

90/10 Copper nickel alloy piping for offshore applications Specification **(Incorporating EEMUA 144, 145 and 146)**

Publication 234

Edition 1

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Preface

The following EEMUA Publication 234 incorporates in this Specification the previous Edition of EEMUA 144/145/146: 90/10 copper nickel tubes, flanges and fittings. Details are as follows, with the Chapters relating to the previous Edition included in brackets:

Publication No. 144 Tubes:
Seamless and welded (Chapters 1 and 2)
Publication No. 145 Flanges:
Composite and solid (Chapters 3 to 6)
Publication No. 146 Fittings (Chapters 7 to 13)

Tubes

The specified outside diameters of tubes, in sizes up to and including 450 mm, covered by this Specification have been selected from BS EN 12449:2012 "Copper and copper alloys – Seamless Round Tubes for General Purposes": Table 16⁽¹⁾.

The specified outside diameters of the remaining sizes covered by this Specification have been selected from BS MA 60 "Summary and application of copper and copper alloy tubes for ships' pipework systems [now withdrawn]"⁽²⁾. The wall thicknesses have been selected to cover the specific requirements of the petroleum industries.

This Specification specifies the requirements for seamless and seam-welded tubes for offshore and associated piping installations based on ASME B31.3-2014⁽³⁾.

The titles of other Publications referred to in this Publication are listed in the References.

Note: The reference to "tube" rather than "pipe" in this Specification is based on the usage of this word in existing copper and copper alloy standards.

Flanges

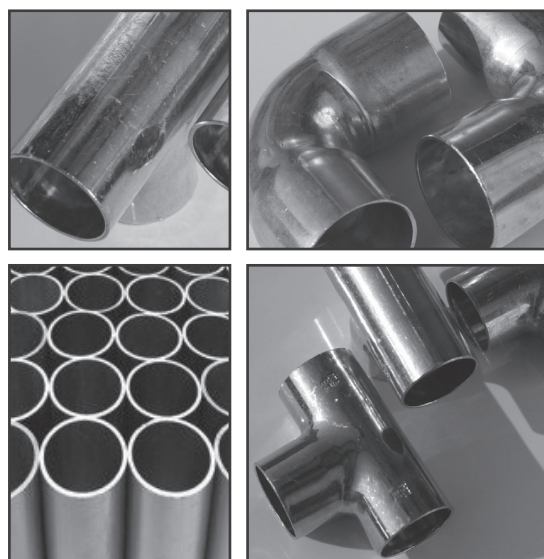
This part of the Specification is for a series of composite (lap type) and solid flanges in metric dimensions based on ASME B16.5-2013⁽⁴⁾, MSS SP-44-2006⁽⁵⁾ and BS EN 1759-1:2004⁽⁶⁾.

The basic metric dimensions for drilling and flange outside diameters are those given in ASME B16.5-2013, BS EN 1759-1:2004 and MSS SP-44-2006 for Class 150 rating with inch size bolting.

The flanges covered in this Specification are suitable for maximum design pressures of 16 bar at 75°C and 20 bar at 38°C.

For sizes of a particular type of flange not covered within this Specification the Purchaser should satisfy himself that the flange is suitable for the service intended.

The diameters of hubs have been chosen to permit the use of ring spanners. A list of other standards and codes referred to in this Publication is given in the References.



Fittings

Material selected from the series of Specifications contained in EEMUA Publication 234 provide for the total requirements of 90/10 copper nickel piping systems intended to operate at pressures up to 16 bar at 75°C or 20 bar at 38°C.

This part of the Publication comprises seven Chapters for pipe fittings suitable for use with 90/10 Cu Ni tube. The Chapters are as follows:

Chapter seven

90/10 Cu Ni butt welding fittings.

Chapter eight

90/10 Cu Ni socket welding fittings (including unions).

Chapter nine

Copper alloy capillary brazing fittings (including unions).

Chapter ten

Copper alloy flareless, non-manipulative type compression fittings.

Chapter eleven

Copper alloy threaded fittings.

Chapter twelve

90/10 Cu Ni reinforced branch connectors.

Chapter thirteen

90/10 Cu Ni saddle pieces.

Fittings other than butt weld tube may be suitable for design pressures and temperatures higher than those required by this Specification. Where this is required the manufacturer of such fittings should be consulted.

In order that a more satisfactory match than hitherto is obtained between the bores of fittings (and other butt welding components) and the bores of tubes to which they would be butt welded, a greater emphasis has been placed on the bore dimensions and tolerances of the fittings. The mean bore dimensions of butt weld fittings (See Chapter seven of this Publication) correspond to the mean bore dimensions of the corresponding 16 or 20 bar rated tubes covered by the tube Chapters of this Publication.

The "building in" dimensions of butt-welding fittings, apart from end caps, have been based on ASME B16.9:2012⁽⁷⁾. End caps have been based on DIN 28011:2012-06⁽⁸⁾ (with suitable amendments) since the majority of manufacturers tend to follow this particular Specification.

Additional compensatory thicknesses have been applied to the intrados of long radius (butt welded) elbows and to the end caps, (see section one of this Publication).

Socket weld type fittings are included as an alternative to capillary brazed fittings or flareless, non-manipulative fittings.

Threaded fittings including caps, plugs and bushings have also been included in this Publication.

Materials of manufacture for each type of fitting are covered in the relevant sections within this Publication. Where other copper base or non-ferrous materials are covered in the various sections, the Purchaser may select accordingly. All materials covered are compatible with the 90/10 Cu Ni alloy. However, reference should also be made to BS MA 18:1973⁽⁹⁾ for design limitations.

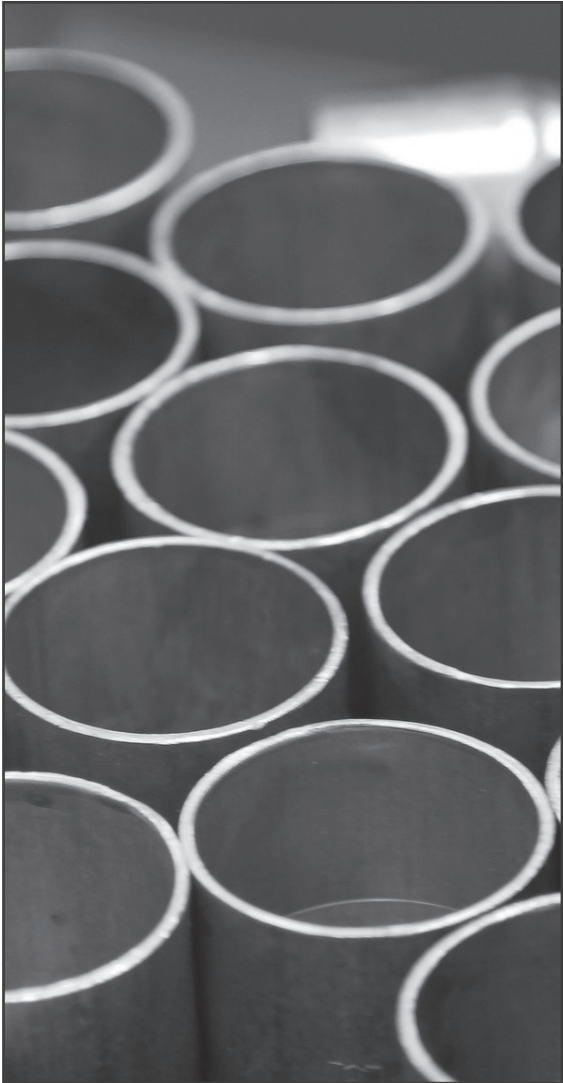
The basic dimensions, based on ASME B16.11-2011⁽¹⁰⁾, together with the acceptance criteria are included with additional test requirements for union type fittings. With reference to capillary brazed fittings, appropriate tests to establish that sufficient brazing alloy has been included as an integral part of the fitting design are outlined, together with the extra test requirements for the acceptance of union type fittings.

A list of other standards and codes referred to in this Publication is given in the References.

The correlation between nominal inch sizes and the specified sizes in millimetres are given below:

Table i

Nominal size - (in)	Specified O/D - (mm)
1/2	16
3/4	25
1	30
1 1/4	38
1 1/2	44.5
2	57
2 1/2	76.1
3	88.9
4	108
6	159
8	219.1
10	267
12	323.9
14	368
16	419
18	457.2
20	508
24	610
28	711
32	813
36	914



Note: For threaded fittings see Table 56.

1. Seamless tubes

1.1 Scope and design basis

Chapter one of this Specification specifies the requirements for seamless 90/10 Cu/Ni Alloy -UNS 7060X^{*1} tubes for offshore and related industries. This section specifies the requirements for seamless tubes in diameters from 10 mm to 450 mm for maximum design pressures of:

- a) 16 bar at a temperature range of minus 29°C and a maximum of + 75°C.
- b) 20 bar at a temperature range of minus 29°C and a maximum of +38°C.

The two corresponding ranges of wall thicknesses comply with the pressure containment requirements of ASME B.31.3-2014 as well as the requirements of IACS (International Association of Classification Societies) with additional allowances for robustness to withstand mechanical damage, especially in the smaller sizes.

The ranges of diameters and related wall thicknesses of seamless tubes are given in Tables 4 (16 bar) and 5 (20 bar), "Dimensions of seamless 90/10 Cu/Ni tubes for offshore and associated installations".

Note: Users of this Publication should note that while observing the requirements of this Specification they should at the same time ensure compliance with such statutory requirements, rules and regulations that may be applicable to an individual offshore or associated installation. It should also be noted that the wall thicknesses stated in Tables 4 and 5 were calculated using an allowable design stress of 68.6 N/mm², together with a corrosion allowance of 0.5 mm. However, to cater for the additional requirements for the use of saddle pieces, an overriding design stress of one fifth of the minimum tensile value of 270N/mm² has been used for final calculation purposes.

1.2 Information to be supplied by the Purchaser

The Purchaser shall state in their enquiry and order the following information:

- a) The title and number of this Chapter (EEMUA Publication 234, Chapter 1) and material designation (see Table 5).
- b) Pressure rating 16 or 20 bar.
- c) Tube size and specified thickness in inches and millimetres.
- d) Whether supplementary mechanical tests are required (see Section 1.7).
- e) Since a hydraulic or eddy current test for each tube is mandatory, the Purchaser shall state whether hydraulic testing is required in addition to, or in preference to, eddy-current testing (see clause 1.9).
- f) Whether manufacturer's certificates are required (see Section 1.11).
- g) Whether it is his intention to inspect the material at the supplier's works (see Chapter 14).
- h) Whether individual cast analyses are required to be supplied (see Chapter 14).
- i) Whether any additional identification marking other than that specified herein is required.
- j) Whether any additional identification marking other than that specified herein is required.

^{*1} Alloy UNS 7060X is a modified form of the following national designated alloys -UNS 70600, BS CW 352N and DIN 2.0872 see Table 5 of this specification for chemical composition and mechanical properties.

1.3 Freedom from defects

The tubes shall be visibly clean, smooth and free from harmful defects and from deleterious films in the bore. No defect shall penetrate the wall of the tube that will give a resulting thickness of less than the minimum stated in Tables 3 and 4.

1.4 Materials and manufacture

The casts and the tubes shall comply with the properties of Table 5. The tubes shall be seamless and in no case shall they be redrawn from used tubes. The tubes shall be supplied in straight lengths in the annealed condition.

1.5 Dimensions and tolerances

1.5.1 Outside diameter

The mean outside diameter of finished tubes in sizes up to and including 4 in/108 mm shall be within the outside diameter tolerances specified in Tables 3 and 4. The mean outside diameter is half the sum of any two diameters measured at right angles on the same cross section of the tube.

Tube sizes 6 in/159 mm up to and including 16 in/419 mm are also based on BS 2871-2, Table 3⁽¹¹⁾ [now withdrawn] for specified diameters but in this Chapter the tolerances have been applied to the inside diameters to facilitate alignment of matching weld preparations.

1.5.2 Inside diameter

The mean inside diameter of finished tubes in sizes 6 in/159 mm and larger shall be within the inside diameter tolerances specified in Tables 3 and 4 for a distance of 100 mm from each end. The mean inside diameter is half the sum of any two inside diameters measured at right angles on the same cross section of the tube.

1.5.3 Ovality

The ovality of finished tubes shall be such that the difference between the maximum and minimum diameters measured on the same cross section shall not exceed 2% of the size specified in column 2 in Tables 3 and 4.

1.5.4 Thickness

The thickness of tubes at any point shall not vary from that specified by more than 10% for diameters up to and including 4 in/108 mm. For diameters 6 in/159 mm and larger the wall thickness at any point shall not be less than the minimum values which equate to minus 12.5% as quoted in Tables 3 and 4.

1.5.5 Length

- (a) When tubes are required in random lengths, the minimum random lengths shall not be less than those specified below. Shorter random lengths may be supplied upon agreement between Purchaser and manufacturer. See Table 1.

Table 1 Minimum random lengths for seamless tubes

Diameter		Minimum random lengths	
Over	Up to and including	16 bar	20 bar
mm	mm	m	m
-	57	6	6
57	159	5	5
159	323.9	5	4
323.9	368	4	3
368	419	3	-

- (b) When tubes are required in specific lengths they shall not vary from that specified by more than the tolerances on length given below, when measured at a temperature of $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

1.5.6 Squareness of ends

The departure from squareness of the plain ends of any tube shall not exceed 1.6% of the specified diameter. The departure from squareness for ends beveled for welding shall not exceed 2.0 mm.

1.5.7 Straightness

The maximum deviation from straight for tube sizes 4 in/108 mm and larger is the depth of arc measured from a straight edge 1 metre in length which shall not exceed 3.0 mm.

Table 2 Tolerances on lengths for seamless tubes

Diameter	Tolerance for specified length in metres						
Over	Up to and including	Over 1 m up to and including 3 m		Over 3 m up to and including 6 m		Over 6 m up to and including 9 m	
mm	mm	mm		mm		mm	
-	88.9	+ 3	- 0	+ 6	- 0	+ 8	- 0
88.9	323.9	+ 5	- 0	+ 8	- 0	+ 10	- 0
323.9	419.0	+ 7	- 0	+ 10	- 0	+ 12	- 0

1.6 Selection of test samples

A batch is defined as a definite quantity of material consisting of one or more casts, or the product or part of a continuous cast run, the composition of which complies with the analytical requirements of Table 5 of this Publication.

For the tests specified in Section 1.7 tubes of anyone size and thickness shall be grouped in batches of 300 tubes or 1300 kg whichever is the greater weight, and one tube shall be taken at random from each and any remaining part of a batch for testing. When the size of the order does not permit batching in the above quantities, one tube of each size and thickness shall be selected for testing.

The sample selected from each batch, as defined above for test purposes, shall also be used for chemical analysis to confirm compliance with Table 5.

1.7 Mechanical tests

1.7.1 Mandatory tests

(a) Tensile tests

Tensile, 0.2% proof stress and elongation shall be determined on test samples of tube selected in accordance with Section 1.6 and tested in full section or on longitudinal strips cut from any part of the tube. The tests shall be performed in accordance with BS EN 6892-1:2009⁽¹²⁾ and the values obtained shall comply with the requirements of Table 5 of this Publication.

1.7.2 Supplementary tests

The following tests are only required when so specified by the Purchaser.

(a) Hardness test

Hardness tests shall be made on test pieces in accordance with BS EN ISO 6507-1:2005(13) and the values obtained shall not exceed 100 HV 5.

(b) Flattening test

This test applies to tubes not exceeding 4 in/108 mm outside diameter. The test pieces shall be flattened until the internal surface meets as shown in Figure 1. When subjected to this test the tube shall show no crack or flaw.

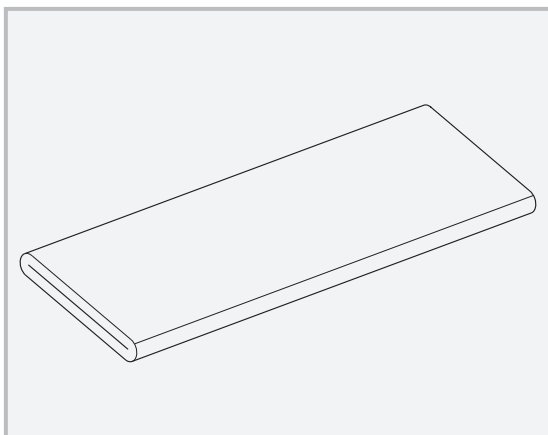


Figure 1 Flattening test

(c) Double-bend test

This test applies to tubes over 4 in/108 mm outside diameter. A test piece 50 mm wide shall be cut longitudinally from the tube. The longer edges shall be carefully rounded and smoothed so that a cross section has approximately semi-circular ends. The test piece shall be flattened and shall have its ends bent through 180° in opposite directions and doubled up close, as shown in Figure 2.

When subjected to this test the tube shall show no crack or flaw.

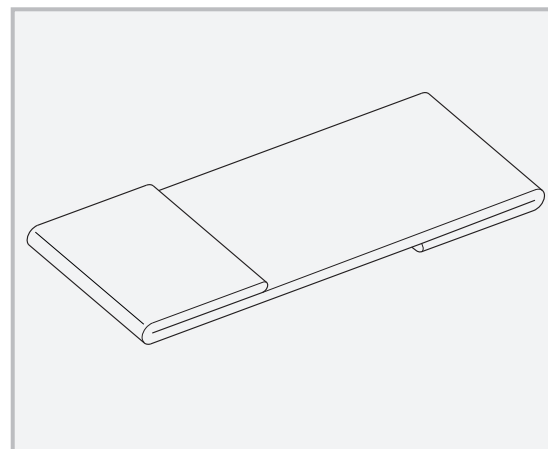


Figure 2 Double-bend test

(d) Drifting test

This test applies to tubes not exceeding 4 in/108 mm outside diameter. The test piece shall be expanded as shown in Figure 3 by means of a taper drift having an included angle of 45°, until the outside diameter of the expanded portion exceeds the original outside diameter by 30%. When subjected to this test the tube shall show no crack or flaw.

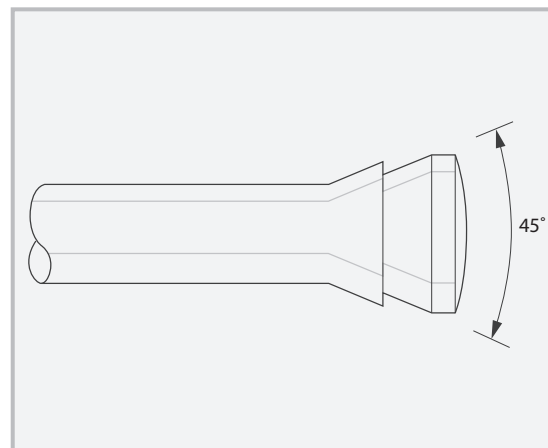


Figure 3 Drifting test

1.8 Retests

Should any one of the test pieces first selected fail to pass any of the prescribed mechanical tests, two further samples from the same batch shall be selected for testing, one of which shall be from the tube from which the original test sample was taken, unless that tube has been withdrawn by the supplier. Should the test piece from both these additional samples pass, the batch represented by the test samples shall be deemed to comply with this Specification.

Should the test pieces from either of these additional samples fail, the batch represented by the test samples shall be deemed not to comply with this Specification.

1.9 Hydraulic or eddy current tests (mandatory tests)

Manufacturers shall perform one of the following tests:

1.9.1 Hydraulic test

Each tube shall be hydraulically tested to an internal pressure of not less than 1.5 multiples of the design pressure in line with the ratings given in Tables 3 and 4. Thus the test pressure for 16 bar rated tubes shall be 24 bar and the test pressure for 20 bar rated tubes shall be 30 bar. In each case the pressure shall be stabilised and maintained for sufficient time to allow for inspection for leakage and/or signs of distress. In each case the test pressure shall be maintained for a minimum of 10 seconds for tubes up to and including 4 in/108 mm and a minimum of 20 seconds for tubes over 4 in/108 mm.

1.9.2 Eddy current test

An eddy current test shall be performed on each tube with an outside diameter within the capacity of the equipment in accordance with BS EN 1971-1:2011⁽¹⁴⁾, or ASTM E243⁽¹⁵⁾ plus ASTM B466⁽¹⁶⁾ paragraphs 11.2 and 14.2.3.

1.10 Marking

1.10.1: Tube sizes 1½ in/44.5 mm and above shall be individually marked.

All tubes shall be individually permanently marked and identified by clear legible printing by means of a vibratory etching tool, electrochemical etching or paint or ink stencilling in such colours as to be clearly visible, as follows:

- (a) Purchase order number (PO).
- (b) The number of this section (Publication 234: Chapter 1).
- (c) Material designation UNS 7060X.
- (d) Size inches and millimetres.
- (e) Nominal pressure rating -16 or 20 bar.
- (f) Manufacturer's name or trademark (MTM).
- (g) Test certificate number (TCN).
- (h) Batch traceability number (BTN).

Example of Marking:

PO 234/1 7060X 3/88.9 16 MTM TCN BTN

1.10.2: Tubes in sizes 1¼ in/38 mm and smaller, where it is not practicable to apply the full requirements of 1.10.1, shall be marked as follows:

- (a) Material designation UNS 7060X.
- (b) Size in inches and millimetres.
- (c) Nominal rating.
- (d) Manufacturer's trademark (MTM).
- (e) Batch traceability number (BTN).

In such cases the tubes shall be securely bundled and provided with secure indestructible type labels on which the remaining information given in Section 1.10.1 is clearly and permanently marked.

Note 1: Stamping with metallic stamps is not permitted.

Note 2: Manufacturers shall ensure that any marking materials used shall not be detrimental to the tube material.

1.11 Certification

Certificate(s) shall be supplied, either:

1.11.1: A certificate of compliance which shall state that the tubes have been made in accordance with all the requirements of this Chapter of EEMUA Publication 234; or

1.11.2: A manufacturer's certificate(s) which shall state that the tubes have been made in accordance with all the requirements of this Chapter of EEMUA Publication 234 and:

- (a) State the actual compositional limits determined for each of the elements designated in Table 5 of the casts used in the manufacture of each batch.
Note: Individual cast analyses shall be retained by the manufacturer - see Chapter 14: discretionary contractual clauses.
- (b) State product analysis of material selected from each batch in accordance with Section 1.6.
- (c) State the results of the mechanical tests detailed in Section 1.7.
- (d) State the results of any non-mandatory or special tests specified in the purchase order.
- (e) State the results of the hydraulic test in accordance with Section 1.9.

Table 3 Dimensions of seamless 90/10 Cu/Ni tubes: 16 bar rating

Tube size		Thickness		Outside diameter		Inside diameter	
1	2	3	4	5	6	7	8
Nom in	Specified OD mm	Specified mm	Minimum mm	Maximum mm	Minimum mm	Maximum mm	Minimum mm
				See notes 1, 3 and also clause 1.5		See notes 2, 3 and also clause 1.5	
½	16	2.0	1.80	16.045	15.965	-	-
¾	25	2.0	1.80	25.055	24.975	-	-
1	30	2.5	2.25	30.055	29.975	-	-
1¼	38	2.5	2.25	38.07	37.99	-	-
1½	44.5	2.5	2.25	44.57	44.49	-	-
2	57	2.5	2.25	57.20	57.12	-	-
2½	76.1	2.5	2.25	76.30	76.15	-	-
3	88.9	2.5	2.25	89.15	89.00	-	-
4	108	3.0	2.70	108.25	108.00	-	-
6	159	3.0	2.63	-	-	153.87	153.63
8	219.1	4.0	3.50	-	-	211.40	210.80
10	267	4.5	3.94	-	-	258.37	257.57
12	323.9	5.5	4.81	-	-	313.38	312.28
14	368	6.5	5.69	-	-	354.92	353.52
16	419	7.0	6.13	-	-	404.97	403.37

Note 1: Tube sizes ½ in/16 mm up to and including 4 in/108 mm are based on BS 2871: Part 2: 1972 [now withdrawn] Table 3 for outside diameters and their tolerances to allow for the use of capillary and compression fittings and brazed (and welded) slip-on flanges. The wall thicknesses of the 16 bar range have been increased to match the 20 bar range in Table 4 for mechanical strength.

Note 2: Tube size 6 in/159 mm up to and including 16 in/419 mm are also based on BS 2871: Part 2: 1972 [now withdrawn] Table 3 for specified diameters but the tolerances have been applied to the inside diameters to facilitate alignment of matching weld preparations.

Note 3: The ovality of finished tubes shall be such that the difference between the maximum and minimum diameters measured on the same cross section shall not exceed 2% of the size specified in column 2 in the above Table (see also Section 1.5.3).

Table 4 Dimensions of seamless 90/10 Cu/Ni tubes 20 bar rating

Tube size		Thickness		Outside diameter		Inside diameter	
1	2	3	4	5	6	7	8
Nom in	Specified OD mm	Specified mm	Minimum mm	Maximum mm	Minimum mm	Maximum mm	Minimum mm
				See notes 1, 3 and also clause 1.5		See notes 2, 3 and also clause 1.5	
½	16	2.0	1.80	16.045	15.965	-	-
¾	25	2.0	1.80	25.055	24.975	-	-
1	30	2.5	2.25	30.055	29.975	-	-
1¼	38	2.5	2.25	38.07	37.99	-	-
1½	44.5	2.5	2.25	44.57	44.49	-	-
2	57	2.5	2.25	57.20	57.12	-	-
2½	76.1	2.5	2.25	76.30	76.15	-	-
3	88.9	2.5	2.25	89.15	89.00	-	-
4	108	3.0	2.70	108.25	108.00	-	-
6	159	3.5	3.06	-	-	152.50	152.26
8	219.1	4.5	3.94	-	-	210.40	209.80
10	267	5.5	4.81	-	-	256.33	255.53
12	323.9	7.0	6.13	-	-	310.29	309.19
14	368	8.0	7.00	-	-	351.70	350.30
16	419	9.0	7.88	-	-	400.64	399.04

Note 1 Tube sizes ½ in/16 mm up to and including 4 in/108 mm are based on BS 2871: Part 2: 1972 [now withdrawn] Table 3 for outside diameters and their tolerances to allow for the use of capillary and compression fittings and brazed (and welded) slip-on flanges. The wall thicknesses of the 16 bar range in Table 3 have been increased to match the 20 bar range in the above Table for mechanical strength.

Note 2 Tube size 6 in/159 mm up to and including 16 in/419 mm are also based on BS 2871: Part 2: 1972 [now withdrawn] Table 3 for specified diameters but the tolerances have been applied to the inside diameters to facilitate alignment of matching weld preparations.

Note 3 The ovality of finished tubes shall be such that the difference between the maximum and minimum diameters measured on the same cross section shall not exceed 2% of the size specified in column 2 in the above Table (see also Section 1.5.3).

Table 5 Chemical composition and mechanical properties of seamless 90/10 copper/nickel tubes

Chemical composition - %			Mechanical properties			
Element	min	max	Tensile Strength – N/mm ²		0.2% Proof Stress N/mm ² min	Elongation % min On L = 5.65√So
			min	max		
Copper	Rem	-	300	380	105	30
Lead	-	0.010				
Iron[†]	1.50	2.00				
Nickel	10.0	11.00				
Zinc	-	0.20				
Manganese	0.50	1.00				
Sulphur	-	0.020				
Phosphorous	-	0.020				
Carbon	-	0.050				
Total impurities* including those in lighter types		0.30				

[†] The minimum iron content has been selected to improve erosion resistance.

* Impurities are elements other than copper (including silver), iron, nickel (including cobalt) and manganese.

2. Seam-welded tubes

Note: British Standards do not currently include a document relating to seam welded copper-nickel alloy tubes. ASTM B467⁽¹⁷⁾ is referenced in this section as a replacement for the section on welded tubes in BS 2871 referred to in EEMUA 144/145/146 which has been withdrawn.

2.1 Scope and design basis

Section two of this Specification specifies the requirements for seam-welded 90/10 Cu/Ni Alloy UNS 7060X^{*2} tubes for offshore and related industries. This Specification specifies the requirements for seam-welded tubes in diameters from 6 in/159 mm up to 36 in/914 mm^{*3} for maximum design pressures of:

- (a) 16 bar at a temperature range of minus 29°C and a maximum of +75°C.
- (b) 20 bar at a temperature range of minus 29°C and a maximum of +38°C.

The two corresponding ranges of wall thicknesses comply with the pressure containment requirements of ASME B31.3-2014 as well as the requirements of IACS (International Association of Classification Societies) with a joint efficiency factor of 1.0.

The ranges of diameters and related wall thicknesses of seam-welded tubes are given in Tables 6 (16 bar) and 7 (20 bar) respectively for seam-welded 90/10 Cu/Ni tubes for offshore and associated installations.

Note: Users of this Specification should note that while observing the requirements of this Specification they should at the same time ensure compliance with such statutory requirements, rules and regulations that may be applicable to an individual offshore or associated installation. It should also be noted that the wall thickness stated in Tables 8 and 9 were calculated using an allowable design stress of 68.6N/mm², together

with a corrosion allowance of 0.5 mm. However, to cater for the additional requirements for the use of saddle pieces, an overriding design stress of one fifth of the minimum tensile value of 270N/mm², has been used for final calculation purposes.

2.2 Information to be supplied by the Purchaser

The Purchaser shall state in his enquiry and order the following information:

- (a) The title and number of this section (EEMUA Publication 234, Chapter 2) and material designation (see Table 10).
- (b) Seamless or seam welded as appropriate.
- (c) Pressure rating: 16 or 20 bar.
- (d) Tube size and specified thickness in inches and millimetres^{*3}.
- (e) Any additional mechanical tests: (see ASTM B467) or other tests as applicable).
- (f) Whether manufacturer's certificates are required (see clause 2.13).
- (g) Whether it is the intention of the Purchaser to inspect the material at the supplier's works (see Chapter 14).
- (h) Whether individual cast analyses are required to be supplied (see Chapter 14).
- (i) Whether the external or internal weld reinforcement shall be removed (see Section 2.4).
- (j) Whether any additional identification marking other than that specified herein is required.

^{*2} Alloy UNS 7060X is a modified form of the following national designated alloys UNS 70600, BS CW352N and DIN 2.0872 - see Table 3 of this specification for chemical composition and mechanical properties.

^{*3} For purposes of this specification inch dimensions are nominal and the metric dimensions refer to specified outside diameters.

2.3 Freedom from defects

The tubes shall be visibly clean, smooth and free from harmful defects and free from deleterious films in the bore. No defect shall penetrate the wall of the tube that will give a resulting thickness of less than the minimum stated in Tables 8 and 9.

2.4 Materials and manufacture

The tubes shall be manufactured from hot rolled or cold rolled and annealed sheets or plates manufactured in accordance with BS EN 1652:1998⁽¹⁸⁾, BS EN 1653:1998⁽¹⁹⁾ or ASTM B171-12⁽²⁰⁾, but with mechanical properties and chemical composition as modified in Table 10.

Mechanical testing shall be carried out in accordance with the relevant standards as stated above.

The tubes shall be supplied in the "as welded" condition with the external and internal weld reinforcement intact except for cosmetic improvement or unless specified by the Purchaser that such reinforcements shall be removed.

2.5 Welding

2.5.1 Consumables

The composition of the filler wire or rods used for the production of seam-welds shall be selected from BS EN ISO 24373:2009⁽²¹⁾ Table 1 - alloy Cu7158.

Alternatively filler wire and rods shall be selected from the American Welding Society Specification -AWS-A5.7 - Class ER Cu Ni. Flux coated electrodes shall be selected from the American Welding Society Specification AWS-A5.6 - Class E Cu Ni.

2.5.2 Welding procedure qualification

The welding procedure qualifications shall be as quoted in ASME Boiler and Pressure Vessel code⁽²²⁾ section IX "Qualification standard for welding and

brazing procedures, welders, brazers, and welding and brazing operators."

2.5.3 Welder qualification

The welder qualification shall be in accordance with ASME Boiler and Pressure Vessel Code section IX.

2.6 Dimensions and tolerances

2.6.1 Outside diameter

The tube sizes quoted in Tables 8 and 9 are based on BS 2871: Part 2 [now withdrawn] for specified diameters up to and including 20 in/508 mm whereas larger sizes are based on BS MA 60 [now withdrawn].

2.6.2 Inside diameter

The mean inside diameter of finished tubes shall be within the inside diameter tolerances specified in Tables 8 and 9 for a distance of 100 mm from each end. The mean inside diameter is half the sum of the maximum and minimum diameters measured on the same cross section of the tube.

2.6.3 Ovality

The ovality of finished tubes shall be such that the difference between the maximum and minimum diameters measured on the same cross section shall not exceed 2% of the size specified in column 2 in Tables 6 and 7.

2.6.4 Circularity (permissible deviation from circularity)

In the region of the weld (but excluding the weld) tubes shall be circular within $\pm 0.5\%$ of the specified diameter for a distance of 100 mm from each end.

2.6.5 Thickness

The thickness of tubes at any point shall not be less than the minimum values which equate to minus 12.5% as quoted in Tables 6 and 7.

2.6.6 Length

- (a) When tubes are required in random lengths, the minimum random lengths shall not be less than those specified below. Shorter random lengths may be supplied by agreement between Purchaser and manufacturer.

Table 6 Minimum random lengths for seam-welded tubes

Diameter		Minimum random lengths	
Over	Up to and including	16 bar	20 bar
mm	mm	m	m
-	323.9	5	4
323.9	368	4	3
368	610	3	3
610	914	2	2

- (b) When tubes are required in specific lengths they shall not vary from that specified by more than the tolerances on length specified below, when measured at a temperature of $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

Table 7 Tolerances on lengths for seam-welded tubes

Diameter		Tolerance on lengths for seam-welded tubes					
Over	Up to and including	Over 1 m up to and including 3 m		Over 3 m up to and including 6 m		Over 6 m up to and including 9 m	
mm	mm	mm	mm	mm	mm	mm	mm
-	323.9	+ 5	- 0	+ 8	- 0	+ 10	- 0
323.9	419.0	+ 7	- 0	+ 10	- 0	+ 12	- 0
419	-	+ 12	- 0	+ 12	- 0	+ 13	- 0

2.6.7 Squareness of ends

The departure from squareness of the plain ends of any tube shall not exceed 1.6% of the specified diameter. The departure from squareness for ends bevelled for welding shall not exceed 2.0 mm.

2.6.8 Straightness

The maximum deviation from straight for all sizes of tube is the depth of arc as measured from a straight edge 1 metre in length which shall not exceed 3 mm.

2.7 Selection of test samples

Samples representing each cast shall be selected from one sheet or plate. Refer to Section 7 of BS EN 1652/1653:1998 but chemical composition and mechanical properties shall comply with Table 10 of this Publication.

2.8 Non-destructive testing

2.8.1 Liquid dye penetrant test

The weld seams of all tube sizes shall be examined externally by the liquid dye penetrant method in accordance with ASME Boiler and Pressure Vessel Code section V, article 6 and shall meet the acceptance requirements of ASME Boiler and Pressure Vessel Code section VIII, division 1, Appendix 8.

2.8.2 Radiography

Radiographic examination shall be performed for the complete length of each weld to meet the requirements of ASME Boiler and Pressure Vessel Code, section VIII, UW51.

2.9 Repairs to weld seams

Visible defects such as cracks, pinholes and incomplete fusion and defects detected by the tests performed under Sections 2.8 and 2.11 shall be removed and repaired in accordance with Section 2.5.

2.10 Retest of repairs

A repaired weld seam shall meet the requirements of the original weld and be re-examined and retested in accordance with Sections 2.8 and 2.11.

2.11 Hydraulic test

Each tube shall be hydraulically tested to an internal pressure of not less than 1.5 multiples of the design pressure in line with the ratings given in Tables 8 and 9. Thus the test pressure for 16 bar rated tube shall be 24 bar and the test pressure for 20 bar rated tubes shall be 30 bar.

In each case the pressure shall be stabilised and maintained for sufficient time to allow for inspection for leakage and/or signs of distress. In each case the test pressure shall be maintained for a minimum of 20 seconds for tube sizes up to and including 16 in/419 mm and a minimum of 30 seconds for sizes over 16 in/419 mm.

2.12 Marking

All tubes shall be individually permanently marked and identified by clear legible printing by means of a vibratory etching tool, electrochemical etching, paint or ink stencilling, and where applicable, in such colours as to be clearly visible as follows:

- (a) Purchase order number (PO).
- (b) The number of this Chapter (Publication 234, Chapter 2).
- (c) Material designation UNS 7060X.
- (d) Size: inches and millimetres.
- (e) Nominal pressure rating, 16 or 20 bar.
- (f) Manufacturer's name or trademark (MTM).
- (g) Test certificate number (TCN).
- (i) Cast identity number.
- (j) Welder identity (WI).

Note 1: Stamping with metallic stamps is not permitted.

Note 2: Manufacturers shall ensure that any marking materials used shall not be detrimental to the tube material.

Example of marking:

PO 234/2 7060X 14/368 16 MTM TCN Cast No WI.

2.13 Certification

Certificate(s) shall be supplied, either:

2.13.1: A certificate of compliance which shall state that the tubes have been made in accordance with all the requirements of this section (EEMUA Publication 234, Chapter 2) or:

2.13.2: A manufacturer's certificate(s) which shall state that the tubes have been made in accordance with all the requirements of this section (EEMUA Publication 234, Chapter 2) and:

- (a) State the actual composition, determined for each of the elements specified in Table 10 of each cast used in the manufacture of the tubes.
- (b) State the results of mechanical tests performed on a plate or sheet from each cast formed into tubes as designated in Table 10.
- (c) State the results of the hydraulic test in accordance with Section 2.11.
- (d) State the results of the dye penetrant and radiographic examinations of each weld seam in each tube in accordance with Section 2.8.
- (e) State the results of any non-mandatory or special tests specified in the purchase order.

Table 8 Dimensions of seam-welded 90/10 Cu Ni tubes: 16 bar rating

Tube size		Thickness		Inside diameter	
1	2	3	4	5	6
Nom in	Specified OD mm	Specified mm	Minimum mm	Maximum mm	Minimum mm
				See notes 1, 2 and also clause 2.6	
6	159	3.0	2.63	153.87	153.63
8	219.1	4.0	3.50	211.40	210.80
10	267	4.5	3.94	258.37	257.57
12	323.9	5.5	4.81	313.38	312.28
14	368	6.5	5.69	354.92	353.52
16	419	7.0	6.13	404.97	403.37
18	457.2	8.0	7.00	443.0	440.0
20	508	8.5	7.44	492.0	489.0
24	610	10.5	9.19	591.0	588.0
28	711	12.0	10.50	689.0	686.0
32	813	13.5	11.81	788.0	785.0
36	914	15.5	13.56	885.0	882.0

Note 1: Tube sizes 6 in/159 mm up to and including 20 in/508 mm are based on BS 2871-2:1972 [now withdrawn] Table 3 for specified diameters, but the tolerances have been applied to the inside diameters to facilitate alignment of matching weld preparations. The inside diameters of tube sizes 6 in/159 mm up to and including 16 in/419 mm are also in alignment with the corresponding tube sizes and thicknesses in Table 1.

Note 2: The ovality of finished tubes shall be such that the difference between the maximum and minimum diameters measured on the same cross section shall not exceed 2% of the size specified in column 2 in the above Table (see also Section 2.6.3).

Table 9 Dimensions of seam-welded 90/10 Cu Ni tubes: 20 bar rating

Tube size		Thickness		Inside diameter	
1	2	3	4	5	6
Nom in	Specified OD mm	Specified mm	Minimum mm	Maximum mm	Minimum mm
				See notes 1, 2 and also clause 2.6	
6	159	3.5	3.06	152.50	152.26
8	219.1	4.5	3.94	210.40	209.80
10	267	5.5	4.81	256.33	255.53
12	323.9	7.0	6.13	310.29	309.19
14	368	8.0	7.00	351.70	350.30
16	419	9.0	7.88	400.64	399.04
18	457.2	9.5	8.31	440.0	437.0
20	508	11.0	9.63	488.0	485.0
24	610	13.0	11.38	586.0	583.0
28	711	15.0	13.13	683.0	680.0
32	813	17.0	14.88	781.0	778.0
36	914	19.0	16.63	878.0	875.0

Note 1: Tube sizes 6 in/159 mm up to and including 20 in/508 mm are based on BS2871: Part 2: 1972 [now withdrawn] Table 3 for specified diameters, but the tolerances have been applied to the inside diameters to facilitate alignment of matching weld preparations. The inside diameters of tube sizes 6 in/159 mm up to and including 16 in/419 mm are also in alignment with the corresponding tube sizes and thicknesses in Table 2.

Note 2: The ovality of finished tubes shall be such that the difference between the maximum and minimum diameters measured on the same cross section shall not exceed 2% of the size specified in column 2 in the above Table (see also Section 2.6.3).

Table 10 Chemical composition and mechanical properties of seam-welded 90/10 Cu Ni tubes

Chemical composition - %			Mechanical properties				
Element	min	max	Tensile Strength – N/mm ²		0.2% Proof Stress N/mm ² min	Elongation % min On L = 5.65√S ₀	Hardness HV 5 max
			min	max			
Copper	Rem	-	280	-	105	30	120**
Lead	-	0.010					
Iron[†]	1.50	2.00					
Nickel	10.0	11.00					
Zinc	-	0.20					
Manganese	0.50	1.00					
Sulphur	-	0.020					
Phosphorous	-	0.020					
Carbon	-	0.050					
Total impurities* including those in lighter types		0.30					

[†] The minimum iron content has been selected to improve erosion resistance.

* Impurities are elements other than copper (including silver) iron, nickel (including cobalt) and manganese.

** Determined on finished tube outside of heat affected zone (HAZ).

3. Composite weld neck flanges

3.1 Scope and design basis

Section 3.4 gives details of the 90/10 copper nickel weld neck stub ends, whereas Section 3.5 gives details of the forged carbon steel plate-type backing flanges.

The range of sizes covered for these composite weld-neck flanges are ½ in/16 mm - 36 in/914 mm^{*4}.

Two types of weld neck stub ends are included in Section 3.4. The short components (type S) are based on DIN 86037⁽²³⁾ but modified to suit the appropriate tube wall dimensions. The long components (type L) are based on MSS SP-43:2013⁽²⁴⁾ to suit the appropriate tube wall dimensions. The long stub ends have been included to facilitate the attachment of this type of flange to butt welding elbows, tees, and the small end of reducers.

Only one type of backing flange is included in Section 3.5. The same backing flange is required for all weld neck stub ends whether they be long or short, 16 bar or 20 bar. This type of backing flange is not suitable for use with composite slip-on stub ends (Section 4.4).

The thicknesses of the plate type backing flanges have been determined to meet the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Appendix 2, except that design stresses have been established in accordance with ASME B31.3-2014 criteria.

The following design criteria have been used:

- (a) Drilling and outside diameter dimensions of flange sizes ½ inch/16 mm - 24 in/610 mm are in accordance with ASME B16.5-2013 and BS EN 1759-1:2004,

whereas the larger sizes, 28 in/711 mm - 36 in/914 mm are in accordance with MSS SP-44-2006.

- (b) All calculations for backing flanges have been carried out using a design pressure of 20 bar at 38°C.
- (c) Backing flanges: ASTM A105-14⁽²⁵⁾ forged carbon steel.
- (d) Gaskets: 1.5 mm thick.
- (e) Bolting: ASTM A193-B7⁽²⁶⁾.

Design stresses used in the calculations were as follows:

- (i) Steel backing flanges: 160.7 N/mm².
- (ii) B7 bolting: 172.4 N/mm².

Based on the results of the above calculations an attempt has been made to rationalise ½ in/16 mm up to and including 1½ in/44.5 mm backing flanges which utilise the same bolting. The opportunity was taken therefore to use the same flange thickness (dimension 'b') determined for the largest of this size range and apply it to the smaller sizes, resulting in identical bolt lengths for all flanges in that range. This was considered to be a practical and economical advantage within the industry.

The dimensions of backing flanges are governed by the strength required to resist the bolting forces which may occur on bolting up. Therefore all backing flanges are suitable for a maximum working pressure of 20 bar at 38°C.

This Specification does not specify hydraulic test pressures for flanges or components, details of which should be obtained from the appropriate application standards.

^{*4}For purposes of this specification inch dimensions are nominal and metric dimensions refer to specified outside diameters.

3.2 Pressure/temperature ratings

Pressure/temperature ratings are the maximum allowable working pressures (MAWP) at the temperatures shown in Appendix B.

If a stub end rated at 16 bar is required to be connected to a stub end rated at 20 bar then that flanged joint shall be rated at 16 bar (see Tables 12 and 13).

The temperature shown for a corresponding pressure rating is considered to be the same as that of the contained fluid.

3.3 Materials

3.3.1 Flanges

Stub ends detailed in Section 3.4 shall be manufactured in 90/10 Cu Ni alloy UNS 7060X*⁵ the composition and mechanical properties of which are specified in Table 17. Backing flanges detailed in Section 3.4 shall be manufactured from the material specified in Table 18. Alternative steels may be used for the backing flanges provided that they have mechanical properties equal to or better than those specified in ASTM A105-14 (normalised) and are acceptable to the Purchaser.

3.3.2 Gaskets

The gaskets shall not be graphited. Alternatively neoprene type gaskets with a minimum Shore hardness of not less than 75 may be used located within the bolt circle.

Note: Gaskets should not be used when mating with elastomer/rubber faced flanges.

3.3.3 Bolting (stud bolts)

Bolting for flanges to this Specification shall be selected from ASTM A193-B7 and ASTM A194-2H⁽²⁷⁾ and should be suitably protected from corrosion.

3.4 Weld neck stub ends

3.4.1 Manufacture

Stub ends shall be manufactured by one or more of the following processes:

- (a) Hot forging.
- (b) Cold forging followed by annealing.
- (c) Friction welded from wrought material in accordance with the requirements of BS EN ISO 15620:2000⁽²⁸⁾.
- (d) Other methods of manufacture shall be as agreed between the Purchaser and the manufacturer.

3.4.2 Information to be supplied by the Purchaser

The following shall be specified by the Purchaser on the order (for stub ends).

- (a) The title and number of this Specification (EEMUA Publication 234 Section 3.4).
- (a) Size: inches and millimetres.
- (b) The pressure rating: 16 bar or 20 bar.
- (c) Whether type "S" or type "L" stub ends are required.
- (d) Whether certificates of compliance or manufacturer's certificates are required (see Section 3.4.8).
- (e) Whether it is his intention to inspect the material at the supplier's works.
- (f) Whether the individual cast analyses are required to be supplied (see Chapter 14). See Section 3.5.2 for information to be supplied by the Purchaser for backing flanges.
- (g) Whether any additional identification marking other than that specified herein is required.

*⁵Alloy UNS 7060X is a modified form of the following national designated alloys UNS 70600, BS CW 352N and DIN 2.0872.

3.4.3 Freedom from defects

The stub ends shall be visibly clean, smooth and free from defects greater than 0.5 mm in depth, irregularities, scale or deposits.

3.4.4 Joint facings and surface finish

All stub end jointing surfaces shall be machine finished and when compared by visual or tactile means with reference specimens, they shall comply with the values shown in Table 11.

It is not intended that instrument measurements be taken on the faces themselves and the R_a and R_z values relate to the reference specimens.

Table 11 Surface finish (weld neck stub ends)

Method of machining	$R_a^* \mu m$		$R_z^* \mu m$	
	min	max	min	max
Turning	3.2	12.5	12.5	50

Note: The term "turning" includes any method of machining producing concentric or spiral grooves.

* R_a and R_z are defined in BS 1134:2010⁽²⁹⁾

3.4.5 Selection of test samples

For stub ends produced by hot forging or cold forging followed by annealing, samples for determination of mechanical properties shall be selected in accordance with Table 20 of BS EN 12420:2014⁽³⁰⁾. The mechanical properties so determined shall comply with the requirements of Table 17 of this Publication.

Samples shall be selected from each cast for chemical analysis and shall comply with the requirements of Table 17 of this section.

For stub ends produced by friction welding using seamless tube and hot rolled or cold rolled and annealed sheet or plate, samples shall be selected as follows:

- (a) Seamless tube in accordance with Section 1.6 of this Publication. The mechanical properties of the finished components shall comply with the requirements of Table 17 of this Publication.
- (b) Sheet/plate in accordance with BS EN 1652:1998 and BS EN 1653:1998. The analysis and mechanical properties of each sheet or plate used to produce the stub ends shall comply with the requirements of Table 17 of this section.

3.4.6 Marking

3.4.6.1 All stub ends 2 in/57 mm and larger shall be clearly and permanently marked by means of a vibratory etching tool or electrochemical etching as follows:

- (a) Purchase order number (PO).
- (b) The number of this section (EEMUA Publication 234: Section 3.4).
- (c) Size: inches and millimetres.
- (d) The nominal pressure rating: 16 bar or 20 bar.
- (e) Material designation UNS 7060X.
- (f) Batch traceability number (BTN).
- (g) Manufacturer's name or trademark (MTM).

Examples of marking:

PO 234/3.4 2/57 20 7060X BTN MTM

Notes:

- (i) Stamping with metallic stamps is not permitted.
- (ii) Marking shall not be on the gasket contact surfaces.

3.4.6.2 Stub ends in sizes 1 1/2 in/44.5 mm and smaller where it is not practical to apply the full requirements of Section 3.4.6.1 shall be marked as follows:

- (a) Material designation UNS 7060X.
- (b) Batch traceability number (BTN).
- (c) Manufacturer's name or trademark (MTM).
- (d) Size: inches and millimetres.
- (e) Nominal pressure rating: 16 bar or 20 bar.

The remainder of the marking requirements shall be applied to indestructible-type labels securely attached to the component. The labels shall be clearly and permanently marked.

3.4.7 Inspection and testing

This Section does not make provision for routine pressure testing of stub ends. They shall, however, be dimensionally correct and be marked in accordance with this Section. All stub ends shall be capable of withstanding without leakage or signs of distress a hydraulic pressure as follows:

16 bar rated flanges, test pressure = 24 bar.
20 bar rated flanges, test pressure = 30 bar.

3.4.8 Certification

Certificate(s) shall be supplied, either:

3.4.8.1 A certificate of compliance which shall be manufactured in accordance with all the Publication 234: Section 3.4) or:

3.4.8.2 A Manufacturer's certificate(s) which shall state that the stub ends have been manufactured in accordance with all the requirements of this section (EEMUA Publication 234: Section 3.4) and:

- (a) State the actual compositional limits determined for each of the elements designated in Table 17 of the casts used in the manufacture of each batch as defined in Table 20 of BS EN 12420:2014.

In the case of stub ends produced by friction welding state the actual

compositional limits determined for each of the elements separately designated in Table 17 of the casts used for producing the seamless tube and for the sheet/plate used in each batch of stub ends.

Note: Individual cast analyses shall be retained by the manufacturer see Chapter 14: discretionary contractual clauses.

- (b) State the results of mechanical tests performed on each batch (see Section 3.4.5 - selection of test samples).

3.5 Weld neck backing flanges

3.5.1 Manufacture

Backing flanges shall be of forged carbon steel to ASTM A105-14 (normalised) except that the carbon content and the carbon equivalent shall not exceed the values given in Table 18.

3.5.2 Information to be supplied by the Purchaser

The following shall be specified by the Purchaser on the order (for backing flanges):

- (a) The title and number of this Specification (EEMUA Publication 234 Section 3.5).
- (b) Size: inches and millimetres.
- (c) Pressure rating: Class 150.
- (d) Whether it is his intention to inspect the material at the supplier's works (see Chapter 14).
- (e) Whether manufacturer's certificates are required (see Section 3.5.8).
- (f) Whether any additional identification marking other than that specified herein is required.
- (g) Whether any temporary or permanent corrosion protection is required other than that specified in Section 3.5.9.

See Section 3.4.2 for information to be supplied by the Purchaser for stub ends.

3.5.3 Drilling

All bolt holes shall be drilled and shall be equally spaced on the pitch circle diameter 'K' (see Table 14).

3.5.4 Facings and surface finish

The outside diameters and bores of backing flanges shall be machine finished and edges shall have a radius of 3 mm in accordance with Table 14. The face of the backing flange to be in contact with the stub ends shall be machined flat.

3.5.5 Selection of test samples

Samples representing each lot of backing flanges shall be selected, and subjected to testing, in accordance with the requirements of ASTM A105-14.

3.5.6 Marking

Backing flanges shall be clearly marked with round-nose steel stamps around the rim.

Backing flanges shall be clearly marked as follows:

- (a) Purchase Order Number (PO).
- (b) The number of this section (EEMUA Publication 234: section 3.5).
- (c) Size: inches and millimetres.
- (d) The nominal pressure rating: Class 150.
- (e) Material designation: A105 (ASTM A105-14) see Table 18.
- (f) Batch traceability number (BTN).
- (g) Manufacturer's name or trademark (MTM).

Examples of marking:

PO 234/3.5 10/267 150 A105 BTN MTM.

3.5.7 Inspection and testing

Backing flanges shall be dimensionally correct and be marked in accordance with this section.

Backing flanges shall be visually examined for defects and irregularities in the protective coat.

3.5.8 Certification

Certificate(s) shall be supplied, either:

3.5.8.1: A certificate of compliance which shall state that the backing flanges have been manufactured in accordance with all the requirements of this Chapter (EEMUA Publication 234, Chapter 3) or:

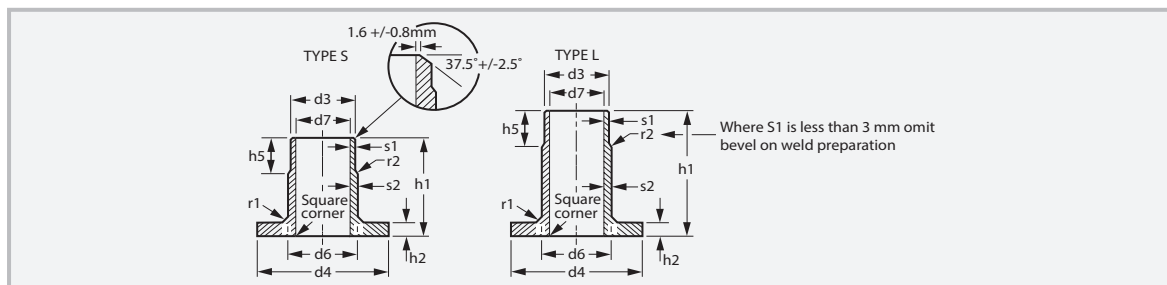
3.5.8.2: A manufacturer's certificate which shall state that the backing flanges have been manufactured in accordance with all the requirements of this Chapter (EEMUA Publication 234 Chapter 3) and:

- (a) State the analysis of each heat used in the manufacture of each order (see Section 3.5: selection of test samples).
- (b) State the results of mechanical tests performed on each heat used in the manufacture of each order (see Section 3.5: selection of test samples).

3.5.9 Temporary corrosion protection

Unless otherwise specified by the Purchaser flanges shall be protected against corrosion during transit and storage according to the following procedure:

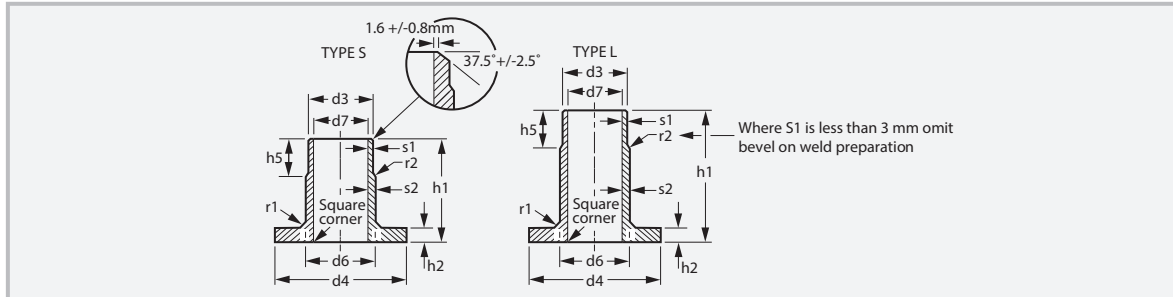
- (a) blast clean to standard Sa2.5 as specified in BS EN ISO 8501-1:2007⁽³¹⁾.
- (b) apply blast primer of zinc rich epoxy coating to a dry film thickness of 25-50 μm immediately after blast cleaning. After blast priming the identification marking shall be repeated, as necessary, by painting in such colours as to be clearly visible.

Table 12 Weld neck 90/10 Cu Ni stub ends: 16 bar rating*⁶

For tolerances see Table 15												
Size in/ mm	d3	d4	d6	d7	Type S h1* ⁷	Type L h1	h2	r1	r2	h5	S1 min	S2
1/2/16	Use 20 bar see Table 13											
3/4/25												
1/30												
1 1/4/38												
1 1/2/44.5												
2/57												
2 1/2/76.1												
3/88.9												
4/108												
6/159	159	212	161.5	153.75	50	89	9	5	5	15	3.0	4.0
8/219.1	219.1	270	222	211.10	50	102	9	5	5	15	4.0	5.5
10/267	267	320	270	257.97	50	127	9	5	5	15	4.5	6.0
12/323.9	323.9	370	327	312.83	50	152	11	7	5	16	5.5	7.0
14/368	368	430	371	354.22	50	152	11	7	5	16	6.5	8.0
16/419	419	482	422	404.17	50	152	12	7	7	16	7.0	8.5
18/457.2	457.2	530	460	441.5	50	152	12	7	7	16	8.0	9.5
20/508	508	585	511	490.5	50	152	12	7	7	20	8.5	10.0
24/610	610	685	613	589.5	60	152	14	9	7	20	10.5	12.0
28/711	711	800	719	687.5	60	190	19	9	7	24	12.0	14.5
32/813	813	905	821	786.5	60	190	20.5	9	7	24	13.5	16.0
36/914	914	1000	922	883.5	60	190	22	9	7	32	15.5	17.5

*⁶ For weld-neck stub-ends operating at a maximum design pressure of 20 bar at 38°C - see table 13.

*⁷ Type "S" stub ends are not suitable for welding with the backing flange in position on stub end.

Table 13 Weld neck 90/10 Cu Ni stub ends: 20 bar rating^{*8}

For tolerances see table 15												
Size in/ mm	d3	d4	d6	d7	Type S h1 ^{*9}	Type L h1	h2	r1	r2	h5	S1 min	S2
1/2/16	16	40	18	12.00	35	51	4	2	3	15	2.0	3.0
3/4/25	25	50	27	21.00	40	51	5	3	3	15	2.0	3.0
1/30	30	60	32	25.00	40	51	5	4	3	15	2.5	3.5
1 1/4/38	38	70	40	33.03	40	51	5	4	3	15	2.5	3.5
1 1/2/44.5	44.5	80	46.5	39.53	45	51	6	4	3	15	2.5	3.5
2/57	57	99	59	52.16	45	64	6	5	3	15	2.5	3.5
2 1/2/76.1	76.1	120	78	71.23	45	64	6	5	3	15	2.5	3.5
3/88.9	88.9	130	91	84.08	50	64	7	5	3	15	2.5	3.5
4/108	108	158	110	102.13	50	76	7	5	3	15	3.0	4.0
6/159	159	212	161.5	152.38	50	89	9	5	5	15	3.5	4.5
8/219.1	219.1	270	222	210.10	50	102	9	5	5	15	4.5	6.0
10/267	267	320	270	255.93	50	127	9	5	5	15	5.5	7.0
12/323.9	323.9	370	327	309.74	50	152	11	7	5	16	7.0	8.5
14/368	368	430	371	351.00	50	152	11	7	5	16	8.0	9.5
16/419	419	482	422	399.84	50	152	12	7	7	16	9.0	10.5
18/457.2	457.2	530	460	438.5	50	152	12	7	7	16	9.5	11.0
20/508	508	585	511	486.5	50	152	12	7	7	20	11.0	12.5
24/610	610	685	613	584.5	60	152	14	9	7	20	13.0	14.5
28/711	711	800	719	681.5	60	190	19	9	7	24	15.0	19.0
32/813	813	905	821	779.5	60	190	20.5	9	7	24	17.0	21.0
36/914	914	1000	922	876.5	60	190	22	9	7	32	19.0	23.0

^{*8}For weld-neck stub-ends operating at a maximum design pressure of 16 bar at 75°C - see table 12.

^{*9}Type "S" stub ends are not suitable for welding with the backing flange in position on stub end.