

# TECHNICAL SPECIFICATIONS TECHNICAL SPECIFICATIONS SPECIFICATIONS

**BTM<sup>®</sup> TS28**

LOW CARBON ERW HI-FORM<sup>®</sup> AND HI-FORM<sup>®</sup>(ALUMINISED) STEEL TUBING FOR USE IN AUTOMOTIVE EXHAUST SYSTEMS



PRECISION



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## 1.0 | Scope

This specification covers the technical requirements for the production and supply of circular low carbon ERW (electric resistance welded), uncoated and aluminised steel tubing intended for use in exhaust pipes and other applications requiring ductile tubing suitable for severe manipulation. This product is generally denoted BTM Hi-Form<sup>®</sup>.

**Note:** 1. Tubing in the As Formed condition produced from uncoated strip and intended for general applications, is covered in; TS21 Low Carbon ERW Steel Tubing for General Applications (BTM EzyForm).

## 2.0 | References

BTM Customer Information Handbook Standard Terminology.  
Specification ASTM A463-97 "Steel Sheet, Aluminium-Coated, by the Hot-Dip Process".

## 3.0 | Definitions

Terms used in this specification are defined in the BTM Customer Information Handbook.

## 4.0 | Designation

Tubing ordered to this specification shall be designated as either:

- (i) TS28 ERW Hi-Form - for uncoated tube in the As Formed condition, or
- (ii) TS28 ERW Hi-Form (Aluminised) - for aluminised tube in the As Formed condition

For tube with special requirements (eg specific end condition on cut lengths) or with additional/supplementary requirements (eg special dimensional tolerances) the suffix S shall be used and the tube designated as:

- (i) TS28S ERW Hi-Form, or
- (ii) TS28S ERW Hi-Form (Aluminised)

## 5.0 | Information to be Supplied by the Purchaser:

The purchaser should supply the following information at the time of an enquiry and/or order.

- (a) Dimensions of cross section (diameter and wall thickness).
- (b) Length required (in mm) and type (ML, NSML, CL) - refer to clause 6.6.
- (c) Designation eg TS28 ERW Hi-Form - refer to clause 4.
- (d) Surface Finish ie Commercial Quality or Bright Quality - refer to clause 6.4.
- (e) Quantity and delivery instructions.
- (f) Any optional information (eg specific end condition on cut lengths) or additional/supplementary requirements or exceptions to this specification (eg special dimensional tolerances). In these cases the designation TS28S Hi-Form or TS28S Hi-Form (Aluminised) shall be used.

## 6.0 | Requirements

### 6.1 Tube Condition

Tubing shall be supplied in the As Formed condition ie as produced ex the weldmill.

**Note:** 1. In the case of aluminised tube the weld zone is recoated using an aluminium spray onto the steel surface - refer to Clause 6.4.

### 6.2 Chemical Composition

#### 6.2.1 Aluminised

The tube shall be manufactured from aluminised strip with coating designation T1 25 (75g/m<sup>2</sup>) produced in accordance with specification ASTM A463 “Steel Sheet, Aluminium Coated, by the Hot-Dip Process”, Type 1.

The cast analysis of the steel used shall conform to the limits specified for DDS strip in ASTM A463, which are as follows:

**TABLE 1 : TS28 HI-FORM (ALUMINISED) CHEMISTRY**

Element	Composition %
Carbon (C)	0.06 max
Manganese (Mn)	0.50 max
Phosphorous (P)	0.020 max
Sulphur (S)	0.025 max
Aluminium (Al)	0.01 min

**6.2.2 Uncoated**

The tube shall be manufactured from low carbon commercial quality steel strip the cast analysis of which shall conform to the following:

<b>TABLE 2 : TS28 HI-FORM CHEMISTRY</b>		
<b>Element</b>	<b>Guaranteed Maximum (%)</b>	<b>Typical (%)</b>
Carbon (C)	0.10	0.060
Phosphorous (P)	0.040	0.015
Manganese (Mn)	0.45	0.20
Silicon (Si)	-	0.0050
Sulphur (S)	0.040	0.010
Aluminium (Al)	-	0.035

**6.3 Mechanical Properties**

**6.3.1 Tensile Test**

Tubing in the As Formed condition shall conform to the tensile properties shown in the tables below:

<b>TABLE 2 : MECHANICAL PROPERTIES</b>				
<b>D/t Ratio</b>	<b>&lt; 15</b>	<b>15 ≤ D/t &lt; 25</b>	<b>25 ≤ D/t &lt; 35</b>	<b>≥ 35</b>
Yield Strength MPa (min)	300	275	250	200
Tensile Strength MPa (min)	310	300	290	280
Elongation % (min)	15	20	25	30

where : D = outside diameter or equivalent round  
t = nominal wall thickness

**6.3.2 Flare test**

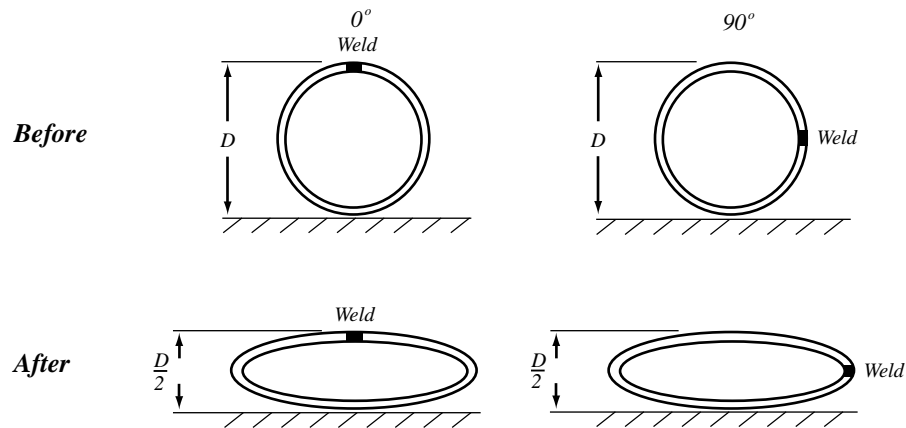
The tube shall be capable, with suitable end preparation, of being expanded over a cone, having an included angle of 60 degrees, to increase the outside diameter by 35% without failure in the weld.

**6.3.3 Bulge Test**

The tube shall be capable, with suitable end preparation, of being expanded over a segmented mandrel or a parallel punch to increase the outside diameter by 20% without failure in either the parent metal or the weld.

**6.3.4 Flattening Tests**

Circular tube shall be capable of being flattened without cracking between two parallel plane surfaces with the weld located at 90° and 0° to the direction of flattening until the distance between the surfaces is half the nominal outside diameter of the tube.



**6.4 Surface Finish**

Aluminised tube shall be supplied with a commercial quality (CQ) surface finish as set out in the table below. Uncoated tube shall be supplied with a commercial quality (CQ) or a bright quality (BQ) surface finish, the requirements of which are set out in the table below.

**TABLE 4 : CQ AND BQ SURFACE FINISH**

Feature	Bright Quality (BQ) <sup>(1)</sup>	Commercial Quality (CQ)
Coil Break (Creases in Strip)	The surface shall be free of visual evidence of coil break.	Coil break up to 0.10mm deep shall not be cause for rejection.
Pitting	Isolated pits not exceeding 0.05mm deep shall not be cause for rejection.	Isolated pits not exceeding 0.15mm deep shall not be cause for rejection.
O.D. Scarfing	The external weld flash shall be cleanly removed to produce a smooth surface free of tool chatter marks.	The external weld flash shall be cleanly removed. Tool chatter marks up to 0.10mm deep shall not be cause for rejection.
Other Surface Marking <sup>(2)</sup>	Surface marking up to 0.05mm deep shall not be cause for rejection. <sup>(3)</sup>	Surface marking up to 0.10mm deep shall not be cause for rejection. <sup>(3)</sup>

**Note:** 1. Bright quality is suitable for applications where the surface finish is an important feature (eg. for subsequent plating). The amount of polishing required prior to plating will depend upon the standard of finish required.

2. Other surface marking includes longitudinal roll marks, chop marks (quarter moon shaped roll marks), indentations due to metal pick up on weldmill tooling, scratches, reeler straightening marks, handling marks and weld burn (low frequency welding only).

**3. Notwithstanding the above table of possible defects, the overall appearance of the tube shall be consistent with good workmanship.**

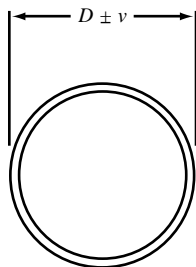
4. The aluminised tube shall be supplied with a commercial quality (CQ) finish as set out above except for the metal sprayed weld area. The aim shall be for a smooth fully coated surface of good workmanship, however surface roughness, flaking or uncoated areas shall not be cause for rejection.

**6.5 Tube Dimensions & Wall Thickness**

**6.5.1 Outside Diameter - Circular Tube**

Circular tube shall be supplied to the following dimensional tolerances:

<b>TABLE 5 : OD TOLERANCES</b>	
<b>Outside Diameter, D (mm)</b>	<b>Maximum Permissible Variation in Outside Diameter, v (mm)</b>
$D \leq 16$	$\pm 0.10$
$16 < D \leq 25$	$\pm 0.15$
$25 < D \leq 50$	$\pm 0.20$
$50 < D \leq 75$	$\pm 0.25$
$75 < D \leq 100$	$\pm 0.30$
$100 < D \leq 125$	$\pm 0.35$



**Note:**

1. If the wall thickness is less than 2.5% of the diameter, the above extreme tolerances shall be increased to 1.5 times the values shown.
2. Due to the possible distortion of the tube on cutting, the outside diameter tolerance does not apply for a distance of 25 mm from the end of mill lengths (MLs) or non standard mill lengths (NSMLs) ie. on tube cut to length on the weldmill - refer to clause 6.8.

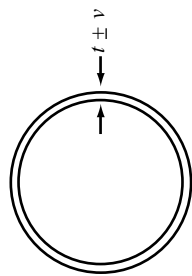
3. For special applications, tighter tolerances can be negotiated in some cases and would be supplied as TS28S.

4. As Formed ERW tube may change shape near the end of the tube due to the effects of welding and cutting when the tube is cut to the final required length.

**6.5.2 Wall Thickness**

Tubing shall be supplied to the wall thickness tolerances as set out below:

<b>TABLE 6 : WALL THICKNESS TOLERANCE</b>	
<b>Wall Thickness, t (mm)</b>	<b>Maximum Permissible Variation in Wall Thickness, v (mm)</b>
$t \leq 1.0$	$\pm 0.10$
$1.0 < t \leq 1.6$	$\pm 0.15$
$1.6 < t \leq 2.0$	$\pm 0.20$
$2.0 < t \leq 3.0$	$\pm 0.25$
$3.0 < t \leq 4.0$	$\pm 0.30$
$4.0 < t \leq 5.0$	$\pm 0.35$
$5.0 < t \leq 6.0$	$\pm 0.40$



**Note:** 1. As localised thickening may occur, the above plus variations do not apply to the weld area as indicated by the width of the heat affected zone.

2. For special applications, tighter tolerances can be negotiated in some cases and would be supplied as TS28S.

## 6.6 Length

### 6.6.1 Mill Lengths

Unless otherwise specified on the order, tubing shall be supplied in mill lengths (ML) of 6100 mm (6.1 metres), or by arrangement, tubing can be supplied ex the weldmill as a non-standard mill length (NSML) within the length range 4000 to 8000 mm eg. 5850 mm NSML. In both cases, a length tolerance of plus 50 mm minus Nil shall apply. No short lengths are to be included in the consignment.

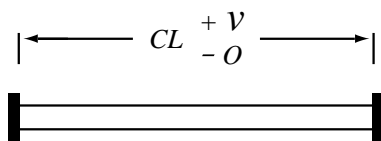
Due to material handling restrictions, NSMLs are normally only supplied within the length range 4000 to 8000 mm. However, by arrangement, lengths outside of this range may be supplied in some cases.

### 6.6.2 Cut Lengths

By arrangement, tubing can be supplied as cut lengths (CL). The tolerances applicable to length are:

**TABLE 7 : CUT LENGTH TOLERANCES**

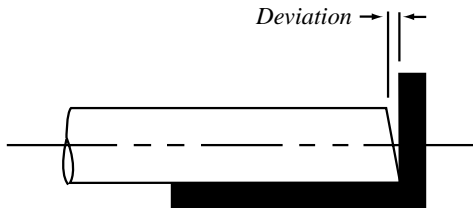
Cut Length, CL(mm)	Max. Permissible Variation in Cut Length, v (mm)
CL ≤ 1000	+1.0, - Nil
1000 < CL ≤ 2000	+1.5, - Nil
2000 < CL ≤ 4000	+3.0, - Nil
4000 < CL ≤ 6000	+4.5, - Nil
CL > 6000	+6.0, - Nil



**Note:** 1. The tube length shall be taken to be the measured distance between two parallel plates in contact with each end of the tube. This could vary from the overall length measured along the outside of the tube using a micrometer, vernier or similar device due to the tolerance for end squareness.

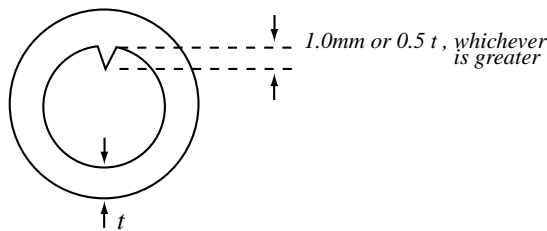
**6.6.3 End Squareness**

End squareness shall be expressed as the maximum deviation that can be measured between the end of the tube and a straight edge in contact with the end of the tube and at right angles to the tube axis. The maximum allowable out of squareness shall be 0.05 mm per 10 mm of O.D. (equivalent to 0.3°). End squareness shall apply only to cut lengths up to 1000 mm.



**6.7 Height of Weld Upset**

The external weld upset shall be removed completely i.e. flush with the outside surface of the tube. The internal weld upset or fin is not normally removed and the height may measure up to 1.0 mm or 50% of the nominal wall thickness whichever is the greater. This condition is designated Normal Fin (NF).



**6.8 End Condition**

**6.8.1 Mill Lengths**

Tube shall be supplied with shear or saw cut mill ends that may have a small shear dimple or burrs.

**Note:** 1. As Formed ERW tube may change shape near the end of the tube due to the effects of welding and cutting. Due to the possible distortion of the tube on cutting, the outside dimensional tolerance does not apply for a distance of 25 mm from each end of tube cut on the weldmill. By arrangement, tube with reduced end distortion can be supplied in some cases, and would be supplied to TS28.

**6.8.2 Cut Lengths**

Cut lengths can be supplied with the following specific end conditions:

**(a) As Cut**

Tube ends will be as cut by a shear, saw, laser or lathe and some cutting burr could remain.

**(b) Deburred**

Safe to handle and no dimensional evidence of burr on the outside or inside of the tube.

The aim is to completely remove the external and internal burr with minimum stock removal. Unless otherwise specified, there may be evidence of a burr on the end face. Tool chatter is to be avoided but shall not be cause for rejection (workmanship).

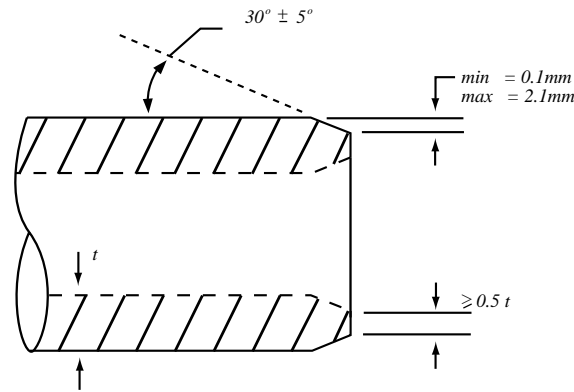
**(c) Chamfer**

The tube end shall be tool cut on the external and/or internal surface of the tube end to the following dimensions (unless otherwise negotiated and specified on the order).

Angle of Chamfer	=	$30^{\circ} \pm 5^{\circ}$
Min. Length of Chamfer	=	0.10 mm
Max. Length of Chamfer	=	2.10 mm

Stock removal - at least 50% of nominal wall thickness shall remain after internal and/or external chamfering.  
 Tool chatter - shall be avoided but shall not be cause for rejection (workmanship).

- Note:**
1. Cut lengths specified as Deburred may be supplied in the Chamfered condition.
  2. Other specific end finishing requirements can be supplied subject to enquiry.



**6.9 End Welds [Cross Welds]**

Tubes containing the cross welds used to join the end of one coil of strip to the next shall not be included in the consignment.

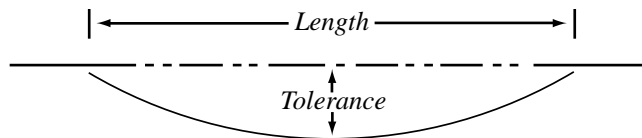
**6.10 Straightness**

For lengths greater than or equal to 1000 mm the straightness tolerance shall be as shown in the table below, which assumes the tube to be bent in a constant radius, measured against a straight edge.

For lengths less than 1000 mm the straightness tolerance shall be 0.20 mm maximum deviation.

**TABLE 12 : STRAIGHTNESS TOLERANCE**

<b>Length (mm)</b>	1,000	2,000	3,000	4,000	5,000	6,000	6,100	7,000	8,000
<b>Tolerance (mm)</b>	0.2	1.1	2.5	4.4	6.9	10.0	10.3	13.6	17.8



By arrangement, tube with other straightness tolerances can be supplied in some cases, and would be supplied to TS28S.

**6.11 Rust Prevention**

Uncoated Hi-Form (non aluminised) tubes shall be supplied with a light, readily removable, rust preventative, designed to withstand corrosion when stored in normal conditions under cover for at least 3 months from the time of delivery.

Hi-Form (Aluminised) tube shall be supplied without the above temporary rust preventative coating.

**6.12 Packaging**

Standard packaging for mill lengths and some cut lengths is batten-strapped, rectangular packs.

- Note:**
1. By arrangement, packs can be supplied with plastic wrapping.
  2. By arrangement, other packaging options may be available. For example, stillages may be used to supply cut lengths, and large diameter tubing may be supplied in crates.
  3. Standard pack sizes for mill lengths are described in the Dimensions and Properties section of the BTM Customer Information Handbook. Different pack sizes shall be the subject of agreement between the customer and the supplier.

**7.0 Control**

This specification is not to be reproduced without the authority of the originator.

Holders of this specification should determine its validity prior to use.

# BTM<sup>®</sup> TUBE PRODUCTS

**Technical specifications are also available for the following BTM Precision Tubing products:**

<b>TS 11</b>	Black (hot rolled) ERW steel tubing for general applications
<b>TS 21</b>	Low carbon ERW steel tubing for general applications(EzyForm)
<b>TS 22</b>	ERW steel tubing with specified mechanical properties(Hi-Lite <sup>®</sup> )
<b>TS 28</b>	Low carbon ERW Hi-Form <sup>®</sup> and Hi-Form <sup>®</sup> (Aluminised) steel tubing for use in automotive exhaust systems
<b>TS 29</b>	ERW stainless steel tubing for use in automotive exhaust applications
<b>TS 30</b>	Low carbon ERW Galvabond <sup>®</sup> steel tubing for general applications
<b>TS 31</b>	Low carbon ERW steel tubing with special requirements
<b>TS 41</b>	Low carbon ERW steel tubing for fluid carrying applications.
<b>TS 50</b>	Low carbon powder coated ERW Galvabond <sup>®</sup> steel tubing(Tubecolor <sup>®</sup> ).

**OneSteel Market Mills has a range of other Technical Specifications for products and/or applications not listed above.**

**Please contact OneSteel Direct for further Information**

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