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Government of India
Ministry of Commerce and Industry
Department of Industrial Policy and Promotion
(Central Boilers Board)

New Delhi, the 10th April, 2001.

Notification

G.S.R 219.- Whereas certain draft regulations, further to amend the Indian Boiler Regulations, 1950, were published, as required by sub-section (1) of section 31 of the Indian Boilers Act, 1923 (5 of 1923), at pages 3755 to 3789 in Part II, Section 3, Sub-section (i) of the Gazette of India, dated the 23rd December, 2000 vide notification of the Government of India in the Ministry of Commerce and Industry (Department of Industrial Policy and Promotion) (Central Boilers Board) number G.S.R. 512, dated the 12th December, 2000 for inviting objections and suggestions from persons likely to be affected thereby till the expiry of forty-five days from the date on which copies of the Gazette containing the said notification were made available to the public;

And whereas the copies of the said Gazette were made available to the (general) public on the 27th day of December, 2000;

And whereas no objections or suggestions were received within the specified period;

Now, therefore, in exercise of the powers conferred by section 28 of the Indian Boilers Act, 1923, the Central Boilers Board hereby makes the following regulations further to amend the Indian Boiler Regulations, 1950, namely:-

1. (1) These regulations may be called the Indian Boiler (Amendment) Regulations, 2001.
(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Indian Boiler Regulations, 1950, for regulations 36 to 56, the following regulations shall be substituted, namely : -

"COLD DRAWN SEAMLESS CARBON STEEL BOILER, SUPERHEATER AND HEAT EXCHANGER TUBES FOR DESIGN METAL TEMPERATURES NOT EXCEEDING 454 DEGREE C (850 DEGREE F)

36.(a) General.- (i) These regulations cover both hot finished and cold drawn seamless boiler, superheater and heat exchanger tubes, which shall conform in all respects with the requirements herein specified.

(ii)The seamless tubes conforming to other national or international standards which are known to be commonly used as being suitable for use as boiler, superheater and heat exchanger tubes can also be used with the designations of the national or international standards, provided such materials are not specifically prohibited by the regulations.

(iii) While making tubes to other national/international standards the allowable stresses of the respective standards shall be strictly followed while designing the tubes.

(b) Material. - (i)The tubes shall be seamless and manufactured from steel produced by an open hearth or electric process or any of the oxygen processes. The steel shall be fully killed.

(ii)The steel shall conform to the following limits of chemical composition.

Chemical composition (%)

Grade	C	Mn	Si	S	P
TA	0.06-0.18	0.27.-0.63	0.25 max	0.035 max	0.035 max
TB	0.27 max*	0.93 max	0.10 min	0.035 max	0.035 max
TC	0.35 max*	0.29-1.06	0.10 min	0.35 max	0.035 max

* For grade TB and TC for each reduction of 0.01% below the specified carbon maximum, an increase of 0.06% Manganese above the specified maximum will be permitted up to a maximum of 1.35%.

(c) Heat Treatment.- Hot finished tubes need not be heat treated, cold drawn tubes shall be given a sub-critical annealing, a full anneal, or a normalising heat treatment after the final cold finishing process.

(d) Workmanship and Tolerance.-The tubes shall be well finished, cleaned free from harmful defects. They shall be reasonably straight, smooth, cylindrical and subject to the following tolerances. Finished tubes shall be reasonably straight and have smooth ends free of burrs. They shall have a workmanlike finish. Surface imperfections like any discontinuity or irregularity found in the tube may be removed by grinding, provided that smooth curved surface is maintained, and the wall thickness is not decreased to less than that permitted. The outside diameter at the point of grinding may be reduced by the amount so removed.

(i) Permissible variations in outside diameter.

Outside Diameter (mm)	Permissible variation Over (mm)	Permissible variation Under (mm)
Hot finished seamless tubes		
101.6 and under	0.4	0.8
Over 101.6 to 190.5 incl.	0.4	1.2
Over 190.5 to 228.6 incl.	0.4	1.6
Cold finished seamless tubes		
Under 25.4	0.1	0.1
25.4 to 38.1 incl.	0.15	0.15
Over 38.1 to 50.8 excl.	0.2	0.2
50.8 to 63.5 excl	0.25	0.25
63.5 to 76.2 excl.	0.3	0.3
76.2 to 101.6 incl.	0.38	0.38
Over 101.6 to 190.5 incl.	0.38	0.64
Over 190.5 to 228.6 incl.	0.38	1.14

(ii) Permissible variation in Wall Thickness in percentage.

Outside diameter (mm)	Wall thickness (mm)							
	2.4 and under		Over 2.4 to 3.8 Incl.		Over 3.8 to 4.6 incl.		Over 4.6	
	Over	Under	Over	Under	Over	Under	Over	Under
Seamless Hot Finished tubes								
101.6 & under	40	0	35	0	33	0	28	0
Over 101.6	0	0	35	0	33	0	28	0

Seamless Cold Finished tubes		
	Over	Under
38.1 and under	20	0
Over 38.1	22	0

(iii) Permissible variations in length

Method of manufacture	Outside diameter (mm)	Cut length (mm)	
		Over	Under
Seamless hot finished	All sizes	5	0
Seamless cold finished	Under 50.8	3	0
	50.8 and over	5	0

Note.- These permissible variations in lengths apply to cut lengths up to and including 7.3 m. For lengths over 7.3 m, an additional over tolerance of 3 mm for each 3 m or fraction thereof, shall be permissible, up to a maximum of 13 mm. Length tolerances on the positive side other than specified may be mutually agreed.

37. (a) Test Specimens – (i) Test specimens required for the flattening and expanding/ flaring test specified in regulations 38, 39 and 40 shall be taken from the ends of finished tubes prior to upsetting swaging, expanding or any other forming operations or being cut to length. They shall be smooth on the ends and free from burrs and flaws.

(ii) If desirable and practicable, tensile test may be carried out on full section of the tubes up to the capacity of the testing machine. For large size tubes, the tensile test specimen shall consist of strip cut longitudinally from the tube and which is not straightened within the gauge length and further heat treated.

(iii) If any test specimen shows flaws or defective machining it may be discarded and another specimen substituted.

(iv) All specimens shall be tested at room temperature.

(b) Number of tests. - The test specified in regulations 38, 39 and 40 shall be made on minimum 2 tubes for first 100 tubes and 1 per 100 or part thereof for tubes over 100 numbers.

38. Tensile and Hardness tests. - The test specimen shall comply with the following requirements. The hardness test may be carried out on the wall cross section or on a flat on the outside surface of the tube sample.

Grade	Yield Strength Mpa ($kg./mm^2$) min	Tensile Strength Mpa (kg/mm^2) min	% Elongation on GL = 50 mm min	Hardness HRB or HB	
				Min	Max
TA	180(18.3)	325(33.1)	35	77	137
TB	255(26.1)	415(42.2)	30	79	143
TC	275(28.2)	485(49.3)	30	89	179

Note.- For longitudinal strip tests a deduction in percentage elongation 1.5% shall be made for each 0.8 mm decrease in wall thickness under 8mm from the minimum elongation value requirement.

39. Flattening test. -A section of the tube not less than 63 mm in length shall be flattened cold between two parallel flat surfaces to a distance between the plates (H) as calculated by the formula given below, without showing any sign of a crack or flaw.

$$H = \frac{(1 + e)\, t}{E + t/D}$$

where t = specified thickness of tube (mm)
D = specified outside diameter of the tube (mm)
e = a constant, as given below
e = 0.07 for Carbon steel with maximum specified carbon 0.19% or greater
e = 0.09 for Carbon steel with maximum specified carbon 0.18% or less

40. Expanding or Flaring test. - A section of the tube approximately 100 mm in length shall stand being flared with a tool having a 60 degree included angle until the tube at the mouth of the flare has been expanded to the percentages given below, without cracking.

Ratio of inside diameter to outside diameter	Minimum expansion of inside diameter %
0.9	21
0.8	22
0.7	25
0.6	30
0,5	39
0.4	51
0.3	68

41. Additional test before rejection. - (i) If any one or more tests specified in these regulations fail, two further tests of the same kind may be made on two other tubes of the same batch. If any of these tests fails, the batch of the tubes represented may be given a further heat treatment and entire set of test shall be repeated.

(ii) If the repeat tests are satisfactory the tubes shall be accepted. If any failure in the tests should occur, the entire batch of the tubes shall be rejected.

42. Hydraulic test. - (i) Each tube shall be tested by the manufacturer and shall withstand a hydraulic pressure to one and half times the design pressure subject to a

minimum of 1.00 kgf/mm^2, but not greater than pressure calculated by the following formula.

$$P = \frac{2 S t}{D}$$

where P = test pressure
D = specified outside diameter of the tube
t = specified wall thickness of the tube
S = stress which shall be taken as 40% of the minimum tensile strength at room temperature.

(ii) Notwithstanding any thing contained in the above clause, the hydraulic test at the maker's works may be dispensed with, provided that the tubes are subject to non destructive testing by an appropriate method like Ultrasonic or Eddy Current or Stray Flux testing.

SEAMLESS CARBON STEEL PIPES FOR HIGH TEMPERATURE SERVICE FOR DESIGN METAL TEMPERATURES NOT EXCEEDING 454 DEGREE C (850 DEGREE F)

43. (a) General - (i) These regulations cover both hot finished and cold drawn seamless carbon steel pipes for high temperature service. The pipes shall conform in all respects with the requirements herein specified.

(ii) The seamless pipes conforming to other national/international standards which are known to be commonly used as being suitable for high temperature service can also be used with the designations of the national/international standards, provided such materials are not specifically prohibited by the regulations.

(iii) While making pipes to other national/internationals standards the allowable stresses of the respective nation/international standards shall be strictly followed while designing the tubes.

(b) Material. - (i) The pipes shall be seamless and manufactured from steel produced by an open hearth or electric process or any of the oxygen processes. The steel shall be fully killed.

(ii) The steel shall conform to the following limits of chemical composition.

Grade	Chemical composition %				
	C	Mn	Si	S	P
PA	0.25* Max	0.27 0.93	0.10 min	0.035 max	0.035 max
PB	0.30* Min	0.29 1.06	0.10 min	0.035 max	0.035 max
PC	0.35* Max	0.29 1.06	0.10 min	0.035 max	0.035 max

* For each reduction of 0.01% below the specified carbon maximum, an increase of 0.06% manganese above the specified maximum will be permitted up to a maximum of 1.35%.

(b) Heat treatment. - Hot finished pipes need not be heat treated. Cold drawn pipes shall be given a sub-critical anneal, a full anneal, or a normalising heat treatment after the final cold finishing process.

(c) Workmanship and Tolerance. - The pipes shall be well finished, cleaned free from harmful defects. They shall be reasonably straight, smooth, cylindrical and subject to the following tolerance. Pipes manufacturer shall explore a sufficient number of visual inspections to provide reasonable assurance that they have been properly evaluated.

(i) Permissible variations in outside diameter :

Hot finished and cold finished seamless pipes

Outside diameter (mm)	Permissible variations (mm)	
	Over	Under
10.3 to 48.3 incl.,	0.40	0.79
Over 48.3 to 114.3 incl.,	0.79	0.79
Over 114.3 to 219.1 incl.,	1.59	0.79
Over 219.1 to 457.0 incl.,	2.38	0.79
Over 457.0 to 660.0 incl.,	3.18	0.79
Over 660.0 to 864.0 incl.,	3.97	0.79
Over 864.0 to 1219.0 incl.,	4.76	0.79

(ii) Permissible variation in wall thickness:

The minimum wall thickness at any point shall not be more than 12.5% under the nominal wall thickness specified.

(iii) Permissible variation in exact length:

Seamless Hot finished and Cold finished pipes can be ordered in specified length or in random length. If ordered in specified length, the tolerances for all sizes shall be +6.0 mm/-0.0mm.

(d) Test specimens. - (i) Test specimen required for flattening and expanding/flaring test specified in regulations 44(a), 44(b) and 44(c) shall be taken from ends of finished pipes prior to upsetting, swaging, expanding or any other forming operations or being cut to length. They shall be smooth on ends and free from burrs and flaws.

(ii) If desirable and practicable, tensile test may be carried out on full section of the pipe up to the capacity of the testing machine. For large size pipes, the tensile test specimen shall consist of strip cut longitudinally from the pipe and which is not straightened within the gauge length and further heat treated.

(iii) If any test specimen shows flaws or defective machining it may be discarded and another specimen substituted.

(iv) All specimens shall be tested at room temperature.

(e) Number of tests. - The tests specified in regulations 44(a), 44(b) and 44(c) shall be made on minimum 2 pipes for first 100 pipes and 1 per 100 or part thereof for pipes over 100 numbers.

44. (a) Tensile test. - Test pieces cut from the ends of the selected pipes shall comply with the following requirements. The tensile test may be carried out on the test pieces cut out from the pipe in the longitudinal direction which shall not be further heat treated nor straightened within the gauge length. As an alternative, pipes may be tested on full cross section.

Grade	Yield Strength MPa (kg/mm^2) min	Tensile Strength Mpa (kg/mm^2) Min	%Elongation on G.L.=50mm min
PA	205 (21.1)	330(33.1)	35
PB	240 (24.7)	415 (42.2)	30
PC	275 (28.2)	485 (49.3)	30

For longitudinal strip test, the minimum required elongation shall be determined by the following equation.

$$e = 1942.57 (A^{0.02}/U^{0.9})$$

where e = minimum elongation in 50.8 mm, % rounded to the nearest 0.5%.
A = cross sectional area of the tensile test specimen in mm^2 based on specified outside diameter or nominal specimen width and specified wall thickness rounded to the nearest 6.45 mm^2. If the area thus calculated is more than 484 mm^2 then use area as 484 mm^2. If the calculated area is less than 484mm^2 then use the actual area thus obtained.
U = specified tensile strength in Mpa.

(b) Bend test. - For pipes of outside diameter 60.3 mm and under, a bend test shall be conducted. A sufficient length of pipe shall stand being bent cold through 90 degree around a cylindrical mandrel, the diameter of which is 12 times the nominal diameter of the pipe, without developing cracks.

(c) Flattening test. - (i) For pipes of outside diameter over 60.3 mm, a flattening test shall be conducted. A section of the pipe not less than 63 mm in length shall be flattened cold between two parallel flat surfaces to a distance between the plates (H) as calculated by the formula given below, without showing any sign of a crack or flaw.

$$H = \frac{(1 + e)\, t}{e + t/D}$$

where t = specified thickness of pipe (mm)
D = specified outside diameter of the pipe (mm)
e = a constant, as given below
e = 0.07 for carbon steel with maximum specified carbon 0.19% or more
e = 0.09 for carbon steel with maximum specified carbon 0.18% or less.

(ii) For pipe whose diameter equals or exceeds 254 mm, a bend test may be conducted instead of the flattening test. The bend test specimens shall be bent at room temperature through 180 degree without cracking on the outside of the bent portion. The inside diameter of the bend shall be 25 mm. Substitution of the bend test for the flattening test shall be subject to the approval of the purchaser.

(iii) For pipe whose diameter exceeds 635 mm and whose diameter to wall thickness ratio is 7.0 or less, the bend test described in clause (b) shall be conducted instead of the flattening test.

45. Additional tests before rejection. - If any one or more tests specified in these regulations fail, two further tests of the same kind may be made on two other pipes of the same batch. If any of these tests fails, the batch of the pipes represented may be given a further heat treatment and entire set of tests shall be repeated.

If the repeat tests are satisfactory the pipes shall be accepted. If any failure in the tests should occur the entire batch of the pipes shall be rejected.

46. Hydraulic test. - (i) Each pipe shall be tested by the manufacturer and shall withstand a hydraulic pressure to one and half time the design pressure, but not greater than pressure calculated by the formula given below. In the absence of working pressure indicated in the Test Certificate then the test pressure indicated in the Test Certificate divided by 1.5 shall be the maximum working pressure.

$$P = 2St/D$$

where P = test pressure
D = specified outside diameter of the pipe
t = specified wall thickness of the pipe
S = stress which shall be taken as 40% of the minimum tensile strength at room temperature.

(ii) Notwithstanding anything contained in the above clause, the hydraulic test at the maker's works may be dispensed with provided that the pipes are subject to non destructive testing by an appropriate method like Ultrasonic or Eddy Current or Stray flux testing.

SEAMLESS FERRITIC AND AUSTENITIC ALLOY STEEL BOILER, SUPERHEATER AND HEAT EXCHANGER TUBES

47. General. - (i) These regulations cover both hot finished and cold drawn seamless boiler, superheater and heat exchanger tubes of ferritic and austenitic alloy steel grades. These shall conform in all respects with the requirements herein specified.

(ii) The seamless tubes conforming to other national/international standards which are known to be commonly used as being suitable for use as boiler and superheater tubes can also be used with the designations of the national/international standards, provided such materials are not specifically prohibited by the regulations.

(iii) While making tubes to other national/internationals standards the allowable stresses of the respective standard shall be strictly followed while designing the tubes.

(iv) The design metal temperatures shall not exceed the following limits :-

Grade	Temp. Degree C(Degree F)
T1, T2	537 (1000)
T5, T9, T11, T12, T22, T91, 12X1Mo, X20CrMoV121, TP 304, TP 304H, TP 304L, TP 310S, TP 316, TP316H, TP 316L, TP321, TP321H, TP347, TP347H	648 (1200)

48. (a) Material. - (i) The tubes shall be seamless and manufactured from steel produced by an open hearth or electric process or any of the oxygen processes. The steel shall be fully killed.

(ii) The steel shall conform to the limits of chemical compositions given in Table-1 and 2.

(iii) The grain size of cold worked grade TP 321H shall be No.7 or coarser.

(b) Heat treatment. - (i) All tubes of grades in Table-1, except T 91, 12X1Mo and X20CrMoV121 shall be reheated and furnished in full annealed, isothermal annealed or normalised and tempered condition. If furnished in the normalised and tempered condition, the minimum tempering temperature for Grades T1 and T11 shall be 650 degree C and the minimum tempering temperature for Grades T5, T9 and T22 shall be 675 Degree C.

(ii) Tubing of Grades T1, T2 and T12 either hot finished or cold drawn, may be given a final heat treatment at 650 degree C to 730 degree C, instead of heat treatments specified in sub-clause (i) above, at the option of the manufacture.

(iii) Grade T91 shall be normalised at 1040 degree C minimum and tempered at 730 degree C minimum as a final heat treatment.

(iv) Grade 12x1Mo shall be normalised at 950 - 980 degree C and tempered at 720 - 750 degree C for a period of 1 to 3 hours.

(v) Grade X20CrMoV121 shall be normalised at 1020 - 1070 degree C and tempered at 730 - 780 degree C for a period of 1 hour minimum.

(vi) All austenitic tubes (Table 2) shall be furnished in the heat treated condition. The heat treatment procedure, except for the H grades shall consist of heating the material to a minimum temperature of 1040 degree C and quenching in water or rapidly cooling by other means.

(vii) All H grades shall be furnished in the solution treated condition. If cold working is involved in processing, the minimum solution treating temperatures for grades TP321H and TP347H shall be 1100 degree C and for grades TP304H and TP316H shall be 1040

degree C. If the P grade is hot rolled, the minimum solution treatment for grades TP 321 H and TP 347 H shall be 1050 degree C and for grades TP 304H and TP 316H shall be 1040 degree C.

(c) Workmanship and tolerance - The tubes shall be well finished, cleaned free from harmful defects. They shall be reasonably straight, smooth, cylindrical and subject to the following tolerances. Finished tubes shall be reasonably straight and have smooth ends free of burrs. They shall have a workmanlike finish. Surface imperfections like any discontinuity or irregularity found in the tube may be removed by grinding, provided that a smooth curved surface is maintained, and the wall thickness is not decreased to less than that permitted. The outside diameter at the point of grinding may be reduced by the amount so removed.

(i) Permissible variation in outside diameter:

For all grades except 12X1Mo and X20CrMoV121

Outside diameter (mm)	Permissible Variation (mm)	
	Over	Under
Hot finished Seamless tubes		
101.6 and under	0.4	0.8
Over 101.6 to 190.5 incl.	0.4	1.2
Over 190.5 to 228.6 incl.	0.4	1.6
Cold finished Seamless tubes		
Under 25.4	0.10	0.10
Over 25.4 to 38.1 incl.	0.15	0.15
Over 38.1 to 50.8 excl.	0.20	0.20
50.8 to 63.5 excl.	0.25	0.25
63.5 to 76.2 excl.	0.30	0.30
76.2 to 101.6 incl.	0.38	0.38
Over 101.6 to 190.5 incl.	0.38	0.64
Over 190.5 to 228.6 incl.	0.38	1.14

For grade 12X1Mo

Outside diameter (mm)	Permissible Variation (mm)	
	Over	Under
Hot finished and cold finished tubes		
Under 30.0	0.30	0.30
30 to 50	0.40	0.40
Over 50.0	0.80%	0.80%

For grade X20CrMoV121

Outside diameter	Permissible Variation (mm)	
	Over	Under
Hot finished Seamless tubes		
100 and under	0.75% (0.5 mm min)	0.75% (0.5 mm min)
Cold finished seamless tubes		
120 and under	0.60% (0.25 mm min)	0.60%(0.25 mm min)
Over 120	0.75%	0.75%

(ii) Permissible variation in Wall Thickness :

For all grades except 12X1Mo and X20CrMoV121

Outside Diameter (mm)	Wall thickness %							
	2.4 and under		Over 2.4 to 3.8 incl.		Over 3.8 to 4.6 incl.		Over 4.6	
	Over	Under	Over	Under	Over	Under	Over	Under
Seamless hot finished tubes								
101.6 and Under	40	0	35	0	33	0	28	0
Over 101.6	0	0	35	0	33	0	28	0
Seamless cold finished tubes								

	Over	Under
38.1 and under	20	0
Over 38.1	22	0

For Grade 12X1Mo

Outside Diameter (mm)	Permissible variation %	
	Over	Under
Hot Finished Seamless Tubes		
108 and under	15	10
Over 108	20	5
Cold Finished Seamless Tubes		
All sizes	10	10

For Grade X20CrMoV121

Outside diameter (mm)	Permissible variation %	
	Over	Under
100 and under	12.5	10

(iii) Permissible variation in length for exact length tubes.

For all Grades except 12 X 1Mo and X20CrMoV121

Method of manufacture	Outside diameter (mm)	Cut length (mm)	
		Over	Under
Seamless Hot finished	All sizes	5	0
Seamless Cold finished	Under 50.8	3	0
	50.8 Over	5	0

Note : These permissible variations in lengths apply to cut lengths upto and including 7.3 m. For lengths over 7.3 m, an additional over tolerance of 3 mm for each 3 m or fraction thereof, shall be permissible, upto a maximum of 12 mm.

For grade 12X1Mo

Out side diameter (mm)	Length of tubes (m)	Permissible variation (mm) Over	Under
Under 108	Under 9	15	0
	9 to 12	35	0
108 and over	All lengths	50	0

For grade X20CrMoV121

Length of tube (m)	Permissible variation (mm) Over	Under
6 and under	10	0
Over 6 to 12 incl.	15	0

(d) Test specimens. - (i) Test specimens required for the flattening and expanding/ flaring test specified in regulations 49(a), 49 (b) and 49(c) shall be taken from the ends of finished tubes prior to upsetting, swaging, expanding or any other forming operations or being cut to length. They shall be smooth on the ends and free from burrs and flaws.

(ii) If desirable and practicable, tensile test may be carried out on full section of the tubes upto the capacity of the testing machine. For large size tubes, the tensile test specimen shall consist of strip cut longitudinally from the tube and which is not straightened within the gauge length further heat treated.

(iii) If any test specimen shows flaws or defective machining it may be discarded and another specimen substituted.

(iv) All specimens shall be tested at room temperature.

(e) Number of tests. - The tests specified in regulations 49(a), 49(b) and 49(c) shall be made on minimum 2 tubes for first 100 and 1 per 100 or part thereof for tubes over 100 numbers.

49. (a) Tensile and hardness tests. - The test specimen shall comply with the requirements as given in Table 3. The hardness test may be carried out on the wall cross section or on a flat on the outside surface of the tube sample.

(b) Flattening test. - A section of the tube not less than 63 mm in length shall be flattened cold between two parallel flat surfaces to a distance between the plates (H) as calculated by the formula given below, without showing any sign of a crack of flaw.

$$H = \frac{(1 + e)t}{e + t/D}$$

where t = specified thickness of tube (mm)
D = specified outside diameter of the tube (mm)
e = a constant, as given below
e = 0.08 for ferritic alloy steel
e = 0.09 for austenitic steel

(c) Expanding or flaring test. - A section of the tube approximately 100 mm in length shall stand being flared with a tool having a 60 degree included angle until the tube at the mouth of the flare has been expanded to the percentages given below, without cracking.

Ratio of inside diameter to outside diameter	Minimum expansion of inside diameter %
0.9	21
0.8	22
0.7	25
0.6	30
0.5	39
0.4	51
0.3	68

50. Additional tests before rejection. - (i) If any one or more tests specified in these regulations fail, two further tests of the same kind may be made on two other tubes of the same batch. If any of these tests fails, the batch of the tubes represented may be given a further heat treatment and entire set of tests shall be repeated.

(ii) If the repeat tests are satisfactory the tubes shall be accepted. If any failure in the tests should occur the entire batch of the tubes shall be rejected.

51. Hydraulic test. - (i) Each tube shall be tested by the manufacturer and shall withstand a hydraulic pressure to one and a half time the design pressure subject to a minimum of 1.00 kgf/mm^2, but not greater than pressure calculated by the following formula:-

$$P = 2\ St/D$$

where P = test Pressure
D = specified out side diameter of the tube
t = specified wall thickness of the tube
S = stress which shall be taken as 40% of the minimum tensile strength at room temperature.

(ii) Notwithstanding anything contained in the above clause, the hydraulic test at the maker's works may be dispensed with, provided that the tubes are subject to non destructive testing by an appropriate method like Ultrasonic or Eddy current or Stray Flux testing.

TABLE 1
CHEMICAL REQUIREMENTS FOR FERRITIC STEELS

Grade	Chemical composition %									
	C	Mn	Si	S	P	Cr	Mo	V	Ni	Other Elements
T1	0.10 0.20	0.30 0.80	0.10 0.50	0.025 max	0.025 max	-------	0.44 0.65	---	---	----
T2	0.10 0.20	0.30 0.61	0.10 0.30	0.025 max	0.025 max	0.50 0.81	0.44 0.65	----	---	-----
T5	0.15 max	0.30 0.60	0.50 max	0.025 max	0.025 max	4.00 6.00	0.45 0.65	----	----	-----
T9	0.15 max	0.30 0.60	0.25 1.00	0.025 max	0.025 max	8.00 10.0	0.90 1.10	----	----	-----
T11	0.05 0.15	0.30 0.60	0.50 1.00	0.025 max	0.025 max	1.00 1.50	0.44 0.65	----	----	-----
T12	0.05 0.15	0.30 0.61	0.50 max	0.025 max	0.025 max	0.80 1.25	0.44 0.65	----	---	-----
T22	0.05 0.15	0.30 0.60	0.50 max	0.025 max	0.025 max	1.90 2.60	0.87 1.13	----	----	-----
T91	0.08 0.12	0.30 0.60	0.20 0.50	0.010 max	0.020 max	8.00 9.50	0.85 1.05	0.18 0.25	----	Nb=0.06 - 0.10 N=0.030 - 0.70 Ni=0.40 max Al=0.04 max
12X1 Mo	0.10 0.15	0.40 0.70	0.17 0.37	0.025 max	0.025 max	0.90 1.20	0.25 0.35	0.15 0.30	0.25 max	Cu=0.20 Max
X20 CrMoV 121	0.17 0.23	1.00 max	0.50 max	0.030 max	0.03 max	10.0 12.5	0.80 1.20	0.25 0.35	0.30 0.80	

TABLE 2
CHEMICAL REQUIREMENTS OF AUSTENTIC STEEL

Grade	Chemical composition %									
	C	Mn	Si	S	P	Cr	Mo	V	Ni	Other Elements
TP304	0.08 max	2.00 max	0.75 max	0.030 max	0.40 max	18.0 20.0	----	----	8.00 11.0	----
TP304H	0.04 0.10	2.00 max	0.75 max	0.030 max	0.040 max	18.0 20.0	-----	----	8.00 11.0	-----
TP304L	0.035 max	2.00 max	0.75 max	0.030 max	0.040 max	18.0 20.0	-----	----	8.00 13.0	-----
TP310S	0.08 max	2.00 max	0.75 max	0.030 max	0.045 max	24.0 26.0	0.75 max	----	19.0 22.0	-----
TP316	0.08 max	2.00 max	0.75 max	0.030 max	0.040 max	16.0 18.0	2.00 3.00	----	11.0 14.0	-----
TP316H	0.040 0.10 0.10	2.00 max	0.75 max	0.030 max	0.040 max	16.0 18.0	2.00 3.00	----	11.0 14.0	-----

TP316L	0.035 max	2.00 max	0.75 max	0.030 max	0.040 max	16.0 18.0	2.00 3.00	----	10.0 15.0	-----
TP321	0.08 max	2.00 max	0.75 max	0.030 max	0.040 max	17.0 20.0	----	----	9.00 13.0	Ti=5xC min 0.60 max
TP321H	0.04 0.10	2.00 max	0.75 max	0.030 max	0.040 max	17.0 20.0	----	----	9.00 13.0	Ti=4xC min 0.60 max
TP347	0.08 max	2.00 max	0.75 max	0.030 max	0.040 max	17.0 20.0	----	----	9.00 13.0	Nb+Ta=10xC min 1.000 max
TP347H	0.04 0.10	2.00 max	0.75 max	0.030 max	0.040 max	17.0 20.0	----	-----	9.00 13.00	Nb+Ta=8xC min 1.00 max

TABLE 3
MECHANICAL PROPERTY REQUIREMENTS

Grade	Yield strength Mpa (kg/mm^2) Min	Tensile Strength Mpa (kg/mm^2) Min	% Elongation on GL=50mm min *	Hardness	
				HRB max	HB max
T1	205 (21.1)	380 (38.7)	30	80	146
T2	205 (21.1)	415 (42.2)	30	85	163
T5	205 (21.1)	415 (42.2)	30	85	163
T9	205 (21.1)	415 (42.2)	30	89	179
T11	205 (21.1)	415 (42.2)	30	85	163
T12	220 (22.5)	415 (42.2)	30	85	163
T22	205 (21.1)	415 (42.2)	30	85	163
T91	415 (42.2)	585 (59.6)	20	25 HRC	250
12X1Mo	274 (28.0)	441 (45.0) 637 (65.0)	21	85	163
X20Cr MoV121	490 (50.0)	690 (70.4) 840 (85.7)	17	25HRC	250
TP 304	205 (21.1)	515 (52.5)	35	90	192
TP304H	205 (21.1)	515 (52.5)	35	90	192
TP304L	170 (17.3)	485 (49.5)	35	90	192
TP310S	205 (21.1)	515 (52.5)	35	90	192
TP316	205 (21.1)	515 (52.5)	35	90	192
TP316H	205 (21.1)	515 (52.5)	35	90	192
TP316L	170 (17.3)	485 (49.5)	35	90	192
TP321	205 (21.1)	515 (52.5)	35	90	192
TP321H	205 (21.1)	515 (52.5)	35	90	192
TP347	205 (21.1)	515 (52.5)	35	90	192
TP347H	205 (21.1)	515 (52.5)	35	90	192

*GL = $5.65\sqrt{SO}$

SEAMLESS FERRITIC PIPES FOR HIGH TEMPERATURE SERVICE

52. General. - (i)These regulations cover both hot finished and cold drawn seamless pipes of ferritic alloy steel grades. These shall conform in all respects with the requirements herein specified.

(ii) The seamless pipes conforming to other national/international standards which are known to be commonly used as being suitable for high temperature service can also be used with the designations of the national/international standards, provided such materials are not specifically prohibited by the regulations.

(iii) While making pipes to other national/international standards the allowable stresses of the respective standard shall be strictly followed while designing the tubes.

(iv) The design metal temperatures shall not exceed the following limits

Grade	Temp. Degree C (Degree F)
P1, P2	537 (1000)
P5, P9, P11, P12, P22, P91, X20CrMoV121	648 (1200)

53. (a). Material. - (i) The pipes shall be seamless and manufactured from steel produced by an open hearth or electric process or any of the Oxygen processes. The steel shall be fully killed.

(ii) The steel shall conform to the limits of chemical composition as given in table-4.

(b) Heat treatment. - (i) All pipes of grades in table-1 except P91 and X20CrMoV121 shall be reheated and furnished in full annealed, isothermal annealed or normalised and tempered condition. If furnished in the normalised and tempered condition, the minimum tempering temperature for grade P1, P2, P11 and P12 shall be 650 degree C and the minimum tempering temperature for grades P5, P9 and P22 shall be 675 degree C.

(ii) Pipes of grades P1, P2 and P12 either hot finished or cold drawn may be given a final heat treatment at 650 degree C to 705 degree C, instead of heat treatment specified in sub-clause (i) above at the option of the manufacturer.

(iii) Grades P91 shall be normalised at 1040 degree C minimum and tempered at 730 degree minimum as a final heat treatment.

(iv) Grades X20CrMoV121 shall be normalised at 1020 - 1070 degree C and tempered at 730-780 degree C for a period of one hour minimum.

(c) Workmanship and tolerance - The pipes shall be well finished, cleaned free from harmful defects. They shall be reasonably straight, smooth, cylindrical and subject to the following tolerances. Pipes manufacturer shall explore a sufficient number of visual inspections to provide reasonable assurance that they have been properly evaluated.

(i) Permissible variation in outside diameter.

For all grades except X20CrMoV121

Hot finished and Cold finished seamless pipes		
Outside diameter (mm)	Permissible variations (mm) Over	Under
10.3 to 48.3 incl.	0.40	0.79
Over 48.3 to 114.3 incl.	0.79	0.79
Over 114.3 to 219.1 incl.	1.58	0.79
Over 219.1 to 457.0 incl.	2.38	0.79
Over 457.0 to 660.0 incl.	3.18	0.79
Over 660.0 to 864.0 incl.	3.97	0.79
Over 864.0 to 1219.0 incl.	4.76	0.79

For Grade X20CrMoV121

Over 100 to 320 incl.	0.90%	0.90%
Over 320	1.00%	1.00%

(ii) Permissible variations in wall thickness :

For all grades, except X20CrMoV121

The minimum wall thickness at any point shall not be more than 12.5% under the nominal wall thickness specified.

For grade X20CrMoV121

Outside diameter (mm)	Permissible variation % Over	Under
Over 100 to 320 incl.	12.5	12.5
Over 320	15.0	12.5

(iii) Permissible variation in length :

Seamless Hot finished and Cold finished pipes can be ordered in specified length or in random length. If ordered in specified length, the tolerance shall be as follows :

For hot finished and cold finished pipes

Grade	Length (m)	Permissible variation in (mm) Over	Under
All grades except X20CrMoV121	All length	6	0
For grade X20CrMoV121	6 and under	10	0
	Over 6 to 12 incl.	15	0

(d) Test specimen - (i) Test specimens required for flattening and expanding/flaring test specified in regulations 54(a), 54(b) and 54(c) shall be taken from ends of finished pipes prior to upsetting, swaging, expanding or any other forming operations or being cut to length. They shall be smooth on ends and free from burrs and flaws.

(ii) If desirable and practicable, tensile test may be carried out on full section of the pipe upto the capacity of the testing machine. For large size pipes the tensile test specimen shall consist of strip cut longitudinally from the pipe and which is not straightened within the gauge length and further heat treated.

(iii) If any test specimen shows flaws or defective machining it may be discarded and another specimen substituted.

(iv)All specimens shall be tested at room temperature.

(e)Number of tests - (i) The tests specified in regulations 54(a), 54(b) and 54(c) shall be made on minimum 2 pipes for first 100 pipes and 1 per 100 part thereof for pipes over 100 numbers.

54. (a)Tensile test. - The test specimen shall comply with the requirements given in the table 5.

(b) Bend test. - For pipes of outside diameter 60.3 mm and under, a bend test shall be conducted. A sufficient length of pipe shall stand being bent cold through 90 around a cylindrical mandrel, the diameter of which is 12 times the nominal diameter of the pipe, without developing cracks.

(c) Flattening test. - (i) For pipes of outside diameter over 60.3 mm a flattening test shall be conducted. A section of the pipe not less than 63 mm is length shall be flattened cold between two parallel flat surfaces to a distance between the plates (H) as calculated by the formula given below, without showing any sign of a crack or flaw.

$$H = (1+e)\, t \,/\, \{e + (t/D)\}$$

where t = specified thickness for pipe (mm)
D = specified outside diameter of the pipe (mm)
e = a constant, 0.08 for ferritic alloy steel.

(ii) For pipe whose diameter equals or exceeds 254 mm, a bend test may be conducted instead of the flattening test. The bend test specimens shall be bent at room temperature through 180 degree C without cracking on the outside of the bent portion. The inside diameter of the bend shall be 25 mm. Substitution of the bend test for the flattening test shall be subject to the approval of the purchaser.

(iii) For pipes whose diameter exceed 635 mm and whose diameter to wall thickness ratio is 7.0 or less, the bend test described in clause (b) shall be conducted instead of the flattening test.

55. Additional tests before rejection. - (i) If any one or more tests specified in these regulations fail, two further tests of the same kind may be made on two other pipes of the same batch. If any of these tests fails, the batch of the pipes represented may be given a further heat treatment and entire set of tests shall be repeated.

(ii) If the repeat tests are satisfactory, the pipes shall be accepted. If any failure in the tests should occur the entire batch of the pipes shall be rejected.

56. Hydraulic test. - (i) Each pipe shall be tested by the manufacturer and shall withstand a hydraulic pressure to one and half times the design pressure but not greater than pressure calculated by the following formula given below. In the absence of working pressure is indicated in the Test Certificate then the tested pressure indicated in the Test Certificate divided by 1.5 shall be the maximum working pressure

$$P = 2 S t / d$$

where P = test pressure
D = specified outside diameter of the pipe
t = specified wall thickness of the pipe
S = stress which shall be taken as 40% of the minimum tensile strength at room temperature.

(ii) Notwithstanding anything contained in the above clause, the hydraulic test at the maker's works may be dispensed with provided that the pipes are subject to non destructive testing by an appropriate method like Ultrasonic or Eddy current or stray flux testing

Table 4
CHEMICAL REQUIREMENTS FOR FERRITIC STEELS

Grade	Chemical composition %									
	C	Mn	Si	S	P	Cr	Mo	V	Ni	Other Elements
P1	0.10 0.20	0.30 0.80	0.10 0.50	0.025 max	0.025 max	----	0.44 0.65	----	----	-----
P2	0.10 0.20	0.30 0.61	0.10 0.30	0.025 max	0.025 max	0.50 0.81	0.44 0.65	----	----	-----
P5	0.15 max	0.30 0.60	0.50 max	0.025 max	0.025 max	4.00 6.00	o.45 0.65	----	----	-----
P9	0.15 max	0.30 0.60	0.25 1.00	0.025 max	0.025 max	8.00 10.0	0.90 1.10	----	----	-----
P11	0.05 0.15	0.30 0.60	0.50 1.00	0.025 max	0.025 max	1.00 1.50	0.44 0.65	----	----	-----
P12	0.05 0.15	0.30 0.61	0.50 max	0.025 max	0.025 max	0.80 1.25	0.44 0.65	----	----	-----
P22	0.05 0.15	0.30 0.60	0.50 max	0.025 max	0.025 max	1.90 2.60	0.87 1.13	----	----	-----
P91	0.08 0.12	0.30 0.60	0.20 0.50	0.010 max	0.020 max	8.00 9.50	0.85 1.05	0.18 0.25	----	Nb=0.06 - 0.10 N=0.030 - 0.70 Ni=0.40 max Al=0.04 max
X20Cr MoV121	0.17 0.23	1.00 max	0.50 max	0.03 max	0.030 max	10.0 12.5	0.80 1.20	0.25 0.35	0.30 0.80	----

Table-5
MECHANICAL PROPERTY REQUIREMENTS

Grade	Yield Strength Mpa (kg/mm^2) min	Tensile Strength Mpa (kg/mm^2) min	% elongation on GL=50mm min *
P1	205(21.1)	380(38.7)	30
P2	205(21.1)	380(38.7)	30
P5	205(21.1)	415(42.2)	30
P9	205(21.1)	415(42.2)	30
P11	205(21.1)	415(42.2)	30
P12	220(22.5)	415(42.2)	30
P22	205(21.1)	415(42.2)	30
P91	415(42.2)	585(59.8)	20
X20CrMoV121	490(50.0)	690(70.4) 840(85.6)	17

*GL=5.65√SO.".

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Sd/-
(V.K. GOEL)
Secretary, Central Boilers Board

Foot note.- The principal regulations were published in the Gazette of India vide S.O. 600, dated the 15th September, 1950 and subsequently amended vide notifications –

(i) G.S.R. 178, dated the 24th March, 1990;
(ii) G.S.R. 179, dated the 24th March, 1990;
(iii) G.S.R. 488, dated the 9th October, 1993;
(iv) G.S.R. 516 dated the 23rd October, 1993;
(v) G.S.R. 634 dated the 25th December, 1993;
(vi) G.S.R. 107 dated the 26th February, 1994;
Errata G.S.R. 223 dated the 14th May, 1994;
(vii) G.S.R. 250 dated the 4th June, 1994;
(viii) G.S.R. 402 dated the13th August, 1994;
(ix) G.S.R. 427 dated the 20th August, 1994;
(x) G.S.R. 562 dated the12th November, 1994;
(xi) G.S.R. 607 dated the10th December, 1994;
(xii) G.S.R. 83 dated the 25th February, 1995;
(xiii) G.S.R. 93 dated the 4th March, 1995;
(xiv) G.S.R. 488 dated the 9th November, 1996;
(xv) G.S.R. 582 dated the 28th December, 1996;
(xvi) G.S.R. 59 dated the 25th January, 1997;
(xvii) G.S.R. 117 dated the 1st March, 1997;
(xviii) G.S.R. 172 dated the 29th March, 1997.
(xix) G.S.R. 221 dated the 21st November, 1998.

(xx) G.S.R. 131 dated 1st May, 1999.
(xxi) G.S.R. 139 dated 8th May, 1999.
(xxii) G.S.R. 237 dated 31st July, 1999.
(xxiii) G.S.R. 345 dated 23rd October, 1999.
(xxiv) G.S.R. 397 dated 14th October, 2000.

To

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