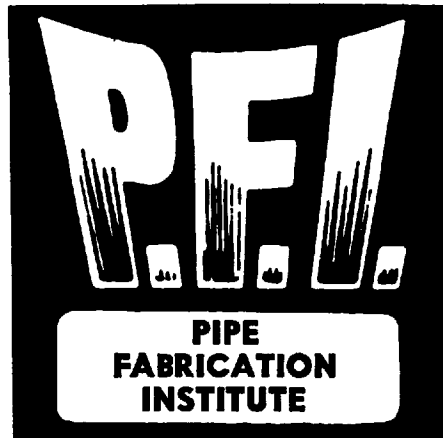


Internal Machining and Fit-up of GTAW Root Pass Circumferential Butt Welds

Prepared by
Pipe Fabrication Institute Engineering Committee



All PFI Standards are advisory only. There is no agreement to adhere to any PFI Standard and their use by anyone is entirely voluntary.

Copyright by
PIPE FABRICATION INSTITUTE
*Dedicated to Technical Advancement and Standardization in
the Pipe Fabrication Industry*
Since — 1913

P. O. Box 173 ● Springdale, PA 15144

Denotes Revision |

INTERNAL MACHINING AND FIT-UP

GTAW ROOT PASS CIRCUMFERENTIAL BUTT ENDS

METRIC CONVERSIONS

The conversion of quantities between systems of units involves a determination of the number of significant digits to be retained. All conversions depend upon the intended precision of the original quantity and are rounded to the appropriate accuracy.

Pipe sizes together with applicable wall thicknesses are not shown with metric equivalents.

Table 1 and 2 Machining Dimensions are not shown with metric equivalents.

The SI (metric) values were included with the customary U.S. values in this Standard are the rounded equivalents of the U.S. values and are for reference only.

Metric units were derived utilizing the following conversion factor.

Conversion	Factor
inches to millimeter	25.4

1. Scope

- 1.1 This Standard covers the internal machining and fit-up tolerances for seamless and welded piping components when the gas tungsten-arc welding process is used for the root pass of circumferential butt welds.

2. End Preparation and Fit-up Tolerances

- 2.1 Typical end preparations for different wall thicknesses are shown in Figures 1 through 5. Those dimensions which are marked with an asterisk (*) may be modified as appropriate for the applicable welding process and variables associated with that process. These specific dimensions shall be defined in the Welding Procedure Specification.
- 2.2 Refer to Table 1 for fit-up tolerances that are applicable to gas tungsten-arc root pass welding with or without consumable insert rings.

3. Internal Machining

- 3.1 To determine I.D. dimensions that must be maintained (usually by machining) to limit internal mismatch to that required for gas tungsten-arc root pass welding, the following terms apply:

A = specified outside pipe diameter
B = nominal inside pipe diameter
C = I.D. machining dimension
d = specified minimum inside diameter
Mo = over tolerance on C-bore
Mu = under tolerance on C-bore
Ru = under tolerance on outside diameter

So = over tolerance on inside diameter

Su = under tolerance on inside diameter

T = minimum ordered wall thickness

t = nominal wall thickness

t_m = minimum wall required by design

- 3.2 To assure proper fit-up of adjoining components, and to assure proper fit-up of consumable inserts (where used), it is recommended that "Mo" be set at $+0.010"$ (0.3mm) and "Mu" at $-0.040"$ (1.0mm).

NOTE:

It must be recognized that large diameter pipe with a relatively thin wall has a tendency to spring back after removal from the machining fixture. The tolerance (Mu or Mo) on the internal machining dimension "C" is therefore applicable to the ends measured in the restrained condition. This should be considered when checking the "C" dimension after removal from the machining fixture.

- 3.3 Pipe and companion components specified by outside diameter.

- 3.3.1 For pipe and companion components specified by outside diameter and minimum wall the I.D. machining dimension is determined as:

$$C = A - Ru - Mo - 2t_m \quad \begin{matrix} + Mo \\ - Mu \end{matrix}$$

- 3.3.2 For seamless and hollow forged pipe to ASTM A106, A312, A335, A376, or A405 "Ru" = 0.031" (0.8mm) Using the recommended values of "Mo" and "Mu" in Paragraph 3.2, Formula 3.3.1 becomes:

$$C = A - 0.041 - 2t_m \quad \begin{matrix} +0.010" \\ -0.040" \end{matrix}$$

- 3.3.3 For pipe specified by outside diameter and nominal wall (or schedule) where the ASTM 12½% nominal to minimum wall thickness tolerance applies, Formula 3.3.1 becomes:

$$C = A - 0.041 - 1.75t \quad \begin{array}{l} +0.010'' \\ -0.040'' \end{array}$$

"C" dimensions for standard ANSI B36.10 pipe sizes, 24" and under with wall thickness 0.562" (14mm) and heavier are published in Table 2. These dimensions have been calculated in accordance with Formula 3.3.3.

- 3.4 Pipe and companion components specified by inside diameter.

- 3.4.1 The formulas below may be used as a guide to determine the internal machining dimension for pipe and companion components specified by inside diameter.

$$C = d + So + Su - Mo \quad \begin{array}{l} + Mo \\ - Mu \end{array}$$

NOTES:

1. Where "d" is specified as nominal instead of minimum I.D., "Su" should be dropped from the expression.
2. When using welded pipe, permissible variations in out-of-roundness and diameter may make procurement of pipe with sized ends desirable. In this case "So" should be set equal to the plus sizing tolerance and "Su" the minus sizing tolerance.
- 3.5 Where the outside and/or inside diameters of the adjacent components differ from each other by more than the nominal tolerances, the heavier component shall be tapered in accordance with ANSI B16.25, Figure 1.

4. Material Ordering

- 4.1 In some cases selection of I.D. machining dimensions may affect ordered wall thicknesses of pipe and companion components.

- 4.2 Seamless pipe ordered by outside diameter: Formulas 3.3.1, 3.3.2 and 3.3.3 are intended to permit minimum wall to be maintained without purchase of material having wall thickness

in excess of that required to satisfy " t_m " or T as applicable.

When pipe and adjoining components are received with the O.D. larger than dimension "A" but within the permitted O.D. tolerance, it may be necessary to perform an additional operation of depositing weld metal on the I.D. or O.D. surface at the welding end (weld buildup) to assure full circumferential boring and t_m .

- 4.3 Pipe ordered to inside diameter:

When the formula listed in 3.4.1 is used for computing internal machining dimensions, and pipe is received with the I.D. at the minimum of the permitted tolerance range, the possibility exists that machining will encroach on " t_m ".

To minimize this problem, one of the following options may be utilized.

- a) The ordered pipe wall thickness must be increased to provide additional stock for machining by use of the following formula:

$$T = So + Su + t_m + Mo$$

- b) The "C" dimension and the minimum wall (t_m) that must be maintained at the "C" dimension should be specified on the purchase order for the pipe.

Note regarding rolled and welded pipe:

Due to the greater tolerances permitted for this material regarding out of roundness and variation in diameter, use of the options listed in 4.3 above may not necessarily eliminate the need for weld buildups in these materials.

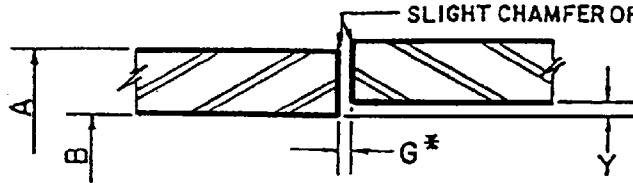


FIG. 1

FOR NOMINAL WALLS 1/16" (1.5mm) AND LESS

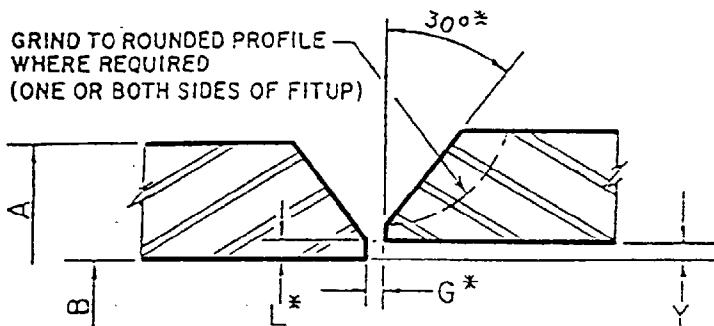


FIG. 2

FOR NOMINAL WALLS OVER 1/16" (1.5mm) TO 7/8" (22mm) INCLUSIVE

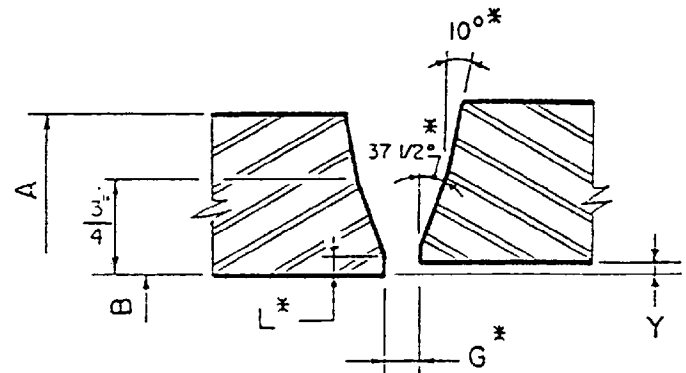


FIG. 3

FOR NOMINAL WALLS OVER 7/8" (22mm)

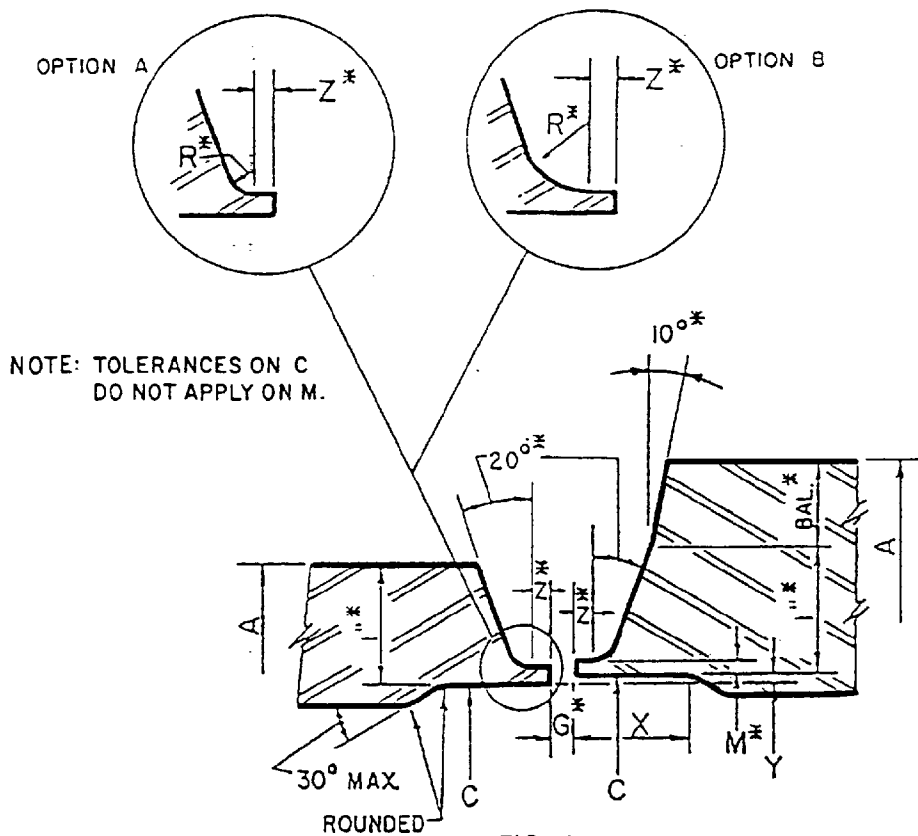


FIG. 4

ALTERNATE
FOR NOMINAL WALLS OVER 3/8" (10mm)

TABLE 1.

Dimensional joint & fit-up tolerances applicable to welding with and without consumable insert rings.

LEGEND	FIG.	WITH INSERT			WITHOUT INSERT
		TYPE A	TYPE B	TYPE C	
G	1	TT + 1/32" Max.	TT + 1/32" Max.	TT + 1/32" Max.	0 to 1/32" Max.
G	2&3	TT + 1/32" Max.	TT + 1/32" Max.	TT + 1/32" Max.	0 to 3/32" Max.
G	4	TT + 1/32" Max.	TT + 1/32" Max.	TT + 1/32" Max.	0 to 1/16" Max.
Y	1	0 to 1/32" Max.	0 to 1/32" Max.	0 to 1/32" Max.	0 to 1/32" Max.
Y	4	0 to 3/32 " Max.	0 to 1/32" Max.	0 to 1/16" Max.	0 to 1/16" Max.
Y	4&5	0 to 3/32" Max.	0 to 1/32" Max.	0 to 1/16" Max.	0 to 1/32" Max.
		With or Without Insert			
R	4A	Slightly Rounded			
R	4B	3/16" (5mm)			
Z	4A	1/8" (3mm) Minimum			
Z	4B	0 to Approx. 1/8" (3mm)			
L	2&3	1/16" ± 1/32" (1.5mm ± 0.8mm)			
M	4	5/64" ± (2mm ± 0.4mm)			
X	4	3/16" (5mm) Minimum			
<u>TYPICAL INSERT RING TYPES</u>					
 TT (TYP.)   TYPE A TYPE B TYPE C					

TABLE 2 MACHINING DIMENSIONS (Continued)

Nominal Pipe Size	Schedule Number or Wall	Nominal O. D. "A"	Nominal I. D. "B"	Nominal Wall Thickness "t"	Machined I. D. of Pipe "C" Tolerance + 0.010 - 0.040
3	XXS	3.500	2.300	.600	2.409
4	XXS	4.500	3.152	.674	3.279
5	160	"	4.313	.625	4.428
	XXS	5.563	4.063	.750	4.209
6	120	6.625	5.501	.562	5.600
	160	"	5.187	.719	5.327
	XXS	"	4.897	.864	5.072
8	100	8.625	7.437	.594	7.546
	120	"	7.187	.719	7.327
	140	"	7.001	.812	7.163
	XXS	"	6.875	.875	7.053
	160	"	6.813	.906	6.998
10	80	10.750	9.562	.594	9.671
	100	"	9.312	.719	9.452
	120	"	9.062	.844	9.234
	140	"	8.750	1.000	8.959
	160	"	8.500	1.125	8.740
12	60	12.750	11.626	.562	11.725
	80	"	11.374	.688	11.507
	100	"	11.062	.844	11.234
	120	"	10.750	1.000	10.959
	140	"	10.500	1.125	10.740
	160	"	10.126	1.312	10.413
14 O.D.	60	14.000	12.812	.594	12.921
	80	"	12.500	.750	12.646
	100	"	12.124	.938	12.319
	120	"	11.812	1.094	12.046
	140	"	11.500	1.250	11.771
	160	"	11.188	1.406	11.498

All dimensions are in inches.

TABLE 2 MACHINING DIMENSIONS

Nominal Pipe Size	Schedule Number or Wall	Nominal O. D. "A"	Nominal I. D. "B"	Nominal Wall Thickness "t"	Machined I. D. of Pipe "C" Tolerance + 0.010 - 0.040
16 O. D.	60	16.000	14.688	.656	14.811
	80	"	14.312	.844	14.484
	100	"	13.938	1.031	14.155
	120	"	13.562	1.219	13.827
	140	"	13.124	1.438	13.442
	160	"	12.812	1.594	13.171
18 O. D.	40	18.000	16.876	.562	16.975
	60	"	16.500	.750	16.646
	80	"	16.124	.938	16.319
	100	"	15.688	1.156	15.936
	120	"	15.250	1.375	15.553
	140	"	14.876	1.562	15.225
20 O. D.	160	"	14.438	1.781	14.842
	40	20.000	18.812	.594	18.921
	60	"	18.376	.812	18.538
	80	"	17.938	1.031	18.155
	100	"	17.438	1.281	17.717
	120	"	17.000	1.500	17.334
22 O. D.	140	"	16.500	1.750	16.896
	160	"	16.062	1.969	16.515
	—	22.000	20.750	.625	20.865
	60	"	20.250	.875	20.428
	80	"	19.750	1.125	19.990
	100	"	19.250	1.375	19.553
24 O. D.	120	"	18.750	1.625	19.115
	140	"	18.250	1.875	18.678
	160	"	17.750	2.125	18.240
	30	24.000	22.876	.562	22.975
	40	"	22.624	.688	22.757
	60	"	22.062	.969	22.265
24 O. D.	80	"	21.562	1.219	21.827
	100	"	20.938	1.531	21.280
	120	"	20.376	1.812	20.788
	140	"	19.876	2.062	20.350
	160	"	19.312	2.344	19.859

dimensions are in inches.

A current index of the latest revised ES Standards and Technical Bulletins is available from the Pipe Fabrication Institute.

PFI Standards and Technical Bulletins are published to serve proven needs of the pipe fabricating industry at the design level and in actual shop operations. Hence, such needs are continually considered and reviewed by the Engineering Committee of the Pipe Fabrication Institute to provide recommended procedures which have been demonstrated by collective experiences to fulfill requirements in a manner for Code compliance. However, as the PFI Standards are for minimum requirements the designer or fabricator always has the option of specifying supplementary conditions in the form of requirements beyond the scope of the PFI publications.