



MECHANICAL TUBE



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Enhancing Product Potential for both Motor Vehicles and Machinery in the 21st Century.

The machinery industries, Particularly motor vehicles and industrial and construction machinery, are setting their sights on what is in store for them in the 21st century. As they sharpen their focus at this century, the industries are upgrading their requirements for steel pipe and tubes for machine structures—requirements that are increasingly severe and more diversified than ever before.

JFE Steel Pipe and Tubes for Machine Structures are produced under an integrated system covering everything from raw materials to finished products—with high technology in iron and steel production employed throughout. Be it surface finish, dimensional accuracy, quality stability or any other aspect, structural-quality pipe and tubes from JFE Steel measure up to the strictest customer requirements. User confidence in JFE Steel pipe and tubes is also bolstered by the stringent quality control exercised by JFE Steel, and process using one of the most advanced testing systems in the industry.

Throughout the 21th century, JFE Steel shall have been a consistently excellent partner for companies in all machinery industries. JFE Steel will exert the same, unflagging efforts in the years ahead, always pushing research and development so as to deliver high-quality, low-cost products to customers around the world.

In order to match specific customer needs, JFE Steel offers a wide variety of

1 Products manufactured under strict quality control

At all stages from raw materials to finished products, JFE Steel pipe and tubes are produced under an integrated system using the most advanced equipment, with rigid quality control exercised at each process.

2 Pleasing surface finish

JFE Steel pipe and tubes come in surface finishes that exactly meet customer requirements or match the specifications for the intended applications. Inherently excellent properties are further enhanced by advanced heat treating technology to offer a smooth, pleasing surface texture.

3 High dimensional accuracy

To meet increasingly severe standards for dimensional accuracy, JFE Steel exercises extra care in producing and inspecting pipe and tubes to particularly rigid dimensional tolerances. Outstanding dimensional accuracy is a result of such efforts.

product characteristics to choose from.

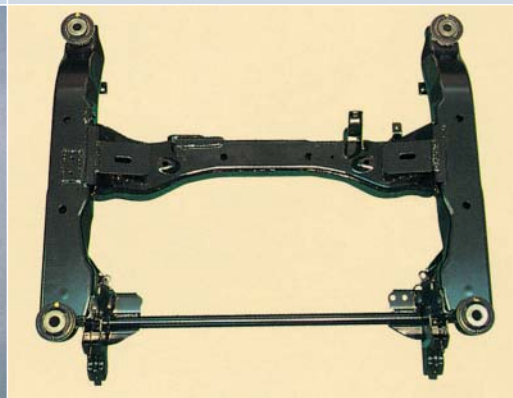
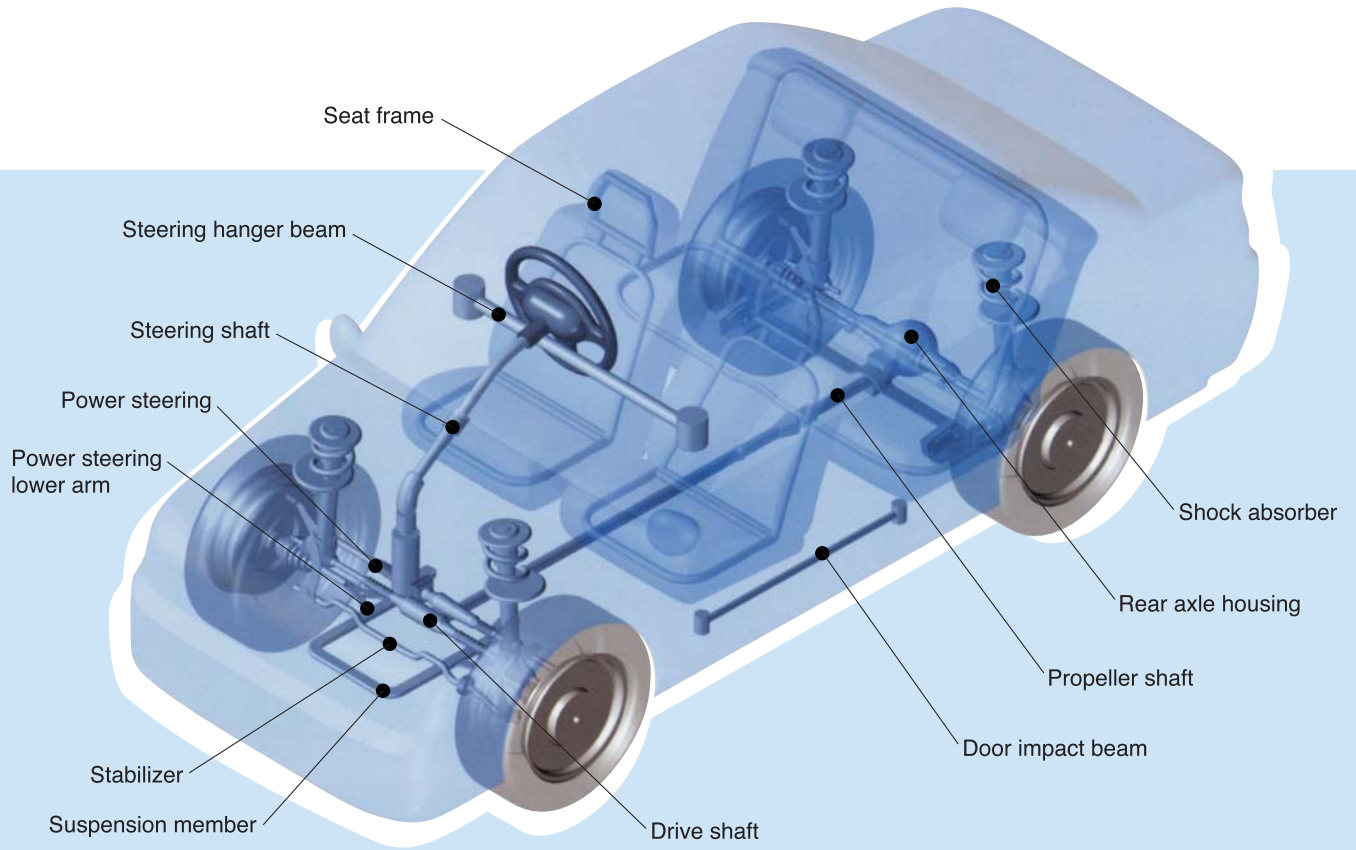
4 Stable mechanical properties

Because pipe and tubes form the basic framework of motor vehicles, industrial and construction machinery and so forth, JFE Steel makes sure the products it delivers exhibit consistent and uniform strength, workability and durability.

5 Wide product and size availability

Steel pipe and tubes for machine structures are produced to a broad variety of specifications and in a wide range of sizes. JFE Steel pipe and tubes for such applications are available in what may be just about the widest ranges of types and sizes anywhere.

Applications of Automotive Tubes

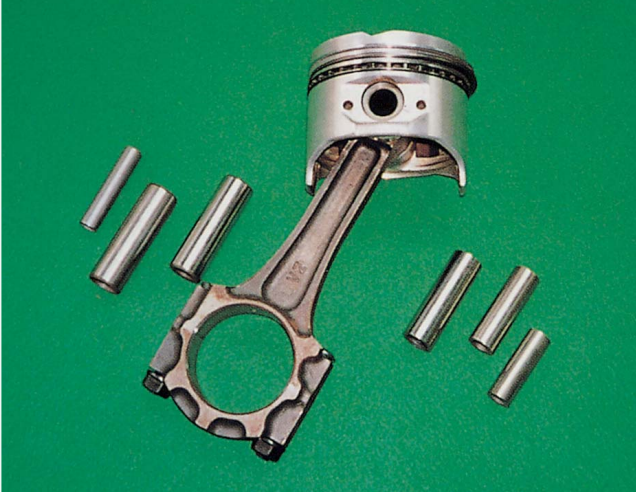


▲ Stabilizer

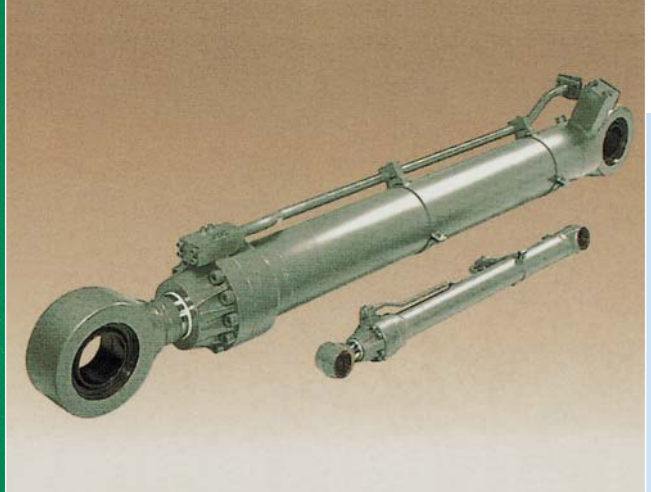
▲ Suspension member

Steel pipes for structural use

▼ Piston pins



▼ Cylinders



▲ Pins and bushes



▲ Scuba diving tanks



▲ Hydraulic cylinder

Location

Chita Works is part of the Chukyo Industrial Zone and faces Kinuura Bay, which has good access to the world's sea lanes. Located almost in the center of the Kinuura Coastal Industrial Zone, Chita takes advantage of excellent site conditions as a base for supplying tubular products to users around the world while coexisting with nature. Materials for pipemaking are produced at West Japan Works. The site also has outstanding access to other related industries, beginning with the East Japan Works. In short, Chita enjoys an excellent location for growing hand in hand with companies around the world.



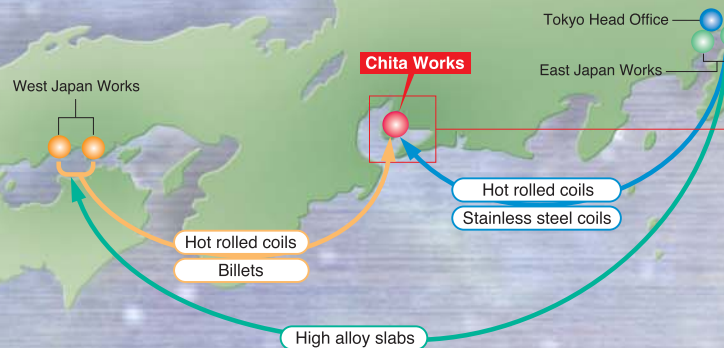
An Integrated Production System and Ideal Layout

The group of shops that make up Chita Works was laid out on a 1.81 million m² site to create the ideal pipe production system. All aspects of the production system, from unification of research and development to concentration of technology and foolproof quality control are realized by taking full advantage of the features of the location. This modern plant is a tangible symbol of Chita's confidence that it can meet demand for steel pipes of all types and sizes as one of the world's leading pipemaking works.



- ① North casting shop
- ② Plug mill
- ③ South casting shop
- ④ Machine shop
- ⑤ Spiral pipe mill
- ⑥ 26inch OD ERW pipe mill
- ⑦ 6inch / 3inch OD ERW pipe mill
- ⑧ 4inch OD ERW pipe mill
- ⑨ Large diameter coated pipe mill
- ⑩ Small diameter shot blast mill
- ⑪ Medium diameter seamless pipe mill
- ⑫ Small diameter seamless pipe mill
- ⑬ Special steel pipe mill
- ⑭ Stainless flexible tubing mill
- ⑮ Works power station
- ⑯ Main building
- ⑰ Technical Research Laboratories/
Tubular Products and Castings Research Center
- ⑱ Quality Assurance Group (Inspection)
- ⑲ Pipe Testing Center
- ⑳ Training Center

Site area : 1,813,177.13m²



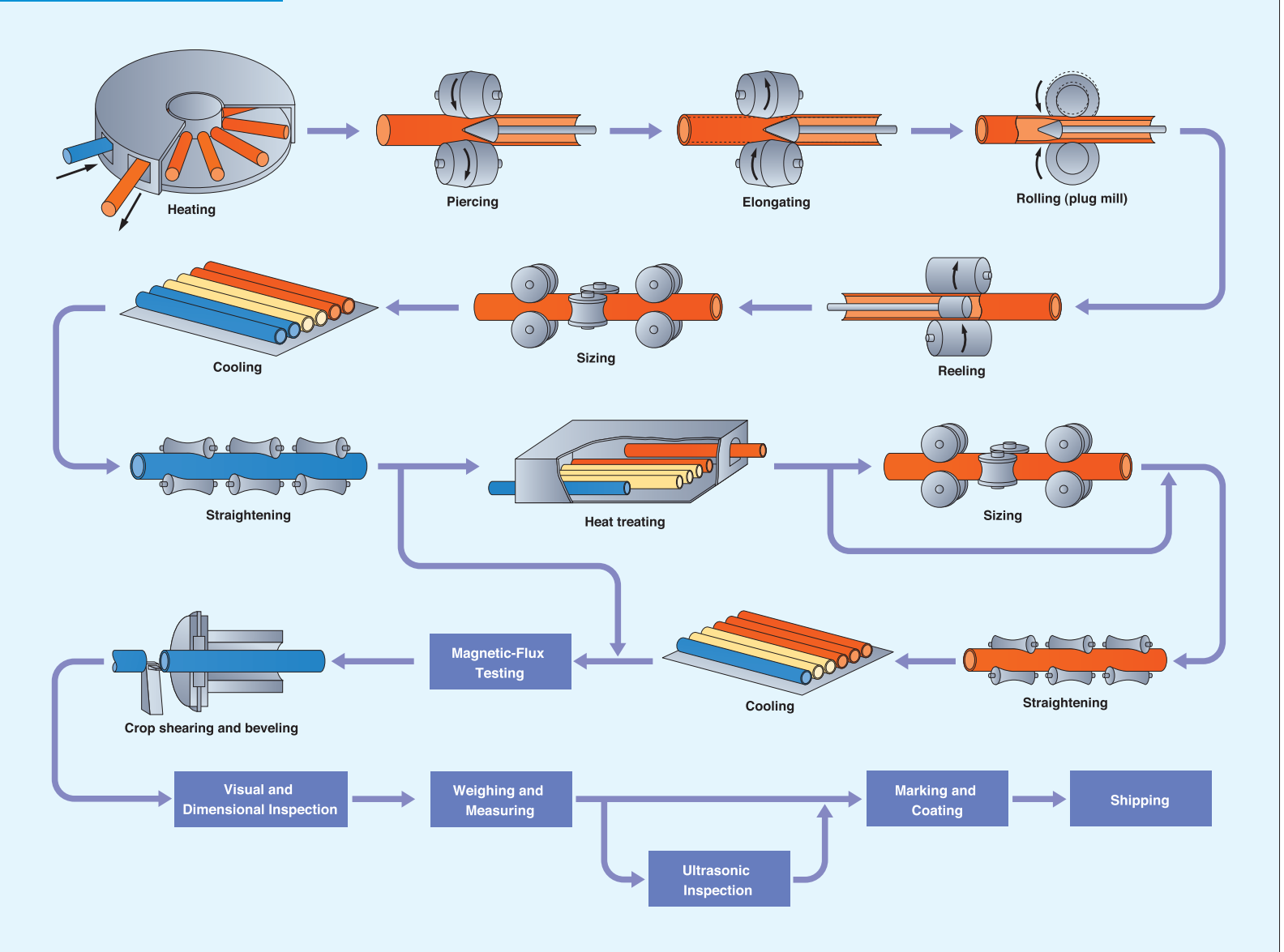
1 Mannesmann Plug Mill Seamless, Hot Finishing

In the plug mill process, a solid round (billet) is used. It is uniformly heated in the rotary hearth heating furnace and then pierced by a Mannesmann piercer. The pierced billet or hollow shell is rollreduced in outside diameter and wall thickness. The rolled tube simultaneously burnished inside and outside by a reeling machine. The reeled tube is then sized by a sizing mill to the specified dimensions. From this step the tube goes through the straightener. This process completes the hot working of the tube. The tube (referred to as a mother tube) after finishing and inspection, becomes a finished product.

Dimension Range (Chita Works)

Outside Diameter : 7 - 16.77in (177.8 - 426.0mm)
 Wall Thickness : 0.20 - 2.56in (5.1 - 65mm)
 Maximum Length : 45ft (13,500mm)

Sequence of Plug Mill Operation



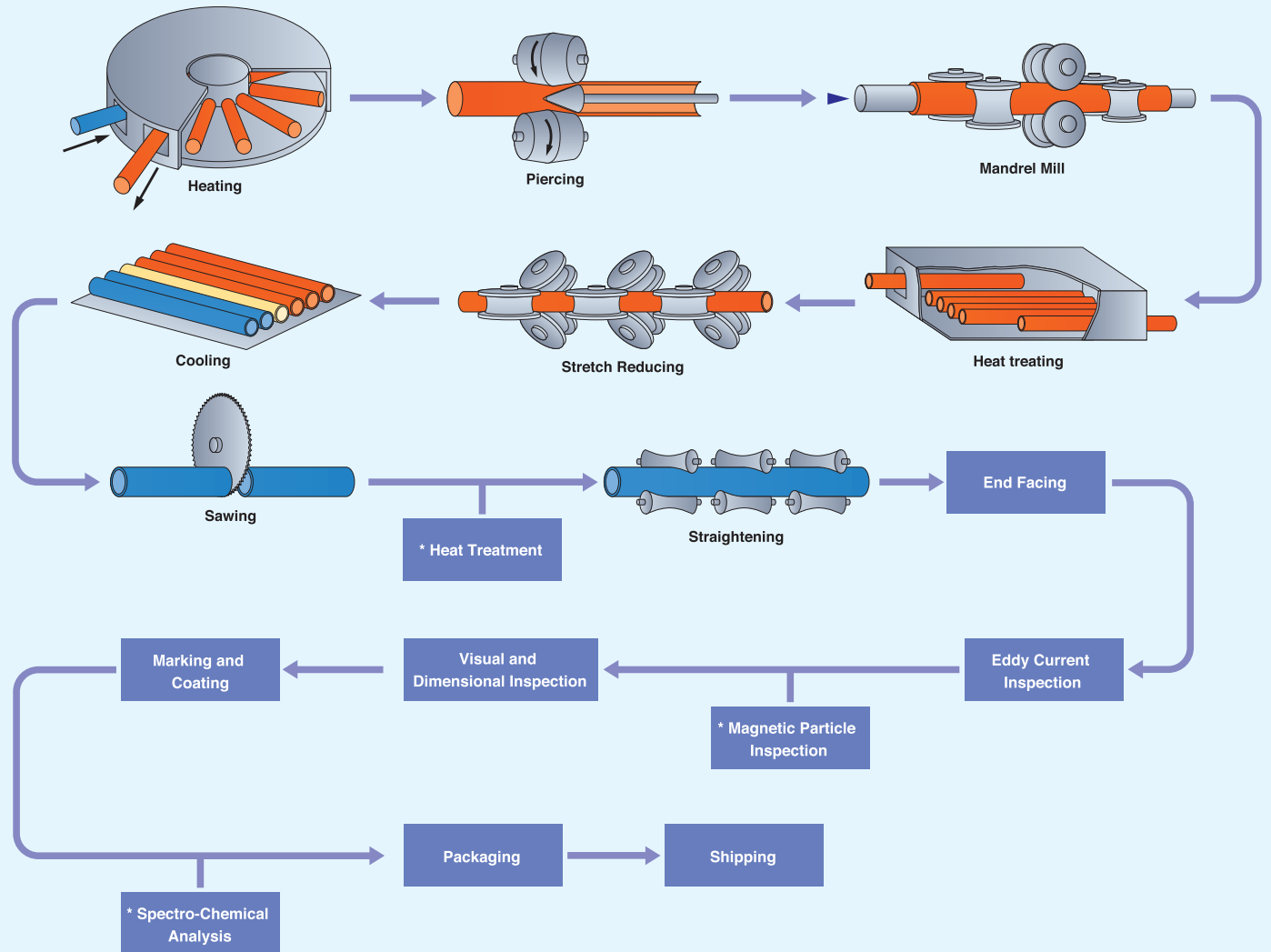
2 Mandrel Mill Seamless, Hot Finishing

In the mandrel mill process, a solid round (billet) is also used. It is heated in a rotary hearth heating furnace and then pierced by a Mannesmann piercer. The pierced billet or hollow shell is rolled by an 8-stand mandrel mill to reduce the outside diameter and wall thickness which forms a multiple length mother tube. The mother tube is reheated and further reduced to specified dimensions by the stretch reducer. The tube is then cooled, cut, straightened and subjected to finishing and inspection processes before shipment.

Dimension Range (Chita Works)

Outside Diameter : 1 - 7in (25.4 - 177.8mm)
 Wall Thickness : 0.090 - 1.57in (2.3 - 40mm)
 Maximum Length : 72ft (22,000mm)

Sequence of Mandrel Mill Operation



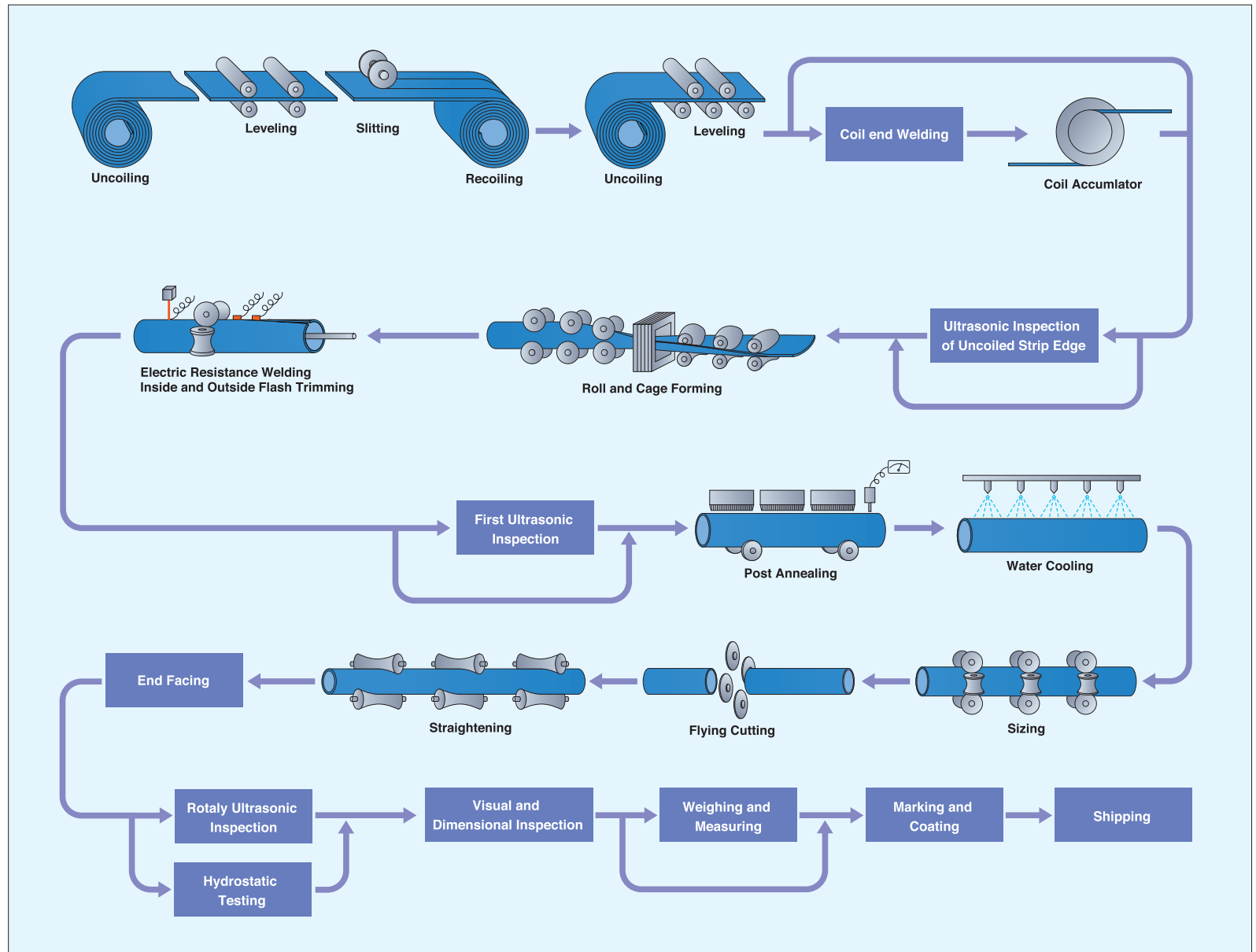
* Note : Processes marked by an asterisk are conducted according to specification and/or customer requirements.

3 Medium Dia. Electric Weld Pipe Mill ERW as Weld

Steel strip in coil, which has been slit into the required width from wide strip, is shaped by a series of forming rolls into a multiple length shell. The longitudinal edges are continuously joined by high frequency resistance/induction welding.

The weld of the multiple length shell is then heat treated electrically, sized, and cut to specified lengths by a flying cut-off machine. The cut pipe is straightened and squared at both ends.

These operations are followed by ultrasonic inspection or hydrostatic testing.



Dimension Range ●East Japan Works / keihin
●Chita Works

Outside Diameter : 7-1/2 - 26in (190.7 - 660.4mm)
 Wall Thickness : 0.150 - 0.937in (3.8 - 23.8mm)
 Maximum Length : 66ft (20,000mm)

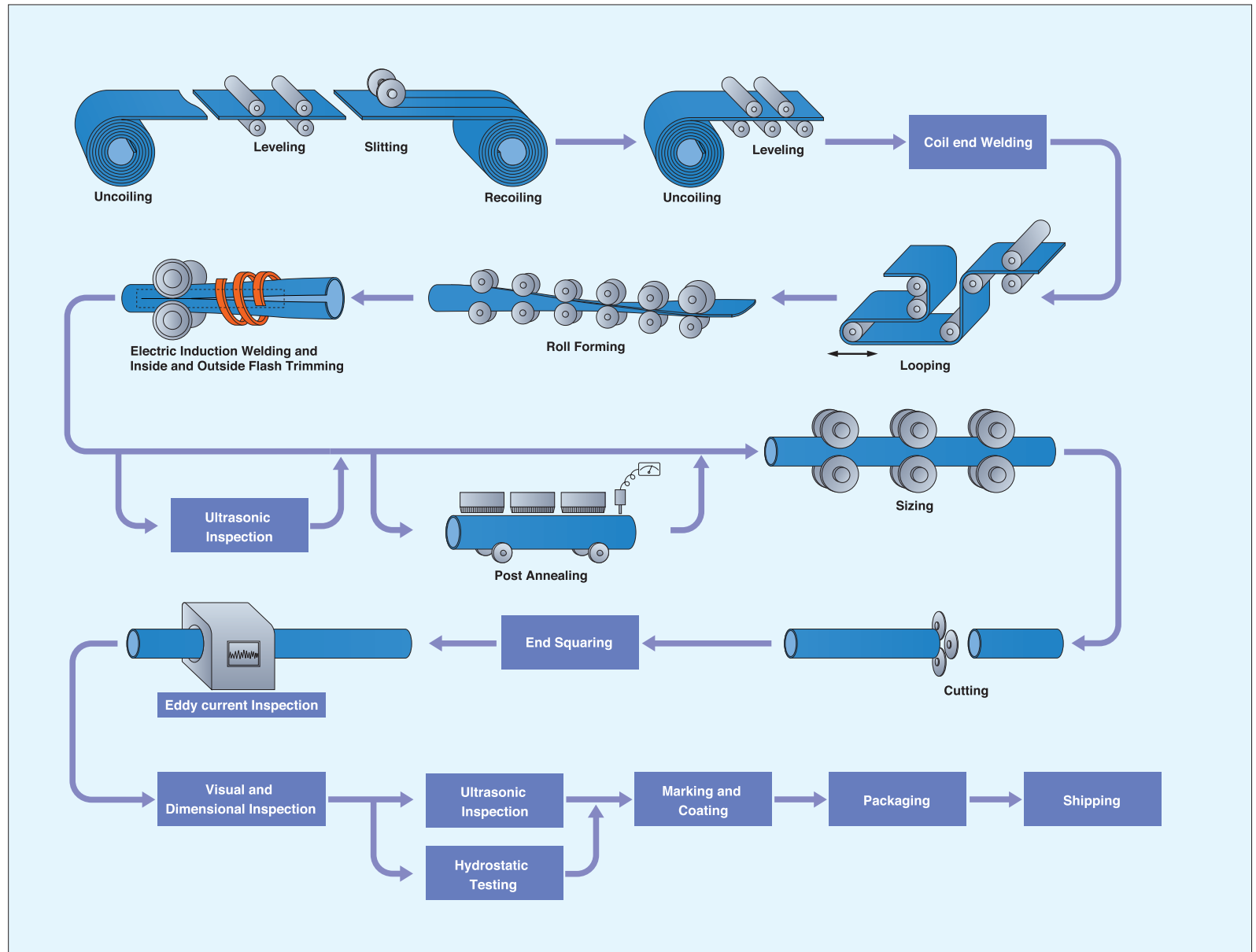
4 Small Dia. Electric Weld Pipe Mills

ERW as Weld

Steel strip in coil, which has been slit into the required width from wide strip, is shaped by a series of forming rolls into a multiple length shell. The longitudinal edges are continuously joined by high frequency induction welding.

The weld of the multiple length shell is then sized, and cut to specified lengths by a flying cut-off machine. The cut pipe is straightened and squared at both ends.

These operations are followed by ultrasonic inspection or hydrostatic testing.



Dimension Range (

- Chita Works
- Koukan Kenzai
- Kawasaki Koukan

Outside Diameter : 0.39 - 6-⁵/₁₆in (10.0 - 168.3mm)
 Wall Thickness : 0.024 - 0.50in (0.6 - 12.7mm)
 Maximum Length : 52.5ft (16,000mm)

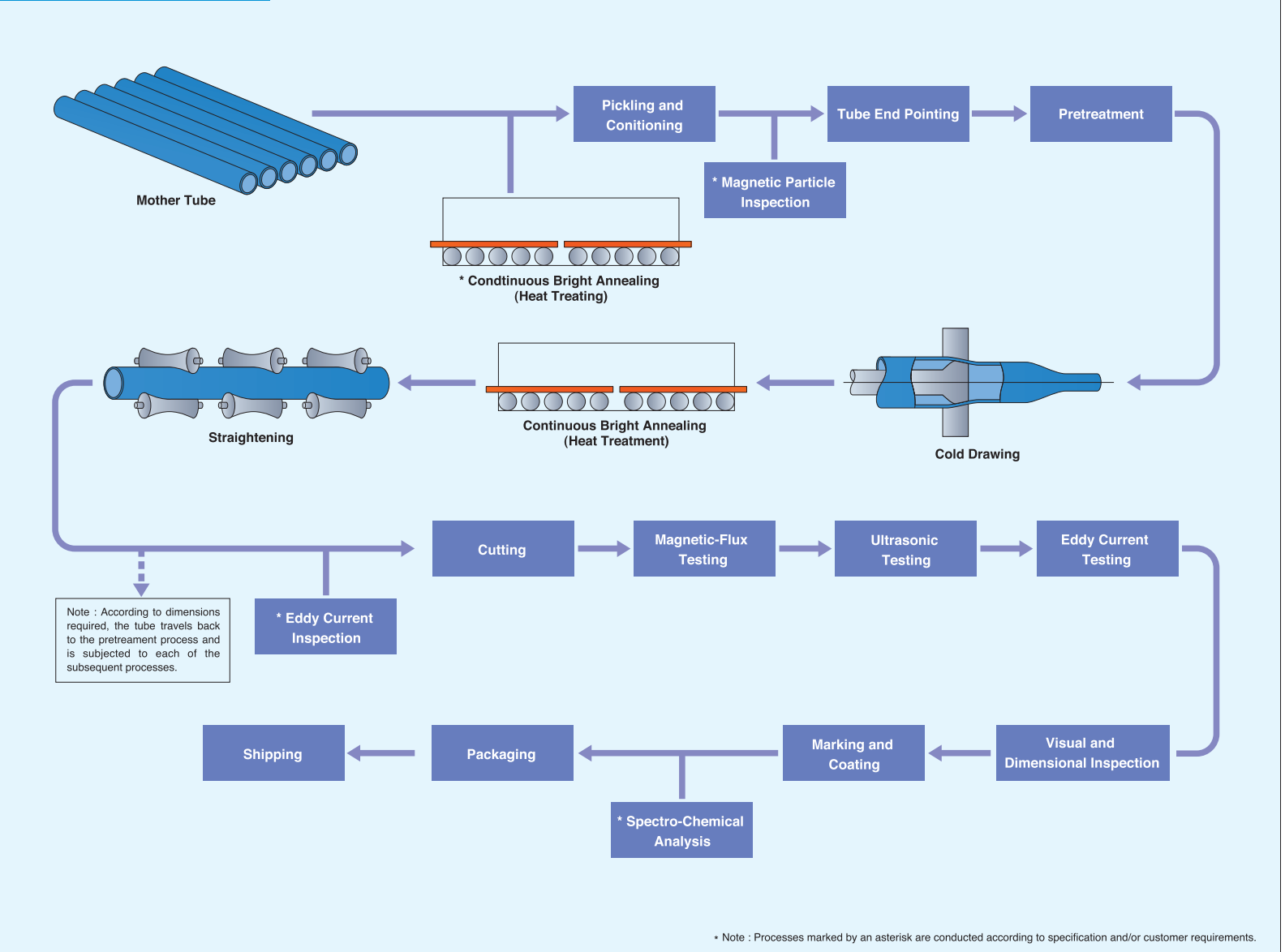
5 Cold Drawing Mill Seamless, Cold Finishing

In the cold drawing process, a hot finished seamless tube or electric welded tube is used as the material (mother tube). The mother tube, after pretreatment, is cold drawn by the drawing bench to specified dimensions, as shown in the following diagram. The processed tube is subjected to final heat treatment based on its intended end use and then sent to the finishing and inspection processes.

Dimension Range (Chita Works)

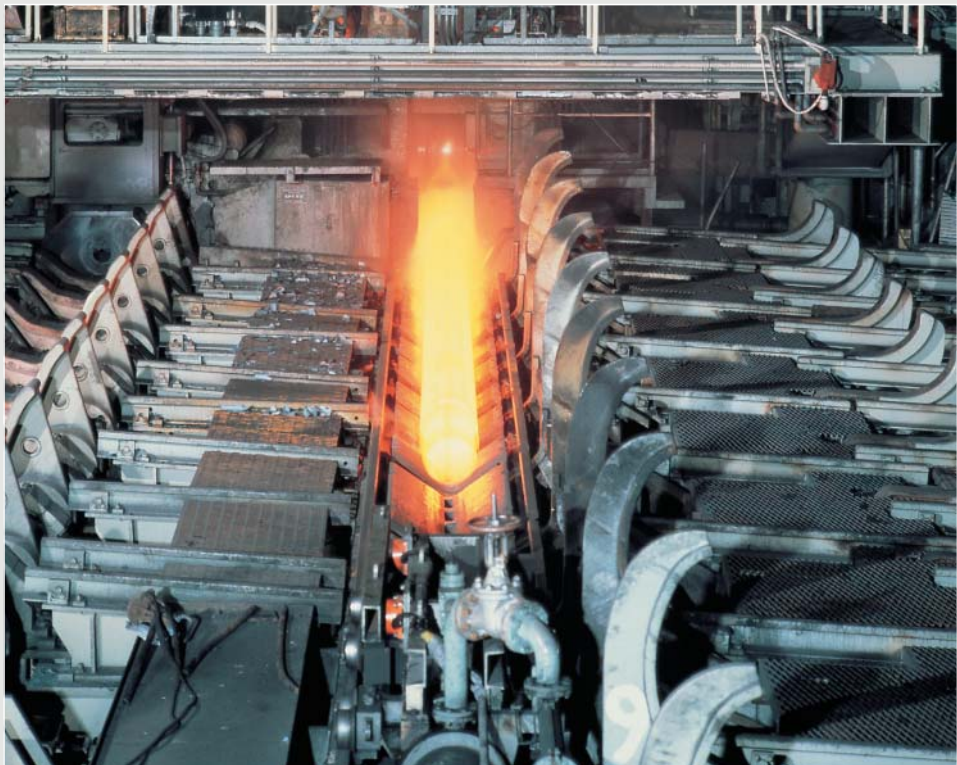
Outside Diameter : $\frac{5}{8}$ - 4in (15.9 - 101.6mm)
 Wall Thickness : 0.59 - 0.44in (1.5 - 13.9mm)
 Maximum Length : 42.6ft (13,000mm)

Sequence of Cold Drawing Mill

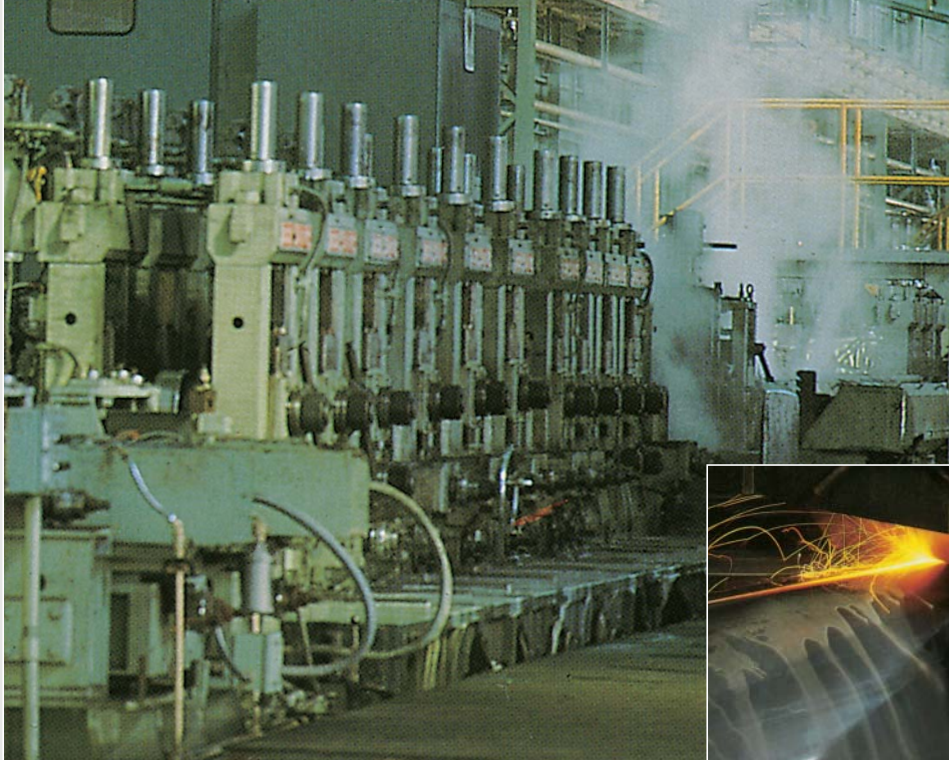




Mandrel mill



Plug mill



Electric Induction Welder



Drawing Bench

List of JFE N.D.I. Devices and Comparison of Capabilities

(Chita Works)

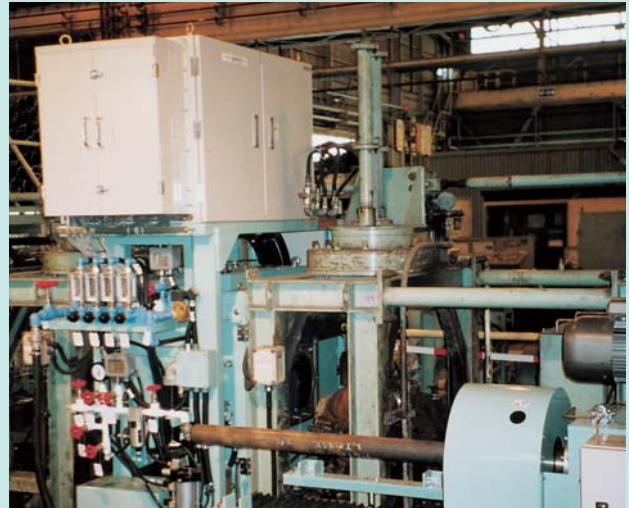
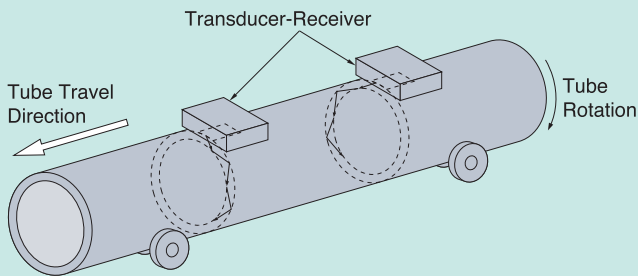
Flaw Detecting Method	Sensitivity			Name of Device	Applicable Tube Dimension (OD, mm)	Number of Equipment
	Outside Surface Flaw	Flaw in Steel	Inside Surface Flaw			
Ultrasonic	○	○	○	Stationary	59.8 - 431.8	5
				Stationary (End area of pipe)	15.9 - 114.3	1
				Rotary	15.9 - 431.8	4
				Portable	All sizes	Install in all mills concerned
Electro Magnetic	○	-	○	AMALOG SONOSCOPE	177.8 - 406.4	1
				Magnetic Leakage Flux (AC. Magnetization)	15.9 - 193.7	4
Eddy Current	○	○	○	Eddy current	15.9 - 177.8	8
Magnetic Particle	○	-	-	Automatic fluorescent	10.0 - 431.8	4
				Automatic fluorescent (End area of pipe)	60.3 - 431.8	4
				Portable and other types	All sizes	Installed in all mills concerned
Dye Penetrant	○	-	-	Penetrant	All sizes	Installed in all mills concerned
Hydrostatic	-	-	-	Hydrostatic	13.8 - 1,066.8	9
Spectro-Chemical Analysis	-	-	-	Metal spectroscope	All sizes	3
Others	-	-	-	Automatic ultrasonic thickness gauge	15.9 - 431.8	6
	-	-	-	Ultrasonic thickness gauge		Installed in all mills concerned
	-	-	○	Borescope	All sizes	3
	-	-	-	Air micrometer	10.4 - 53.5(ID)	1

Ultrasonic Inspection

a. Stationary type (Pulse echo Method)

Ultrasonic inspection is in accordance with pulse-echo method using water gap method.

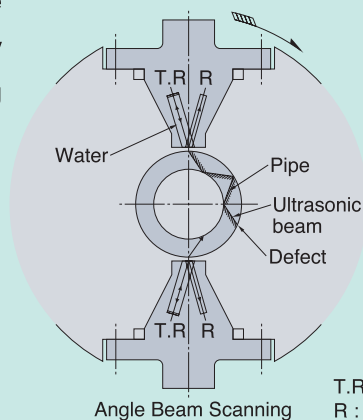
Flaw detection is performed by angle beam technique to detect longitudinal and transverse flaws on the inner and outer surface of pipe, and wall thickness measurement is performed by normal beam technique. The pipe which is conveyed helically or linearly through the testing device, is inspected.



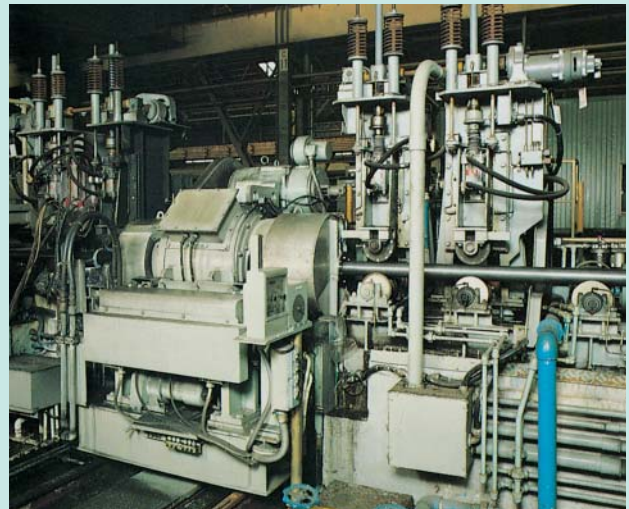
b. Rotary probe type, pulse echo method

Ultrasonic inspection is in accordance with pulse-echo method using water column coupling method.

Flaw detection is performed by angle beam technique to detect longitudinal and transverse flaws on the inner and outer surface of pipe, and wall thickness measurement is performed by normal beam technique. The pipe travels linearly through the rotating device and inspection.



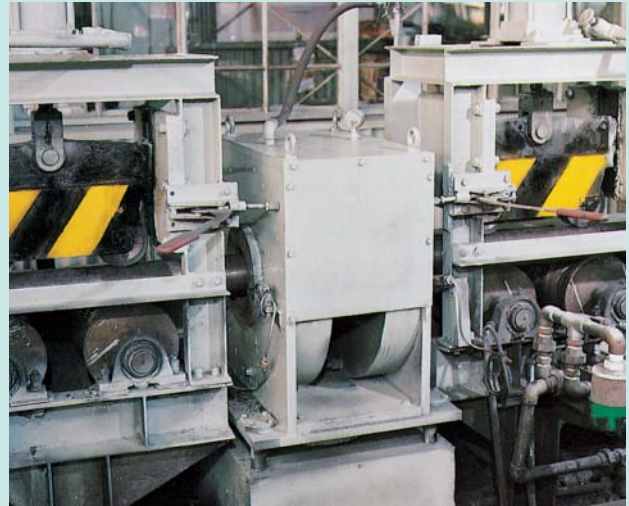
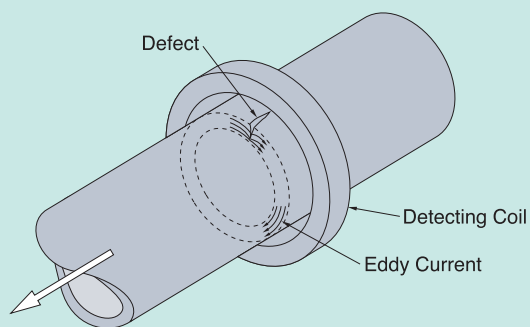
T.R : Transmission and receiving probe for defection
R : Receiving probe for surface echo tracking



Eddy Current Inspection

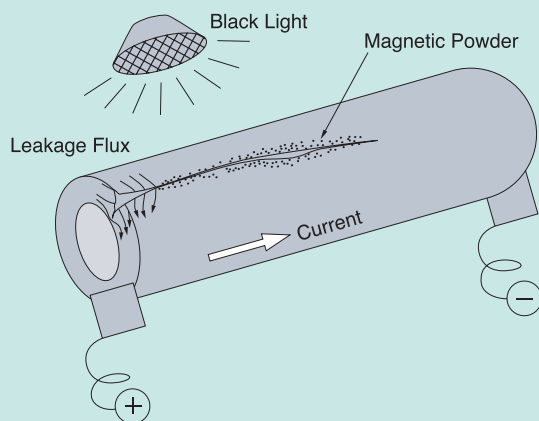
A test coil assembly forcibly generates a strong eddy current in the tube section under test. The presence of flaws disturbs the eddy current and is sensed by a detecting coil.

The apparatus is equipped with an automatic warning, marking and recording system.



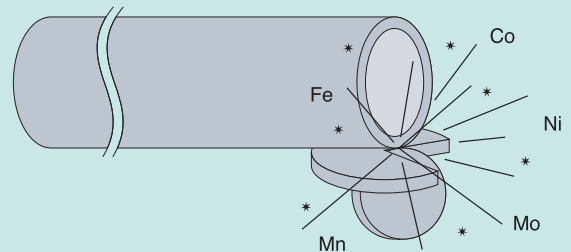
Magnetic Particle Inspection

The tube is magnetized and provided with magnetic particles (mostly fluorescent magnetic particles). The presence of flaws creates a magnetic flux which shows changes in fluorescent brilliance under black light. The change is detected visually.



Spectro-Chemical Analysis

The tube is subjected to arc discharge. Sparks created by this method have their own spectrums according to the metal elements. Such spectrums are analysed to determine the chemical composition of the tube, quantitatively and qualitatively.



Electromagnetic Inspection

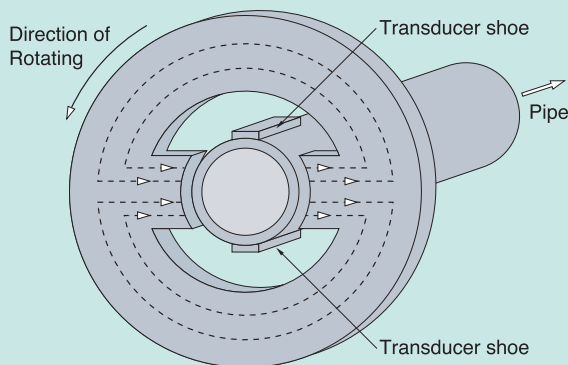
JFE's plug mill is equipped with one Analog-Sonoscope electromagnetic inspection units after heat treatment.

The Analog-Sonoscope pipe inspection system detects defects using flux leakage induced by electromagnetic induction in the search coil.

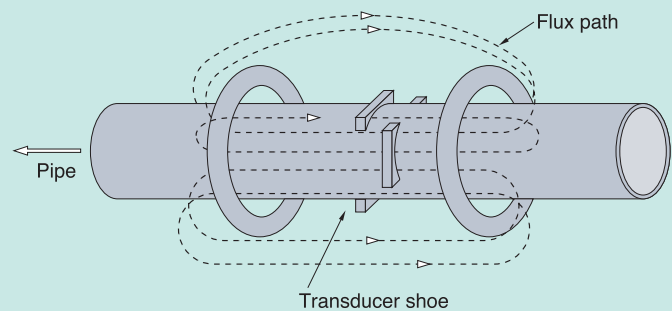
Amalog magnetic circuits detect longitudinal defects in both the inside and outside surfaces. Sonoscope magnetic circuits detect circumferential defects.



Amalog Magnetic Circuit

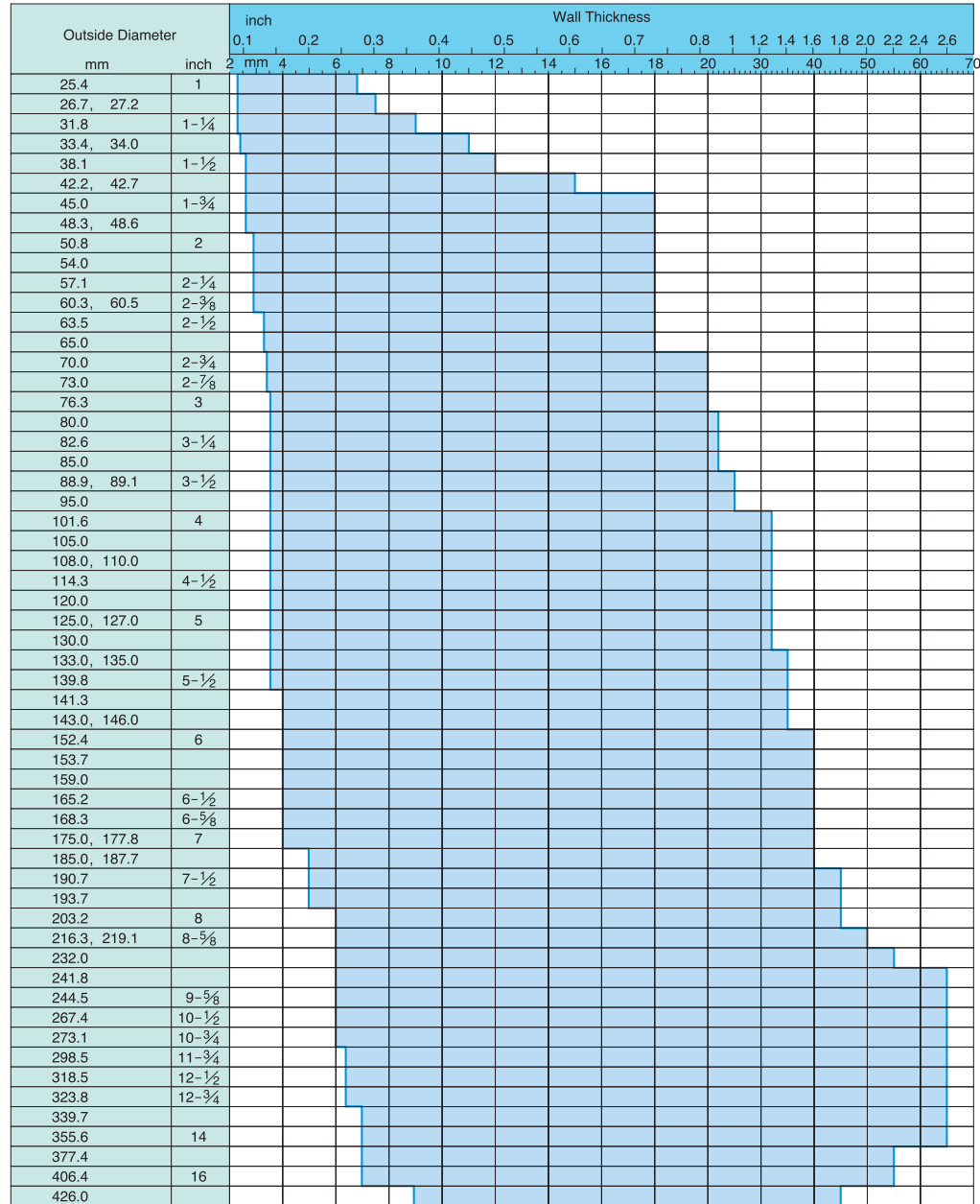


Sonoscope Magnetic Circuit

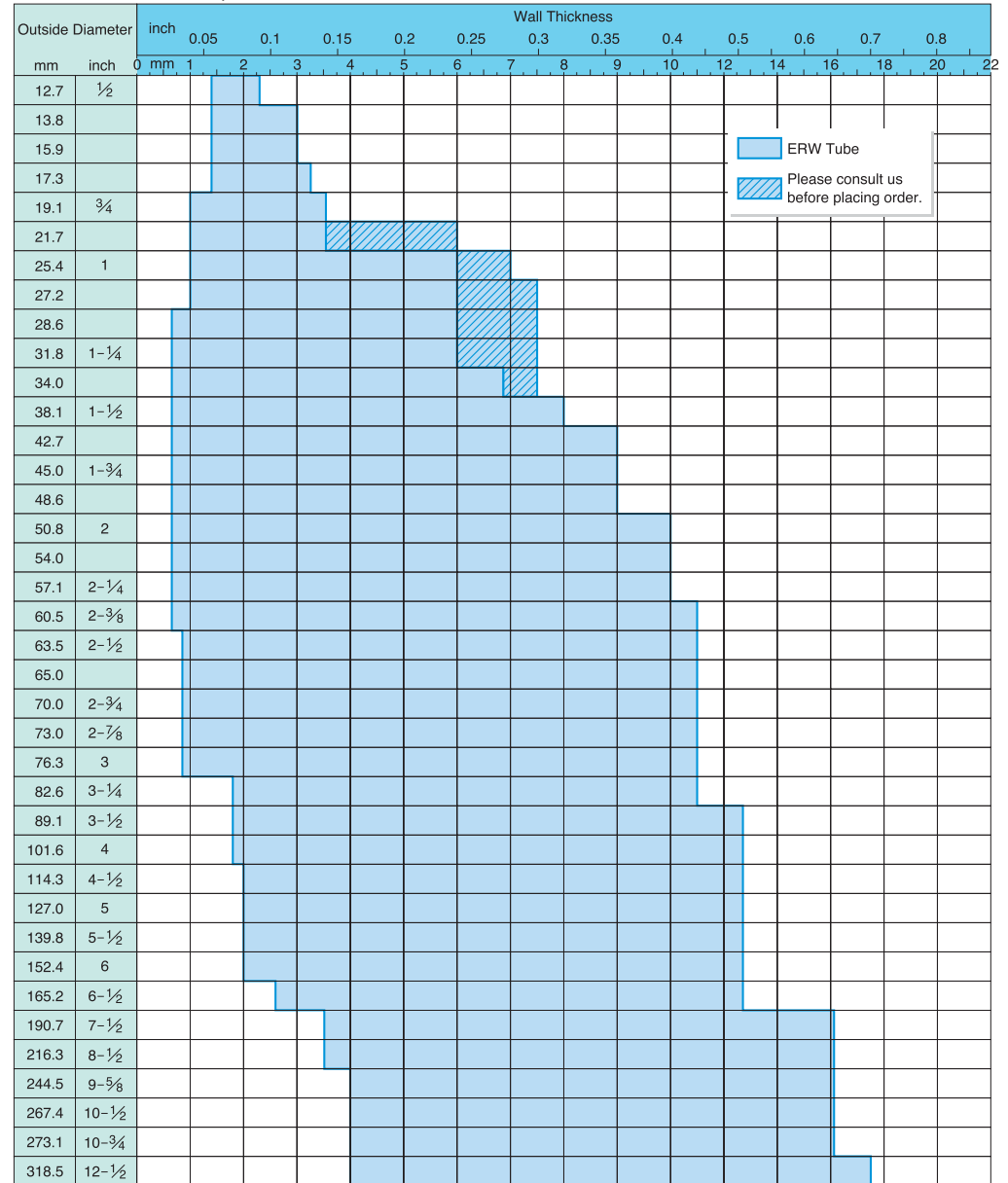


Manufacturing Range by Process and Dimensions

Hot Finished Seamless Tube



Electric Welded Pipe



Cold Finished Tube

Outside Diameter		Wall Thickness															
		inch	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.5	0.6	0.7				
mm	inch	0	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
15.9	$\frac{5}{8}$																
17.3																	
19.1	$\frac{3}{4}$																
21.3, 21.7																	
25.0, 25.4	1																
26.7, 27.2																	
30.0																	
31.8	$1\frac{1}{4}$																
33.4, 34.0																	
38.1	$1\frac{1}{2}$																
42.2, 42.7																	
44.5, 45.0	$1\frac{3}{4}$																
48.3, 48.6																	
50.8	2																
54.0																	
57.0, 57.1	$2\frac{1}{4}$																
60.3, 60.5	$2\frac{3}{8}$																
63.5	$2\frac{1}{2}$																
65.0																	
70.0	$2\frac{3}{4}$																
73.0	$2\frac{7}{8}$																
76.2, 76.3	3																
82.6	$3\frac{1}{4}$																
88.9, 89.1	$3\frac{1}{2}$																
101.6	4																

Product Availability Specification

Specification	Title	Grade	Product Process			
			Seamless		ERW	
			Hot Finished	Cold Finished	As Welded	Cold Finished
JIS G 3429	Seamless Steel Tubes for High Pressure Gas Cylinder	STH 11/12 STH 21/22 STH 31	○	—	—	—
JIS G 3441	Alloy Steel Tubes for Machine Purposes	SCr 420TK SCM 415TK - 440TK	○	○	○	○
JIS G 3445	Carbon Steel Tubes for Machine Structural Purposes	STKM 11A - STKM 20A	○	○	○	○
JIS G 3465	Seamless Steel Tubes for Drilling	STM C540 - C640 STM R590 - R690	○	○	—	—
JIS G 3472	Electric Resistance welded Carbon Steel Tubes for Automobile Structural Purposes	STAM 440H - 540H	—	—	○	○
JIS G 3473	Carbon Steel Tubes for Cylinder Barrels	STC 370 - 590B	(1)	(1)	(1)	(1)
ASTM A 519	Seamless Carbon and Alloy Steel Mechanical Tubing	MT 1010 - MT 4142	○	○	—	—
ASTM A 513	Electric Resistance Welded Carbon and Alloy Steel Mechanical Tubing	MT 1010 - MT 8630	—	—	○	○
SAE/AISI	Carbon Steels	1010 - 1045	○	○	○	○
	High Manganese Steels	1524 - 1541	○	○	○	○
	Alloy Steels	4130 - 4142	○	○	○	○

Remarks (1) : The pipes are manufactured by the specified process in the specification.

Specification (Excerpts)

1. Carbon Steel Tubes for Machine Structural Purposes (Japanese Industrial Standards ; JIS G 3445-88)

Table 1. Chemical Composition and Mechanical Properties

Class	Symbol	Chemical composition %						Tensile Test				Flattening Test	Bend Test	
		C	Si max.	Mn	P max.	S max.	Nb or V	Tensile strength min. N/mm ²	Yield strength or proof stress min. N/mm ²	Elongation min. %		Distance between flattening plates (H) (D : outside diameter of tubes)	Bend angle	Inside radius (D is outside diameter of the tube)
										No. 11, 12 test piece longitudinal	No. 5 test piece transversal			
Class 11	A STKM 11A	0.12 max.	0.35	0.60 max.	0.040	0.040	—	290	—	35	30	1/2 D	180°	4 D
Class 12	A STKM 12A	0.20 max.	0.35	0.60 max.	0.040	0.040	—	340	175	35	30	2/3 D	90°	6 D
	B STKM 12B							390	275	25	20	2/3 D	90°	6 D
	C STKM 12C							470	355	20	15	—	—	—
Class 13	A STKM 13A	0.25 max.	0.35	0.30 - 0.90	0.040	0.040	—	370	215	30	25	2/3 D	90°	6 D
	B STKM 13B							440	305	20	15	3/4 D	90°	6 D
	C STKM 13C							510	380	15	10	—	—	—
Class 14	A STKM 14A	0.30 max.	0.35	0.30 - 1.00	0.040	0.040	—	410	245	25	20	3/4 D	90°	6 D
	B STKM 14B							500	355	15	10	7/8 D	90°	8 D
	C STKM 14C							550	410	15	10	—	—	—
Class 15	A STKM 15A	0.25 - 0.35	0.35	0.30 - 1.00	0.040	0.040	—	470	275	22	17	3/4 D	90°	6 D
	C STKM 15C							580	430	12	7	—	—	—
Class 16	A STKM 16A	0.35 - 0.45	0.40	0.40 - 1.00	0.040	0.040	—	510	325	20	15	7/8 D	90°	8 D
	C STKM 16C							620	460	12	7	—	—	—
Class 17	A STKM 17A	0.45 - 0.55	0.40	0.40 - 1.00	0.040	0.040	—	550	345	20	15	7/8 D	90°	8 D
	C STKM 17C							650	480	10	5	—	—	—
Class 18	A STKM 18A	0.18 max.	0.55	1.50 max.	0.040	0.040	—	440	275	25	20	7/8 D	90°	6 D
	B STKM 18B							490	315	23	18	7/8 D	90°	8 D
	C STKM 18C							510	380	15	10	—	—	—
Class 19	A STKM 19A	0.25 max.	0.55	1.50 max.	0.040	0.040	—	490	315	23	18	7/8 D	90°	6 D
	C STKM 19C							550	410	15	10	—	—	—
Class 20	A STKM 20A	0.25 max.	0.55	1.60 max.	0.040	0.040	1)	540	390	23	18	7/8 D	90°	6 D

Remarks : 1) Nb or V or a combination shall be used at the discretion of manufacturer to the extent of 0.15%.

2) The values of elongation shall not be applied to the tube 40mm or smaller in outside diameter. However, it may be agreed upon by the purchaser and the manufacturer, when especially required.

3) The bending test shall be applied to the tubes 50mm or under in outside diameter in lieu of flattening test when especially specified by the purchaser.

Table 2. Outside Diameter Tolerance

Classification	Outside Diameter	
No.1	Under 2in. (50mm)	$\pm 0.02\text{in.}$ ($\pm 0.5\text{mm}$)
	2in. (50mm) and over	$\pm 1\%$
No.2	Under 2in. (50mm)	$\pm 0.01\text{in.}$ ($\pm 0.25\text{mm}$)
	2in. (50mm) and over	$\pm 0.5\%$
No.3	Under 1in. (25mm)	$\pm 0.0047\text{in.}$ ($\pm 0.12\text{mm}$)
	1in. (25mm) to 1.6in. (40mm) excl.	$\pm 0.006\text{in.}$ ($\pm 0.15\text{mm}$)
	1.6in. (40mm) to 2in. (50mm) excl.	$\pm 0.007\text{in.}$ ($\pm 0.18\text{mm}$)
	2in. (50mm) to 2.4in. (60mm) excl.	$\pm 0.008\text{in.}$ ($\pm 0.20\text{mm}$)
	2.4in. (60mm) to 2.8in. (70mm) excl.	$\pm 0.009\text{in.}$ ($\pm 0.23\text{mm}$)
	2.8in. (70mm) to 3.2in. (80mm) excl.	$\pm 0.010\text{in.}$ ($\pm 0.25\text{mm}$)
	3.2in. (80mm) to 3.6in. (90mm) excl.	$\pm 0.012\text{in.}$ ($\pm 0.30\text{mm}$)
	3.6in. (90mm) to 4.0in. (100mm) excl.	$\pm 0.016\text{in.}$ ($\pm 0.40\text{mm}$)
	4.0in. (100mm) and over	$\pm 0.5\%$

Table 3. Wall Thickness and Length Tolerance

Classification	Wall Thickness	Length	
No.1	Under 0.16in. (4mm)	+ 2in. (+ 50mm) - 0 (- 0mm)	
			+ 0.024in. (+ 0.6mm) - 0.020in. (- 0.5mm)
	0.16in. (4mm) and over		+ 15% - 12.5%
No.2	Under 0.12in. (3mm)		$\pm 0.012\text{in.}$ ($\pm 0.3\text{mm}$)
	0.12in. (3mm) and over		$\pm 10\%$
No.3	Under 0.08in. (2mm)		$\pm 0.006\text{in.}$ ($\pm 0.15\text{mm}$)
	0.08in. (2mm) and over		$\pm 8\%$

Remarks : 1) No.1 shall be applicable to both outside diameter and wall tickness in the dimensional tolerance for hot finished seamless steel tube.
 2) Tolerance on outside diameter of the tube subjected to quenching and tempering shall be in accordance with the agreement between the purchaser and the manufacturer.

2. Alloy Steel Tubes for Machine Purposes (JIS G 3441-88)

Table 1. Chemical Composition

Designation of grade	Chemical composition %						
	C	Si	Mn	P max.	S max.	Cr	Mo
SCr 420 TK	0.18 - 0.23	0.15 - 0.35	0.60 - 0.85	0.030	0.030	0.90 - 1.20	—
SCM 415 TK	0.13 - 0.18	0.15 - 0.35	0.60 - 0.85	0.030	0.030	0.90 - 1.20	0.15 - 0.30
SCM 418 TK	0.16 - 0.21	0.15 - 0.35	0.60 - 0.85	0.030	0.030	0.90 - 1.20	0.15 - 0.30
SCM 420 TK	0.18 - 0.23	0.15 - 0.35	0.60 - 0.85	0.030	0.030	0.90 - 1.20	0.15 - 0.30
SCM 430 TK	0.28 - 0.33	0.15 - 0.35	0.60 - 0.85	0.030	0.030	0.90 - 1.20	0.15 - 0.30
SCM 435 TK	0.33 - 0.38	0.15 - 0.35	0.60 - 0.85	0.030	0.030	0.90 - 1.20	0.15 - 0.30
SCM 440 TK	0.38 - 0.43	0.15 - 0.35	0.60 - 0.85	0.030	0.030	0.90 - 1.20	0.15 - 0.30

Remarks : 1) As impurities, Ni and Cu for each grade shall not exceed 0.25% and 0.30% respectively.

2) When the tensile test, impact test and hardness test are required by the purchaser, the method and the deviation limits of the test shall be agreed upon between the purchaser and the manufacturer.

Table 2. Outside Diameter Tolerance

Classification	Outside Diameter	
No.1	Up to 2in. (50mm)	± 0.020 in. (± 0.5 mm)
	2in. (50mm) and over	$\pm 1\%$
No.2	Up to 2in. (50mm)	± 0.010 in. (± 0.25 mm)
	2in. (50mm) and over	$\pm 0.5\%$
No.3	Up to 1in. (25mm)	± 0.0047 in. (± 0.12 mm)
	1in. (25mm) and over, up to 1.6in. (40mm)	± 0.006 in. (± 0.15 mm)
	1.6in. (40mm) and over, up to 2in. (50mm)	± 0.007 in. (± 0.18 mm)
	2in. (50mm) and over, up to 2.4in. (60mm)	± 0.008 in. (± 0.20 mm)
	2.4in. (60mm) and over, up to 2.8in. (70mm)	± 0.009 in. (± 0.23 mm)
	2.8in. (70mm) and over, up to 3.2in. (80mm)	± 0.010 in. (± 0.25 mm)
	3.2in. (80mm) and over, up to 3.6in. (90mm)	± 0.012 in. (± 0.30 mm)
	3.6in. (90mm) and over, up to 4.0in. (100mm)	± 0.016 in. (± 0.40 mm)
	4in. (100mm) and over	$\pm 0.50\%$
No.4	Up to 0.5in. (13mm)	± 0.010 in. (± 0.25 mm)
	0.5in. (13mm) and over, up to 1in. (25mm)	± 0.016 in. (± 0.40 mm)
	1in. (25mm) and over, up to 1.6in. (40mm)	± 0.024 in. (± 0.60 mm)
	1.6in. (40mm) and over, up to 2.6in. (65mm)	± 0.032 in. (± 0.80 mm)
	2.6in. (65mm) and over, up to 3.6in. (90mm)	± 0.040 in. (± 1.00 mm)
	3.6in. (90mm) and over, up to 5.6in. (140mm)	± 0.048 in. (± 1.20 mm)
	5.6in. (140mm) and over	To be subject to an agreement between the concerned parties.

Remarks : 1) For hot finished seamless steel tubes, outside diameter tolerance shall apply the values of No.1
 2) For quenched and tempered tubes, outside diameter tolerance shall apply, as a rule, the values of No.4.

Table 3. Wall Thickness and Length Tolerance

Classification	Wall Thickness		Length
No.1	Up to 0.16in. (4mm)	+ 0.024in. (+0.6mm) - 0.020in. (-0.5mm)	+ 2in. (+50mm) - 0 (-0mm)
	0.16in. (4mm) and over	+ 15% - 12.5%	
No.2	Up to 0.12in. (3mm)	± 0.012in. (±0.3mm)	
	0.12in. (3mm) and over	± 10%	
No.3	Up to 0.08in. (2mm)	± 0.006in. (±0.15mm)	
	0.08in. (2mm) and over	± 8%	

Remark : 1) Wall thickness tolerance for hot finished seamless steel tubes shall apply No. 1.

3. Seamless Steel Tubes for Drilling (JIS G 3465-88)

Table1. Chemical Composition and Mechanical Properties

Scope	Application	Class	Chemical Composition, %		Tensile Strength min N/mm ²	Yield Strength or Proof Stress min N/mm ²	Elongation, No.11, 12 test piece longitudinal min %	Method of Manufacture
			P max	S max				
This standard specifies seamless steel tubes used for casing tube, core tube and drill rod for drilling.	casing tube, core tube	STM-C540	0.040	0.040	540	—	18	1. The tube shall be manufactured by seamless process from steel ingot by the LD-converter or the electric furnace. 2. The tube shall be furnished by the cold finished method or the hot finished method and suitably heat treated, if required.
	core tube	STM-C640	0.040	0.040	640	—	16	
	drill rod	STM-R590	0.040	0.040	590	375	18	
		STM-R690	0.040	0.040	690	440	16	

Notes : 1) Values of yield strength may be substituted for those of tensile strength and the value of yield strength shall be expressed by stresses at the time when the elongation of the gauge length 0.5% in tensile test.
2) When the tensile test is conducted with No.12 test piece for the tube of less than 8 mm in wall thickness, the minimum value of elongation shall be the value calculated by subtracting from the elongation given in above table the value at the rate of 1.5% per 1 mm decrease in wall thickness of tube from 8 mm and by rounding off to an integer in accordance with JIS Z 8401-Rules for Rounding off of Numerical Values.

Table2. Outside Diameter Tolerance (for Drill Rods)

Classification	Outside Diameter	
No.1	Up to 2in. (50mm) exel. 2in. (50mm) and over	± 0.02in. (± 0.5mm) ± 1%
No.2	Up to 1.6in. (40mm) exel. 1.6in. (40mm) and over	± 0.008in. (± 0.2mm) ± 0.5%

Table3. Wall Thickness Tolerance (for Drill Rods)

Classification	Wall Thickness
No.1	± 10%
No.2	± 8%

Notes : 1) When tolerances other than that specified in TABLE 2-3 are required, the tolerance shall comply with the agreement between the purchaser and the manufacturer.

Table4. Length Tolerance

Classification	Length
20ft.(6m) or less in length	± 0.4in. (+10mm) 0 (0)
More than 20ft.(6m) in length	± 0.6in. (+15mm) 0 (0)

Table5. Drift Test

Nominal Diameter of Tube	Drift Mandrel Size	
	Outside Diameter	Length
1.69 - 3.27in. (43 - 83mm)	Inside diameter of tube — 0.04in. (1.0mm)	12in. (300mm)

4. Electric Resistance Welded Carbon Steel Tubes for Automobile Structural Purposes (Japanese Industrial Standard : JIS G 3472-88)

Table1. Chemical Composition and Mechanical Properties

Class	Symbol	Chemical Composition %						Tensile Test			Flaring Test
		C max	Si max	Mn	P max	S max	Nb or V	Tensile Strength min. N/mm ²	Yield Strength or Proof Stress min. N/mm ²	Elongation min. %	Flaring Ratio (D is outside diameter of tube)
										No.11, 12 test piece longitudinal	
G	STAM 290GA	0.12	0.35	0.60 max.	0.035	0.035	1)	290	175	40	1.25 D
	STAM 290GB	0.12	0.35	0.60 max.	0.035	0.035	1)	290	175	35	1.20 D
	STAM 340G	0.20	0.35	0.30 - 0.90	0.035	0.035	1)	340	195	35	1.20 D
	STAM 390G	0.25	0.35	0.30 - 0.90	0.035	0.035	1)	390	235	30	1.20 D
	STAM 440G	0.25	0.35	0.30 - 0.90	0.035	0.035	1)	440	305	25	1.15 D
	STAM 470G	0.25	0.35	0.30 - 1.00	0.035	0.035	1)	470	325	22	1.15 D
	STAM 500G	0.30	0.35	0.30 - 1.00	0.035	0.035	1)	500	355	18	1.15 D
H	STAM 440H	0.25	0.35	0.30 - 0.90	0.035	0.035	1)	440	355	20	1.15 D
	STAM 470H	0.25	0.35	0.30 - 0.90	0.035	0.035	1)	470	410	18	1.10 D
	STAM 500H	0.30	0.35	0.30 - 1.00	0.035	0.035	1)	500	430	16	1.10 D
	STAM 540H	0.30	0.35	0.30 - 1.00	0.035	0.035	1)	540	480	13	1.05 D

Remarks 1) Nb or V or a combination shall be used at the discretion of manufacturer to the extent of 0.15%.

Table 2. Outside Diameter Tolerance

Classification	Outside Diameter	
No.1	Under 2in. (50mm)	$\pm 0.010\text{in.}$ ($\pm 0.25\text{mm}$)
	2in. (50mm) and over	$\pm 0.5\%$
No.2	Under 2in. (50mm)	$\pm 0.008\text{in.}$ ($\pm 0.20\text{mm}$)
	2in. (50mm) to 3.2in. (80mm) excl.	$\pm 0.010\text{in.}$ ($\pm 0.25\text{mm}$)
	3.2in. (80mm) to 4in. (100mm) excl.	$\pm 0.012\text{in.}$ ($\pm 0.30\text{mm}$)
	4in. (100mm) and over	$\pm 0.016\text{in.}$ ($\pm 0.40\text{mm}$)
No.3	Under 1in. (25mm)	$\pm 0.0047\text{in.}$ ($\pm 0.12\text{mm}$)
	1in. (25mm) to 2in. (50mm) excl.	$\pm 0.006\text{in.}$ ($\pm 0.15\text{mm}$)
	2in. (50mm) and over	*

Remark : 1) * mark shall be in accordance with the agreed upon between the purchaser and the manufacturer.

Table 3. Wall Thickness Tolerance

Classification	Wall Thickness	
No.1	Under 0.12in. (3mm)	$\pm 0.012\text{in.}$ ($\pm 0.30\text{mm}$)
	0.12in. (3mm) and over	$\pm 10\%$
No.2	Under 0.064in. (1.6mm)	+ 0.008in. (+ 0.20mm) - 0.006in. (- 0.15mm)
	0.064in. (1.6mm) to 0.092in. (2.3mm) excl.	$\pm 0.008\text{in.}$ ($\pm 0.20\text{mm}$)
	0.092in. (2.3mm) to 0.12in. (3.0mm) excl.	$\pm 0.010\text{in.}$ ($\pm 0.25\text{mm}$)
	0.12in. (3.0mm) and over	$\pm 8\%$
No.3	Under 0.08in. (2mm)	$\pm 0.004\text{in.}$ ($\pm 0.10\text{mm}$)
	0.08in. (2mm) and over	$\pm 5\%$

Remarks : 1) No.1 shall be applicable to both outside diameter and wall tickness in the dimensional folerance for hot finished seamless steel tube.

2) Tolerance on outside diameter of the tube subjected to quenching and tempering shall be in accordance with the agreement between the purchaser and the manufacturer.

Table 4. Length Tolerance

Classification	Length
All	+ 2in. (+ 50mm) - 0in. (- 0mm)

Remark : 1) When the tolerance other than listed above is specially required, it shall be agreed upon between the purchaser and the manufacturer.

Table 5. Tolerance on the height of inside bead

Classification		Height of Inside Bead
No.1	As weld	Minus side tolerance are not allowed
No.2	Crush	Not specified
No.3	Cut	+ 0.018in. (+ 0.45mm) - 0 (- 0)
No.4		+ 0.01in. (+ 0.25mm) - 0 (- 0)
No.5		+ 0.008in. (+ 0.20mm) - 0.004in. (- 0.10mm)
No.6		± 0.008in. (± 0.20mm)

5. Carbon Steel Tubes for Cylinder Barrels (Japanese Industrial Standard ; JIS G 3473-88)

Table 1. Chemical Composition and Mechanical Properties

Symbol	Chemical Composition %						Tensile Test			Product Condition	
	C max	Si max	Mn	P max	S max	Nb or V	Tensile Strength min. N/mm ²	Yield strength or proof stress min. N/mm ²	Elongation min. %	Manufacturing	Heat Treatment
									No.11, 12 test piece longitudinal		
STC 370	0.25	0.35	0.30 - 0.90	0.040	0.040	—	370	215	30	Hot finished Seamless	As rolled (hard)
STC 440	0.25	0.35	0.30 - 0.90	0.040	0.040	—	440	305	10	Cold finished ERW	As cold finished (hard) or Stress relieving
STC 510A	0.25	0.35	0.30 - 0.90	0.040	0.040	—	510	380	10	Cold finished Seamless and cold finished ERW	As cold finished (hard) or Stress relieving
STC 510B	0.18	0.55	1.50 max.	0.040	0.040	—	510	380	15	Cold finished Seamless and cold finished ERW	Stress relieving
STC 540	0.25	0.55	1.60 max.	0.040	0.040	1)	540	390	20	Hot finished Seamless	As rolled
STC 590A	0.25	0.35	0.30 - 0.90	0.040	0.040	—	590	490	10	Cold finished Seamless	As cold finished (hard) or Stress relieving
STC 590B	0.25	0.55	1.50 max.	0.040	0.040	—	590	490	15	Cold finished Seamless	Stress relieving

Remarks : 1) Nb or V or a combination shall be used at the discretion of manufacturer to the extent of 0.15%.

Table 2. Outside Diameter Tolerance

Classification	Outside Diameter	
Hot finished Seamless steel tube	Under 2in. (50mm)	± 0.02in. (± 0.5mm)
	2in. (50mm) to 5in. (125mm) excl.	± 1% (± 1.0mm)
	5in. (125mm) and over	± 0.8%
Cold finished Seamless steel tube	Under 2in. (50mm)	± 0.01in. (± 0.25mm)
	2in. (50mm) and over	± 0.5%

Table 3. Inside Diameter Tolerance

Classification	Inside Diameter	
Cold finished Seamless steel tube or Cold finished ERW steel tube	2in. (50mm) and under	- 0.004in. (- 0.10mm) - 0.012in. (- 0.30mm)
	Over 2in. (50mm) to 3.2in. (80mm) incl.	- 0.004in. (- 0.10mm) - 0.016in. (- 0.40mm)
	Over 3.2in. (80mm) to 4.8in. (120mm) incl.	- 0.004in. (- 0.10mm) - 0.020in. (- 0.50mm)
	Over 4.8in. (120mm) to 6.4in. (160mm) incl.	- 0.004in. (- 0.10mm) - 0.024in. (- 0.60mm)
	Over 6.4in. (160mm) to 7.2in. (180mm) incl.	- 0.004in. (- 0.10mm) - 0.032in. (- 0.80mm)
	Over 7.2in. (180mm) to 8in. (200mm) incl.	- 0.004in. (- 0.10mm) - 0.036in. (- 0.90mm)

Remarks : The figures of tolerances on the inside diameter shall be applied to the tubes whose ratio of the wall thickness to the inside diameter is 4.5% or more. For those of the ratio less than 4.5%, the tolerance on the inside diameter of the tube shall be agreed upon by the purchaser and the manufacturer.

Table 4. Wall Thickness Tolerance

Classification	Wall Thickness	
Hot finished Seamless steel tube	± 12.5%	0.02in. (0.5mm) min.
Cold finished Seamless steel tube	± 10%	0.012in. (0.3mm) min.
Cold finished ERW steel tube	± 8%	0.006in. (0.15mm) min.

6. Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing (A519-96)

Table 1. Chemical Composition

Kind of Steel	Grade Designation	Chemical composition, %							
		C	Mn	P max	S	Si	Ni	Cr	Mo
Low-Carbon Steel	MT 1010	0.05 - 0.15	0.30 - 0.60	0.040	0.050 max.	—	—	—	—
	MT 1015	0.10 - 0.20	0.30 - 0.60	0.040	0.050 max.	—	—	—	—
	MT X 1015	0.10 - 0.20	0.60 - 0.90	0.040	0.050 max.	—	—	—	—
	MT 1020	0.15 - 0.25	0.30 - 0.60	0.040	0.050 max.	—	—	—	—
	MT X 1020	0.15 - 0.25	0.70 - 1.00	0.040	0.050 max.	—	—	—	—
Higher-Carbon Steel	1025	0.22 - 0.28	0.30 - 0.60	0.040	0.050 max.	—	—	—	—
	1026	0.22 - 0.28	0.60 - 0.90	0.040	0.050 max.	—	—	—	—
	1030	0.28 - 0.34	0.60 - 0.90	0.040	0.050 max.	—	—	—	—
	1035	0.32 - 0.38	0.60 - 0.90	0.040	0.050 max.	—	—	—	—
	1040	0.37 - 0.44	0.60 - 0.90	0.040	0.050 max.	—	—	—	—
	1045	0.43 - 0.50	0.60 - 0.90	0.040	0.050 max.	—	—	—	—
	1050	0.48 - 0.55	0.60 - 0.90	0.040	0.050 max.	—	—	—	—
High Carbon Steel or Alloy Steel	1330	0.28 - 0.33	1.60 - 1.90	0.040	0.040 max.	0.15 - 0.35	—	—	—
	1335	0.33 - 0.38	1.60 - 1.90	0.040	0.040 max.	0.15 - 0.35	—	—	—
	1340	0.38 - 0.43	1.60 - 1.90	0.040	0.040 max.	0.15 - 0.35	—	—	—
	1345	0.43 - 0.48	1.60 - 1.90	0.040	0.040 max.	0.15 - 0.35	—	—	—
	3140	0.38 - 0.43	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	1.10 - 1.40	0.55 - 0.75	—
	E 3310	0.08 - 0.13	0.45 - 0.60	0.040	0.025 max.	0.15 - 0.35	3.25 - 3.75	1.40 - 1.75	—
	4012	0.09 - 0.14	0.75 - 1.00	0.040	0.040 max.	0.15 - 0.35	—	—	0.15 - 0.25
	4023	0.20 - 0.25	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	—	—	0.20 - 0.30
	4024	0.20 - 0.25	0.70 - 0.90	0.040	0.035 - 0.050	0.15 - 0.35	—	—	0.20 - 0.30
	4027	0.25 - 0.30	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	—	—	0.20 - 0.30
	4028	0.25 - 0.30	0.70 - 0.90	0.040	0.035 - 0.050	0.15 - 0.35	—	—	0.20 - 0.30
	4037	0.35 - 0.40	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	—	—	0.20 - 0.30
	4042	0.40 - 0.45	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	—	—	0.20 - 0.30
	4047	0.45 - 0.50	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	—	—	0.20 - 0.30
	4063	0.60 - 0.67	0.75 - 1.00	0.040	0.040 max.	0.15 - 0.35	—	—	0.20 - 0.30
	4118	0.18 - 0.23	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	—	0.40 - 0.60	0.08 - 0.15
	4130	0.28 - 0.33	0.40 - 0.60	0.040	0.040 max.	0.15 - 0.35	—	0.80 - 1.10	0.15 - 0.25
	4135	0.33 - 0.38	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	—	0.80 - 1.10	0.15 - 0.25
	4137	0.35 - 0.40	0.70 - 0.90	0.040	0.040 max.	0.15 - 0.35	—	0.80 - 1.10	0.15 - 0.25
	4140	0.38 - 0.43	0.75 - 1.00	0.040	0.040 max.	0.15 - 0.35	—	0.80 - 1.10	0.15 - 0.25
4142	0.40 - 0.45	0.75 - 1.00	0.040	0.040 max.	0.15 - 0.35	—	0.80 - 1.10	0.15 - 0.25	

Remarks : 1) Steel making process : Basic oxygen furnace or electric furnace
2) Tube making process : Seamless
3) Tensile tests and hardness tests are conducted subject to negotiation and agreements.

Table 2. Typical Physical Properties

Grade Designation	Typical Physical Properties						
	Condition *	Ultimate Strength		Yield Strength		Elongation in 2in. %	Rockwell Hardness B-Scale
		Ksi	MPa	Ksi	MPa		
1020	HR	50	345	32	221	25	55
	CW	70	483	60	414	5	75
	SR	65	448	50	345	10	72
	A	48	331	28	193	30	50
	N	55	379	34	234	22	60
1025	HR	55	379	35	241	25	60
	CW	75	517	65	448	5	80
	SR	70	483	55	379	8	75
	A	53	365	30	207	25	57
	N	55	379	36	248	22	60
1035	HR	65	448	40	276	20	72
	CW	85	586	75	517	5	88
	SR	75	517	65	448	8	80
	A	60	414	33	228	25	67
	N	65	448	40	276	20	72
1045	HR	75	517	45	310	15	80
	CW	90	621	80	552	5	90
	SR	80	552	70	483	8	85
	A	65	448	35	241	20	72
	N	75	517	48	331	15	80
1050	HR	80	552	50	345	10	85
	SR	82	565	70	483	6	86
	A	68	469	38	262	18	74
	N	78	538	50	345	12	82
4130	HR	90	621	70	483	20	89
	SR	105	724	85	586	10	95
	A	75	517	55	379	30	81
	N	90	621	60	414	20	89
4140	HR	120	855	90	621	15	100
	SR	120	855	100	689	10	100
	A	80	552	60	414	25	85
	N	120	855	90	621	20	100

* The following are the symbol definitions for the various conditions:
 HR – Hot Rolled, CW – Cold Worked, SR – Stress Relieved, A – Annealed, N – Normalized

TABLE 3. Permissible Variations in Dimensions of Round Tubing

TYPE	Diameter and Wall Thickness	Length	Straightness
Hot-Finished Tubing	TABLE 4, 5	a. Commonly furnished in mill lengths, 5 ft and over. b. when specified definite cut lengths are furnished. (See TABLE 10)	TABLE 11
Round Cold Worked Tubing	TABLE 6, 7		
Rough-Turned Tubing	TABLE 8		
Ground Tubing	TABLE 9		

Note : Contained herein are excerpts concerning round tubing.
The data for square and rectangular tubing are not included.

TABLE 4. Outside Diameter Tolerances for Round Hot-Finished Tubing ^{A,B,C}.

Outside Diameter Size Range, in. (mm)	Outside Diameter Tolerance, in. (mm)	
	Over	Under
Up to 2,999 (76.17)	0.020 (0.51)	0.020 (0.51)
3,000 - 4,499 (76.20 - 114.27)	0.025 (0.64)	0.025 (0.64)
4,500 - 5,999 (114.30 - 152.37)	0.031 (0.79)	0.031 (0.79)
6,000 - 7,499 (152.40 - 190.47)	0.037 (0.94)	0.037 (0.94)
7,500 - 8,999 (190.50 - 228.57)	0.045 (1.14)	0.045 (1.14)
9,000 - 10,750 (228.60 - 273.05)	0.050 (1.27)	0.050 (1.27)

- A. Diameter tolerances are not applicable to normalized and tempered or quenched and tempered conditions.
- B. The common range of sizes of hot finished tubes is 1 1/2 in. (38.1mm) to 10 3/4 in. (273.0mm) outside diameter with wall thickness at least 3% or more of outside diameter, but not less than 0.095 in. (2.41mm).
- C. Larger sizes are available ; consult manufacturer for sizes and tolerances.

TABLE 5. Wall Thickness Tolerances for Round Hot-Finished Tubing

Wall Thickness Range as Percent of Outside Diameter	Wall Thickness Tolerance, ^A Percent Over and Under Nominal		
	Outside Diameter 2.999 in. (76.19mm) and smaller	Outside Diameter 3.000 in. (76.20mm) to 5.999 in. (152.37mm)	Outside Diameter 6.000 in. (152.40mm) to 10.750 in. (273.05mm)
Under 15	12.5	10.0	10.0
15 and over	10.0	7.5	10.0

A. Wall thickness tolerances may not be applicable to walls 0.199 in. (5.05mm) and less : consult manufacturer for wall tolerances on such tube sizes.

TABLE 6. Outside and Inside Diameter Tolerances for Round Cold-Worked Tubing ^{A,B,C}.

Outside Diameter Size Range, D in.	Wall Thickness as Percent of Outside Diameter	Thermal Treatment after Final Cold Work Producing Size											
		None, or not exceeding 1100°F Nominal Temperature				Heated Above 1100°F Nominal Temperature Without Accelerated Cooling				Quenched and Tempered			
		OD. in. ^D		ID. in. ^D		OD. in. ^D		ID. in. ^D		OD. in. ^D		ID. in. ^D	
		Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
Up to 0.499	all	0.004	0.000	—	—	0.005	0.002	—	—	0.010	0.010	0.010	0.010
0.500 - 1.699	all	0.005	0.000	0.000	0.005	0.007	0.002	0.002	0.007	0.015	0.015	0.015	0.015
1.700 - 2.099	all	0.006	0.000	0.000	0.006	0.006	0.005	0.005	0.006	0.020	0.020	0.020	0.020
2.100 - 2.499	all	0.007	0.000	0.000	0.007	0.008	0.005	0.005	0.008	0.023	0.023	0.023	0.023
2.500 - 2.899	all	0.008	0.000	0.000	0.008	0.009	0.005	0.005	0.009	0.025	0.025	0.025	0.025
2.900 - 3.299	all	0.009	0.000	0.000	0.009	0.011	0.005	0.005	0.011	0.028	0.028	0.028	0.028
3.300 - 3.699	all	0.010	0.000	0.000	0.010	0.013	0.005	0.005	0.013	0.030	0.030	0.030	0.030
3.700 - 4.099	all	0.011	0.000	0.000	0.011	0.013	0.007	0.010	0.010	0.033	0.033	0.033	0.033
4.100 - 4.499	all	0.012	0.000	0.000	0.012	0.014	0.007	0.011	0.011	0.036	0.036	0.036	0.036
4.500 - 4.899	all	0.013	0.000	0.000	0.013	0.016	0.007	0.012	0.012	0.038	0.038	0.038	0.038
4.900 - 5.299	all	0.014	0.000	0.000	0.014	0.018	0.007	0.013	0.013	0.041	0.041	0.041	0.041
5.300 - 5.549	all	0.015	0.000	0.000	0.015	0.020	0.007	0.014	0.014	0.044	0.044	0.044	0.044
5.550 - 5.999	under 6	0.010	0.010	0.010	0.010	0.018	0.018	0.018	0.018	—	—	—	—
	6 to 7-1/2	0.009	0.009	0.009	0.009	0.016	0.016	0.016	0.016	—	—	—	—
	over 7-1/2	0.018	0.000	0.009	0.009	0.017	0.015	0.016	0.016	—	—	—	—
6.000 - 6.499	under 6	0.013	0.013	0.013	0.013	0.023	0.023	0.023	0.023	—	—	—	—
	6 to 7-1/2	0.010	0.010	0.010	0.010	0.018	0.018	0.018	0.018	—	—	—	—
	over 7-1/2	0.020	0.000	0.010	0.010	0.020	0.015	0.018	0.018	—	—	—	—
6.500 - 6.999	under 6	0.015	0.015	0.015	0.015	0.027	0.027	0.027	0.027	—	—	—	—
	6 to 7-1/2	0.012	0.012	0.012	0.012	0.021	0.021	0.021	0.021	—	—	—	—
	over 7-1/2	0.023	0.000	0.012	0.012	0.026	0.015	0.021	0.021	—	—	—	—
7.000 - 7.499	under 6	0.018	0.018	0.018	0.018	0.032	0.032	0.032	0.032	—	—	—	—
	6 to 7-1/2	0.013	0.013	0.013	0.013	0.023	0.023	0.023	0.023	—	—	—	—
	over 7-1/2	0.026	0.000	0.013	0.013	0.031	0.015	0.023	0.023	—	—	—	—
7.500 - 7.999	under 6	0.020	0.020	0.020	0.020	0.035	0.035	0.035	0.035	—	—	—	—
	6 to 7-1/2	0.015	0.015	0.015	0.015	0.026	0.026	0.026	0.026	—	—	—	—
	over 7-1/2	0.029	0.000	0.015	0.015	0.036	0.015	0.026	0.026	—	—	—	—
8.000 - 8.499	under 6	0.023	0.023	0.023	0.023	0.041	0.041	0.041	0.041	—	—	—	—
	6 to 7-1/2	0.016	0.016	0.016	0.016	0.028	0.028	0.028	0.028	—	—	—	—
	over 7-1/2	0.031	0.000	0.015	0.016	0.033	0.022	0.028	0.028	—	—	—	—
8.500 - 8.999	under 6	0.025	0.025	0.025	0.025	0.044	0.044	0.044	0.044	—	—	—	—
	6 to 7-1/2	0.017	0.017	0.017	0.017	0.030	0.030	0.030	0.030	—	—	—	—
	over 7-1/2	0.034	0.000	0.015	0.019	0.038	0.022	0.030	0.030	—	—	—	—
9.000 - 9.499	under 6	0.028	0.028	0.028	0.028	0.045	0.045	0.049	0.049	—	—	—	—
	6 to 7-1/2	0.019	0.019	0.019	0.019	0.033	0.033	0.033	0.033	—	—	—	—
	over 7-1/2	0.037	0.000	0.015	0.022	0.043	0.022	0.033	0.033	—	—	—	—
9.500 - 9.999	under 6	0.030	0.030	0.030	0.030	0.045	0.045	0.053	0.053	—	—	—	—
	6 to 7-1/2	0.020	0.020	0.020	0.020	0.035	0.035	0.035	0.035	—	—	—	—
	over 7-1/2	0.040	0.000	0.015	0.025	0.048	0.022	0.035	0.035	—	—	—	—
10.000 - 10.999	under 6	0.034	0.034	0.034	0.034	0.045	0.045	0.060	0.060	—	—	—	—
	6 to 7-1/2	0.022	0.022	0.022	0.022	0.039	0.039	0.039	0.039	—	—	—	—
	over 7-1/2	0.044	0.000	0.015	0.029	0.055	0.022	0.039	0.039	—	—	—	—
11.000 - 12.000	under 6	0.035	0.035	0.035	0.035	0.050	0.050	0.065	0.065	—	—	—	—
	6 to 7-1/2	0.025	0.025	0.025	0.025	0.045	0.045	0.045	0.045	—	—	—	—
	over 7-1/2	0.045	0.000	0.015	0.035	0.060	0.022	0.045	0.045	—	—	—	—

A. Many tubes with inside diameter less than 50% of outside diameter or with wall thickness more than 25% of outside diameter, or with wall thickness over 1 1/4 in., or weighing more than 90 lb/ft. are difficult to draw over a mandrel. Therefore, the inside diameter can vary over or under by an amount equal to 10% of the wall thickness. See also footnote B.

B. For those tubes with inside diameter less than 1/2 in. (or less than 5/8 in. when the wall thickness is more than 20% of the outside diameter), which are not commonly drawn over a mandrel. Footnote A is not applicable. Therefore, for those tubes, the inside diameter is governed by the outside diameter tolerance shown in this table and the wall thickness tolerances shown in Table 7.

C. Tubing having a wall thickness less than 3% of the outside diameter cannot be straightened properly without a certain amount of distortion.

Consequently such tubes, while having an average outside diameter and inside diameter within the tolerances shown in this table, require an ovality tolerance of 1/2% over and under nominal outside diameter, this being in addition to the tolerances shown in this table, require an ovality tolerance of 1/2% over and under nominal outside diameter, this being in addition to the tolerances indicated in this table.

D. 1 in.=25.4mm.

TABLE 7. Wall Thickness Tolerances for Round Cold-Worked Tubing

Wall Thickness Range as % of Outside Diameter	Wall Thickness Tolerance, Over and Under Nominal,%	
	Up to 1.499in., ID	ID 1.500in., and Over
25 and under	10.0	7.5
Over 25	12.5	10.0

TABLE 8. Outside Diameter and Wall Tolerances for Rough-Turned Seamless Steel Tubing

Specified Size Outside Diameter, in. (mm)	Outside Diameter, in. (mm)		Wall Thickness, %	
	Plus	Minus	Plus	Minus
Up to but not including 6-3/4 (171.4)	0.005 (0.13)	0.005 (0.13)	12.5	12.5
6-3/4 to 8 (171.4 to 203.2)	0.010 (0.25)	0.010 (0.25)	12.5	12.5

TABLE 9. Outside Diameter Tolerances for Ground Seamless Tubing

Size Outside Diameter, in. (mm)	Outside Diameter Tolerances for Sizes and Lengths Given, in. (mm)			
	Lengths up to 16ft. (4.9m), incl.		Lengths over 16ft. (4.9m)	
	Over	Under	Over	Under
Up to 1-1/4(31.8), incl.	0.003 (0.08)	0.000	0.004 (0.10)	0.000
Over 1-1/4 to 2 (31.8 to 50.8), incl.	0.005 (0.13)	0.000	0.006 (0.15)	0.000
Size Outside Diameter, in. (mm)	Lengths up to 12ft. (3.7m), incl.		Lengths to 16ft. (4.9m)	
	Over	Under	Over	Under
Over 2 to 3 (50.8 to 76.2), incl.	0.005 (0.13)	0.000	0.006 (0.15)	0.000
Over 3 to 4 (76.2 to 101.6), incl.	0.006 (0.15)	0.000	0.008 (0.20)	0.000

Note – The wall thickness and inside diameter tolerances are the same as for cold-worked mechanical tubing tolerances given in Table6.

TABLE 10. Length Tolerances for Round Hot-Finished or Cold-Finished Tubing

Length, ft (m)	Outside Diameter, in. (mm)	Tolerance, in. (mm)	
		Over	Under
4 (1.2) and under	up to 2 (50.8), incl.	1/16 (1.6)	0
	over 2 to 4 (50.8 to 101.6), incl.	3/32 (2.4)	0
	over 4 (101.6)	1/8 (3.2)	0
Over 4 to 10 (1.2 to 3.0), incl.	up to 2 (50.8), incl.	3/32 (2.4)	0
	over 2 (50.8)	1/8 (3.2)	0
Over 10 to 24 (3.0 to 7.3), incl.	all sizes	3/16 (4.8)	0
Over 24 (7.3)	all sizes	3/16 (4.8)+ 1/2(12.7) for each 10ft. (3.0m) or fraction over 24ft. (7.3m)	0

Note – The Producer should be consulted for length tolerances for tubes produced by liquid- or air-quenching heat treatment.

TABLE 11. Straightness Tolerances for Seamless Round Mechanical Tubing

Size Limits	Maximum Curvature in any 3 ft. / in. (mm/m)	Maximum Curvature in Total Lengths, in. (mm)	Maximum Curvature for Lengths under 3 ft or 1 m
OD 5in.(127.0mm) and smaller. Wall thickness, over 3% of OD.	0.030 (0.83)	0.030 x (no.of ft of length / 3) (0.83 x no.of m of length)	ratio of 0.010in./ft or 0.83mm/m
OD over 5 to 8in. (127.0 to 203.2mm), incl. Wall thickness, over 4% of OD.	0.045 (1.25)	0.045 x (no.of ft of length / 3) (1.25 x no.of m of length)	ratio of 0.015in./ft or 1.25mm/m
OD over 8 to 12- ³ / ₄ in. (203.2 to 323.8mm), incl. Wall thickness, over 4% of OD.	0.060 (1.67)	0.060 x (no.of ft of length / 3) (1.67 x no.of m of length)	ratio of 0.020in./ft or 1.67mm/m

- Note : 1. The straightness variation for any 3 ft (0.9m) of length is determined by measuring the concavity between the tube and a 3-ft straightedge with a feeler gage. The total variation, that is, the maximum curvature at any point in the total length of tube, is determined by rolling the tube on a surface plate and measuring the concavity with a feeler gage.
2. The tolerances apply generally to unannealed, finish-annealed and medium-annealed cold-finished or hot-finished tubes. When straightening stress would interfere with the use of the end product, the straightness tolerances shown do not apply when tubing is specified "not to be straightened after furnace treatment." These straightness tolerances do not apply to soft-annealed or quenched and tempered tubes.



7. Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing (ASTM A513-00)

Table 1. Chemical Composition

Kind of Steel	Grade Designation	Chemical Composition %							
		C	Mn	P max.	S max.	Si	Ni	Cr	Mo
Low Carbon Steel	MT 1010	0.05 - 0.15	0.30 - 0.60	0.035	0.035	—	—	—	—
	MT 1015	0.10 - 0.20	0.30 - 0.60	0.035	0.035	—	—	—	—
	MTX 1015	0.10 - 0.20	0.60 - 0.90	0.035	0.035	—	—	—	—
	MT 1020	0.15 - 0.25	0.30 - 0.60	0.035	0.035	—	—	—	—
	MTX 1020	0.15 - 0.25	0.70 - 1.00	0.035	0.035	—	—	—	—
Carbon or Alloy Steel	1008	0.10 max.	0.50 max.	0.035	0.035	—	—	—	—
	1010	0.08 - 0.13	0.30 - 0.60	0.035	0.035	—	—	—	—
	1012	0.10 - 0.15	0.30 - 0.60	0.035	0.035	—	—	—	—
	1015	0.12 - 0.18	0.30 - 0.60	0.035	0.035	—	—	—	—
	1016	0.12 - 0.18	0.60 - 0.90	0.035	0.035	—	—	—	—
	1017	0.14 - 0.20	0.30 - 0.60	0.035	0.035	—	—	—	—
	1018	0.14 - 0.20	0.60 - 0.90	0.035	0.035	—	—	—	—
	1019	0.14 - 0.20	0.70 - 1.00	0.035	0.035	—	—	—	—
	1020	0.17 - 0.23	0.30 - 0.60	0.035	0.035	—	—	—	—
	1021	0.17 - 0.23	0.60 - 0.90	0.035	0.035	—	—	—	—
	1022	0.17 - 0.23	0.70 - 1.00	0.035	0.035	—	—	—	—
	1023	0.19 - 0.25	0.30 - 0.60	0.035	0.035	—	—	—	—
	1024	0.18 - 0.25	1.30 - 1.65	0.035	0.035	—	—	—	—
	1025	0.22 - 0.28	0.30 - 0.60	0.035	0.035	—	—	—	—
	1026	0.22 - 0.28	0.60 - 0.90	0.035	0.035	—	—	—	—
	1027	0.22 - 0.29	1.20 - 1.55	0.035	0.035	—	—	—	—
	1030	0.27 - 0.34	0.60 - 0.90	0.035	0.035	—	—	—	—
	1033	0.29 - 0.36	0.70 - 1.00	0.035	0.035	—	—	—	—
	1035	0.31 - 0.38	0.60 - 0.90	0.035	0.035	—	—	—	—
	1040	0.36 - 0.44	0.60 - 0.90	0.040	0.050	—	—	—	—
	1050	0.47 - 0.55	0.60 - 0.90	0.040	0.050	—	—	—	—
	1060	0.55 - 0.66	0.60 - 0.90	0.040	0.050	—	—	—	—
	1340	0.38 - 0.43	1.60 - 1.90	0.035	0.040	0.15 - 0.35	—	—	—
	1524	0.18 - 0.25	1.35 - 1.65	0.040	0.050	—	—	—	—
	4118	0.18 - 0.23	0.70 - 0.90	0.035	0.040	0.15 - 0.35	—	0.40 - 0.60	0.08 - 0.15
	4130	0.28 - 0.33	0.40 - 0.60	0.035	0.040	0.15 - 0.35	—	0.80 - 1.10	0.15 - 0.25
	4140	0.38 - 0.43	0.75 - 1.00	0.035	0.040	0.15 - 0.35	—	0.80 - 1.10	0.15 - 0.25
	5130	0.23 - 0.33	0.70 - 0.90	0.035	0.040	0.15 - 0.35	—	0.80 - 1.10	—
8620	0.18 - 0.23	0.70 - 0.90	0.035	0.040	0.15 - 0.35	0.40 - 0.70	0.40 - 0.60	0.15 - 0.25	
8630	0.28 - 0.33	0.70 - 0.90	0.035	0.040	0.15 - 0.35	0.40 - 0.70	0.40 - 0.60	0.15 - 0.25	

Table 2. Physical Properties

Grade Designation	Yield Strength, ksi (MPa), min	Ultimate Strength, ksi (MPa), min	Elongation in 2 in. or 50mm, %, min	RB min.	RB max.
As-Welded Tubing					
1008	30 (207)	42 (290)	15	50	
1010	32 (221)	45 (310)	15	55	
1015	35 (241)	48 (331)	15	58	
1020	38 (262)	52 (359)	12	62	
1021	40 (276)	54 (372)	12	62	
1025	40 (276)	56 (386)	12	65	
1026	45 (310)	62 (427)	12	68	
1030	45 (310)	62 (427)	10	70	
1035	50 (345)	66 (455)	10	75	
1040	50 (345)	66 (455)	10	75	
1340	55 (379)	72 (496)	10	80	
1524	50 (345)	66 (455)	10	75	
4130	55 (379)	72 (496)	10	80	
4140	70 (485)	90 (621)	10	85	
Normalized Tubing					
1008	23 (159)	38 (262)	30		65
1010	25 (172)	40 (276)	30		65
1015	30 (207)	45 (310)	30		70
1020	35 (241)	50 (345)	25		75
1021	35 (241)	50 (345)	25		78
1025	37 (255)	55 (379)	25		80
1026	40 (276)	60 (414)	25		85
1030	40 (276)	60 (414)	25		85
1035	45 (310)	65 (448)	20		88
1040	45 (310)	65 (448)	20		90
1340	50 (345)	70 (483)	20		100
1524	45 (310)	65 (448)	20		88
4130	50 (345)	70 (483)	20		100
4140	65 (448)	90 (621)	20		105
Sink-Drawn Tubing					
1008	38 (262)	48 (331)	8	65	
1010	40 (276)	50 (345)	8	65	
1015	45 (310)	55 (379)	8	67	
1020	50 (345)	60 (414)	8	70	
1021	52 (359)	62 (428)	7	70	
1025	55 (379)	65 (448)	7	72	
1026	55 (379)	70 (483)	7	77	
1030	62 (427)	70 (483)	7	78	
1035	70 (483)	80 (552)	7	82	

Grade Designation	Yield Strength, ksi (MPa), min	Ultimate Strength, ksi (MPa), min	Elongation in 2 in. or 50mm, %, min	RB min.	RB max.
Mandrel-Drawn Tubing					
1008	50 (345)	60 (414)	5	73	
1010	50 (345)	60 (414)	5	73	
1015	55 (379)	65 (448)	5	77	
1020	60 (414)	70 (483)	5	80	
1021	62 (427)	72 (496)	5	80	
1025	65 (448)	75 (517)	5	82	
1026	70 (483)	80 (552)	5	85	
1030	75 (517)	85 (586)	5	87	
1035	80 (552)	90 (621)	5	90	
1040	80 (552)	90 (621)	5	90	
1340	85 (586)	95 (655)	5	90	
1524	80 (552)	90 (621)	5	90	
4130	85 (586)	95 (655)	5	90	
4140	100 (690)	110 (758)	5	90	
Mandrel-Drawn Stress Relieved Tubing					
1008	45 (310)	55 (379)	12	68	
1010	45 (310)	55 (379)	12	68	
1015	50 (345)	60 (414)	12	72	
1020	55 (379)	65 (448)	10	75	
1021	58 (400)	68 (469)	10	75	
1025	60 (414)	70 (483)	10	77	
1026	65 (448)	75 (517)	10	80	
1030	70 (483)	80 (552)	10	81	
1035	75 (517)	85 (586)	10	85	
1040	75 (517)	85 (586)	10	85	
1340	80 (552)	90 (621)	10	87	
1524	75 (517)	85 (586)	10	85	
4130	80 (552)	90 (621)	10	87	
4140	95 (655)	105 (724)	10	90	

Note : 1. These values are based on normal mill stress relieving temperatures. For particular applications, properties may be adjusted by negotiation between purchaser and producer.

2. For longitudinal strip tests, the width of the gage section shall be 1 in. (25.4mm) and a deduction of 0.5 percentage points from the basic minimum elongation for each $\frac{1}{32}$ in. (0.8mm) decrease in wall thickness under $\frac{5}{16}$ in. (7.9mm) in wall thickness shall be permitted.

Table 3. Permissible Variation in Dimensions for Round Tubing

TYPE Number	Code Letters	Description	Diameter	Wall Thickness	Length	Squareness of Cut	Straightness	Ovality
1	A.W.H.R.	"as-welded" from hot rolled steel	TABLE 4	TABLE 7	a. Commonly furnished in mill lengths 5 feet and over. b. When specified, definite cut lengths are furnished. (See TABLE 10)	TABLE 11	to OD 8 in.: max 0.030 in./3-ft. length OD 8 in. and above: max 0.060 in./3-ft. length	The ovality shall be within the tolerances except when the wall thickness is less than 3% of outside diameter. See Table 4 and 5.
2	A.W.C.R.	"as-welded" from cold rolled steel	TABLE 5	TABLE 8				
3	S.D.H.R.	"sink-drawn" hot rolled steel	TABLE 6	± 10% of the nominal wall or ± 0.010 in. whichever is greater				
4	S.D.C.R.	"sink-drawn" cold rolled steel	TABLE 6					
5	M.D.	mandrel drawn	TABLE 6	TABLE 9				
6	S.S.I.D.	special smooth inside diameter						

TABLE 4. Diameter Tolerances for Type 1 (A.W. H. R.) Round Tubing

Outside Diameter Range in. ^A	Wall Thickness		Flash-in-Tubing ^{B,C}		Flash Controlled to 0.010 in. max Tubing ^{C,E}		Flash Controlled to 0.005 in. max Tubing ^{D,E}	
	Bwg ^F	in. ^A	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Inside Diameter Plus and Minus	Tolerance, in. ^{A,G}	
			Tolerance, in. ^{A,G}		Tolerance, in. ^{A,G}			
1/2 to 1-1/8, incl.	16 to 10	0.065 to 0.134	0.0035	0.0035	0.0035	0.020		
Over 1-1/8 to 2, incl.	16 to 14	0.065 to 0.083	0.005	0.005	0.005	0.021		
Over 1-1/8 to 2, incl.	13 to 7	0.095 to 0.180	0.005	0.005	0.005	0.025		
Over 1-1/8 to 2, incl.	6 to 5	0.203 to 0.220	0.005	0.005	0.005	0.029		
Over 1-1/8 to 2, incl.	4 to 3	0.238 to 0.259	0.005	0.005	0.005	0.039		
Over 2 to 2-1/2, incl.	16 to 14	0.065 to 0.083	0.006	0.006	0.006	0.022		
Over 2 to 2-1/2, incl.	13 to 5	0.095 to 0.220	0.006	0.006	0.006	0.024		
Over 2 to 2-1/2, incl.	4 to 3	0.238 to 0.259	0.006	0.006	0.006	0.040		
Over 2-1/2 to 3, incl.	16 to 14	0.065 to 0.083	0.008	0.008	0.008	0.024		
Over 2-1/2 to 3, incl.	13 to 5	0.095 to 0.220	0.008	0.008	0.008	0.026		
Over 2-1/2 to 3, incl.	4 to 3	0.238 to 0.259	0.008	0.008	0.008	0.040		
Over 2-1/2 to 3, incl.	2 to 0.320	0.284 to 0.320	0.010	0.010	0.010	0.048		
Over 3 to 3-1/2, incl.	16 to 14	0.065 to 0.083	0.009	0.009	0.009	0.025		
Over 3 to 3-1/2, incl.	13 to 5	0.095 to 0.220	0.009	0.009	0.009	0.027		
Over 3 to 3-1/2, incl.	4 to 3	0.238 to 0.259	0.009	0.009	0.009	0.043		
Over 3 to 3-1/2, incl.	2 to 0.360	0.284 to 0.360	0.012	0.012	0.012	0.050		
Over 3-1/2 to 4, incl.	16 to 14	0.065 to 0.083	0.010	0.010	0.010	0.026		
Over 3-1/2 to 4, incl.	13 to 5	0.095 to 0.220	0.010	0.010	0.010	0.028		
Over 3-1/2 to 4, incl.	4 to 3	0.238 to 0.259	0.010	0.010	0.010	0.044		
Over 3-1/2 to 4, incl.	2 to 0.500	0.284 to 0.500	0.015	0.015	0.015	0.053		
Over 4 to 5, incl.	16 to 14	0.065 to 0.083	0.020	0.020	0.020	0.036		
Over 4 to 5, incl.	13 to 5	0.095 to 0.220	0.020	0.020	0.020	0.045		
Over 4 to 5, incl.	4 to 3	0.238 to 0.259	0.020	0.020	0.020	0.054		
Over 4 to 5, incl.	2 to 0.500	0.284 to 0.500	0.020	0.020	0.020	0.058		
Over 5 to 6, incl.	16 to 10	0.065 to 0.134	0.020	0.020	0.020	0.036		
Over 5 to 6, incl.	9 to 5	0.148 to 0.220	0.020	0.020	0.020	0.040		

Outside Diameter Range in. ^A	Wall Thickness		Flash-in-Tubing ^{B,C}		Flash Controlled to 0.010 in. max Tubing ^{C,E}		Flash Controlled to 0.005 in. max Tubing ^{D,E}	
	Bwg ^F	in. ^A	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Inside Diameter Plus and Minus	Tolerance, in. ^{A,G}	
			Tolerance, in. ^{A,G}		Tolerance, in. ^{A,G}			
Over 5 to 6, incl.	4 to 3	0.238 to 0.259	0.020	0.020	0.020	0.054		
Over 5 to 6, incl.	2 to 0.500	0.284 to 0.500	0.020	0.020	0.020	0.058		
Over 6 to 8, incl.	11 to 10	0.120 to 0.134	0.025	0.025	0.025	0.043		
Over 6 to 8, incl.	9 to 5	0.148 to 0.220	0.025	0.025	0.025	0.045		
Over 6 to 8, incl.	4 to 3	0.238 to 0.259	0.025	0.025	0.025	0.059		
Over 6 to 8, incl.	2 to 0.500	0.284 to 0.500	0.025	0.025	0.025	0.063		
Over 8 to 10, incl.	14 to 12	0.083 to 0.109	0.030	0.030	0.030	0.041		
Over 8 to 10, incl.	11 to 10	0.120 to 0.134	0.030	0.030	0.030	0.043		
Over 8 to 10, incl.	9 to 5	0.148 to 0.220	0.030	0.030	0.030	0.045		
Over 8 to 10, incl.	4 to 3	0.238 to 0.259	0.030	0.030	0.030	0.059		
Over 8 to 10, incl.	2 to 0.500	0.248 to 0.500	0.030	0.030	0.030	0.063		
Over 10 to 12, incl.	14 to 12	0.083 to 0.109	0.035	0.035	0.035	0.041		
Over 10 to 12, incl.	11 to 10	0.120 to 0.134	0.035	0.035	0.035	0.043		
Over 10 to 12, incl.	9 to 5	0.148 to 0.220	0.035	0.035	0.035	0.045		
Over 10 to 12, incl.	4 to 3	0.238 to 0.259	0.035	0.035	0.035	0.059		
Over 10 to 12, incl.	2 to 0.500	0.284 to 0.500	0.035	0.035	0.035	0.063		

Note : Measurements for diameter are to be taken at least 2 in. ^A from the ends of the tubes.

- A. 1 in. = 25.4mm.
- B. Flash-In-Tubing is produced only to outside diameter tolerances and wall thickness tolerances and the inside diameter welding flash does not exceed the wall thickness or 3/32 in., whichever is less.
- C. Flash Controlled to 0.010 in. maximum tubing consists of tubing which is commonly produced only to outside diameter tolerances and wall thickness tolerances, in which the height of the remaining welding flash is controlled not to exceed 0.010 in.
- D. No Flash tubing is further processed for closer tolerances with mandrel-tubing produced to outside diameter and wall, inside diameter and wall, or outside diameter and inside diameter to tolerances with no dimensional indication of inside diameter flash. This condition is available in Types 5 and 6.
- E. Flash controlled to 0.005 in. maximum tubing is produced to outside diameters and wall thickness tolerance, inside diameter and wall thickness tolerances, or outside diameters and inside diameter tolerances, in which the height of the remaining flash is controlled not to exceed 0.005 in. Any remaining flash is considered to be part of the applicable inside diameter tolerances.
- F. Birmingham Wire Gage.
- G. The ovality shall be within the above tolerances except when the wall thickness is less than 3% of the outside diameter, and the ovality may be 50% greater than the outside tolerances but the mean outside diameter shall be within the specified tolerance.

TABLE 5. Diameter Tolerances for Types 2 (A.W.C.R.) Round Tubing

Outside Diameter Range in. ^A	Wall Thickness		Flash-in-Tubing ^B	Flash Controlled to 0.010 in. max Tubing ^C	Flash Controlled to 0.005 in. max Tubing	
	Bwg ^E	in. ^A	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Inside Diameter Plus and Minus
			Tolerance, in. ^F			
3/8 to 5/8, incl.	24 to 16	0.022 to 0.065	0.003	—	—	—
Over 5/8 to 1-1/8, incl.	24 to 19	0.022 to 0.042	0.0035	0.0035	0.0035	0.013
Over 5/8 to 1-1/8, incl.	18	0.049	0.0035	0.0035	0.0035	0.015
Over 5/8 to 1-1/8, incl.	16 to 14	0.065 to 0.083	0.0035	0.0035	0.0035	0.019
Over 3/4 to 1-1/8, incl.	13	0.095	0.0035	0.0035	0.0035	0.019
Over 7/8 to 1-1/8, incl.	12 to 11	0.109 to 0.120	0.0035	0.0035	0.0035	0.021
Over 1-1/8 to 2, incl.	22 to 18	0.028 to 0.049	0.005	0.005	0.005	0.015
Over 1-1/8 to 2, incl.	16 to 13	0.065 to 0.095	0.005	0.005	0.005	0.019
Over 1-1/8 to 2, incl.	12 to 10	0.109 to 0.134	0.005	0.005	0.005	0.022
Over 2 to 2-1/2, incl.	20 to 18	0.035 to 0.049	0.006	0.006	0.006	0.016
Over 2 to 2-1/2, incl.	16 to 13	0.065 to 0.095	0.006	0.006	0.006	0.020
Over 2 to 2-1/2, incl.	12 to 10	0.109 to 0.134	0.006	0.006	0.006	0.023
Over 2-1/2 to 3, incl.	20 to 18	0.035 to 0.049	0.008	0.008	0.008	0.018
Over 2-1/2 to 3, incl.	16 to 13	0.065 to 0.095	0.008	0.008	0.008	0.022
Over 2-1/2 to 3, incl.	12 to 10	0.109 to 0.134	0.008	0.008	0.008	0.025
Over 3 to 3-1/2, incl.	20 to 18	0.035 to 0.049	0.009	0.009	0.009	0.019
Over 3 to 3-1/2, incl.	16 to 13	0.065 to 0.095	0.009	0.009	0.009	0.023
Over 3 to 3-1/2, incl.	12 to 10	0.109 to 0.134	0.009	0.009	0.009	0.026
Over 3-1/2 to 4, incl.	20 to 18	0.035 to 0.049	0.010	0.010	0.010	0.020
Over 3-1/2 to 4, incl.	16 to 13	0.065 to 0.095	0.010	0.010	0.010	0.024
Over 3-1/2 to 4, incl.	12 to 10	0.109 to 0.134	0.010	0.010	0.010	0.027
Over 4 to 6, incl.	16 to 13	0.065 to 0.095	0.020	0.020	0.020	0.034
Over 4 to 6, incl.	12 to 10	0.109 to 0.134	0.020	0.020	0.020	0.037
Over 6 to 8, incl.	14 to 13	0.083 to 0.095	0.025	0.025	0.025	0.039
Over 6 to 8, incl.	12 to 10	0.109 to 0.134	0.025	0.025	0.025	0.042
Over 8 to 10, incl.	16 to 13	0.065 to 0.095	0.030	0.030	0.030	0.044
Over 8 to 10, incl.	12 to 10	0.109 to 0.134	0.030	0.030	0.030	0.049
Over 10 to 12, incl.	14 to 13	0.083 to 0.095	0.035	0.035	0.035	0.049
Over 10 to 12, incl.	12 to 10	0.109 to 0.134	0.035	0.035	0.035	0.054

Note : Measurements for diameter are to be taken at least 2 in. ^A from the ends of the tubes.

A. 1 in.=25.4mm.

B. Flash-In-Tubing is produced to outside diameter tolerances and wall thickness tolerances only, and the height of the inside welding flash does not exceed the wall thickness or 3/32 in., whichever is less.

C. Flash Controlled to 0.010 in. maximum tubing consists of tubing over 5/8 in. outside diameter which is commonly produced to outside diameter tolerances and wall thickness tolerances only, in which the height of the remaining inside welding flash is controlled not to exceed 0.010 in.

D. Flash Controlled to 0.005 in. maximum tubing is produced to outside diameter tolerances and wall thickness tolerances, inside diameter tolerances and wall thickness tolerances, or outside diameter tolerances and inside diameter tolerances, in which the height of the remaining inside welding flash is controlled not to exceed 0.005 in. Any remaining flash is considered to be part of the applicable inside diameter tolerances.

E. Birmingham Wire Gage.

F. The ovality shall be with the above tolerances except when the wall thickness is less than 3% of the outside diameter, and the ovality may be 50% greater than the outside tolerances but the mean outside diameter shall be within the specified tolerance.

TABLE 6. Diameter Tolerances for Types 3,4,5,
and 6 (S.D.H.R., S.D.C.R., M.D. and S.S.I.D.) Round Tubing

Outside Diameter Range in	Wall Percent of OD	Types 3, 4,(Sink Drawn) ^{A, B,} and 5, 6,(Mandrel Drawn) ^{B, C,} OD In.		Types 5 and 6(Mandrel Drawn) ^{B, C,} ID In.	
		Over	Under	Over	Under
Up to 0.499	all	0.004	0.000	—	—
0.500 to 1,699	all	0.005	0.000	0.000	0.005
1,700 to 2,099	all	0.006	0.000	0.000	0.006
2,100 to 2,499	all	0.007	0.000	0.000	0.007
2,500 to 2,899	all	0.008	0.000	0.000	0.008
2,900 to 3,299	all	0.009	0.000	0.000	0.009
3,300 to 3,699	all	0.010	0.000	0.000	0.010
3,700 to 4,099	all	0.011	0.000	0.000	0.011
4,100 to 4,499	all	0.012	0.000	0.000	0.012
4,500 to 4,899	all	0.013	0.000	0.000	0.013
4,900 to 5,299	all	0.014	0.000	0.000	0.014
5,300 to 5,549	all	0.015	0.000	0.000	0.015
5,550 to 5,999	Under 6	0.010	0.010	0.010	0.010
	6 and over	0.009	0.009	0.009	0.009
6,000 to 6,499	Under 6	0.013	0.013	0.013	0.013
	6 and over	0.010	0.010	0.010	0.010
6,500 to 6,999	Under 6	0.015	0.015	0.015	0.015
	6 and over	0.012	0.012	0.012	0.012
7,000 to 7,499	Under 6	0.018	0.018	0.018	0.018
	6 and over	0.013	0.013	0.013	0.013
7,500 to 7,999	Under 6	0.020	0.020	0.020	0.020
	6 and over	0.015	0.015	0.015	0.015
8,000 to 8,499	Under 6	0.023	0.023	0.023	0.023
	6 and over	0.016	0.016	0.016	0.016
8,500 to 8,999	Under 6	0.025	0.025	0.025	0.025
	6 and over	0.017	0.017	0.017	0.017
9,000 to 9,499	Under 6	0.028	0.028	0.028	0.028
	6 and over	0.019	0.019	0.019	0.019
9,500 to 9,999	Under 6	0.030	0.030	0.030	0.030
	6 and over	0.020	0.020	0.020	0.020
10,000 to 10,999	all	0.034	0.034	0.034	0.034
11,000 to 11,999	all	0.035	0.035	0.035	0.035
12,000 to 12,999	all	0.036	0.036	0.036	0.036
13,000 to 13,999	all	0.037	0.037	0.037	0.037
14,000 to 14,999	all	0.038	0.038	0.038	0.038

Note : Measurements for diameter are to be taken at least 2 in. from the ends of the tubes.

- A. Tubing, flash in or flash controlled which is further processed without mandrel to obtain tolerances closer than those shown in Tables 4 and 5.
- B. The ovality shall be within the above tolerances except when the wall thickness is less than 3% of the outside diameter, the additional ovality shall be as follows but the mean outside diameter shall be within the specified tolerance: See Table 3.
- C. Tubing produced to outside diameter and wall thickness, or inside diameter and wall thickness, or outside diameter and inside diameter, with mandrel to obtain tolerances closer than those shown in Tables 4 and 5 and no dimensional indication of inside diameter flash.

TABLE 7. Wall Thickness Tolerance for Type 1 (A.W.H.R) Round Tubing

Wall Thickness		Outside Diameter, in. ^A															
		$\frac{3}{4}$ to 1, incl.		Over 1 to 1- $\frac{15}{16}$, incl.		Over 1- $\frac{15}{16}$ to 3- $\frac{3}{4}$, incl.		Over 3- $\frac{3}{4}$ to 4- $\frac{1}{2}$, incl.		Over 4- $\frac{1}{2}$ to 6, incl.		Over 6 to 8, incl.		Over 8 to 10, incl.		Over 10 to 12, incl.	
in. ^A	Bwg ^B	Wall Thickness Tolerances, in., \pm															
		+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
0.065	16	0.005	0.009	0.004	0.010	0.003	0.011	0.002	0.012	0.002	0.012	0.002	0.012	-	-	-	-
0.072	15	0.005	0.009	0.004	0.010	0.003	0.011	0.002	0.012	0.002	0.012	0.002	0.012	0.003	0.013	-	-
0.083	14	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.095	13	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.109	12	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.120	11	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.134	10	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013	0.003	0.013
0.148	9	-	-	0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014
0.165	8	-	-	0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014
0.180	7	-	-	0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014	0.004	0.014
0.203	6	-	-	-	-	0.007	0.015	0.006	0.016	0.005	0.017	0.005	0.017	0.005	0.017	0.005	0.017
0.220	5	-	-	-	-	0.007	0.015	0.006	0.016	0.005	0.017	0.005	0.017	0.005	0.017	0.005	0.017
0.238	4	-	-	-	-	0.012	0.020	0.011	0.021	0.010	0.022	0.010	0.022	0.010	0.022	0.010	0.022
0.259	3	-	-	-	-	0.013	0.021	0.012	0.022	0.011	0.023	0.011	0.023	0.011	0.023	0.011	0.023
0.284	2	-	-	-	-	0.014	0.022	0.013	0.023	0.012	0.024	0.012	0.024	0.012	0.024	0.012	0.024
0.300	1	-	-	-	-	0.015	0.023	0.014	0.024	0.013	0.025	0.013	0.025	0.013	0.025	0.013	0.025
0.320		-	-	-	-	0.016	0.024	0.015	0.025	0.014	0.026	0.014	0.026	0.014	0.026	0.014	0.026
0.344		-	-	-	-	0.017	0.025	0.016	0.026	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027
0.360		-	-	-	-	0.017	0.025	0.016	0.026	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027
0.375		-	-	-	-	-	-	0.016	0.026	0.015	0.027	0.015	0.027	0.015	0.027	0.015	0.027
0.406		-	-	-	-	-	-	0.017	0.027	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028
0.438		-	-	-	-	-	-	0.017	0.027	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028
0.469		-	-	-	-	-	-	-	-	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028
0.500		-	-	-	-	-	-	-	-	0.016	0.028	0.016	0.028	0.016	0.028	0.016	0.028

Note : A. 1 in. = 25.4mm. B. Birmingham Wire Gage.

TABLE 8. Wall Thickness Tolerances for Type 2 (A.W.C.R.) Round Tubing

Wall Thickness		Outside Diameter, in. ^A															
		$\frac{3}{8}$ to $\frac{7}{8}$, incl.		Over $\frac{7}{8}$ to 1- $\frac{7}{8}$, incl.		Over 1- $\frac{7}{8}$ to 3- $\frac{3}{4}$, incl.		Over 3- $\frac{3}{4}$ to 5, incl.		Over 5 to 6, incl.		Over 6 to 8, incl.		Over 8 to 10, incl.		Over 10 to 12, incl.	
in. ^A	Bwg ^B	Wall Thickness Tolerances, in., ^A \pm															
		+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
0.022	24	0.001	0.005	0.001	0.005	-	-	-	-	-	-	-	-	-	-	-	-
0.028	22	0.001	0.005	0.001	0.005	-	-	-	-	-	-	-	-	-	-	-	-
0.035	20	0.002	0.005	0.001	0.005	0.001	0.005	-	-	-	-	-	-	-	-	-	-
0.042	19	0.002	0.006	0.001	0.006	0.001	0.006	-	-	-	-	-	-	-	-	-	-
0.049	18	0.003	0.006	0.002	0.006	0.002	0.006	-	-	-	-	-	-	-	-	-	-
0.065	16	0.005	0.007	0.004	0.007	0.004	0.007	0.004	0.007	0.004	0.007	-	-	0.004	0.008	-	-
0.083	14	0.006	0.007	0.005	0.007	0.004	0.007	0.004	0.007	0.004	0.008	0.004	0.008	0.004	0.008	0.004	0.008
0.095	13	0.006	0.007	0.005	0.007	0.004	0.007	0.004	0.007	0.004	0.008	0.004	0.008	0.004	0.008	0.004	0.008
0.109	12	-	-	0.006	0.008	0.005	0.008	0.005	0.008	0.005	0.009	0.005	0.009	0.005	0.009	0.005	0.009
0.120	11	-	-	0.007	0.008	0.006	0.008	0.005	0.008	0.005	0.009	0.005	0.009	0.005	0.009	0.005	0.009
0.134	10	-	-	0.007	0.008	0.006	0.008	0.005	0.008	0.005	0.009	0.005	0.009	0.005	0.009	0.005	0.009

Note : A. 1 in. = 25.4mm. B. Birmingham Wire Gage.

TABLE 9. Wall Thickness Tolerance of Type 5 and 6 (M.D. and S.S.I.D.) Round Tubing.

Outside Diameter, in. ^A									
Wall Thickness		$\frac{3}{8}$ to $\frac{7}{8}$, incl.		Over $\frac{7}{8}$ to $1-\frac{7}{8}$, incl.		Over $1-\frac{7}{8}$ to $3-\frac{3}{4}$, incl.		Over $3-\frac{3}{4}$ to 15, incl.	
in. ^A	Bwg ^E	Wall Thickness Tolerances, in., ^{A,C} ±							
		+	-	+	-	+	-	+	-
0.035	20	0.002	0.002	0.002	0.002	0.002	0.002	-	-
0.049	18	0.002	0.002	0.002	0.003	0.002	0.003	-	-
0.065	16	0.002	0.002	0.002	0.003	0.002	0.003	0.004	0.004
0.083	14	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.005
0.095	13	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.005
0.109	12	0.002	0.003	0.002	0.004	0.003	0.003	0.005	0.005
0.120	11	0.003	0.003	0.002	0.004	0.003	0.003	0.005	0.005
0.134	10	-	-	0.002	0.004	0.003	0.003	0.005	0.005
0.148	9	-	-	0.002	0.004	0.003	0.003	0.005	0.005
0.165	8	-	-	0.003	0.004	0.003	0.004	0.005	0.006
0.180	7	-	-	0.004	0.004	0.003	0.005	0.006	0.006
0.203	6	-	-	0.004	0.005	0.004	0.005	0.006	0.007
0.220	5	-	-	0.004	0.006	0.004	0.006	0.007	0.007
0.238	4	-	-	0.005	0.006	0.005	0.006	0.007	0.007
0.259	3	-	-	0.005	0.006	0.005	0.006	0.007	0.007
0.284	2	-	-	0.005	0.006	0.005	0.006	0.007	0.007
0.300	1	-	-	0.006	0.006	0.006	0.006	0.008	0.008
0.320		-	-	0.007	0.007	0.007	0.007	0.008	0.008
0.344		-	-	0.008	0.008	0.008	0.008	0.009	0.009
0.375		-	-	-	-	0.009	0.009	0.009	0.009
0.400		-	-	-	-	0.010	0.010	0.010	0.010
0.438		-	-	-	-	0.011	0.011	0.011	0.011
0.460		-	-	-	-	0.012	0.012	0.012	0.012
0.480		-	-	-	-	0.012	0.012	0.012	0.012
0.531		-	-	-	-	0.013	0.013	0.013	0.013
0.563		-	-	-	-	0.013	0.013	0.013	0.013
0.580		-	-	-	-	0.014	0.014	0.014	0.014
0.600		-	-	-	-	0.015	0.015	0.015	0.015
0.625		-	-	-	-	0.016	0.016	0.016	0.016
0.650		-	-	-	-	0.017	0.017	0.017	0.017

Note : A. 1 in. = 25.4mm. B. Birmingham Wire Gage. C. Where the ellipsis (-) appears in this table, the tolerance is not addressed.

TABLE 10. Cut-Length Tolerances for Lathe-Cut Round Tubing

Outside Diameter Size, in. ^A	6in. and under 12in.	12in. and under 48in.	48in. and under 10ft.	10ft. to 24ft. incl. ^B
3/8 to 3, incl.	± 1/64 in.	± 1/32 in.	± 3/64 in.	± 1/8 in.
Over 3 to 6, incl.	± 1/32 in.	± 3/64 in.	± 1/16 in.	± 1/8 in.
Over 6 to 9, incl.	± 1/16 in.	± 1/16 in.	± 1/8 in.	± 1/8 in.
Over 9 to 12, incl.	± 3/32 in.	± 3/32 in.	± 1/8 in.	± 1/8 in.

Note : A. 1 in. = 25.4mm.

B. For each additional 10 ft or fraction thereof over 24 ft, an additional allowance should be made of plus or minus 1/16in.

TABLE 11. Tolerance (Inch) for Squareness of Cut (Either End) When Specified for Round Tubing A.B

Length of Tube, ft. ^C	Outside Diameter, in. ^B				
	Under 1	1 to 2, incl.	Over 2 to 3, incl.	Over 3 to 4, incl.	Over 4
Under 1	0.006	0.008	0.010	0.015	0.020
1 to 3, incl.	0.008	0.010	0.015	0.020	0.030
Over 3 to 6, incl.	0.010	0.015	0.020	0.025	0.040
Over 6 to 9, incl.	0.015	0.020	0.025	0.030	0.040

Note : A. Actual squareness normal to length of tube, not parallelness of both ends.

B. Values given are "go" value of feeler gage. "no go" value is 0.001 in. greater in each case.

C. 1 ft = 0.3m.

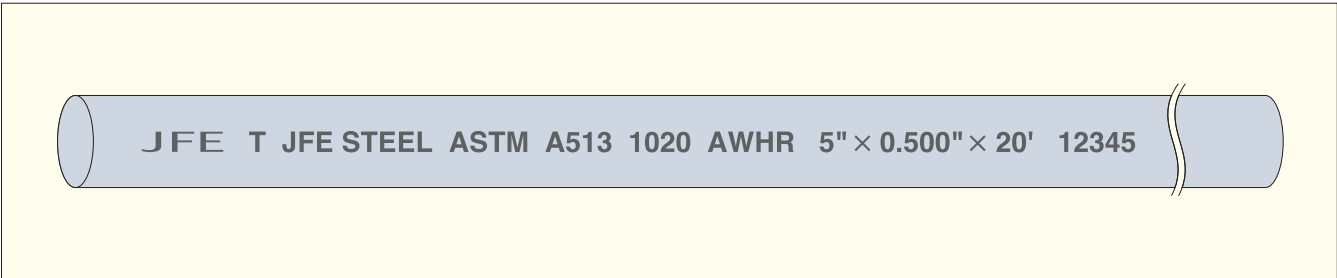
D. 1 in. = 25.4mm.

Marking, Oiling and Packaging

The standard marking, oiling and Packaging methods are shown below.

(1) Marking for Identification

Each tube passed all testing and inspections specified in this proposal shall be marked by stencilling with following items ; Manufacturer's name, Specification No, Steel designation, Size etc.



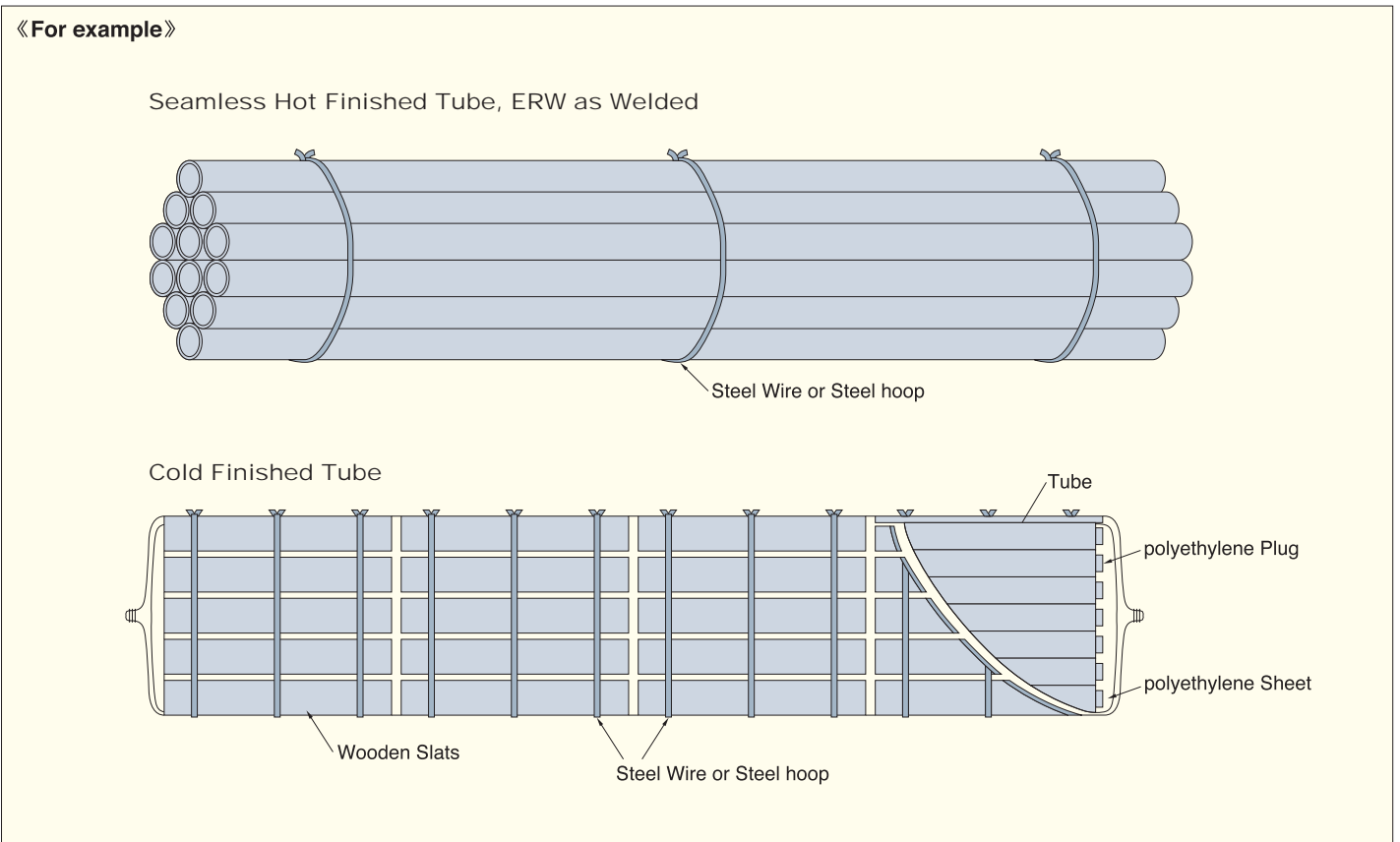
(2) Oiling for rust prevention

Each tube shall be coated on with rust preventive oil.

(Seamless Hot Finished Tube ERW as welded Cold Finished Tube)	Outside : Driing Oil
	Inside : None

(3) Packaging

Packaging shall be as shown below



Information Required With Enquiries and Orders

Please specify the following when placing orders with JFE Steel :

(1) Specification No.

(2) Grade Designation

(3) Manufacturing Method

- 1) Seamless or electric-resistance welding (ERW)
- 2) Hot or cold finishing

(4) Size

- 1) Outside diameter, wall thickness, length and their respective tolerance ;
in addition, processing method in your companies or works

(5) Ordered Quantity

In feet, meters or the number of pipes

(6) Pipe-end Finish

Plain or beveled end

(7) Anticorrosion Method

Whether they are required or not and, if required, their kinds.

(8) Inspection Certificate

Language : English or French, etc. ; Unit : Metric, inch-pound or SI system

(9) Marking or Product

Including color-coded indication of material

(10) Type of Packing and Packed Size

(11) Other Special Requirements

Heat treatment conditions, elevated temperature tensile test, hydrostatic test
or non-destructive inspection

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