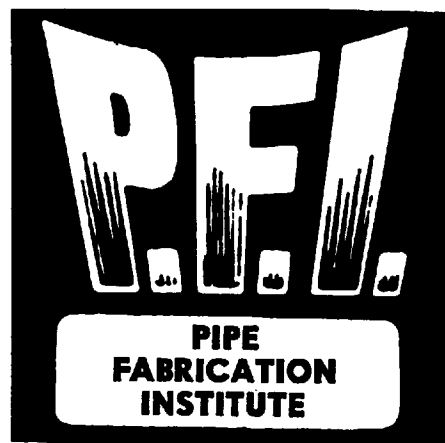


Internal Machining and Solid Machined Backing Rings for Circumferential Butt Welds

Prepared by
Pipe Fabrication Institute Engineering Committee



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INTERNAL MACHINING AND SOLID MACHINED BACKING RINGS FOR CIRCUMFERENTIAL BUTT WELDS

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 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 dimensioning of solid machined backing rings and the internal machining of seamless and welded piping components for use with these rings.
- 1.2 Piping components must be internally machined to a close tolerance to accept solid machined backing rings. For this reason, solid machined backing rings are not recommended for use with piping components with wall thickness less than 0.562" (14mm).

2. Backing Rings

- 2.1 Solid machined backing rings may be of either flat or tapered design. Refer to Figures 1, 2, 3, and 4 for backing ring dimensions and design.
- 2.2 The nominal diameter of a tapered solid machined backing ring shall be 0.010" (0.3mm) larger than the corresponding nominal internal counterbore of the piping component. The nominal diameter of a flat solid machined backing ring shall be equal to the corresponding nominal internal counterbore of the piping component. The diametrical tolerance on either a flat or tapered solid machined backing ring shall be +.000" —.010" (+0.0mm —0.3mm).

3. End Preparation

- 3.1 Typical end preparations for different wall thicknesses are shown in Figures 1 through 4. 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.

4. Internal Machining

- 4.1 The following terms define the various dimensions and tolerances required to compute the internal machining dimensions ("C" dimension) for different types of piping components.

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

- 4.2 To assure proper fit-up of adjoining components, and to assure proper fit-up of the backing ring it is recommended that "Mo" be set at +.010" (0.3mm) and "Mu" at —.000" (—0.000mm).

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, so the tolerance (Mu or Mo) on the internal machining dimension "C" is therefore applicable to pipe ends measured in the restrained condition. This should be considered when checking the "C" dimension after removal from the machining fixture.

- 4.3 Pipe and companion components specified by outside diameter.

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

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

- 4.3.2 For seamless and hollow forged pipe to ASTM A106, A312, A335, A376, or A405, "Ru" = 0.031 in. Using the recommended values of "Mo" and "Mu" in paragraph 4.2 Formula 4.3.1 becomes:

$$C = A - 0.041 - 2t_m \quad \begin{matrix} +.010" \\ -.000" \end{matrix}$$

- 4.3.3 For pipe specified by outside diameter and nominal wall (or schedule) where the ASTM 12½% nominal to minimum wall thickness tolerance applies, Formula 4.3.1 becomes

$$C = A - 0.041 - 1.75 t \quad \begin{matrix} +.010" \\ -.000" \end{matrix}$$

"C" dimensions and corresponding backing ring dimensions for standard ANSI B36.10 pipe sizes, 24" and under with wall thickness 0.562" (14mm) and heavier, are published in Table 1. These dimensions have been calculated in accordance with Formula 4.3.3.

- 4.4 Pipe and companion components specified by inside diameter.

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

- a) for use of flat solid backing rings.

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

- b) for use of tapered solid backing rings where the possibility of weld buildup is to be minimized or eliminated.

$$C = d + So + Mo \quad \begin{matrix} + Mo \\ - Mu \end{matrix}$$

NOTES:

- Where "d" is specified as nominal instead of minimum I.D., "Su" should be dropped from the expression.
- When using welded plate 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.

- 4.5 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.

5. Material Ordering

- In some cases selection of internal machining dimensions may affect ordered wall thicknesses of pipe and mating components.
- Seamless pipe ordered by outside diameter: Formulas 4.3.1, 4.3.2 and 4.3.3 are intended to permit minimum wall to be maintained without purchase of material having wall thickness in excess of that required to satisfy "tm", 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, or when internal machining for solid machined backing rings is performed, 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 satisfactory contact between the internal machined surface of the piping component and the backing ring and to maintain t_m .

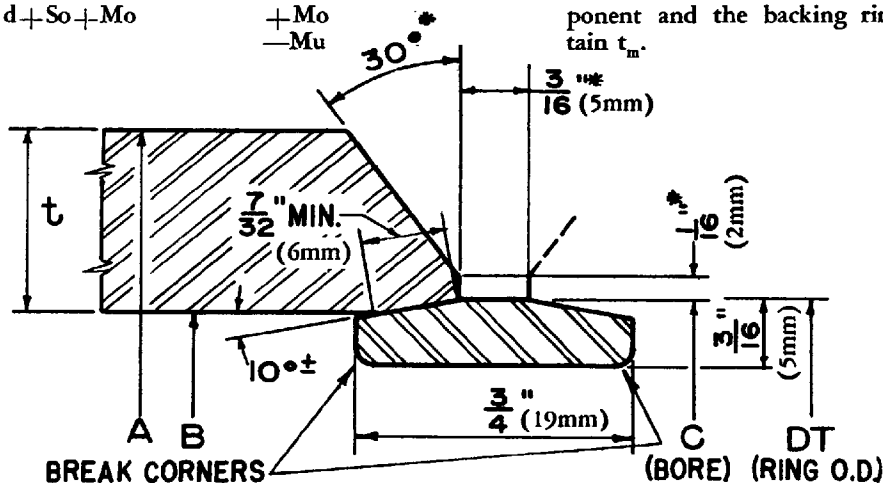


FIG. 1

10° TAPERED BACKING RING FOR NOMINAL WALL THICKNESS (t) 9/16" to 1" (14-25mm) INCLUSIVE

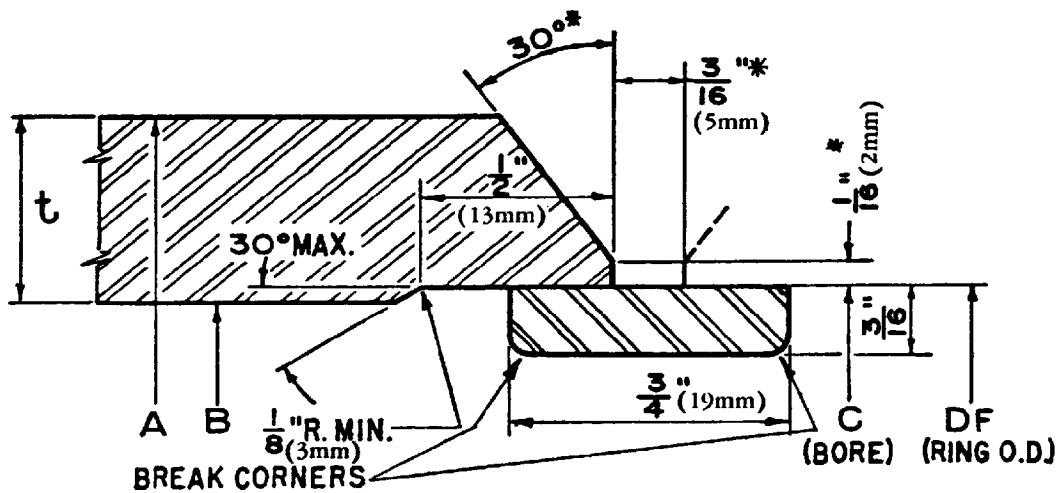


FIG. 2

FLAT BACKING RINGS FOR NOMINAL WALL
THICKNESS (t) 9/16" to 1" INCLUSIVE

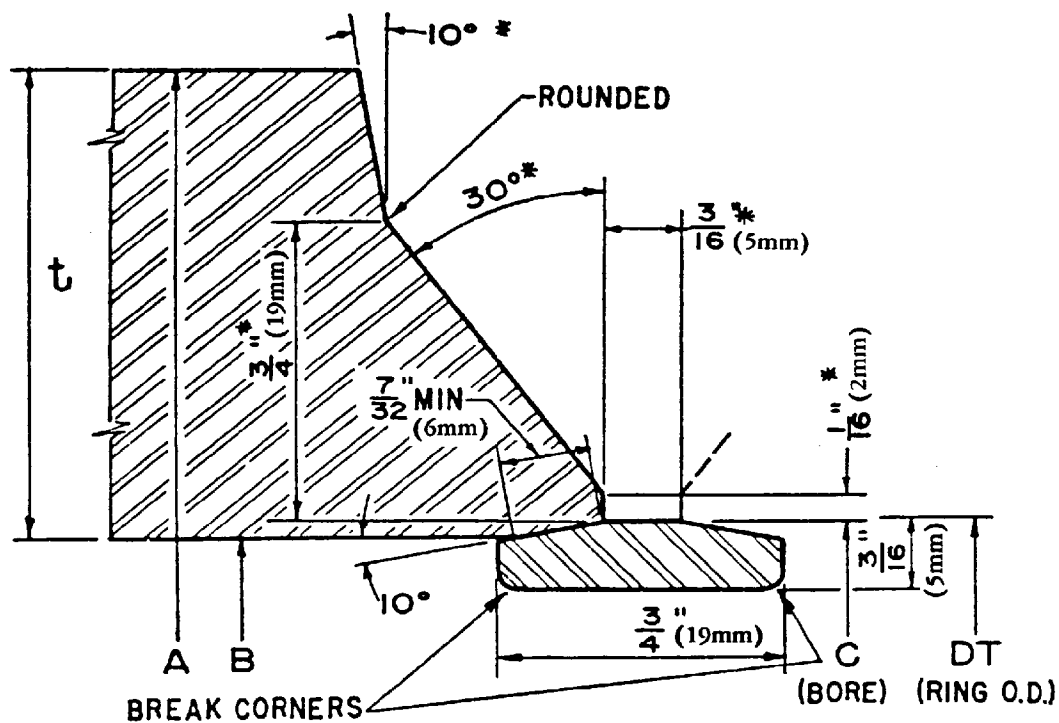


FIG. 3

10° TAPERED RINGS FOR NOMINAL WALL
THICKNESS (t) GREATER THAN 1" (25mm)

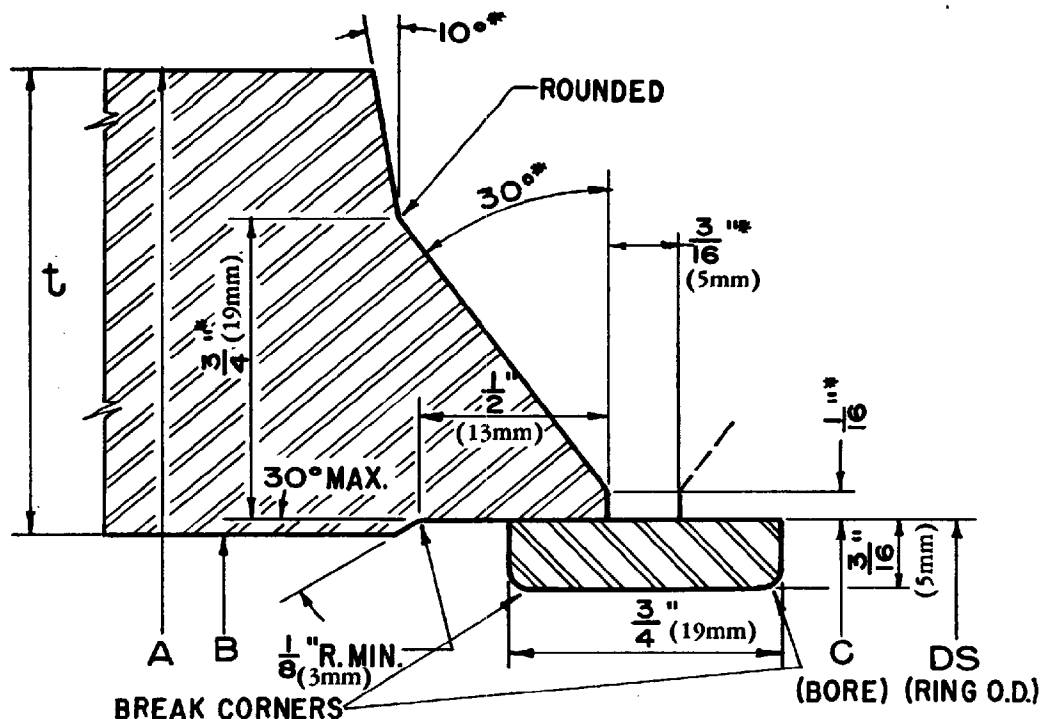


FIG. 4

FLAT BACKING RINGS FOR NOMINAL WALL
THICKNESS (t) GREATER THAN 1" (25mm)

Industry experience indicates that use of Formulas 4.3.1, 4.3.2 and 4.3.3 to determine the internal machining dimension will result in a satisfactory seat contact 7/32" (6mm) minimum (approximately 75% minimum length of contact) between pipe and 10° tapered backing rings. Occasionally it will be necessary to perform a weld buildup to provide sufficient material for machining for satisfactory seating.

5.3 Pipe ordered to inside diameter:

When the formulas listed in 4.4.1 are 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:

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

$$T = S_o + S_u + t_m + M_o$$

- 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 5.3 above may not necessarily eliminate the need for weld buildups in these materials.

TABLE 1 MACHINING DIMENSIONS

Nominal Pipe Size	Schedule Number or Wall	Nominal O. D. "A"	Nominal I. D. "B"	Nominal Wall Thickness "C"	Machined I. D. of Pipe "C" Tolerance $\begin{smallmatrix} + 0.010 \\ - 0.000 \end{smallmatrix}$	O. D. of Backing Ring	
						Tapered Ring "DT" Tolerance $\begin{smallmatrix} + 0.000 \\ - 0.010 \end{smallmatrix}$	Straight Ring "DS" Tolerance $\begin{smallmatrix} + 0.000 \\ - 0.010 \end{smallmatrix}$
3	XXS	3.500	2.300	.600	2.409	2.419	2.409
4	XXS	4.500	3.152	.674	3.279	3.289	3.279
5	160	"	4.313	.625	4.428	4.438	4.428
	XXS	5.563	4.063	.750	4.209	4.219	4.209
6	120	6.625	5.501	.562	5.600	5.610	5.600
	160	"	5.187	.719	5.327	5.337	5.327
	XXS	"	4.897	.864	5.072	5.082	5.072
8	100	8.625	7.437	.594	7.546	7.556	7.546
	120	"	7.187	.719	7.327	7.337	7.327
	140	"	7.001	.812	7.163	7.173	7.163
	XXS	"	6.875	.875	7.053	7.063	7.053
	160	"	6.813	.906	6.998	7.008	6.998
10	80	10.750	9.562	.594	9.671	9.681	9.671
	100	"	9.312	.719	9.452	9.462	9.452
	120	"	9.062	.844	9.234	9.244	9.234
	140	"	8.750	1.000	8.959	8.969	8.959
	160	"	8.500	1.125	8.740	8.750	8.740
12	60	12.750	11.626	.562	11.725	11.735	11.725
	80	"	11.374	.688	11.507	11.517	11.507
	100	"	11.062	.844	11.234	11.244	11.234
	120	"	10.750	1.000	10.959	10.969	10.959
	140	"	10.500	1.125	10.740	10.750	10.740
	160	"	10.126	1.312	10.413	10.423	10.413
14 O.D.	60	14.000	12.812	.594	12.921	12.931	12.921
	80	"	12.500	.750	12.646	12.656	12.646
	100	"	12.124	.938	12.319	12.329	12.319
	120	"	11.812	1.094	12.046	12.056	12.046
	140	"	11.500	1.250	11.771	11.781	11.771
	160	"	11.188	1.406	11.498	11.508	11.498

All dimensions are in inches.

TABLE 1 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 $\begin{smallmatrix} + 0.010 \\ - 0.000 \end{smallmatrix}$	O. D. of Backing Ring	
						Tapered Ring "DT" Tolerance $\begin{smallmatrix} + 0.000 \\ - 0.010 \end{smallmatrix}$	Straight Ring "DS" Tolerance $\begin{smallmatrix} + 0.000 \\ - 0.010 \end{smallmatrix}$
16 O. D.	60	16.000	14.688	.656	14.811	14.821	14.811
	80	"	14.312	.844	14.484	14.494	14.484
	100	"	13.938	1.031	14.155	14.165	14.155
	120	"	13.562	1.219	13.827	13.837	13.827
	140	"	13.124	1.438	13.442	13.452	13.442
	160	"	12.812	1.594	13.171	13.181	13.171
18 O. D.	40	18.000	16.876	.562	16.975	16.985	16.975
	60	"	16.500	.750	16.646	16.656	16.646
	80	"	16.124	.938	16.319	16.329	16.319
	100	"	15.688	1.156	15.936	15.946	15.936
	120	"	15.250	1.375	15.553	15.563	15.553
	140	"	14.876	1.562	15.225	15.235	15.225
20 O. D.	160	"	14.438	1.781	14.842	14.852	14.842
	40	20.000	18.812	.594	18.921	18.931	18.921
	60	"	18.376	.812	18.538	18.548	18.538
	80	"	17.938	1.031	18.155	18.165	18.155
	100	"	17.438	1.281	17.717	17.727	17.717
	120	"	17.000	1.500	17.334	17.344	17.334
22 O. D.	140	"	16.500	1.750	16.896	16.906	16.896
	160	"	16.062	1.969	16.515	16.525	16.515
	—	22.000	20.750	.625	20.865	20.875	20.865
	60	"	20.250	.875	20.428	20.438	20.428
	80	"	19.750	1.125	19.990	20.000	19.990
	100	"	19.250	1.375	19.553	19.563	19.553
24 O. D.	120	"	18.750	1.625	19.115	19.125	19.115
	140	"	18.250	1.875	18.678	18.688	18.678
	160	"	17.750	2.125	18.240	18.250	18.240
	30	24.000	22.876	.562	22.975	22.985	22.975
	40	"	22.624	.688	22.757	22.767	22.757
	60	"	22.062	.969	22.265	22.275	22.265
24 O. D.	80	"	21.562	1.219	21.827	21.837	21.827
	100	"	20.938	1.531	21.280	21.290	21.280
	120	"	20.376	1.812	20.788	20.798	20.788
	140	"	19.876	2.062	20.350	20.360	20.350
	160	"	19.312	2.344	19.859	19.869	19.859

Dimensions are in inches.

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