

## **Introduction:**

Called Duplex Pipe because of its mixed microstructure with about equal proportions of ferrite and austenite, duplex stainless steels are a family of grades, which range in corrosion performance depending on their alloy content. The chemical composition based on high contents of Cr and Mo, improves intergranular and pitting corrosion resistance, respectively. Additions of nitrogen can promote structural hardening by interstitial solid solution mechanism, which raises the yield strength and ultimate strength values without impairing toughness. Moreover, the two-phase microstructure guarantees higher resistance to pitting and stress corrosion cracking in comparison with conventional stainless steels.

Duplex is a stainless steel made from a mixture of austenite and ferrite phases. Like most austenitic stainless steels, duplex has a strong resistance to corrosion, similar to those of a Type 304 and 316.

Unlike similar steels, duplex also displays an improved resistance to localized corrosion, particularly pitting, crevice corrosion and stress corrosion cracking. And because duplex has a lower nickel and molybdenum content than other austenitic stainless steels, it can prove a more cost effective option due to a lower alloying content.

Due to its Ferritic qualities, duplex steel also shows very good resistance to stress corrosion cracking when compared to standard austenitic. In some cases, the strength of duplex steel can be up to double that of the most commonly used grades of stainless steel.

Duplex becomes brittle at extreme temperatures so its use is normally restricted to a maximum temperature of 300 degrees. Duplex also shows signs of embrittlement at –50 degrees.

## **Benefits:**

Stronger than 300 series stainless steel which also brings weight advantages.

Cheaper than some stainless steels.

High resistance to pitting, crevice corrosion and stress corrosion cracking.

Higher heat conductivity and lower thermal expansion than austenitic steels.

## **Uses:**

Pipes for production and transportation of oil and gas

Structural and mechanical components

Heat exchangers

Cooling pipes

Cargo vessels and containers  
High strength wiring

## Standard of ASTM A789

### 1. Scope\*

1.1 This specification covers grades of nominal wall thickness, stainless steel tubing for services requiring general corrosion resistance, with particular emphasis on resistance to stress corrosion cracking. These steels are susceptible to embrittlement if used for prolonged periods at elevated temperatures.

1.2 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification. The inch-pound units shall apply unless the *M* designation of this specification is specified in the order.

### 2. Referenced Documents

#### 2.1 *ASTM Standards:* 3

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

A 1016/A 1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

E 527 Practice for Numbering Metals and Alloys (UNS)

#### 2.2 *SAE Standard:* 4

SAE J 1086 Practice for Numbering Metals and Alloys (UNS)

### 3. Ordering Information

3.1 Orders for product under this specification should include the following, as required, to describe the desired material adequately:

3.1.1 Quantity (feet, metres, or number of lengths),

3.1.2 Name of product (seamless or welded tubes),

3.1.3 Grade (see Table 1),

3.1.4 Size (outside diameter and nominal wall thickness),

3.1.5 Length (specific or random),

3.1.6 Optional requirements (for product analysis, see Section

8; for hydrostatic or nondestructive electric test, see Section 10),

3.1.7 Test report required (see the Inspection section of

Specification A 1016/A 1016M),

3.1.8 Specification designation, and

3.1.9 Special requirements.

#### **4. General Requirements**

4.1 Product furnished under this specification shall conform to the applicable requirements of Specification A 1016/A 1016M, unless otherwise provided herein.

### **Tensile and Hardness Requirements A**

UNS Designation	Tensile Strength,	Yield Strength,	Elongation in 2 in. or 50	Hardness, max
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	min, ksi[MPa]	min, ksi [MPa]	mm,min, %	Brinell	HRC
S31803	90 [620]	65 [450]	25	290	30
S32205	95 [655]	70 [485]	25	290	30
S31500	92 [630]	64 [440]	30	290	30
S32550	110 [760]	80 [550]	15	297	31
S31200	100 [690]	65 [450]	25	280	...
S31260B	100 [690]	65 [450]	25	290	30
S32001	90 [620]	65 [450]	25	290	30
S32304					
OD 1 in. [25 mm] and Under	100 [690]	65 [450]	25	...	...
OD over 1 in. [25 mm]	87 [600]	58 [400]	25	290	30
S39274	116 [800]	80 [550]	15	310	...
S32750	116 [800]	80 [550]	15	300	32
S32760	109 [750]	80 [550]	25	300	...
S32900	90 [620]	70 [485]	20	271	28
S32950C	100 [690]	70 [480]	20	290	30
S39277	120 [825]	90 [620]	25	290	30
S32520	112 [770]	80 [550]	25	310	...
S32906					
Wall below 0.40 in.(10 mm)	116 [800]	94 [650]	25	300	32
Wall 0.40 in. (10 mm) and above	109 [750]	80 [550]	25	300	32
S32003	90 [620]	65 [450]	25	290	30

A For tubing smaller than 1/2 in. [12.7 mm] in outside diameter, the elongation values given for strip specimens in Table 4 shall apply. Mechanical property requirements do not apply to tubing smaller than 1/8 in. [3.2 mm] in outside diameter or with walls thinner than 0.015 in. [0.4 mm].

B Prior to A 789/A 789M-87, the values for S31260 were: 92 ksi tensile strength, 54 ksi yield strength, and 30 % elongation.

C Prior to A 789/A 789M-89, the tensile strength value was 90 ksi for UNS S32950.

## Chemical Requirements:

UNS Designation A	C	Mn	P	S	Si	Ni	Cr	Mo	N	Cu	Others
S31803	0.030 max	2.00 max	0.030 max	0.020 max	1.00 max	4.5–6.5	21.0–23.0	2.5–3.5	0.08–0.20	...	...
S32205	0.030 max	2.00 max	0.030 max	0.020 max	1.00 max	4.5–6.5	22.0–23.0	3.0–3.5	0.14–0.20	...	...
S31500	0.030 max	1.20–2.00	0.030 max	0.030 max	1.40–2.00	4.3–5.2	18.0–19.0	2.50–3.00	0.05–0.1	...	...
S32550	0.04 max	1.50 max	0.040 max	0.030 max	1.00 max	4.5–6.5	24.0–27.0	2.9–3.9	0.10–0.25	1.50–2.50	...
S31200	0.030 max	2.00 max	0.045 max	0.030 max	1.00 max	5.5–6.5	24.0–26.0	1.20–2.00	0.14–0.20	...	...
S31260	0.030 max	1.00 max	0.030 max	0.030 max	0.75 max	5.5–7.5	24.0–26.0	2.5–3.5	0.10–0.30	0.20–0.80	W 0.10–0.50
S32001	0.030 max	4.00–6.00	0.040 max	0.030 max	1.00 max	1.0–3.0	19.5–21.5	0.60 max	0.05–0.17	1.00 max	...
S32304	0.030 max	2.50 max	0.040 max	0.040 max	1.00 max	3.0–5.5	21.5–24.5	0.05–0.60	0.05–0.20	0.05–0.60	...
S39274	0.030 max	1.00 max	0.030 max	0.020 max	0.80 max	6.0–8.0	24.0–26.0	2.5–3.5	0.24–0.32	0.20–0.80	W 1.50–2.50
S32750	0.030 max	1.20 max	0.035 max	0.020 max	0.80 max	6.0–8.0	24.0–26.0	3.0–5.0	0.24–0.32	0.50 max	...

S32760	0.05 max	1.00 max	0.030 max	0.010 max	1.00 max	6.0–8.0	24.0–26.0	3.0–4.0	0.20–0.30	0.50–1.00	W 0.50–1.00 40 minB
S32900	0.08 max	1.00 max	0.040 max	0.030 max	0.75 max	2.5–5.0	23.0–28.0	1.00–2.00	...	...	...
S32950	0.030 max	2.00 max	0.035 max	0.010 max	0.60 max	3.5–5.2	26.0–29.0	1.00–2.50	0.15–0.35	...	...
S39277	0.025 max	0.80 max	0.025 max	0.002 max	0.80 max	6.5–8.0	24.0–26.0	3.00–4.00	0.23–0.33	1.20–2.00	W 0.80–1.21
S32520	0.030 max	1.50 max	0.035 max	0.020 max	0.80 max	5.5–8.0	23.0–25.0	3.–5.	0.20–0.35	0.50–3.00	...
S32906	0.030 max	1.50 max 0.80 min	0.030 max	0.030 max	0.50 max	7.5 max 5.8 min	30.0 max 28.0 min	2.60 max 1.50 min	0.40 .30	0.80 ...	... ...
S32003	0.030 max	2.00 max	0.030 max	0.020 max	1.00 max	3.0-4.0	19.5-22.5	1.50-2.00	0.14-0.20	...	...

### Permissible Variations in Dimensions:

Group	Size, Outside Diameter, in. [mm]	Permissible Variations in Outside Diameter, in.[mm]	Permissible Variations in Wall Thickness,A %	Permissible Variations in Cut Length, in.B [mm]		Thin Walled TubesC
				Over	Under	
1	Up to 1/2 [12.7], excl	±0.005 [0.13]	±15	1/8 [3]	0	...
2	1/2 to 1 1/2 [12.7 to 38.1], excl	±0.005 [0.13]	±10	1/8 [3]	0	less than 0.065 in. [1.6 mm] nominal
3	1 1/2 to 3 1/2 [38.1 to 88.9], excl	±0.010 [0.25]	±10	3/16 [5]	0	less than 0.095 in. [2.4 mm] nominal
4	3 1/2 to 5 1/2 [88.9 to 139.7], excl	±0.015 [0.38]	±10	3/16 [5]	0	less than 0.150 in. [3.8 mm] nominal
5	5 1/2 to 8 [139.7 to 203.2], incl	±0.030 [0.76]	±10	3/16 [5]	0	less than 0.150 in. [3.8 mm] nominal

A When tubes as ordered require wall thicknesses 3/4 in. [19 mm] or over, or an inside diameter 60 % or less of the outside diameter, a wider variation in wall thickness

is required. On such sizes a variation in wall thickness of 12.5 % over or under will be permitted.

For tubes less than 1/2 in. [12.7 mm] in inside diameter that cannot be successfully drawn over a mandrel, the wall thickness may vary 615 % from that specified.

B These tolerances apply to cut lengths up to and including 24 ft [7.3 m]. For lengths greater than 24 ft [7.3 m], the above over-tolerances shall be increased by 1/8 in.

[3 mm] for each 10 ft [3 m] or fraction thereof over 24 ft or 1/2 in. [13 mm], whichever is the lesser.

C Ovality provisions of 12.2 apply.