consumable weld inserts

FOR HIGH-QUALITY ROOT-PASS WELDS

in butt joints of piping and closure welds for vessels

SHAPE A

SHAPE K

Arcos Industries LLC
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1-800-233-8460

standard compositions

The composition of all Arcos Consumable Weld Insert material is carefully controlled to provide sound, crack-free weld metal in the root pass. The effect of typical base metal dilution is considered in determining the composition of the insert necessary to produce root pass weld metal having the required properties. As preplaced filler metal, the Weld Insert assures uniformity in the amount of filler metal added and thereby controls dilution.

Table 1

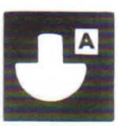
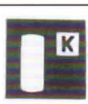
Standard Composition of Consumable Weld Inserts

Type	For Welding	C	Mn	Si	Cr	Ni	Mo	Cb-Ta	Ti	Al	Cu	Fe	W	Co
MS-1	Carbon Steel	.04	1.2	0.5	-	-	-	-	0.1†	0.1	-	Bal.	-	-
MS-2	Carbon Steel	.08	1.2	0.5	-	-	-	-	-	-	-	Bal.	-	-
308L *	302, 304, 304L	.02	1.7	0.4	21.0	10.0	-	-	-	-	-	Bal.	-	-
309L *	309	.02	1.8	0.4	24.0	13.0	-	-	-	-	-	Bal.	-	-
310	310	.10	1.7	0.4	27.0	21.0	-	-	-	-	-	Bal.	-	-
316L	316, 316L	.02	1.7	0.4	19.0	12.0	2.4	-	-	-	-	Bal.	-	-
16-8-2	316	.05	1.5	0.4	16.0	8.5	1.5	-	-	-	-	Bal.	-	-
320LR	20Cb-3	.02	-	1.0	20.0	34.0	2.5	.35	-	-	3.5	Bal.	-	-
348	347, 348	.05	1.7	0.4	20.0	10.0	-	10xC	-	-	-	Bal.	-	-
382	Inconel **	.02	3.0	0.1	20.0	68.0	-	2.5	.05	-	.02	1.0	-	-
382H	Inconel ** (C-.03-,.10)	.04	3.0	0.1	20.0	68.0	-	2.5	.05	-	.02	2.0	-	-
410	410	.10	0.5	0.4	13.0	-	0.5	-	-	-	-	Bal.	-	-
502	502	.08	0.5	0.4	5.5	-	0.5	-	-	-	-	Bal.	-	-
505	9% Cr	.08	0.4	0.4	9.5	-	1.0	-	-	-	-	Bal.	-	-
515	1 1/4% Cr, 1/2% Mo	.08	0.5	0.4	1.3	-	0.5	-	-	-	-	Bal.	-	-
521	2 1/4% Cr, 1% Mo	.08	0.5	0.4	2.5	-	1.0	-	-	-	-	Bal.	-	-
4130	4130, 4340	.30	0.5	0.3	1.0	-	0.2	-	-	-	-	Bal.	-	-
625	625	.04	0.2	0.4	21.5	61.5	9.0	3.5	0.3	0.3	0.2	Bal.	-	-
C276	C276	.01	0.5	.04	16.0	59.8	15.8	-	-	-	-	4.0	3.9	.10
813	Cupro Nickel	.02	0.8	*.05	-	30.0	-	-	0.4	-	Bal.	0.6	-	-
816	Monel**	.10	0.8	*.05	-	64.0	-	-	2.0	1.0	Bal.	2.0	-	-
861	Nickel Steel	.04	.60	*.50	.01	Bal.	-	-	3.0	.45	.03	0.4	-	-

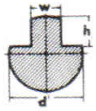
* .04 - .08 C 308, 309, and 316 inserts also available.
** Registered trade names of International Nickel Co., Inc.
† Also Zr 0.03
Note: Several other grades of material other than those listed above can be made into consumable weld inserts, either in ring form, continuous footage, or straight lengths.

standard shapes

The only difference between the two shapes is in their cross-section. The "K" shape inserts permit somewhat greater joint mismatch; otherwise the performance of the two is the same. Best results will be obtained with good fit-up, regardless of the shape used.

Shape	Size in	Size mm	Applications	Fit-up Tolerance in	Fit-up Tolerance mm	MIL Class MIL-I-23413
	3/32" 1/8" 5/32" 3/16"	2.4 3.2 4.0 4.8	For all nuclear power piping and other highly controlled applications where rigid fabrication specifications must be met. Requires matching of I.D., bevel and land.	+/- 1/32	+/- .8	1
	1/16" x 1/8" 1/16" x 3/16" 1/8" x 5/32"	1.6 x 3.2 1.6 x 4.8 3.2 x 4.0	Principal use is for small diameter pipe and for program-controlled automatic welding.	+/- 3/32	+/- 2.4	5

standard sizes

class 1 

class 5 

Table II

Nominal Size	Shape	Class		Diameter (d)				Heigth (h)				Width (w)			
				Dimension in	Dimension mm	Tolerances in	Tolerances mm	Dimension in	Dimension mm	Tolerances in	Tolerances mm	Dimension in	Dimension mm	Tolerances in	Tolerances mm
3/32	A		Com	.093	**2.4**	+/- .004	**.1**	.044	**1.1**	+/- .005	**.1**	.029	**0.7**	+/- .005	**.1**
1/8	A	1	MIL Com	.125 .125	**3.2** **3.2**	+/- .004 +/- .004	**.1** **.1**	.055 .055	**1.4** **1.4**	+ .012 - .002 + .019 - .008	**.3** **.05** **.5** **.2**	.047 .047	**1.2** **1.2**	+ .002 - .012 + .008 - .019	**.05** **.3** **.2** **.5**
5/32	A	1	MIL Com	.156 .156	**4.0** **4.0**	+/- .005 +/- .005	**.1** **.1**	.063 .063	**1.6** **1.6**	+ .014 - .003 + .019 - .008	**.4** **.1** **.5** **.2**	.063 .063	**1.6** **1.6**	+ .003 - .014 + .008 - .019	**.1** **.4** **.2** **.5**
3/16	A		Com	.188	**4.8**	+/- .005	**.1**	.083	**2.1**	+/- .010	**.3**	.066	**1.7**	+/- .010	**.3**
1/16x1/8	K	5	MIL† Com					.125	**3.2**	+/- .004	**.1**	.063	**1.6**	+/- .004	**.1**
1/16x3/16	K	5	MIL† Com					.188	**4.8**	+/- .004	**.1**	.063	**1.6**	+/- .004	**.1**
1/8x5/32	K	5	MIL† Com					.156	**4.0**	+ .004	**.1**	.125	**3.2**	+ .004	**.1**

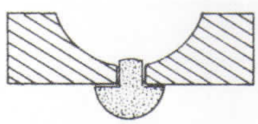
***Dimension is used for MIL-spec insert only.** **† Dimensions and tolerances as specified in ordering documents.**

Arcos manufacturing facilities also have the capabilities to produce K-shaped dimensions other than those listed in the table above.
Contact Customer Service for information on your special requirements.

standard rings

Preformed rings are furnished in standard sizes and with an overlap. Such rings with overlap are designated "Style B" in MIL-1-23413. Split rings (no overlap) are also supplied with close tolerances to fit users templates, designated "Style C" by the MIL-specification.

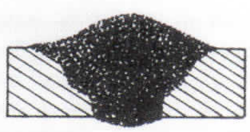
ARCOS consumable weld inserts...



Insert in place.

Insert tack welded.

Insert consumed.



Completed weld.

...produce the best root conditions

Conventional weld with backing ring.

standard coils

The Arcos Consumable Weld Insert material is also furnished in standard 50-foot (16 m) lengths wound on a 12-inch (300 mm) rim, and packaged in a sturdy cardboard container for easy storage and identification. Insert furnished in coils is designated "Style A" in MIL-I-23413.

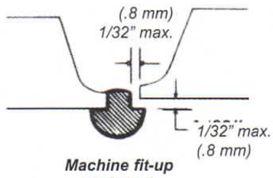
ARCOS Consumable-Weld Inserts

selecting the shape

Both will produce an excellent root pass but the differences should be understood when making a selection.

The "A" or Mushroom (Inverted T-shaped*) Shape

The "A" shape is the best choice when the application requires the ultimate predictability in root pass reinforcement and when the joint is aligned correctly.

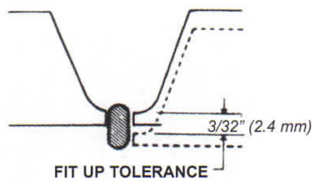


Machine fit-up preferred.

The "K" or Flat Shape

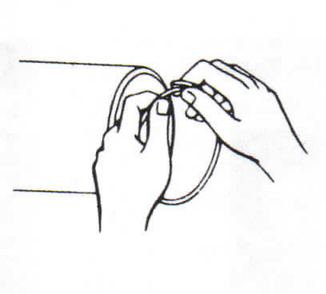
The "K" shape is an excellent selection for use with the new automatic TIG pipe welding machines for small diameter pipe or where poor joint alignment or hand ground lands are encountered.

*Designation used in MIL-I-23413.



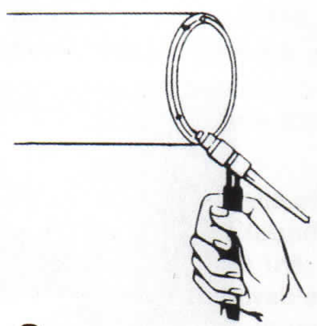
Misalignment up to 3/32" (2.4 mm) can be tolerated.

Recommended procedures for Welding with



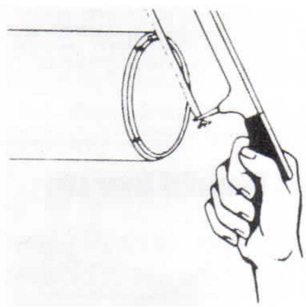
1

Place an insert (in ring form) with its overlap on one pipe end that has been properly prepared as shown in the section "joint design," page 5.



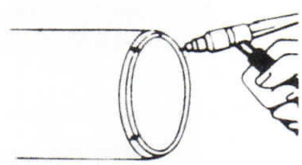
2

Using an inert-gas tungsten-arc torch, make small tacks appropriately spaced to obtain a close fit, starting at one end of the insert and continuing half way around the circumference.



3

Cut off the overlap carefully so that the gap between the ends of the insert does not exceed 1/32" (0.8 mm). Either a hacksaw or hand shears can be used to trim the insert.



4

Tack weld the remainder of the insert to the pipe end. One of the tack welds should be located at the split where the insert ends are butted together.

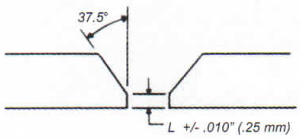
Arcos

joint design

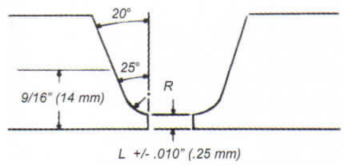
When using the Arcos Consumable Weld Insert process, joint design and preparation are important. Where highest quality joints are desired, the pipe ends should be prepared by machining. For certain less critical applications, flame-beveling followed by surface grinding has been found suitable.

In general, most joints are prepared in the shop where the pipe ends are machined. At the work site, various other means have been employed. For example, a pear-shaped milling cutter mounted on a compressed air tool has been found effective.

The recommended joint designs shown below are similar to ANSI B16.9 Pipe Fitting Standards. The V-joint may be used for certain thin walled ferrous tubes, but the U-joint is generally more desirable - particularly for the heavier sections and non-ferrous metals.



"V" groove may be used for wall thicknesses under 3/16" (4.8 mm) Also, with the "K" shape insert on thin wall pipe a simple, butt preparation may be used.

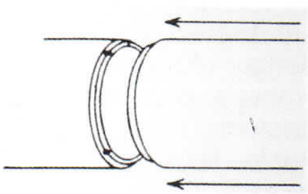


"U" groove preparation preferred for all joints, particularly for wall thicknesses over 3/16" (4.8 mm)

Metal	L-Land	R-Radius
Austenitic Stainless Steel Non-Ferrous Alloys	.055" **1.4 mm**	1/4" **6.4 mm**
Carbon Steel Chrome-Moly & Chrome Steels	.055" **1.4 mm**	1/8" **3.2 mm**

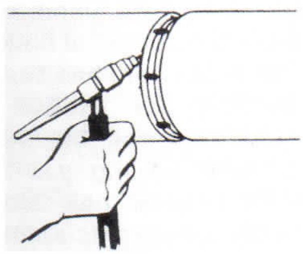
Pipe misalignment or out-of-roundness may be encountered in pipe joints. If such occurs, a mismatch can be tolerated as shown in sketches on page 4.

the Arcos Consumable Weld Insert Process



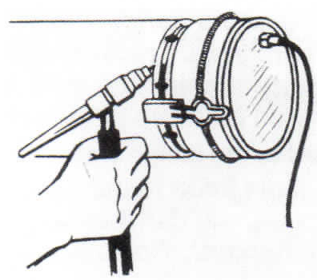
5

Bring pipe ends together ascertaining that spacing is within tolerances shown on page 4 for insert shape being used.



6

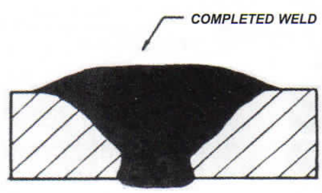
Midway between the original tacks, tack weld the second pipe to the insert and continue the tack across the insert to include the first pipe.



7

Purge inside of pipe adjacent to joint with helium, argon, or nitrogen gas (see "Gas Protection," Page 6, Fig. 8).

When welding in the horizontal fixed position (pipe axis horizontal), weld upwards first one side, then the other, fusing the insert with the pipe ends to complete the root pass.



WELDING PROCEDURE

To qualify a welder, he must be given the opportunity for practice in a few joints. Qualifications can be expedited or quality improved by closing the end of the pipe sample for gas backing and providing a window of #4 filter so that a second operator can observe the penetration and capillary attraction. The second operator can then call out his observations to the torch operator so that he knows what is happening at the root by observing the surface behavior.

tack welding

A striking bar, shown adjacent to the torch in Figs. 8 and 9, is sometimes used in striking and extinguishing the arc in the tacking and welding. To break the arc when a striking bar is not used, the torch should be moved deliberately away from the molten pool and the arc broken on the beveled wall of the pipe. Use of this technique will minimize the "crater cracks" sometimes associated with the craters of certain crack-sensitive alloys. Each tack weld should be as small as possible, and one of them should be located at the split where the insert ends butt together so as to fuse these to each other and to the edge of the joint.

gas protection

Production devices for sealing the pipes to contain the purging gas are largely dictated by the conditions existing in each shop and on the job. Metal discs with rubber gaskets connected to a gas hose are commonly employed. Pressure seals are neither necessary nor desirable. The weld insert process does not rely on pressure to form the desired weld contour.

Simple paper discs fastened to the inside walls of the pipe by masking tape have been found suitable and they have an advantage in that they can be ignited and burned for removal. Removable paper cones can be made to avoid the burning operation. Water soluble paper barriers provide another method of sealing the purging gas and provide a simple removal system.

Metal cones can also be used. Both types can easily be withdrawn through the pipe after welding has been completed. In either case two cones are used. The vertex of both cones is placed in the direction in which they will be pulled for removal. Connected to an inlet in the vertex of one cone is the hose which will carry the purging gas.

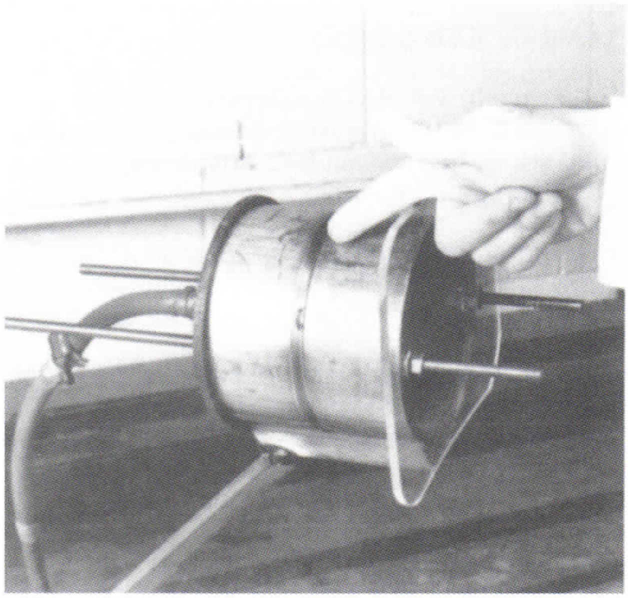


Fig. 8 Fixed horizontal pipe set for operator training or qualification. Tube at left introduces purging gas through plastic disc.

The vertex of the mating cone is connected with a wire to the inside of the gas coupling, allowing a suitable distance between the two cones. With such an arrangement, the cones can easily be removed, even around complex bends.

A convenient method of sealing the joint area for training operators and for procedure qualification tests is to place plastic discs over both free ends of the pipe and seal them to the pipe with masking tape (Figs. 8 and 9). These discs, being transparent, permit an instructor to view the inside during welding, and thus advise the operator whether complete fusion has been accomplished. In this case a fitting for the connection is provided on one disc. An escape hole is provided in the other, in order to displace the atmospheric gases without the danger of building up a back pressure. So far, most work has been done using argon as a protecting gas. Helium may also be found suitable. Nitrogen has been found very satisfactory as a purging gas for austenitic stainless steels. Special gas mixtures may be advantageous for specific application.

root pass welding

Welding may be done in all positions-overhead, horizontal, or vertical. Hardenable steels such as 4130 and 4340 should be preheated for welding. The chromium molybdenum steels, such as 2 1/4 Cr 1% Mo (Type 521) which are much lower in carbon, have been successfully welded without preheat. This is true even though a 300° F (150° C) minimum preheat is usually recommended for such steels when using covered arc welding electrodes.

The insert-gas torch to be used in making the root pass, is fitted with a tungsten electrode which has been ground to a long, tapering point. The end of the electrode should project about 3/16 inch (4.8 mm) beyond the torch cup. Fig. 9 shows an air-cooled torch which is suitable for use up to about 75 amperes; for higher currents, a water-cooled torch is recommended.

The flow rate of the shielding gas should be adjusted to 10 cfh (5 1/min.) for argon and 30 cfh (14 1/min.) for helium. Direct current,

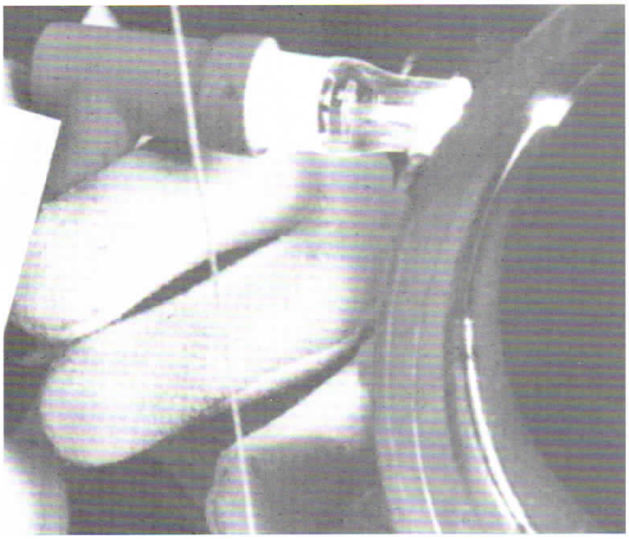


Fig. 9 View from inside pipe of insert rib actually being consumed.

straight polarity (electrode negative), must be used with the arc length held to 1/16-3/32" (1.6-2.4 mm). For stainless steels, when argon is used as a shielding gas, the current should be between 75-100 amperes; for carbon and low alloy steels, currents up to 110 amperes are required. When helium is used as a shielding gas, lower currents can be used because helium produces a hotter arc. Combinations of helium and argon are also used at times. These require intermediate amperages. Regardless of which shielding gas is used, the torch during welding should be held with the electrode pointed toward the center of the pipe. With these conditions, the optimum rate of travel is between 2 and 3 inches (50 - 75 mm) per minute.

The bead contour on the inside of the pipe is largely independent of the position of welding (i.e., overhead, horizontal, vertical), but is influenced by amperage and travel speed. When welding currents are too low or travel speeds are too high, less of the insert will be pulled up into the joint, leaving more reinforcement on the underside.

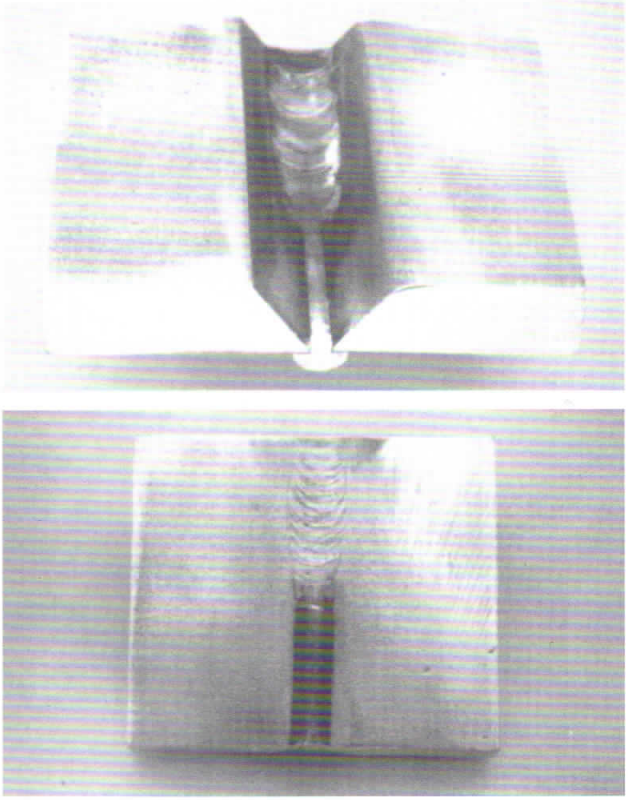


Fig. 10 ABOVE: cross section showing unfused and fused insert.
BELOW: inside pipe view showing unfused and fused portions of insert.

Conversely, flatter beads are obtained with either higher currents or lower speeds. With a little experience a welder will be able to adjust his current setting to obtain the proper bead contour. Fig. 10 shows a cross section and perspective views of the insert in place in a joint before fusion and the root pass after fusion.

With pipe in the horizontal fixed position, the root pass sequence need not follow a set pattern, although most welders prefer to start just off center near the bottom of the pipe, welding first up one side and then the other. The best technique is to hold an arc 1/16" to 1/32" (1.6-2.4 mm) in length to obtain proper fusion and puddle control. Too short an arc increases the risk of "shorting out" and causing tungsten inclusions in the weld. A striking bar may be used for striking the arc. It is especially useful for critical applications and avoids the need for the cleaning of "arc strikes." The striking bar is conveniently placed adjacent to the joint, to facilitate the striking of the arc. After the arc is struck, it is quickly moved to the location in the joint where welding is to be done. At this time the proper arc length is established.

(Continued on page 8)

Once fusion begins and a pool of molten metal is obtained, the welder uses a very slight weaving motion with the torch to distribute the heat across the insert and into both halves of the joint. At some point as the pool gets larger and the heat penetrates deeper, a definite rise or "pull-up" will occur in the molten metal. As soon as this takes place, the welder begins to move the torch ahead along the joint at the proper travel speed and at a uniform rate to assure complete fusion of each increment of the joint. The rising of the molten pool indicates that complete fusion has been achieved at that location. At the completion of the weld, the arc should be broken by moving the torch sideways up the bevel of the joint in the same manner as was described for tack welding. This helps to avoid large craters.

In an installation where there is limited access to the joint and where visibility is restricted, successful welds can be made by observing the arc and the molten pool through a mirror. If there is not sufficient room in which to manipulate a conventional tungsten-arc torch, a modified short torch should be used.

root pass inspection

Normal inspection of the root pass consists of a close visual inspection for uniformity of the outer surface of the weld bead. Any depression in the surface is usually evidence of incomplete fusion of the insert where the weld metal has not been drawn by strong capillary forces into its proper place. Such defects are easily corrected by remelting the area until the rise of the molten pool is observed.

Dyed oil penetrants are occasionally used for inspection of the surface of the bead to detect crater cracks or other fissures. During procedure qualifications and during early stages of production welding, radiographic inspection of the root pass is often considered prudent.

completion of weld

The weld joint can be completed by any of the standard welding processes using Arcos filler metals as pointed out previously. Arc welding with covered electrodes is usually the preferred practice.

Table III

Specifications for Austenitic Stainless Steel Pipe (ASTM: A312)
Dimensions of Welded and Seamless Stainless Steel Pipe*

Norminal Pipe Size	Outside Diameter		Nominal Wall Thickness								Recommended Insert	
			Schedule 5S[a]		Schedule 10S[a]		Schedule 40S		Schedule 80S		Shape A	Shape K
in	in	mm	in	mm	in	mm	in	mm	in	mm		
1/8	0.405	10.29	--	--	0.049	1.24	0.068	1.73	0.095	2.41		
1/4	0.540	13.72	--	--	0.065	1.65	0.088	2.24	0.119	3.02		
3/8	0.675	17.15	--	--	0.065	1.65	0.091	2.31	0.126	3.20	3/32" (2.4mm)	1/16"x1/8" (1.6x3.2mm)
1/2	0.840	21.34	0.065	1.65	0.083	2.11	0.109	2.77	0.147	3.73		
3/4	1.050	26.67	0.065	1.65	0.083	2.11	0.113	2.87	0.154	3.91		
1.0	1.315	33.41	0.065	1.65	0.109	2.77	0.133	3.38	0.179	4.55		
1-1/4	1.660	42.16	0.065	1.65	1.109	2.77	0.140	3.56	0.191	4.85	1/8" (3.2mm)	1/16"x3/16" (1.6x4.8mm)
1-1/2	1.900	48.26	0.065	1.65	0.109	2.77	0.145	3.68	0.200	5.08		
2	2.375	60.03	0.065	1.65	0.109	2.77	0.154	3.91	0.218	5.54		
2-1/2	2.875	73.03	0.083	2.11	0.120	3.05	0.203	5.16	0.276	7.01		
3	3.500	88.90	0.083	2.11	0.120	3.05	0.216	5.33	0.300	7.62		
3-1/2	4.000	101.60	0.083	2.11	0.120	3.05	0.226	5.74	0.318	8.08	5/32" (4.0mm)	
4	4.500	114.30	0.083	2.11	0.120	3.05	0.237	6.02	0.337	8.56		
5	5.563	141.30	0.109	2.77	0.134	3.40	0.258	6.55	0.375	9.52		1/8"x5/32" (3.2x4.0mm)
6	6.625	168.28	0.109	2.77	0.134	3.40	0.280	7.11	0.432	10.97		
8	8.625	219.18	0.109	2.77	1.148	3.76	0.322	8.18	0.500	12.70		
10	10.750	273.05	0.134	3.40	0.165	4.19	0.365	9.27	0.500[b]	12.70[b]	3/16" (4.8mm)	
12	12.750	323.85	0.156	3.96	0.180	4.57	0.375[b]	9.52[b]	0.500[b]	12.70[b]		

[a]Schedules 5S and 10S wall thickness do not permit threading in accordance with the American National Standard for Pipe Threads (ANSI No. B2.1 - 1960).
[b]These do not conform to the American National Standard for Wrought Steel and Wrought Iron Pipe (ANSI B36.10 - 1965).
*This is a reprint of Table 1 of the American National Standard for Stainless Steel Pipe (ANSI B36.19 - 1965).
Note: - The decimal thickness listed for the respective pipe sizes represents their nominal or average wall dimensions.

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