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An American National Standard

Standard Specification for Non-Reinforced Extruded Tee Connections for Piping Applications[1]

This standard is issued under the fixed designation F 2014; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the pipe materials and dimensions for producing non-reinforced extruded tee connections manufactured by mechanical forming processes. The term "extruded tee connection" applies to butt-weld or socket-weld connections. This specification refers to the forming process that leads to welding or brazing.

1.2 The non-reinforced extruded pipe tee connection is an alternative to the tee fittings, nozzle, and other welded connections.

1.3 The non-reinforced extruded pipe tee connection has been widely used for systems in the marine, process piping, food, pharmaceutical, and similar industries.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 The extruded tee connection will be welded in accordance with Specification F 722. Brazing of tee connections will be in accordance with ANSI B31.5.

2. Referenced Documents

2.1 *ASTM Standards:*

A 53/A 53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless[2]

A 106 Specification for Seamless Carbon Steel Pipe for High-Temperature Service[2]

A 135 Specification for Electric-Resistance-Welded Steel Pipe[2]

A 139 Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)[2]

A 161 Specification for Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service[2]

A 178/A 178M Specification for Electric-Resistance-Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes[2]

A 199/A 199M Standard Specification for Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes[3]

A 200 Specification for Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service[2]

A 209/A 209M Specification for Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes[2]

A 210/A 210M Specification for Seamless Medium-Carbon Steel Boiler and Superheater Tubes[2]

A 250/A 250M Specification for Electric-Resistance-Welded Ferritic Alloy-Steel Boiler and Superheater Tubes[2]

A 252 Specification for Welded and Seamless Steel Pipe Piles[2]

A 312/A 312M Specification for Seamless and Welded Austenitic Stainless Steep Pipes[2]

A 333/A 333M Specification for Seamless and Welded Steel Pipe for Low-Temperature Service[2]

A 334/A 334M Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service[2]

A 500 Specification for Cold-Formed Welded and Seamless Carbon-Steel Structural Tubing in Rounds and Shapes[2]

A 512 Specification for Cold-Drawn Buttweld Carbon-Steel Mechanical Tubing[2]

A 519 Specification for Seamless Carbon and Alloy Steel Mechanical Tubing[2]

A 587 Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry[2]

A 589 Specification for Seamless and Welded Carbon-Steel Water-Well Pipe[2]

A 672 Specification for Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures[2]

B 88 Specification for Seamless Copper Water Tube[4]

B 88M Specification for Seamless Copper Water Tube [Metric][4]

B 280 Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service[4]

B 337 Specification for Seamless and Welded Titanium and

[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

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[2] *Annual Book of ASTM Standards*, Vol 01.01.

[3] Discontinued; see *1994 Annual Book of ASTM Standards*, Vol 01.01. Replaced by Specification A 200.

[4] *Annual Book of ASTM Standards*, Vol 02.01.

Titanium Alloy Pipe[5]
B 338 Specification for Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers[6]
B 466/B 466M Specification for Seamless Copper-Nickel Pipe and Tube[4]
B 467 Specification for Welded Copper-Nickel Pipe[4]
F 722 Specification for Welded Joints for Shipboard Piping Systems[7]

2.2 *ANSI Standards:*
B31.1 Power Piping[8]
B31.3 Chemical Plant and Petroleum Refining Piping[8]
B31.5 Refrigeration Piping[8]
B36.10M Welded and Seamless Wrought Steel Pipe[8]

2.3 *ISO Standard:*
ISO-4200 Plain End Steel Tubes, Welded and Seamless—General Table 5 of Dimensions and Masses Per Unit Length[8]

3. Terminology

3.1 *Definitions:*

3.1.1 *extruded tee connection*—the tee outlet formed from the run pipe, subsequently welded or brazed to make a connection (see Fig. 1), also known in industry as a branch connection, mechanically formed tee connection, and also extruded outlet.

3.2 *tee ratio*—the ratio of the formed tee connection diameter, divided by the run pipe diameter as follows:

$$\frac{Dt}{Dr} = \text{tee ratio} \qquad (1)$$

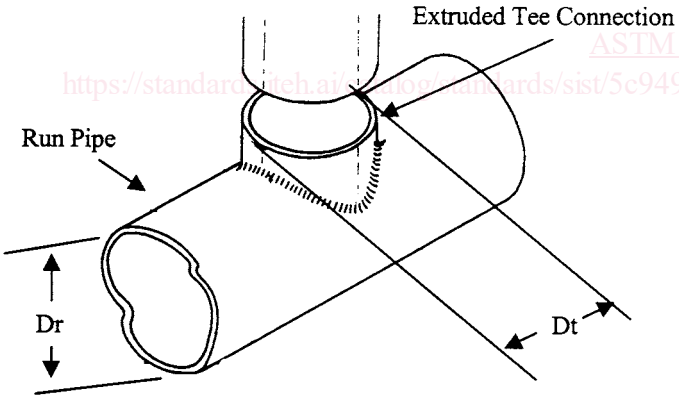

FIG. 1 Extruded Tee Connection

4. Dimensions and Tolerances

4.1 For welded connections, the dimensions and tolerances of the extruded tee connection shall be within the tolerances of the mating pipe in accordance with Specification F 722, as applicable to ANSI B31.1 and B31.3.

4.2 For braze connections, the dimensions and tolerances of the extruded tee connection shall be within the tolerances of the mating pipe in accordance with Specification F 722, as applicable to B31.5.

5. Run Pipe Materials and Limitations

5.1 Table 1 contains a list of materials that have been found to have acceptable forming qualities to produce extruded tee connections:

TABLE 1 Materials That Have Acceptable Forming Qualities To Produce Extruded Tee Connections

Material	ASTM Material Specifications
Copper	B 88, B 88M
	B 280
Copper nickel	B 466/B 466M
	B 467
Titanium[A]	B 337 Grades 1 and 2
	B 338 Grades 1 and 2
Steel[B,C]	A 53/A 53M
	A 135
	A 161 low carbon
	A 199/A 199M Grade T11
	A 209/A 209M Grade T1
	A 250/A 250M Grade T16
	A 333/A 333M Grade 1
	A 500 Grade A
	A 519 Grade 1010
	A 589 Grade A
	A 106 Grade B
	A 139 Grade A
	A 178/A 178M
	A 200 Grade T36
	A 210/A 210M Grade A-1
	A 252 Grade 1
	A 334/A 334M Grade 1
	A 512 Grade MT 1010
	A 587
	A 672 Grade A-4
Stainless steel	A 312/A 312M TP 304
	A 312/A 312M TP 304L
	A 312/A 312M TP 309S
	A 312/A 312M TP 310S
	A 312/A 312M TP 316
	A 312/A 312M TP 316L
	A 312/A 312M TP 317
	A 312/A 312M TP 321
	A 312/A 312M TP 347

[A] Titanium run pipe must be commercially pure (99.1 %) and is limited to a maximum tee ratio of d.8.

[B] The material shall be in a normalized or fully annealed condition before cold forming the extruded tee.

[C] Steel shall be hot formed in the temperature range from 850 to 1000°C (from 1562 to 1832°F). Under these conditions, no subsequent stress relieving is required.

6. Finish, Appearance, and Repairs

6.1 The extruded tee connection shall be free from burrs and cracks, which would affect the suitability for the intended service.

6.2 Pipe/tube repairs are permitted in accordance with the applicable ASTM specification.

[5] Discontinued; see *1996 Annual Book of ASTM Standards*, Vol 02.04. Replaced by Specifications B 861 and B 862.
[6] *Annual Book of ASTM Standards*, Vol 02.04.
[7] *Annual Book of ASTM Standards*, Vol 01.07.
[8] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

7. Run by Tee Connection Sizes (See Figs. 2-13)

7.1 The pipe/tube figures (Figs. 2-13) represent a matrix of the process capabilities, reflecting the extruded tee connections that can be formed from the main pipe/tube diameters and wall thicknesses.

7.2 The pipe and tube sizes and dimensions referred to in Figs. 2-13 are per ANSI B36.10M and ISO 4200. Interpolation is allowable for sizes not covered.

7.3 The limitations are based on current technology and are subject to amendment to equipment or process developments, or both.

8. Allowable Pressures and Temperatures

8.1 The allowable pressures and temperatures shall be in accordance with ANSI B31.1, B31.3, and B31.5 as applicable.

9. Keywords

9.1 extruded outlet; mechanically formed tee connections; outlets; tee connections

RUN TUBE DIAMETER (Dr)	Nominal	Actual	EXTRUDED TEE CONNECTION DIAMETER (Dt) 1/4 (3/8")	3/8 (1/2")	1/2 (5/8")	5/8 (3/4")	3/4 (7/8")	1 (1 1/8")	1 1/4 (1 3/8")	1 1/2 (1 5/8")	2 (2 1/8")	2 1/2 (2 5/8")	3 (3 1/8")	4 (4 1/8")	5 (5 1/8")	6 (6 1/8")	8 (8 1/8")	10 (10 1/8")	12 (12 1/8")
	1/4	(3/8)	L .035																
	3/8	(1/2")	L .040	K .049															
	1/2	(5/8")	L .042	K .049	K .049														
	5/8	(3/4")	L .045	K .065	K .065	K .065													
	3/4	(7/8")	L .050	K .065	K .065	K .065	K .065												
	1	(1 1/8")	L .050	K .065	K .065	K .065	K .080	K .080											
	1 1/4	(1 3/8")	L .055	K .065	K .065	K .065	K .083	K .090	K .080										
	1 1/2	(1 5/8")	M .049	L .065	L .065	K .072	K .083	K .090	K .090	K .109									
	2	(2 1/8")		M .065	M .065	K .083	K .083	K .090	K .120	K .114	K .114								
	2 1/2	(2 5/8")		M .065	M .065	L .083	K .095	K .090	K .120	K .114	K .114	K .104							
	3	(3 1/8")				M .083	L .095	L .095	K .120	K .120	K .120	K .203	K .203						
	4	(4 1/8")					M .095	M .095	L .120	K .142	K .142	K .216	K .216	K .216					
	5	(5 1/8")							M .120	K .142	K .142	K .237	K .237	K .237	K .237				
	6	(6 1/8")							M .122	K .142	K .142	K .258	K .258	K .258	K .258	K .258			
	8	(8 1/8")										L .258	L .258	L .258	K .258	K .258	K .258		
	10	(10 1/8")										L .258	L .258	L .258	L .258	L .258	L .258	L .258	
	12	(12 1/8")										M .258	M .258	M .258	M .258	M .258	M .258	M .258	M .258

Nearest copper designation to maximum wall ⇨ ⇦Max wall (in)

NOTE 1—Limitation shown in applicable box: K = K copper, L = L copper, and M = M copper.
NOTE 2—Minimum wall copper is Class DWV.
NOTE 3—Dimensions are nominal copper tube size (CTS) with actual OD in parentheses.
NOTE 4—All dimensions are in inches.

FIG. 2 Extruded Tee Connection Sizes and Wall Thickness for Copper Tube (Inches)

RUN PIPE DIAMETER (Dr)	EXTRUDED TEE CONNECTION DIAMETER (Dt)													
	OD	21.3	26.9	33.7	42.4	48.3	60.3	76.1	88.9	114.3	139.7	168.3	219.1	273	323.9
	21.3	2.0 1.0													
	26.9	2.0 1.0	2.0 1.0												
	33.7	2.1 1.0	2.3 1.0	2.0 1.0											
	42.4	2.1 1.0	2.3 1.0	2.3 1.0	2.7 1.0										
	48.3	2.1 1.0	2.3 1.0	3.0 1.0	2.9 1.0	2.9 1.0									
	60.3	2.1 1.0	2.3 1.0	3.0 1.0	2.9 1.0	2.9 1.0	3.6 1.0								
	76.1	2.1 1.0	2.3 1.0	3.0 1.0	3.0 1.0	3.0 1.0	5.1 1.0	5.1 1.0							
	88.9	2.1 1.0	2.3 1.0	3.0 1.0	3.0 1.0	3.0 1.0	5.4 1.0	5.4 1.0	5.4 1.0						
	114.3			3.0 1.0	3.2 1.0	3.2 1.0	5.9 1.0	5.9 1.0	5.9 1.0	5.9 1.0					
	139.7			2.9 1.0	3.6 1.0	3.6 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	5.0 1.0				
	168.3			2.9 1.0	3.6 1.0	3.6 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	5.0 1.0			
	219.1			2.9 1.0	3.7 1.0	3.7 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	4.5 1.0		
	273				3.6 1.0	3.6 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	4.9 1.0	
	323.9						6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	6.2 1.0	5.5 1.0	4.9 1.0

Dt
Dr
Max wall (mm)
Min wall (mm)

NOTE 1—All sizes are shown in millimetres (mm).

FIG. 3 Extruded Tee Connection Sizes and Wall Thickness for Copper Nickel Pipe—Metric (mm)

RUN PIPE DIAMETER (Dr)	EXTRUDED TEE CONNECTION DIAMETER (Dt)														
	PIPE (NPS)	½	3/4	1	1¼	1½	2	2½	3	4	5	6	8	10	12
	½	.065 .025													
	3/4	.080 .025	.080 .040												
	1	.080 .025	.090 .040	.080 .040											
	1¼	.083 .025	.090 .040	.090 .040	.109 .040										
	1½	.083 .025	.090 .040	.120 .040	.114 .040	.114 .040									
	2	.083 .025	.090 .040	.120 .040	.114 .040	.114 .040	.154 .040								
	2½	.083 .025	.090 .040	.120 .040	.120 .040	.120 .040	.203 .040	.203 .040							
	3	.083 .025	.090 .040	.120 .040	.120 .040	.120 .040	.216 .040	.216 .040	.216 .040						
	4	.083 .025	.090 .040	.120 .040	.126 .040	.126 .040	.237 .040	.237 .040	.237 .040	.237 .040					
	5			.114 .040	.142 .040	.142 .040	.258 .040	.258 .040	.258 .040	.258 .040	.200 .040				
	6			.114 .040	.142 .040	.142 .040	.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.200 .040			
	8			.114 .040	.148 .040	.148 .040	.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.177 .040		
	10				.142 .040	.142 .040	.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.197 .040	
	12						.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.258 .040	.220 .040	.258 .040

⇦ Max wall (in)
⇦ Min wall (in)

FIG. 4 Extruded Tee Connection Sizes and Wall Thickness for Copper and Copper Nickel Pipe—NPS