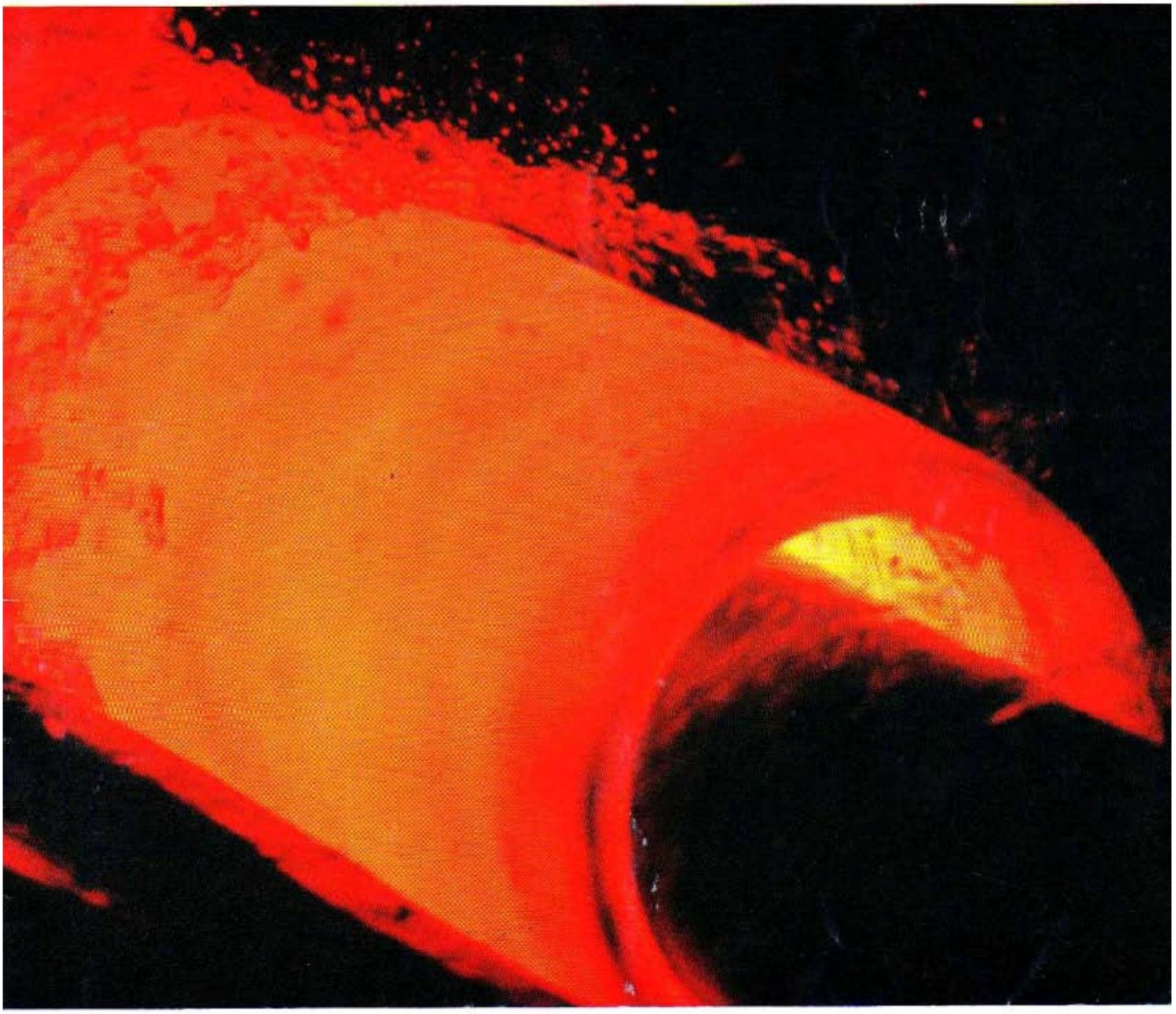
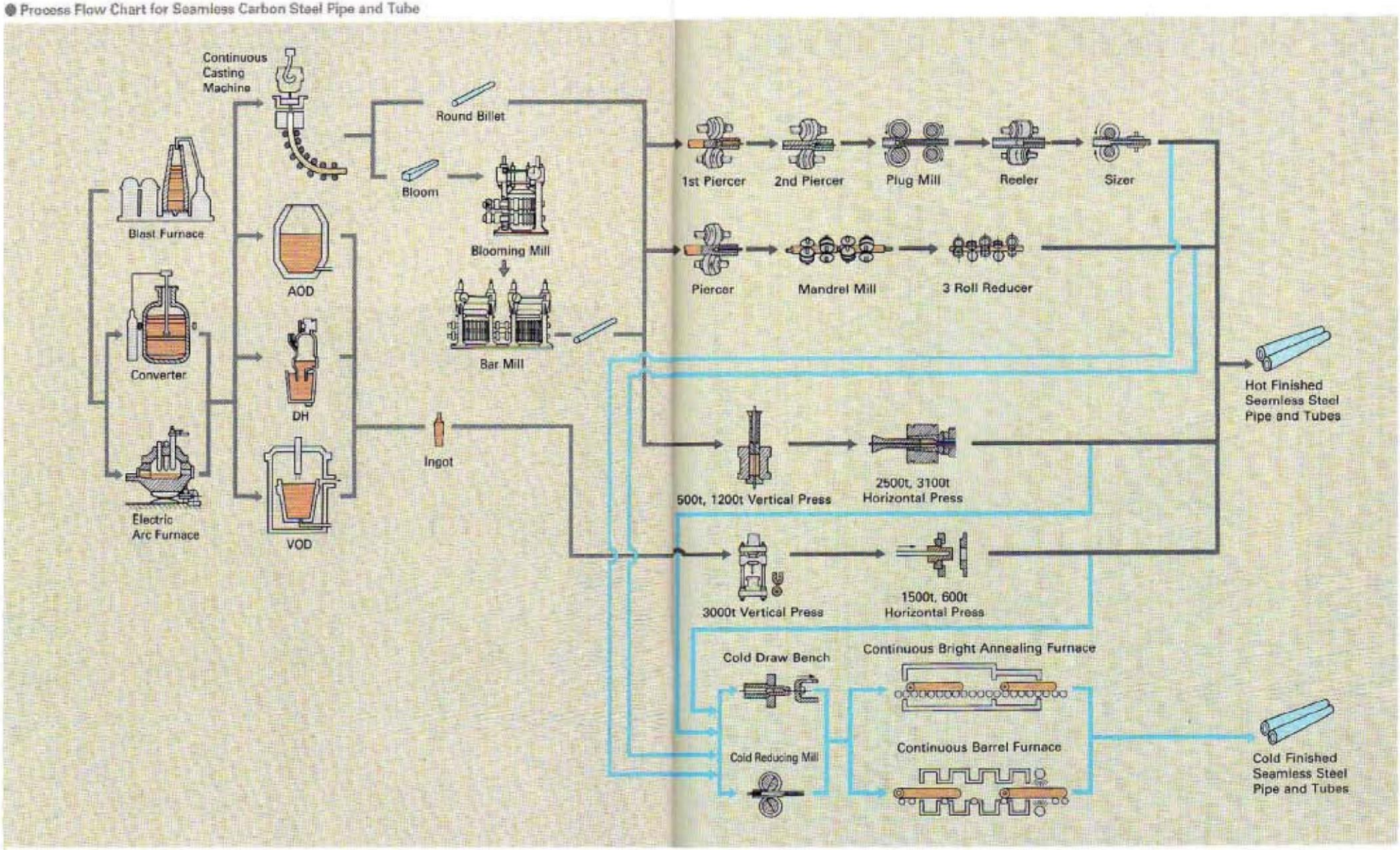
SUMITOMO METALS

SEAMLESS CARBON STEEL PIPE



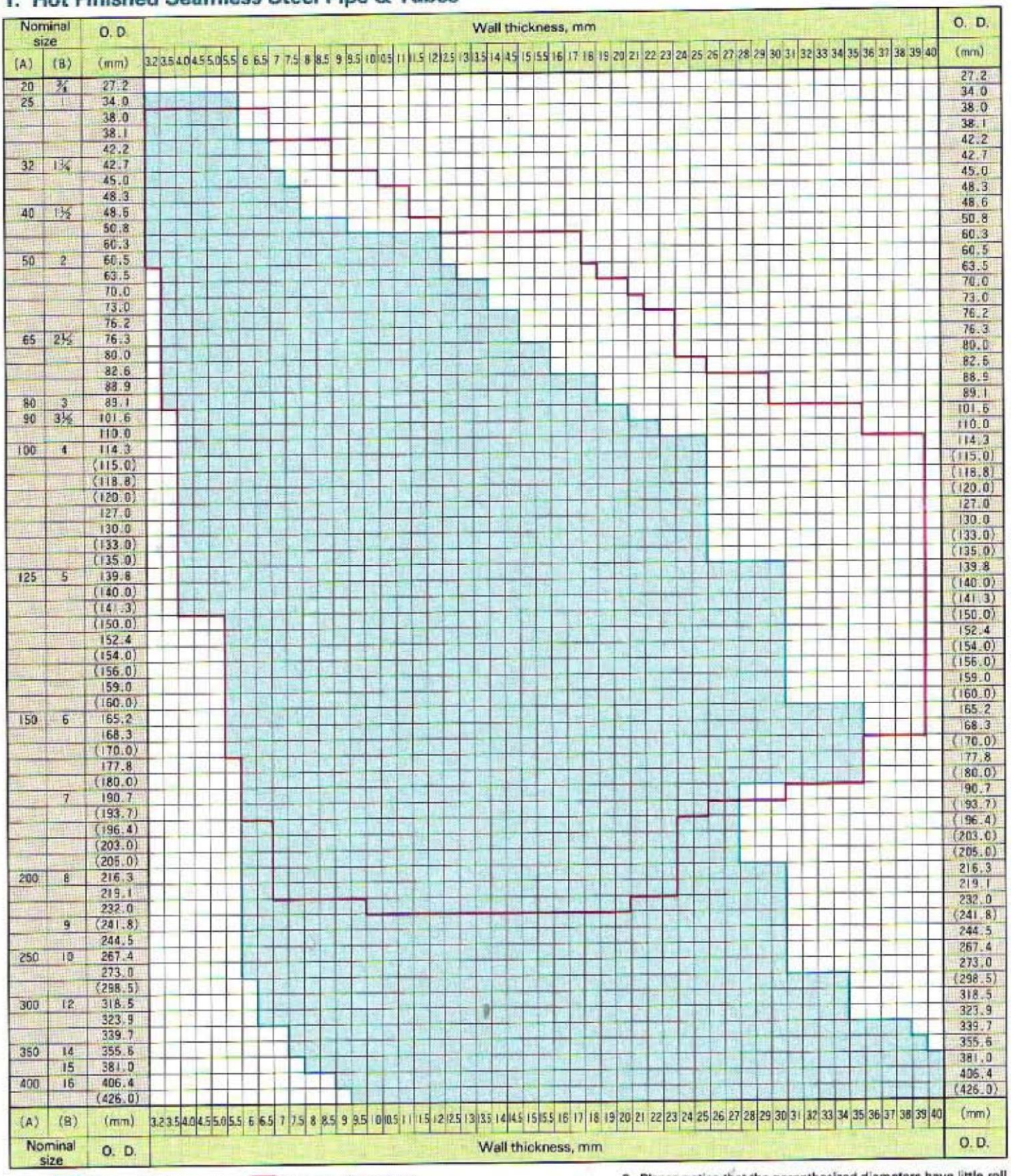
PROCESS FLOW CHART

● Process Flow Chart for Seamless Carbon Steel Pipe and Tube



AVAILABLE SIZE RANGE

1. Hot Finished Seamless Steel Pipe & Tubes



: Rotary piercing process : Hot extrusion process

Remarks:
1. Above range may not apply to some of the special type of steel.
2. Prior consultation with the manufacturer is necessary with thin-walled products on the boundary of the available range.
3. Please notice that the parenthesized diameters have little roll chance.
4. For sizes other than the above, please inquire.

2. Forged Seamless Steel Pipe & Tubes

Nominal size (A)	Nominal size (B)	O.D. (mm)	Wall thickness, mm	O.D. (mm)
		152.4		152.4
150	6	165.2		165.2
		177.8		177.8
	7	190.7		190.7
200	8	216.3		216.3
	9	241.8		241.8
250	10	267.4		267.4
		298.5		298.5
300	12	318.5		318.5
		339.7		339.7
350	14	355.6		355.6
		368.3		368.3
		381.0		381.0
		393.9		393.9
400	16	406.4		406.4
		419.1		419.1
		431.8		431.8
		444.5		444.5
450	18	457.2		457.2
	18½	469.9		469.9
	19	482.6		482.6
	19½	495.2		495.2
500	20	508.0		508.0
	20½	520.7		520.7
	21	533.4		533.4
	21½	546.1		546.1
550	22	558.8		558.8
	22½	571.5		571.5
	23	584.3		584.3
	23½	596.9		596.9
600	24	609.6		609.6
	25	635.0		635.0
650	26	660.4		660.4
	27	685.8		685.8
700	28	711.2		711.2
	29	736.6		736.6
750	30	762.0		762.0
	31	787.4		787.4
800	32	812.8		812.8
850	34	863.6		863.6
	35	889.0		889.0
900	36	914.4		914.4
1000	40	1016.0		1016.0
1100	44	1117.6		1117.6
1200	48	1219.2		1219.2
1300	50	1270.0		1270.0
(A)	(B)	(mm)	17 18 19 20 21 22 23 24 26 28 30 32 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 130 140 150 160 170 180 190 200 210 220 230 240	(mm)
Nominal size		O.D.	Wall thickness, mm	O.D.

Remarks: For sizes other than the above, please inquire.

3. Cold Finished Seamless Steel Pipe & Tubes

Nominal size (A)	Nominal size (B)	O.D. (mm)	Wall thickness, mm: 1.0	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24	26	28	30	32	35	O.D. (mm)
		6																																				6
		8																																				8
6	⅛	10.5																																				10.5
8	¼	13.8																																				13.8
		15.9																																				15.9
10	⅜	17.3																																				17.3
		19.0																																				19.0
15	½	21.7																																				21.7
		25.4																																				25.4
20	¾	27.2																																				27.2
		31.8																																				31.8
25	1	34.0																																				34.0
		38.0																																				38.0
32	1¼	42.7																																				42.7
		45.0																																				45.0
40	1½	48.6																																				48.6
		50.8																																				50.8
		54.0																																				54.0
		57.1																																				57.1
50	2	60.5																																				60.5
		63.5																																				63.5
		65.0																																				65.0
		70.0																																				70.0
65	2½	76.3																																				76.3
		82.6																																				82.6
80	3	89.1																																				89.1
		95.0																																				95.0
90	3½	101.6																																				101.6
		108.0																																				108.0
100	4	114.3																																				114.3
		121.0																																				121.0
		127.0																																				127.0
		130.0																																				130.0
125	5	139.8																																				139.8
		152.4																																				152.4
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		177.8																																				177.8
	7	190.7																																				190.7
200	8	216.3																																				216.3
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	19½	495.2																																				495.2
500	20	508.0																																				508.0
	20½	520.7																																				520.7
(A)	(B)	(mm)	1.0	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24	26	28	30	32	35	(mm)
Nominal size		O.D.	Wall thickness, mm																																				O.D.

Remarks: For sizes other than the above, please inquire.

El % $^{min}_{(2\ in)}$	Impact Test	Flattering Test	Bend Test	Hydrostatic Test
English Formula $e=625{,}000\frac{A^{0.2}}{U^{0.9}}$ or Metric Formula $e=1942.57\frac{A^{0.2}}{U^{0.9}}$ e=min. elongation: 2 in. (50.80 mm) in percent to nearest 1/2 percent. A=cross sectional area of the tensile test specimen. U=min U.T.S.	*2	*3	*3	English Formula $P=\frac{2St}{D}$ Metric Formula $P=\frac{2000St}{D}$ where: P=hydrostatic test pressure in pounds per sq. in. (kPa) S=fiber stress in pounds per sq. in. (MPa), equal to a percentage of the specified minimum yield strength for the various sizes as shown below. t=specified wall thickness in in. (mm) D=specified outside diameter in in. (mm)

Grade	Size	Percent of Specified Minimum Yield Strength: Standard Test Pressure	Alternate Test Pressure
A25	5/16*	60	—
A	2 3/8 and larger**	60	75
B	2 3/8 and larger**	60	75
X42 thru X80†	5/16 and smaller	60	75
	6 3/8 and 8 5/8	75	—
	10 3/4 to 18 incl.	85	—
	20 and larger	90	—

*Test pressures for other sizes established arbitrarily.

**Test pressures were limited to 2500 psi (17200 kPa) for 3½ in. and smaller, and to 2800 psi (19300 kPa) for sizes larger than 3½ in. Test pressures for other sizes established arbitrarily.

†Test pressures for grades X42 thru X70 were limited to 3000 psi (20700 kPa) to accommodate hydrostatic tester limitations.

*1: Welded pipe specification is omitted in this table.

*2: Fracture Toughness Tests. When so specified on the purchase order, the manufacturer shall conduct fracture toughness tests in accordance with Supplementary Requirement SR-5 or SR-6 or SR-8 or any combination of these, as specified by the purchaser, and shall furnish a report of results showing compliance with the supplementary requirement specified.

SR8 and SR5 Mandatory Toughness Requirements

Min. Energy at 32F. Ft. Lbs (a)(b)		Min. Percent Shear Area at 32F (c)	
Avg. of 3 Specimens All Heat Avg.	From One Heat	Avg. of 3 Specimens All Heat Avg.	From One Heat
50	20	70	40

Optional SR8 and SR6 Mandatory Toughness Requirements Based on Charpy and Drop Weight Tear Tests

Min. Charpy Energy at 32F. Ft. Lbs (a)(b)		Min. DWTT Percent Shear Area at 32F (c)	
Avg. of 3 Specimens All Heat Avg.	From One Heat	Avg. of 3 Specimens All Heat Avg.	From One Heat
50	20	60	40

where

SR5; Charpy impact testing on welded pipe 20 in. diameter or larger, grade X-52 or higher

SR6; Drop weight tear testing on welded pipe 20 in. diameter or larger, grade X-52 or higher

SR8; Fracture toughness testing of line pipe 16 in. diameter or larger, grade X-42 or higher (Charpy V-notch impact test)

*3: Specified only on welded pipe, not on seamless pipe.

Tolerances on lengths

1	2	3	4	5
	Shortest Length in Entire Shipment	Shortest Length in 95% of Entire Shipment	Shortest Length in 90% of Entire Shipment	Minimum Average Length Entire Shipment
Threaded-and-Coupled Pipe				
Single random lengths	16.0 ft (4.88 m)	18.0 ft (5.49 m)	—	—
Double random lengths	22.0 ft (6.71 m)	—	—	35.0 ft (10.67 m)
Plain-End Pipe				
Single random lengths	9.0 ft (2.74 m)	—	—	17.5 ft (5.33 m)
Double random lengths	14.0 ft (4.27 m)	—	26.3 ft (8.00 m)	35.0 ft (10.67 m)
As agreed upon lengths in excess of 20 ft. (6.10 m)	40% of average agreed upon	—	75% of average agreed upon	—

*By agreement between the purchaser and the manufacturer, these tolerances shall apply to each carload.

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

Specification	Grade	Chemical Requirements (%)									Tensile Requirements			Impact Test
		C	Mn	P_{max}	S_{max}	Si	Ni	Cr	Cu	Aℓ	T.S. min psi (MPa)	Y.S. min psi (MPa)	El (2 in.)	
ASTM A53 (Welded and Seamless Steel Pipe)	A (AB-2)	max 0.25	max 0.95	0.05	0.06	—	—	—	—	—	48000 (330)	30000 (205)	$62500\frac{A^{0.2}}{U^{0.9}}$ *1	—
	B (AB-3)	max 0.30	max 1.20	0.05	0.06	—	—	—	—	—	60000 (415)	35000 (240)		
ASTM A120 (Black and Hot-Dipped Zinc-Coated, Welded and Seamless Steel Pipe)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ASTM A106 (Seamless Carbon Steel Pipe for High-Temperature Service)	A (AB-4)	max 0.25	0.27 –0.93	0.048	0.058	min 0.10	—	—	—	—	48000 (330)	30000 (205)	*2	—
	B (AB-5)	max 0.30	0.29 –1.06	0.048	0.058	min 0.10	—	—	—	—	60000 (415)	35000 (240)	*2	
	C	max 0.35	0.29 –1.06	0.048	0.058	min 0.10	—	—	—	—	70000 (485)	40000 (275)	*2	
ASTM A333 (Seamless and Welded Steel Pipe for Low Temperature Service)	1	max 0.30	0.40 –1.06	0.05	0.06	—	—	—	—	—	55000 (379)	30000 (207)	*3	*4 –50°F (–46°C)
	3	max 0.19	0.31 –0.64	0.05	0.05	0.18 –0.37	3.18 –3.82	—	—	—	65000 (448)	35000 (241)	*3	*4 –150°F (–101°C)
	4	max 0.12	0.50 –1.05	0.04	0.04	0.08 –0.37	0.47 –0.98	0.44 –1.01	0.40 –0.75	0.04 –0.30	60000 (414)	35000 (241)	*3	*4 –150°F (–101°C)
	6	max 0.30	0.29 –1.06	0.048	0.058	min 0.10	—	—	—	—	60000 (414)	35000 (241)	*3	*4 –50°F (–46°C)
	7	max 0.19	max 0.90	0.04	0.05	0.13 –0.32	2.03 –2.57	—	—	—	65000 (448)	35000 (241)	*3	*4 –100°F (–73°F)
	8	max 0.13	max 0.90	0.045	0.045	0.13 –0.32	8.40 –9.60	—	—	—	100000 (689)	75000 (517)	*3	*4 –320°F (–196°C)
	9	max 0.20	0.40 –1.06	0.045	0.050	—	1.60 –2.24	—	0.75 –1.25	—	63000 (434)	46000 (317)	*3	*4 –100°F (–73°C)

Tolerances

(1) Permissible Variation in Outside Diameter

For A53, A120

Nominal Pipe Size in.	Permissible Variations	
	over	under
1½ and under	+1/64 in	−1/32 in
2 and over	+1%	−1%

For all specifications except A53 and A120

Nominal Pipe Size in.	Permissible Variations	
	over	under
⅛ to 1½ incl.	1/64	1/32
over 1½ to 4 incl.	1/32	1/32
over 4 to 8 incl.	1/16	1/32
over 8 to 18 incl.	3/32	1/32
over 18 to 26 incl.	1/8	1/32
over 26 to 34 incl.	5/32	1/32
over 34 to 48 incl.	3/16	1/32

(2) Permissible Variation in Wall Thickness

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

(3) Permissible Variation in Weight

For A53, A120 and A106

Wall Thickness		Permissible Variation
A53		±10%
A120	Heavier than XS	±10%
	XS and lighter	± 5%
A106		+10% −3.5
For all specifications except A53, A120, A106	NPS 12 and under	+6.5 −3.5
	over 12	+10 − 5

Flattening Test	Bend Test	Other Test	Hydrostatic Test
○ [For pipe over NPS2]	○ [For pipe NPS2 and under]	Weight of coating test	Specified pressure based on the following equation, P=2St/D
—	—		
○ [For pipe over NPS2]	○ [For pipe NPS2 and under]	—	Determine the test pressure from the following equation, P=2St/D P=minimum hydrostatic test pressure, psi S=0.60 times the minimum specified yield strength, psi t=specified wall thickness, in. D=specified outside diameter, in. The maximum hydrostatic test pressure shall not exceed 2,500 psi for pipe NPS3 and under, nor 2,800 psi for pipe over NPS3.
○	—	—	

Unless otherwise agreed upon between the manufacturer and the purchaser, pipe in NPS4 and smaller may be weighed in convenient lots; pipe larger than NPS4 shall be weighed separately.

*1. The minimum elongation in 2 in. (50.8 mm) shall be that determined by the following equation:

$e=625{,}000A^{0.2}/U^{0.9}$

where:

e=minimum elongation in 2 in. (50.8 mm) in percent rounded to the nearest 0.5%.

A=cross-sectional area of the tension test specimen in square inches, based on specified outside diameter or nominal specimen width and specified wall thickness rounded to the nearest 0.01 $in.^2$ If the area thus calculated is greater than 0.75 $in.^2$, then the value 0.75 shall be used.

U=specified tensile strength, psi.

*2.

	Grade A (Explanatory Note 2)		Grade B		Grade C	
Elongation in 2 in. or 50 mm, min, %:	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
Basic minimum elongation for walls 5/16 in. (7.9 mm) and over in thickness, strip tests, and for all small sizes tested in full section	35	25	30	16.5	30	16.5
When standard round 2-in. or 50-mm gage length test specimen is used	28	20	22	12	20	12

*3.

	Grade 1		Grade 3	
Elongation in 2 in. or 50 mm, min, %:	Longitudinal	Transverse	Longitudinal	Transverse
Basic minimum elongation for walls 5/16 in. (7.94 mm) and over in thickness, strip tests, and for all small sizes tested in full section.	35	25	30	20
When standard round 2-in. or 50-mm gage length test specimen is used	28	20	22	14

Grade 4		Grade 6		Grade 7		Grade 8		Grade 9	
Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
30	16.5	30	16.5	30	22	22	—	28	—
22	12	22	12	22	14	16	—	—	—

*4. Impact Requirements for Grades 1, 3, 4, 6, 7, and 9

Size of Specimen, mm	Minimum Average Notched Bar Impact Value of Each Set of Three Specimens[A]		Minimum Notched Bar Impact Value of One Specimen Only of a Set[A]	
	ft-lbf	J	ft-lbf	J
10 by 10	13	17.6	10	13.6
10 by 7.5	10	13.6	8	10.8
10 by 6.67	9	12.2	7	9.5