The People's Republic of China

EDICT OF GOVERNMENT

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GB 3087 (2008) (English): Seamless steel tubes for low and medium pressure boiler

ISO INSIDE

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National Standard of the People's Republic of China

GB 3087 — ××××
Replaces GB 3087-1999

Seamless steel tubes for low and medium pressure boiler

(ISO 9329-1: 1989, NEQ)

(Draft submitted for Approval)

Issue Date: ××××-××-×× Implementation Date: ××××-××-××

Issued by the General Administration of Quality Supervision, Inspection and Quarantine, The People's Republic of China (AQSIQ) and the Standardisation Administration of the People's Republic of China (SAC)

Contents

Introduction

This Standard corresponds to ISO 9329-1: 1989, "Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Unalloyed steels with specified room temperature properties" (English version). The consistency of this Standard with ISO 9329-1: 1989 is non-equivalent.

As of the implementation date of this Standard, GB 3087-1999, "Seamless steel tubes for low and medium pressure" shall be abolished. Compared with GB 3087-1999, the major changes to this Standard are as follows:

— the application scope of steel tubes has been revised;

— ordering contents have been increased;

— the permissible deviation of dimensions has been revised;

— the requirements for full-length curvature have been increased;

—the requirements for terminal head bevelling have been increased;

— examples for markings have been deleted;

—the smelting methods of steel have been revised;

—the requirements for delivery conditions of steel tubes have been revised;

—the requirements for concrete manufacturing methods of hot expansion steel tubes have been increased;

—the requirements for mechanical performance of steel tubes have been revised;

—the judgment rules for the positions of point 6 (bottom) and point 12 (top) of test sample in the flattening test of steel tubes have been increased;

—the requirements for the edge curling test have been deleted;

—flaw detection has been revised to replace the inspection requirements of the hydraulic test.

The agreed clauses and recommended data of this Standard are non-mandatory clauses, whilst the rest of the clauses are mandatory.

This Standard was proposed by China Iron and Steel Association.

This Standard is under the jurisdiction of the National Steel Standardisation Technical Committee.

The units that participated in drafting this Standard are: Angang Steel Co., Ltd., and Pangang Group Chengdu Iron and Steel Co., Ltd.

The main drafters of this Standard are: Peng Zhang, Huixuan Zhang, Zhimin Pu, and Qi Li.

This Standard replaces the following previously issued versions of the Standard:

GB3087-1982 and GB3087-1999.

Seamless steel tubes for low and medium pressure boiler

1 Scope

This Standard specifies the ordering contents, dimensions, shapes, weights, technical requirements, test methods, inspection rules, and requirements for packaging, marking and quality certifications of seamless steel tubes for low and medium pressure boilers.

This Standard is applicable to the manufacturing of seamless steel tubes of quality carbon structural steels for different types of low and medium pressure boilers.

2 Normative references

The provisions of the following documents become provisions of this Standard after being referenced. For dated reference documents, all later amendments (excluding corrigenda) and revised versions do not apply to this Standard. However, the parties to the agreement are encouraged to study whether the latest version of these documents applies. For undated reference documents, the latest versions apply.

GB/T 222 Permissible tolerances for the chemical composition of steel products

GB/T 223.3 Methods for chemical analysis of iron, steel and alloy - The diantipyryl methane phosphomolybdate gravimetric method for the determination of phosphorus content

GB/T 223.5 Methods for chemical analysis of iron, steel and alloy - The reduced molybdosilicate spectrophotometric method for the determination of acid-soluble silicon content

GB/T 223.10 Methods for chemical analysis of iron, steel and alloy - The cupferron separation-chrome azurol S. photometric method for the determination of aluminium content

GB/T 223.12 Methods for chemical analysis of iron, steel and alloy - The sodium carbonate separation-diphenyl carbazide photometric method for the determination of chromium content

GB/T 223.18 Methods for chemical analysis of iron, steel and alloy - The sodium thiosulfate separation iodimetric method for the determination of copper content

GB/T 223.19 Methods for chemical analysis of iron, steel and alloy - The neocuproine-chloroform extraction photometric method for the determination of copper content

GB/T 223.23 Methods for chemical analysis of iron, steel and alloy - The

dimethylglyoxime spectrophotometric method for the determination of nickel content

GB/T 223.24 Methods for chemical analysis of iron, steel and alloy - The extraction separation - The dimethylglyoxime spectrophotometric method for the determination of nickel content

GB/T 223.37 Methods for chemical analysis of iron, steel and alloy - The indophenol blue photometric method for the determination of nitrogen content after distillation separation

GB/T 223.54 Methods for chemical analysis of iron, steel and alloy - The flame atomic absorption spectrophotometric method for the determination of nickel content

GB/T 223.58 Methods for chemical analysis of iron, steel and alloy - The sodium arsenite-sodium nitrite titrimetric method for the determination of manganese content

GB/T 223.59 Methods for chemical analysis of steel, steel and alloy - The reduced molybdoantimonyl phosphoric acid photometric method for the determination of phosphorus content

GB/T 223.60 Methods for chemical analysis of iron, steel and alloy - The perchloric acid dehydration gravimetric method for the determination of silicon content

GB/T 223.61 Methods for chemical analysis of iron, steel and alloy - The ammonium phosphomolybdate volumetric method for the determination of phosphorus content

GB/T 223.62 Methods for chemical analysis of iron, steel and alloy - The butyl acetate extraction photometric method for the determination of phosphorus content

GB/T 223.63 Methods for chemical analysis of iron, steel and alloy - The sodium (potassium) periodate photometric method for the determination of manganese content

GB/T 223.64 Methods for chemical analysis of iron, steel and alloy - The flame atomic absorption spectrometric method for the determination of manganese content

GB/T 223.68 Methods for chemical analysis of iron, steel and alloy - The potassium iodate titration method after combustion in the pipe furnace for the determination of sulphur content

GB/T 223.69 Methods for chemical analysis of iron, steel and alloy - The gas-volumetric method after combustion in the pipe furnace for the determination of carbon content

GB/T 223.71 Methods for chemical analysis of iron, steel and alloy - The gravimetric method after combustion in the pipe furnace for the determination of carbon content

GB/T 223.72 Methods for chemical analysis of iron, steel and alloy - The

alumina chromatographic separation - Barium sulphate gravimetric method for the determination of sulphur content

GB/T 223.74 Methods for chemical analysis of iron, steel and alloy - The combustion gravimetric/gas-volumetric method for the determination of combined carbon content

GB/T 226 Etch test for macrostructure and defect of steels

GB/T 228 Metallic materials - Tensile testing at ambient temperature (GB/T 228-2002, eqv. ISO 6892: 1998)

GB/T 241 Metal tubes - Hydrostatic pressure testing

GB/T 242 Metal tubes - Drift expanding test (GB/T 242-2007, ISO 8493: 1998: IDT)

GB/T 244 Metallic materials - Tubes - Bend test GB/T 244-1997, eqv. ISO 8491: 1986)

GB/T 246 Metallic materials - Tubes - Flattening test (GB/T 246-2007, ISO 8492: 1998, IDT)

GB/T 699 Quality carbon structure steels

GB/T 1979 Diagram of a Low Magnification Texture Blemish Grading of Structural Steel

GB/T 2102 Acceptance, packing, marking and quality certification of steel pipe

GB/T 2975 Steel and steel products - Location and preparation of test pieces for mechanical testing (GB/T 2975-1998, eqv. ISO 377: 1997)

GB/T 4336 Standard test method for spark discharge atomic emission spectrometric analysis of carbon and low-Alloy steel (Routine method)

GB/T 4338 Metallic materials - Tensile testing at elevated temperature (GB/T 4338-2006, ISO 783: 1999, MOD)

GB/T 5777-1996 Seamless steel tubes - Methods for ultrasonic testing (eqv. ISO 9303: 1989)

GB/T 7735 Steel tubes - The inspection method on eddy current test (GB/T 7735-2004, ISO 9304: 1989, MOD)

GB/T 12606 Steel tubes - The testing method of magnetic flux leakage (GB/T 12606, eqv. ISO 9402: 1989, ISO 9598: 1989)

GB/T 17395 Dimensions, shapes, masses and tolerances of seamless steel tubes (GB/T 17395-XXXX, neq. ISO 1127: 1992, ISO 4200: 1991, ISO 5252: 1991)

GB/T 20066 Steel and iron - Sampling and preparation of samples for the determination of chemical composition (GB/T 20066-2006, ISO 14284: 1996, IDT)

GB/T 20123 Steel and iron - Determination of total carbon and sulphur content - Infrared absorption method after combustion in an induction furnace (Routine

method) (GB/T 20123-2006, ISO 15350: 2000, IDT)

GB/T 20124 Steel and iron - Determination of nitrogen content - Thermal conductimetric method after fusion in a current of inert gas (Routine method) (GB/T 20124-2006, ISO 15351: 1999, IDT)

3 Ordering contents

The agreements or orders for steel tubes purchased in accordance with this Standard should include but not be limited to the following contents:

a) Standard numbers;

b) Product name;

c) Steel numbers;

d) Ordering quantity (total weight or total length);

e) Delivery condition;

f) Dimensions and specifications;

g) Special requirements.

4 Dimensions, shapes and weights

4.1. Outer diameter and wall thickness

4.1.1 The outer diameter (D) and wall thickness (S) of steel tubes should meet the requirements set out in GB/T 17395.

4.1.2 According to the demanding party's request, which is then negotiated between the supplying and demanding parties, the other outer diameters and wall thickness of other steel tubes can be provided.

4.2 Permissible deviation of outer diameter and wall thickness

4.2.1 The permissible deviation of the outer diameter of steel tubes should meet the requirements set out in Table 1.

Table 1 Permissible deviation of outer diameter of steel tubes **Unit: mm**

Type of steel tube	Permissible deviation
Hot rolled (extruded, expanded) steel tube	± 1.0% *D* or ± 0.50, take the greater number
Cold drawn (rolled) steel tube	± 1.0% *D* or ± 0.30, take the greater number

4.2.2 The permissible deviation of the wall thickness of hot rolled (extrusion, expansion) steel tubes should meet the requirements set out in Table 2.

4.2.3 The permissible deviation of the wall thickness of cold drawn (rolled) steel tubes should meet the requirements set forth in Table 3.

4.2.4 According to the demanding party’s request, which is then negotiated between the supplying and demanding parties and indicated in the agreement, steel tubes beyond the permissible deviation of dimensions shown in Table 1, Table 2 and Table 3

may be produced.

Table 2 Permissible deviation of the wall thickness of hot rolled (extrusion, expansion) steel tubes **Unit: mm**

Type of steel tube	Outer diameter of steel tube	*S* / *D*	Permissible deviation
Hot rolled (extruded) steel tube	≤ 102	–	± 12.5 % *S* or ± 0.40, take the greater number
	> 102	≤ 0.05	± 15% *S* or ± 0.40, take the greater number
		> 0.05 ~ 0.10	± 12.5% *S* or ± 0.40, take the greater number
		> 0.10	+ 12.5% *S* - 10% *S*
Hot expanded steel tube	+ 15% *S*		

Table 3 Permissible deviation of the wall thickness of cold drawn (rolled) steel tubes **Unit: mm**

Type of steel tube	Wall thickness	Permissible deviation
Cold drawn (rolled) steel tube	≤ 3	$^{+15}_{-10}$ % *S* or ± 0.15, take the greater number
	> 3	+ 12.5% *S* - 10% *S*

4.3 Length

4.3.1 General length

The general length of steel tubes is 4000 mm ~ 12500 mm. After negotiation between the supplying and demanding parties, and as indicated in the agreement, steel tubes with a length greater than 12500 mm may be delivered.

4.3.2 Cut length and multiple length

According to the demanding party's request, and as indicated in the agreement, steel tubes can be delivered according to the cut length or multiple length. The cut length of steel tube should be within the range of the general length. The permissible deviation of the full length should meet the following requirements:

a) Cut length ≤ 6000 mm, 0~10 mm;

b) Cut length > 6000 mm, 0~ 15mm.

The total multiple lengths of steel tubes should be within the range of the general length. The permissible deviation of full length is:

$^{+20}_{0}$ mm.

Each multiple length should leave a cut margin according to the following requirements:

a) When outer diameter is ≤ 159 mm, cut margin is 5 mm ~ 10 mm;

b) When outer diameter is > 159 mm, cut margin is 10 mm ~ 15 mm

4.4 Curvature

4.4.1 The curvature for each metre of steel tube should meet the requirements set out in Table 4.

Table 4 Curvature for each metre of steel tube

Nominal wall thickness, mm	Curvature per metre, mm/m
≤ 15	≤ 1.5
> 15 ~ 30	≤ 2.0
> 30 or outer diameter ≥ 351	≤ 3.0

4.4.2 The full-length curvature of the steel tube should not be greater than 1.5% of the total length of the steel tube, and its full-length bending should not be greater than 12 mm.

4.5 Non-circularity and wall thickness unevenness

According to the demanding party's request, which is then negotiated between the supplying and demanding parties and indicated in the agreement, the non-circularity and wall thickness unevenness of steel tubes should not exceed 80% of the tolerances for outer diameter and wall thickness respectively.

4.6 Shape of terminal head

The terminal surfaces at the two ends of a steel tube should cut straight with the axis of the steel tube. The burrs at the cuts should be cleared. The terminal parts of the steel tube should be bevelled (see Figure 1), and should meet the following requirements:

a) When the outer diameter of steel tube is not greater than 60 mm, the bevelling should not exceed 1.5mm;

b) When the outer diameter of steel tube is greater than 60 mm, the bevelling should not exceed 2.5% of the outer diameter of steel tube, but the maximum bevelling should not exceed 6 mm.

Bevelling

Figure 1 Bevelling

4.7 Delivery weight

4.7.1 Steel tubes are delivered according to their actual weight. They can also be

delivered according to theoretical weight. The theoretical weight of the steel tube should be calculated in accordance with the requirements of GB/T 17395. The density of steel is taken as 7.85 kg/dm^3.

4.7.2 According to the demanding party's request, which is then negotiated between the supplying and demanding parties and indicated in the agreement, the deviation between the theoretical weight and actual weight of the steel tube to be delivered should meet the following requirements:

a) Single steel tubes: ± 10%;

b) Steel tubes with each batch at minimum of 10 tonnes: ± 7.5%.

5 Technical requirements

5.1 Number and chemical composition of steel

5.1.1 Steel tubes are made with steel No 10 and No 20.

5.1.2 The chemical composition (smelting analysis) of steel tubes should meet the requirements set out in GB/T 699.

5.1.3 If the demanding party requests an analysis of the finished product, this request should be indicated in the agreement. The permissible deviation for the chemical composition of finished steel tube products should meet the requirements set out in GB/T 222.

5.2 Methods for making tubes

5.2.1 Smelting method of steel

Steel making should adopt electric furnace and out-of-furnace smelting, or oxygen converter and out-of-furnace smelting. After negotiation between the supplying and demanding parties, a smelting method with other higher requirements may also be adopted. If the demanding party designates a certain smelting method, this should be indicated in the agreement.

5.2.2 Method for making tube billets

Tube billets are made by adopting the continuous casting or hot rolling (forging) method. Steel ingots can also be directly used for making tube billets.

5.2.3 Making method of steel tubes

Steel tubes should be made by using the hot rolled (extrusion, expansion) or cold drawn (rolled) seamless method. If the demanding party designates a certain method for making the tubes, this should be indicated in the agreement. Steel tubes made by hot expansion refer to steel tubes of larger diameter formed by expansion and deformation after billet steel tubes are overall heated.

5.3 Delivery condition

5.3.1 When hot rolled (extrusion, expansion) steel tubes are delivered under hot rolling or normalising condition, the finishing rolling temperature of the delivered

steel tubes under hot rolling conditions should not be lower than the phase-transition critical temperature A_{r3}.

According to the demanding party's request, which is then negotiated between the supplying and demanding parties and indicated in the agreement, hot rolled (extrusion, expansion) steel tubes can be delivered under normalising conditions. When the finishing rolling temperature of hot expansion steel tubes is not lower than the phase-transition critical temperature A_{r3}, and after the steel tubes have undergone air-cooling, the steel tubes are thought to have gone through normalising.

5.3.2 Cold drawn (rolled) steel tubes should be delivered under normalising conditions.

5.4 Mechanical performance

5.4.1 The longitudinal mechanical performance of steel tubes under delivery conditions should meet the requirements set out in Table 5.

Table 5 Mechanics performance of steel tubes

Serial No	Steel No	Tensile strength R_m MPa	Lower yield strength R_{eL}, MPa		Elongation percentage after breaking A %
			Wall thickness, mm		
			≤ 16	> 16	
			No less than		No less than
1	10	335~475	205	195	24
2	20	410~550	245	235	20

5.4.2 When the demanding party indicates in the agreement that the steel tube is to be used as the overheat steam tube of a medium-pressure boiler, the supply party should guarantee that the specified non-proportional elongation strength ($R_{p0.2}$) of the steel tube under high temperatures meets the requirements set out in Table 6. The supplying party is not permitted to carry out an inspection of this.

According to the demanding party's request, which is then negotiated between the supplying and demanding parties and meets the test temperature indicated in the agreement, steel tubes can undergo the high-temperature tensile test. The high temperature specified non-proportional elongation strength ($R_{p0.2}$) under the corresponding temperature should meet the requirements set out in Table 6.

Table 6 Minimum value of specified non-proportional elongation strength of steel tube under high temperature

Steel No	Test condition	Minimum value of specified non-proportional elongation strength $R_{p0.2}$, MPa					
		Test temperature, °C					
		200	250	300	350	400	450
10	Supply	165	145	122	111	109	107

20	condition	188	170	149	137	134	132

5.5 Technical performance

5.5.1 Flattening test

Steel tubes with an outer diameter greater than 22 mm and up to 400 mm, and wall thickness greater than 10 mm should undergo the flattening test. After the samples are flattened, the distance H between two plates should be calculated according to formula (1):

$$H = \frac{(1+\alpha)S}{\alpha + S/D} \quad \text{..... (1)}$$

In the formula:

H — distance between plates, in mm;

S — nominal wall thickness of steel tube, in mm;

D — nominal outer diameter of steel tube, in mm;

α — deformation coefficient of unit length, taking $\alpha = 0.08$; when $S/D \geq 0.1$, taking $\alpha = 0.07$.

After flattening, no fissures or cracks are permitted to appear on the sample.

The following circumstance should be referential for judging whether the flattening test is passed or not:

When $S/D > 0.1$, the point 6 (bottom) and point 12 (top) positions of sample are situated at the cracks on the inner surface.

5.5.2 Drift expansion test

According to the demanding party's request, which is then negotiated between the supplying and demanding parties and indicated in the agreement, steel tubes with wall thickness no greater than 8 mm can undergo the drift expansion test. The drift expansion test is performed for one of the tip tapers being 30^o, 45^o or 60^o. The drift expansion rate of the outer diameter of the sample after drift expansion should meet the requirements set out in Table 7. After drift expansion, no fissures or cracks are permitted to appear on the sample.

Table 7 Drift expansion rate of outer diameter of sample

Steel No	Expansion value of outer diameter of steel tube, %		
	Inner diameter / Outer diameter		
	≤ 0.6	> 0.6 ~ 0.8	> 0.8
10	12	15	19
20	10	12	17

5.5.3 Bending test

Steel tubes with an outer diameter not greater than 22 mm should undergo the bending test. The bending angle is 90^{o}. The bending radius is 6 times the outer diameter of the steel tube. After bending the sample, no fissures or cracks are permitted to appear on the sample.

$$P = 2SR / D \quad \text{..... (2)}$$

In the formula:

P — test pressure, in MPa;

S — nominal wall thickness of steel tube, in mm;

D — nominal outer diameter of steel tube, in mm;

R — permissible stress, being 60% of lower yield strength specified in Table 5, in MPa.

The supplying party can use eddy current flaw detection, magnetic leakage flaw detection or ultrasonic flaw detection instead of the hydraulic test. If the demanding party requests an ultrasonic inspection, the supplying party should replace the hydraulic test with an ultrasonic inspection. During the eddy current flaw detection test, the manual defect of the reference sample tube should meet the requirements set out in post-inspection acceptance grade A specified in GB/T 7735. During the magnetic leakage flaw detection test, the longitudinal manual defect on the outer surface of the reference sample tube should meet the requirements for post-inspection acceptance grade L4 specified in GB/T 12606. During ultrasonic flaw detection, the longitudinal manual defect on the outer surface of reference sample tube should meet the requirements for post-inspection acceptance grade C12 specified in GB/T 5777-1996.

5.7 Macroscopic examination

For steel tubes directly made by continuously cast billets or steel ingots, the supplying party should guarantee that there are no white spots, impurities, sub-surface air bubbles, skull patches or layering on the cross-sectional acid pickled macroscopic tissue of the billet or steel tube.

5.8 Surface quality

No fissures, folding, scabs, rolling creases or separation layers should be visible on the inner and outer surfaces of the steel tube. Such defects should be completely eradicated. The removal depth should not exceed 10% of nominal wall thickness. The actual wall thickness at the clearing place should not be smaller than the minimum value of permissible deviation of wall thickness.

The permissible depth of straight tubes should meet the following requirements:

a) Cold drawn (rolled) steel tube: No greater than 4% of wall thickness, and the maximum depth is 0.3 mm;

b) Hot rolled (extrusion, expansion) steel tube: No greater than 5% of wall

thickness, and the maximum depth is 0.5 mm.

Other partial defects are permitted, provided they do not exceed the negative deviation of wall thickness.

5.9 Non-destructive inspection

According to the demanding party's request, which is then negotiated between the supplying and demanding parties and indicated in the agreement, ultrasonic flaw detection may be individually performed for steel tubes. The longitudinal manual defect of the reference sample tube should meet the requirements for post-inspection acceptance grade C8 specified in GB/T 5777-1996.

6 Test methods

6.1 The dimensions and shapes of steel tubes should adopt the measuring method that meets the accuracy requirements for carrying out the measurement.

6.2 The inner and outer surfaces of the steel tube should undergo individual visual inspection in a well-lit environment.

6.3 Other inspections of steel tubes should meet the requirements set out in Table 8.

Table 8 Inspection items, number of samples, sampling methods and test methods of steel tubes

Serial No	Inspection item	Number of samples	Sampling method	Test method
1	Chemical composition	Take one sample respectively from each furnace	GB/T 20066	GB/T 223 GB/T 4336
2	Tensile test	Take one sample respectively from two steel tubes out of each batch	GB/T 2975	GB/T 228
3	High-temperature tensile test	Take one sample respectively from two steel tubes out of each batch	GB/T 2975	GB/T 4338
4	Flattening test	Take one sample respectively from two steel tubes out of each batch	GB/T 2975	GB/T 246
5	Drift expansion test	Take one sample respectively from two steel tubes out of each batch	GB/T 2975	GB/T 242
6	Bending test	Take one sample respectively from two steel tubes out of each batch	GB/T 2975	GB/T 244
7	Hydraulic test	Tube by tube	—	GB/T 241
8	Eddy current flaw detection	Tube by tube	—	GB/T 7735
9	Magnetic leakage flaw detection	Tube by tube	—	GB/T 12606

10	Ultrasonic flaw detection	Tube by tube	—	GB/T 5777
11	Macroscopic examination	Take one sample respectively from two steel tubes out of each batch	GB/T226	GB/T 226 GB/T 1979

7 Inspection rules

7.1 Inspection and acceptance

The quality technical supervisory department of the supplying party performs the inspection and acceptance of steel tubes.

7.2 Batching rules

7.2.1 The inspection and acceptance of steel tubes is performed batch by batch.

7.2.2 If the steel tubes have been cut to single tubes and do not carry out heat treatment, every tube section cut from the steel tube rolled from a tube billet can be regarded as a tube.

7.2.3 Each batch should be composed of steel tubes of the same steel number, the same furnace number, the same specifications and the same heat treatment system (heat). The quantity of steel tubes in each batch should not exceed the following requirements:

a) Those with outer diameter not greater than 76 mm and wall thickness not greater than 3 mm: 400 steel tubes;

b) Those with outer diameter greater than 351 mm: 50 steel tubes;

c) Those with other dimensions: 200 steel tubes.

With regard to the quantity of other steel tubes, if it is not less than 50% of the above specified quantity, the steel tubes are independently regarded as a batch; however, if it is less than 50% of the above specified quantity, the steel tubes can be included in a similar batch with the same steel number, the same furnace number, the same specifications and the same heat treatment system (heat).

7.3 Number of samples

The number of samples to be taken from each batch to undergo performance inspection should meet the requirements set out in Table 8.

7.4 Re-inspection and judgment rules

The re-inspection and judgment rules of steel tubes should meet the requirements of GB/T 2102.

8 Packaging, markings and quality certifications

The packaging, markings and quality certifications of steel tubes should meet the requirements of GB/T 2102.