.0	28.58	172.27
300	5	323.8	3.96	31.24
300	10	323.8	4.57	35.98
300	20	323.8	6.35	49.71
300	30	323.8	8.38	65.19
300	40	323.8	10.31	79.71
300	60	323.8	14.27	108.93
300	80	323.8	17.48	132.05
300	100	323.8	21.44	159.87
300	120	323.8	25.40	186.92
300	140	323.8	28.58	208.08
300	160	323.8	33.32	238.69
350	5	355.6	3.96	34.34
350	10	355.6	6.35	54.69
350	20	355.6	7.92	67.91
350	30	355.6	9.52	81.25
350	60	355.6	15.09	126.72
350	80	355.6	19.05	158.11
350	100	355.6	23.83	194.98
350	120	355.6	27.79	224.66
350	140	355.6	31.75	253.58
350	160	355.6	35.71	281.72
400	5	406.4	4.19	41.56
400	10	406.4	6.35	62.65
400	20	406.4	7.92	77.83

400	30	406.4	9.52	93.18
400	40	406.4	12.70	123.31
400	60	406.4	16.66	160.13

ANNEXURE 1

(*Clause* 1.1 & 3)

NB	**WTS No.**	**Outside Diameter,** (mm)	**Wall Thickness,** (mm)	**Plain End Weight (Mass), kg/m**
400	80	406.4	21.44	203.54
400	100	406.4	26.19	245.57
400	120	406.4	30.96	286.66
400	140	406.4	36.53	333.21
400	160	406.4	40.49	365.38
450	5	457.2	4.19	46.81
450	10	457.2	6.35	70.60
450	20	457.2	7.92	87.75
450	30	457.2	11.13	122.44
450	40	457.2	14.27	155.88
450	60	457.2	19.05	205.84
450	80	457.2	23.83	254.68
450	100	457.2	29.36	309.78
450	120	457.2	34.92	363.66
450	140	457.2	39.67	408.48
450	160	457.2	45.24	459.62
500	5	508.0	4.78	59.32
500	10	508.0	6.35	78.56
500	20	508.0	9.52	117.03
500	30	508.0	12.70	155.13
500	40	508.0	15.09	183.43
500	60	508.0	20.62	247.84
500	80	508.0	26.19	311.19
500	100	508.0	32.54	381.55
500	120	508.0	38.10	441.52
500	140	508.0	44.45	508.15
500	160	508.0	50.01	564.85
550	5	558.8	4.78	65.31
550	10	558.8	6.35	86.51
550	20	558.8	9.52	128.96
550	30	558.8	12.7	171.04
550	60	558.8	22.22	294.03
550	80	558.8	28.58	373.71
550	100	558.8	34.92	451.15
550	120	558.8	41.28	526.85
550	140	558.8	47.62	600.32
550	160	558.8	53.98	672.03
600	5	609.6	5.54	82.53
600	10	609.6	6.35	94.47
600	20	609.6	9.52	140.89
600	30	609.6	14.27	209.51
600	40	609.6	17.48	255.25
600	60	609.6	24.61	355.04

600	80	609.6	30.96	441.80

ANNEXURE 1

(*Clause* 1.1 & 3)

NB	**WTS No.**	**Outside Diameter,** (mm)	**Wall Thickness,** (mm)	**Plain End Weight (Mass), kg/m**
600	100	609.6	38.89	547.36
600	120	609.6	46.02	639.62
600	140	609.6	52.37	719.68
600	160	609.6	59.54	807.68
650	10	660.4	7.92	127.44
650	20	660.4	12.70	202.86
700	10	711.2	7.92	137.36
700	20	711.2	12.70	218.77
700	30	711.2	15.88	272.30
750	5	762.0	6.35	118.34
750	10	762.0	7.92	147.29
750	20	762.0	12.70	234.68
750	30	762.0	15.88	292.20
800	10	813.0	7.92	157.25
800	20	813.0	12.70	250.65
800	30	813.0	15.88	312.17
800	40	813.0	17.48	342.94
850	10	864.0	7.92	167.21
850	20	864.0	12.70	266.63
850	30	864.0	15.88	332.14
850	40	864.0	17.48	364.92
900	10	914.0	7.92	176.97
900	20	914.0	12.70	282.29
900	30	914.0	15.88	351.73
900	40	914.0	19.05	420.45