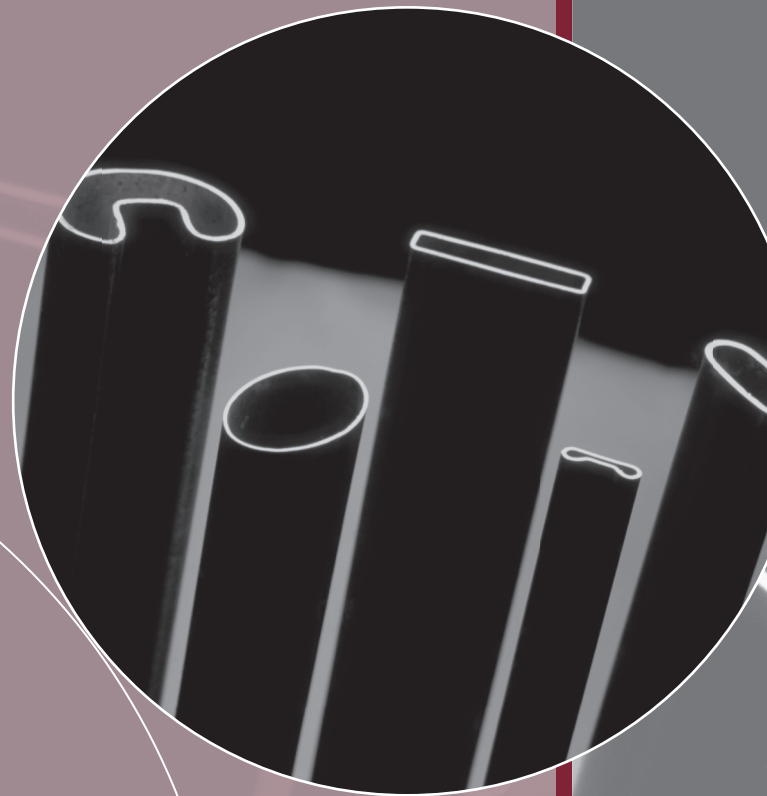


TECHNICAL SPECIFICATION – TS41

LOW CARBON ERW STEEL TUBING FOR FLUID CARRYING APPLICATIONS



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1.0 Scope

This specification covers the technical requirements for the production and supply of low carbon ERW (electric resistance welded) steel tubing supplied in the As Formed Condition with an eddy current test and a commercial quality surface finish. This product is intended for use in fluid carrying applications.

- Note:
1. Tubing in the As Formed condition with a black surface finish and produced from black (hot rolled) strip for general applications, is covered in; TS11 Black (Hot Rolled) ERW Steel Tubing for General Applications.
 2. Tubing in the As Formed condition with a Commercial Quality or Bright Quality surface finish without an special requirements (EzyForm), is covered in; TS21 Low Carbon ERW Steel Tubing for General Applications.
 3. Tubing in other steel grades, which is supplied with specified tensile properties or specific chemistries for structural and mechanical purposes, is covered in; TS22 ERW Steel Tubing with Specified Mechanical Properties (Hi-Lite®).
 4. Tubing supplied in the As Formed condition with special requirements in relation to fin cutting, dimensional tolerances, mechanical tests and/or other additional requirements, is covered in; TS31 Low Carbon ERW Steel Tubing with Special Requirements.
 5. OneSteel recommends that where tube is to be used in a pressure application, the final assembly is pressure tested at a level exceeding the normal working pressure in accordance with statutory requirements.

2.0 References

ATM Precision Tube Customer Information Handbook - Standard Terminology Australian Standard AS2084 Non-Destructive Testing - Eddy Current Testing of Metal Tubes.

3.0 Definitions

Terms used in this specification are defined in the ATM Precision Tube Customer Information Handbook Standard Terminology.

4.0 Designation

Tubing ordered to this specification shall be designated as TS41 EzyForm followed by the calibration standard, eg TS41 Ezyform ED08 - refer clause 6.5

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 6.8.
- (c) Designation eg. TS41 EzyForm EDO8 - refer to clause 4.0.
- (d) Quantity and delivery instructions
- (e) Any special requirements in relation to:
 - (1) Additional mechanical tests - refer to clause 6.3.4
 - (2) Dimensional tolerances - refer to clause 6.7.2.
 - (3) Fin cutting - refer to clause 6.9.2.
 - (4) End distortion for tubing ordered as mill lengths or non-standard mill lengths - refer to clause 6.10.1.
 - (5) End conditions for tubing ordered as exact cut lengths - refer to clause 6.10.2.
 - (6) Straightness - refer to clause 6.12.
 - (7) Any other features - refer to clause 6.15.
- (f) If test certificates are required - refer to clause 6.4.

6.0 Requirements

6.1 Tube Condition

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

6.2 Chemical Composition

The cast analysis of the steel used shall conform to the following:

TABLE 1 : TS41 STANDARD CHEMISTRY		
	Guaranteed Maximum (%)	Typical (%)
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
Alumium (Al)	-	0.035

- Note:
1. The selection of the actual steel grade shall be at the option of OneSteel unless otherwise negotiated and specified on the order.
 2. For special applications, alternative chemical compositions can be negotiated in some cases, and would be supplied to TS22 HiLite®.

6.3 Mechanical Properties

6.3.1 Tensile Test

Tubing in the As-Formed condition shall conform to the following tensile properties:

TABLE 2 : MECHANICAL PROPERTIES				
D/t Ratio	< 15	$15 \leq D/t < 25$	$25 \leq D/t < 35$	≥ 35
Yield Strength MPa (min)	300	275	250	200
Tensile Strength MPa (min)	310	300	290	280
Elongation % (min)	15	20	25	30

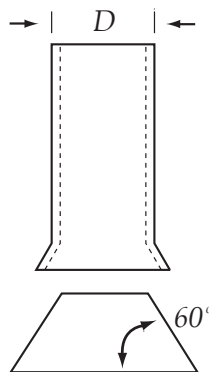
where : D = outside diameter or equivalent round
t = nominal wall thickness

- Note:
1. For special applications, alternative mechanical properties can be negotiated in some cases, and would be supplied to TS22 Hi-Lite®.
 2. Mechanical properties shall be determined in accordance with AS1391.

6.3.2 Flare Test

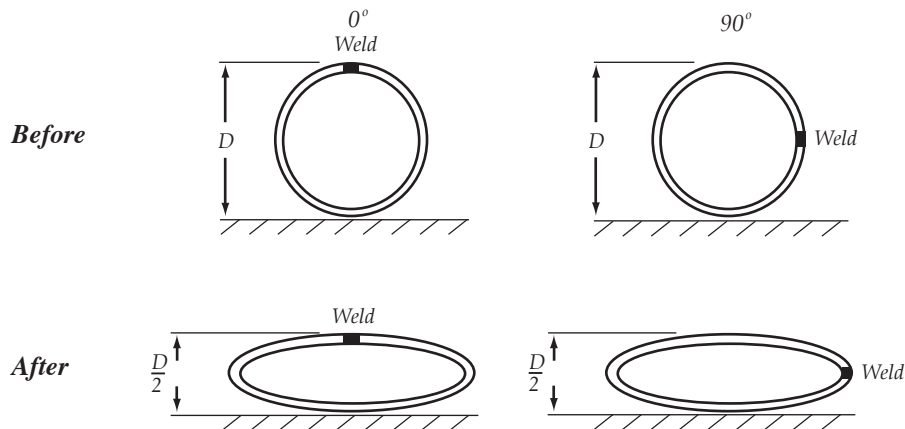
Both circular and non-circular tube shall be capable, with suitable end preparation, of being expanded over a cone or pyramid shaped drift expander until metal failure with no evidence of radial fracture of the weld zone, ie fracture of the weld zone along a radial line from the tube centre to the outside surface is not acceptable.

A ductile/shear (45°) fracture of the weld zone or fracture of the parent metal is acceptable.



6.3.3 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.



Note: 1. These tests are not applicable to non-circular tube.

6.3.4 Special Requirements - Other Tests

By arrangement, tubing can be subjected to more severe flare and/or flattening tests or to other forms of mechanical testing such as bending and bulging.

6.4 Test Certificates

All tube deliveries shall be accompanied by a certificate of compliance to TS41. By arrangement, testing can be performed and certificates supplied.

TABLE 3 : LEVELS OF CERTIFICATION

Designation	Supply Condition
Standard	Certification of Compliance
T	Tested
TC	Test certificate supplied on request

The test certificates contain additional information on traceability, as well as chemical and mechanical test data.

6.5 Eddy Current Test for Verification of Leak Tightness

Each tube shall be eddy current tested for verification of leak tightness. The test shall be performed in accordance with AS2084 Non-Destructive Testing - Eddy Current Testing of Metal Tubes using the calibration standard nominated at the time of order as shown below.

TABLE 4 : EDDY CURRENT TEST	
Designation of Calibration Standard	Diameter of Drilled Hole (mm)
ED08	0.80
ED10	1.00
ED16	1.60

6.6 Surface Finish

Tube shall be supplied with a commercial quality (CQ) surface finish, the requirements of which are:

TABLE 5 : SURFACE FINISH - TS41	
Feature	Commercial Quality (CQ)
Coil Break (Creases in Strip)	Coil break up to 0.10 mm deep shall not be cause for rejection.
Pitting	Isolated pits not exceeding 0.15 mm deep shall not be cause for rejection.
O.D. Scarfing	The external weld flash shall be cleanly removed. Tool chatter marks up to 0.10 mm deep shall not be cause for rejection.
Other Surface Marking ⁽¹⁾	Surface marking up to 0.10 mm deep shall not be cause for rejection. ⁽²⁾

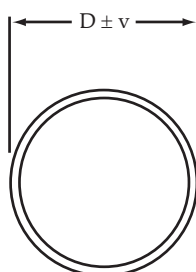
- Note:
- Other surface marking includes longitudinal roll marks, chop marks (quarter moon shaped roll marks), indentations due to metal pick up on weldmill tooling, scratches, reeler straightening marks, handling marks and weld burn (low frequency welding only).
 - Notwithstanding the above table of possible defects, the overall appearance of the tube shall be consistent with good workmanship.

6.7 Tube Dimensions and Wall Thickness

6.7.1 Outside Diameter - Circular Tube

Circular tube shall be supplied to the following dimensional tolerances:

TABLE 6 : OUTSIDE DIMENSIONAL TOLERANCES	
Outside Diameter, D (mm)	Maximum Permissible Variation in Outside Diameter, v (mm)
$D \leq 16$	± 0.10
$16 < D \leq 25$	± 0.15
$25 < D \leq 50$	± 0.20
$50 < D \leq 75$	± 0.25
$75 < D \leq 100$	± 0.30
$100 < D \leq 125$	± 0.35

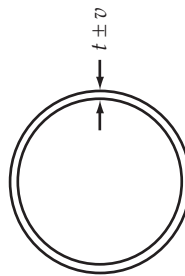


- Note:
1. If the wall thickness is less than 2.5% of the diameter, the above extreme tolerances shall be increased to 1.5 times the values shown.
 2. Due to the possible distortion of the tube on cutting, the outside diameter tolerance does not apply for a distance of 25 mm from the end of mill lengths (MLs) or non standard mill lengths (NSMLs) ie. on tube cut to length on the weldmill - refer to clause 6.9.
 3. 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.

6.7.2 Wall Thickness

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

TABLE 7 : WALL THICKNESS TOLERANCE	
Wall Thickness, t (mm)	Maximum Permissible Variation in Wall Thickness, v (mm)
$t \leq 1.0$	± 0.10
$1.0 < t \leq 1.6$	± 0.15
$1.6 < t \leq 2.0$	± 0.20
$2.0 < t \leq 3.0$	± 0.25
$3.0 < t \leq 4.0$	± 0.30
$4.0 < t \leq 5.0$	± 0.35
$5.0 < t \leq 6.0$	± 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.

6.7.3 Special Requirements - Tighter Dimensional Tolerances

By arrangement, tubing can be supplied to tighter dimensional tolerances in some cases.

6.8 Length

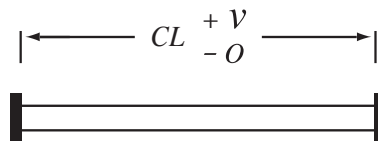
6.8.1 Mill Lengths

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.

6.8.2 Cut Lengths

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

TABLE 8 : CUT LENGTH TOLERANCES	
Cut Length, CL (mm)	Max. Permissible Variation in Cut Length, v (mm)
$CL \leq 1000$	± 0.10
$1000 < CL \leq 2000$	± 0.15
$2000 < CL \leq 4000$	± 0.20
$4000 < CL \leq 6000$	± 0.25
$CL > 6000$	± 0.30



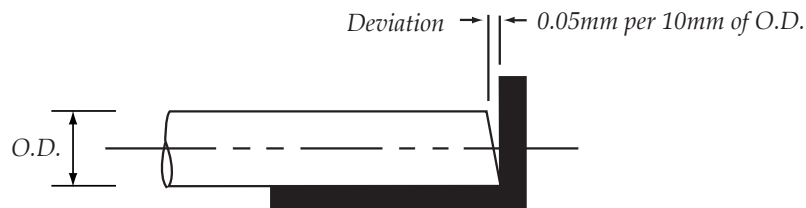
Note: 1. The tube length shall be taken to be the measured distance between two parallel plates in contact with each end of the tube. This could vary from the overall length measured along the outside of the tube using a micrometer, vernier or similar device due to the tolerance for end squareness.

6.8.3 Special Requirements - Tighter Length Tolerances

By arrangement, tubing can be supplied to tighter length tolerances in some cases.

6.8.4 End Squareness

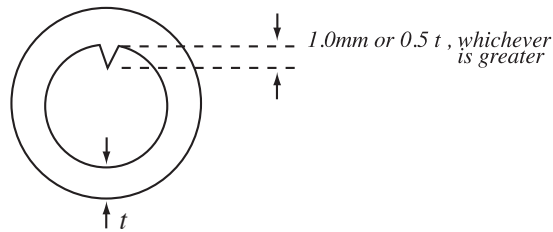
End squareness shall be expressed as the maximum deviation that can be measured between the end of the tube and a straight edge in contact with the end of the tube and at right angles to the tube axis. The maximum allowable out of squareness shall be 0.05 mm per 10 mm of O.D. (equivalent to 0.3°). End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



6.9 Height of Weld Upset

6.9.1 Normal Fin

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).



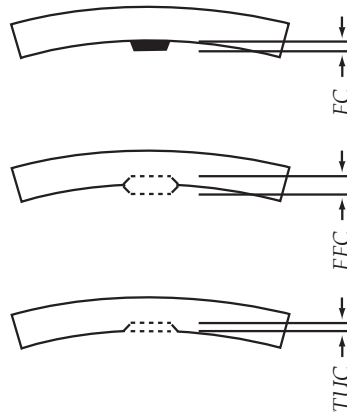
6.9.2 Special Requirements - Fin Cut

By arrangement, the internal weld upset or fin on certain sizes can be removed in accordance with the following standards:

TABLE 9 : FIN CONDITION

Designation	Abbrev.	Wall Thickness, t (mm)	Internal Fin Height ⁽¹⁾ (mm)
Fin Cut	FC	All	+ 0.40 ⁽²⁾
Fully Fin Cut	FFC	All	+ 0.10 ⁽²⁾
Flush to Undercut	FTUC	t < 1.6mm	+ Nil, - 0.15
		1.6 ≤ t ≤ 4.0	+ Nil, - 10% of t
		t > 4.0	+ Nil, - 0.40 ⁽³⁾

- Note:
1. The above tolerances are measured in relation to the wall thickness adjacent to the weld.
 2. In the case of FC and FFC any undercut must not reduce the tube wall thickness below the specified minimum.
 3. In the case of FTUC, it should be noted that the undercutting may reduce the actual wall thickness below the specified minimum.



6.10 End Condition

6.10.1 Mill Lengths

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

6.10.2 Cut Lengths

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

(a) As Cut

Tube ends will be as cut by 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).

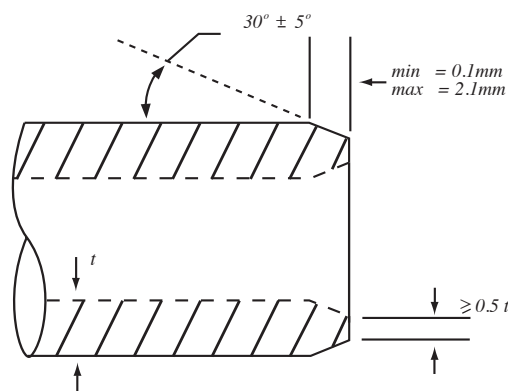
(c) Chamfer

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.



6.11 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.

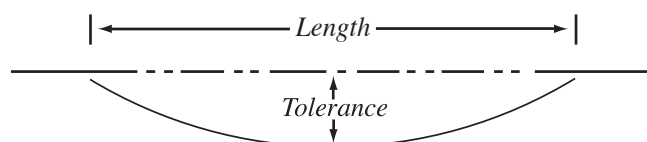
6.12 Straightness

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 1.0mm maximum deviation.

TABLE 10 : STRAIGHTNESS TOLERANCE

Length (mm)	1,000	2,000	3,000	4,000	5,000	6,000	6,100	7,000	8,000
Tolerance (mm)	1.0	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.

6.13 Rust Prevention

6.13.1 Standard Rust Prevention

The tube shall be coated with a light, readily removable, temporary rust preventative, designed to withstand corrosion when stored in normal conditions under cover for at least three months from time of delivery.

6.13.2 Other Rust Prevention

By arrangement, tube may be supplied with greater or lesser amounts of rust preventative in some cases.

6.13.3 No Added Oil

By arrangement, tube can be supplied with no temporary rust preventative added.

- Note:
1. The possibility of corrosion of tube in this state will be greater, and instances of corrosion shall not be cause for rejection.
 2. Residual oils from the manufacturing process may be present.

6.14 Packaging

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

- Note:
1. 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.
 2. Standard rectangular pack sizes for mill lengths are described in the Dimensions and Properties section of the ATM Precision Tube Customer Information Handbook. Different pack sizes shall be the subject of agreement between the customer and the supplier.

6.15 Special Requirements

Any other requirements not covered by the above clauses should be the subject of any enquiry prior to placement of an order.

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.

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

- TS 11** EzyForm - Hot rolled, low carbon ERW steel tubing for general applications
- TS 21** EzyForm - Low carbon ERW steel tubing for general applications
- TS 22** Hi-Lite® - ERW steel tubing with specified mechanical properties
- TS 23** VHS - Mild carbon heat treated ultra high strength ERW steel tubing
- TS 28** Hi-Form® - Low carbon ERW Aluminised steel tubing for use in automotive exhaust systems
- TS 30** GALVATUBE® - Premium low carbon ERW steel tubing for general applications
- TS 31** EzyForm - Low carbon ERW steel tubing with special requirements
- TS 40** ReadiTube® - Low carbon galvanised ERW steel tubing for general applications
- TS 41** EzyForm - Low carbon ERW steel tubing for fluid carrying applications
- TS 50** Tubecolor® - Premium powder coated ERW steel tubing
- TS 60** Painted RT™ - Powder coated ERW steel tubing

OneSteel has a range of other Technical Specifications for products and/or applications not listed above. Please contact OneSteel Direct for further Information or visit our website www.onesteel.com



ONESTEEL DIRECT

Freecall 1800 178 335

Website www.onesteel.com

Freefax 1800 101 141

Email onesteeldirect@onesteel.com

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