Designation: F2014 – 00(Reapproved 2006)

An American National Standard

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

This standard is issued under the fixed designation F2014; 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 F722. Brazing of tee connections will be in accordance with ANSI B31.5.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A106/A106M Specification for Seamless Carbon Steel Pipe for High-Temperature Service

A135 Specification for Electric-Resistance-Welded Steel Pipe

A139/A139M Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

A161 Specification for Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery (Withdrawn 1999)[3]

A178/A178M Specification for Electric-Resistance-Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes

A199/A199M Specification for Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (Withdrawn 1995)[3]

A200 Specification for Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (Withdrawn 1999)[3]

A209/A209M Specification for Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes

A210/A210M Specification for Seamless Medium-Carbon Steel Boiler and Superheater Tubes

A250/A250M Specification for Electric-Resistance-Welded Ferritic Alloy-Steel Boiler and Superheater Tubes

A252 Specification for Welded and Seamless Steel Pipe Piles

A312/A312M Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

A333/A333M Specification for Seamless and Welded Steel Pipe for Low-Temperature Service

A334/A334M Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service

A500 Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

A512 Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing

A519 Specification for Seamless Carbon and Alloy Steel Mechanical Tubing

A587 Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry

A589 Specification for Seamless and Welded Carbon Steel Water-Well Pipe

A672 Specification for Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures

B88 Specification for Seamless Copper Water Tube

B88M Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys 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] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

Cobalt Alloys B0881
B280 Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
B337 Specification for Seamless and Welded Titanium and Titanium Alloy Pipe (Withdrawn 1997)[3]
B338 Specification for Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers
B466/B466M Specification for Seamless Copper-Nickel Pipe and Tube
B467 Specification for Welded Copper-Nickel Pipe
F722 Specification for Welded Joints for Shipboard Piping Systems

2.2 *ANSI Standards:*
B31.1 Power Piping[4]
B31.3 Chemical Plant and Petroleum Refining Piping[4]
B31.5 Refrigeration Piping[4]
B36.10M Welded and Seamless Wrought Steel Pipe[4]

2.3 *ISO Standard:*
ISO-4200 Plain End Steel Tubes, Welded and Seamless—General Table 5 of Dimensions and Masses Per Unit Length[4]

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.

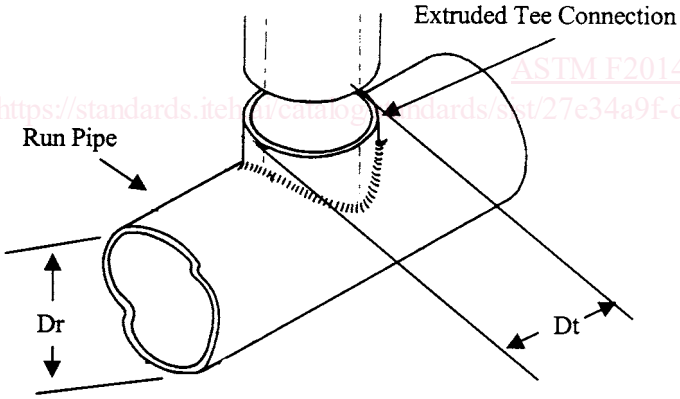

FIG. 1 Extruded Tee Connection

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

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

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

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 F722, 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 F722, 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	B88, B88M
	B280
Copper nickel	B466/B466M
	B467
Titanium[A]	B337 Grades 1 and 2
	B338 Grades 1 and 2
Steel[B,C]	A53/A53M
	A135
	A161 low carbon
	A199/A199M Grade T11
	A209/A209M Grade T1
	A250/A250M Grade T16
	A333/A333M Grade 1
	A500 Grade A
	A519 Grade 1010
	A589 Grade A
	A106/A106M Grade B
	A139/A139M Grade A
	A178/A178M
	A200 Grade T36
	A210/A210M Grade A-1
	A252 Grade 1
	A334/A334M Grade 1
	A512 Grade MT 1010
	A587
	A672 Grade A-4
Stainless steel	A312/A312M TP 304
	A312/A312M TP 304L
	A312/A312M TP 309S
	A312/A312M TP 310S
	A312/A312M TP 316
	A312/A312M TP 316L
	A312/A312M TP 317
	A312/A312M TP 321
	A312/A312M 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.

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

	EXTRUDED TEE CONNECTION DIAMETER (Do)																																	
RUN TUBE DIAMETER (Dr)	Nominal	Actual	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) (rows) × Extruded Tee Connection Diameter (Dt) (columns). Each cell: Max wall (mm) / Min wall (mm).

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

Max wall (mm)
Min wall (mm)

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

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

RUN PIPE DIAMETER (Dr)	EXTRUDED TEE CONNECTION DIAMETER (Dt)													
PIPE (NPS)	½	¾	1	1¼	1½	2	2½	3	4	5	6	8	10	12
½	.065 .025													
¾	.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