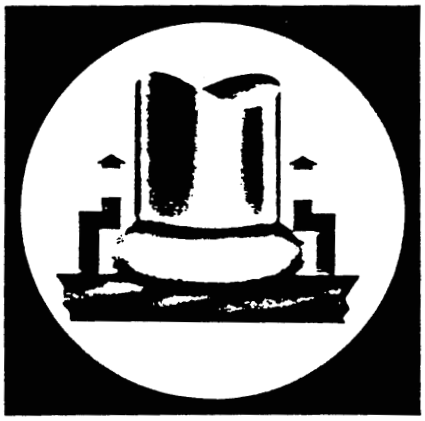
STUDS (General Information)

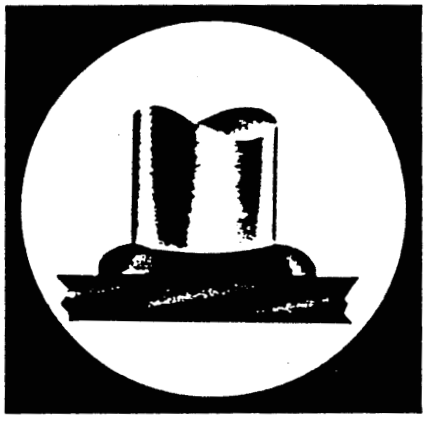
THE ARC STUD WELDING PROCESS

1. STUD AND CERAMIC FERRULE AGAINST THE WORK PLATE.



2. STUD LIFTS AND ARC IS DRAWN.

3. CONTROL TIMES OUT AND STUD PLUNGES INTO MOLTEN STEEL.



4. METAL SOLIDIFIES AND WELD IS COMPLETED IN MILLISECONDS.

ARC Stud Welding involves the same basic principles and metallurgical aspects as any other arc welding procedure. The weld gun lifts the stud a short distance from the base metal and initiates a controlled electric arc from the power source which melts the end of the stud and a portion of the base metal. The ceramic ferrule contains the molten metal into which the stud is thrust automatically and a high quality fusion weld is accomplished.

ARC Stud Welding is generally used to weld larger diameter studs to thick base metals. ARC studs may be almost any shape and there are literally hundreds, however, they must have one end of the stud designed for ARC welding and must be made of weldable materials. Mild steel, stainless steel, and aluminum are applicable materials for ARC stud welding.

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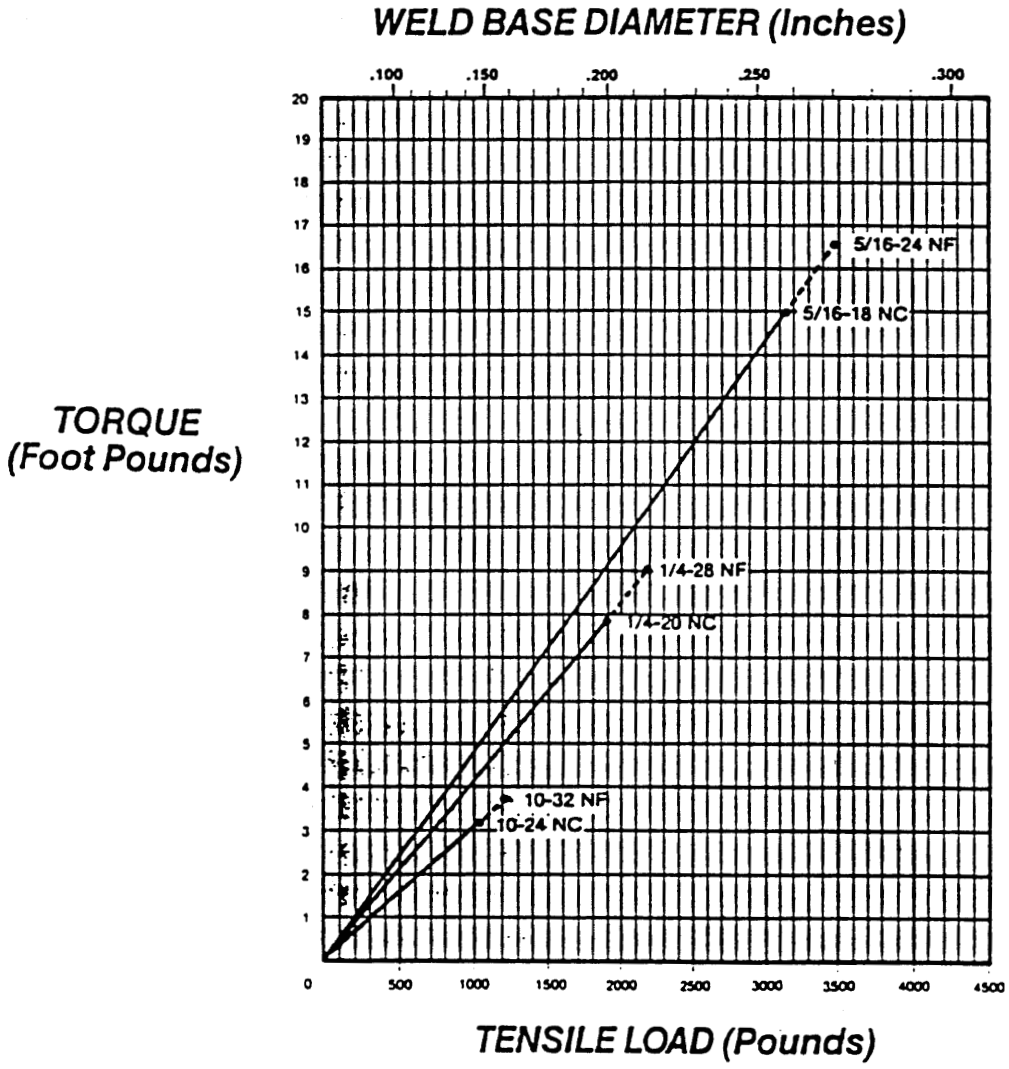
STUDS (General Information)

WELDED STEEL ARC STUDS TENSILE & TORQUE STRENGTHS



Graphs are based on 60,000 psi strength steel.

Of course, in actual practice, a stud should never be used at its yield load. A factor of safety must be applied. It is generally recommended that studs be used at no more than 60% of yield. However, the factor of safety may vary up or down, depending of the particular application. The user will make this determination.

Scale along the top of each graph represents weld base diameter in inches, while the one at the graph's bottom edge shows tensile load in pounds. A separate line is plotted for each thread diameter. The solid portion of each line terminates at a small dot which represents the tensile yield of the national course thread. A dashed line is then extended to a second dot at the tensile yield load of the national fine thread.

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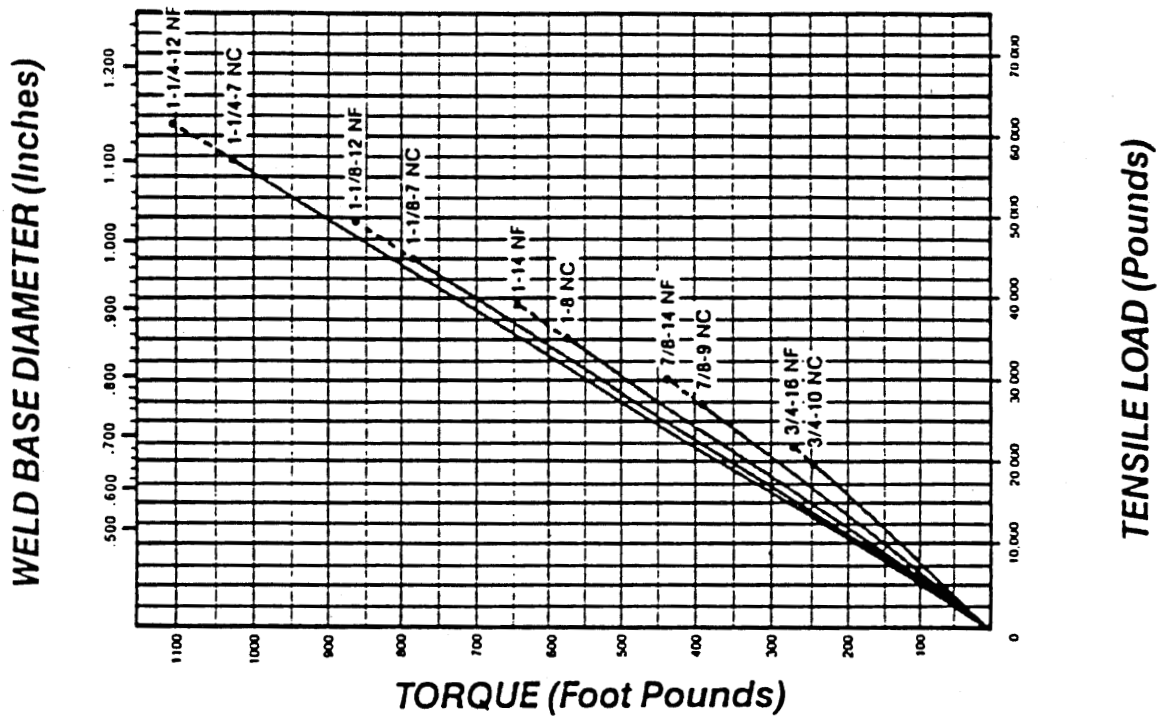
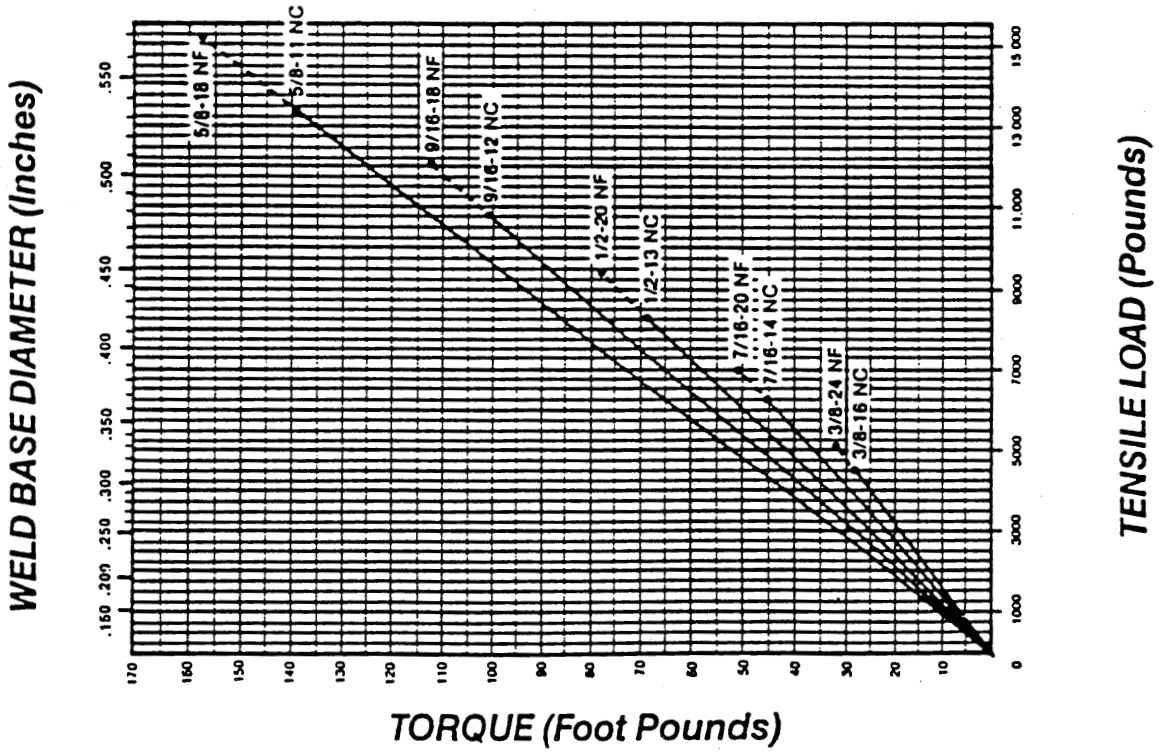
STUDS (General Information)





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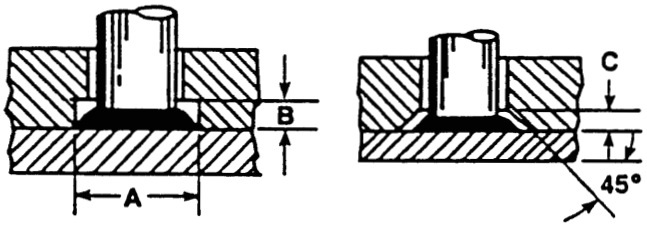
STUDS (General Information)

ARC STUD WELD FILLET ACCOMMODATION

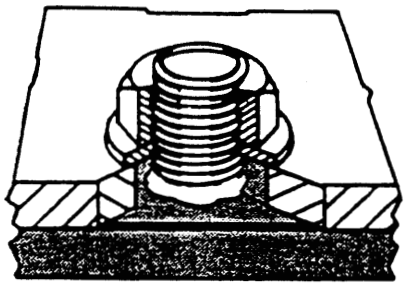


STUD SIZE (In.)	*COUNTERBORE (In.)*		*90° COUNTERSINK (In.)*
	A	B	C
1/4	0.437	0.125	0.125
5/16	0.500	0.125	0.125
3/8	0.593	0.125	0.125
7/16	0.656	0.187	0.125
1/2	0.750	0.187	0.187
5/8	0.875	0.218	0.187
3/4	1.125	0.312	0.187

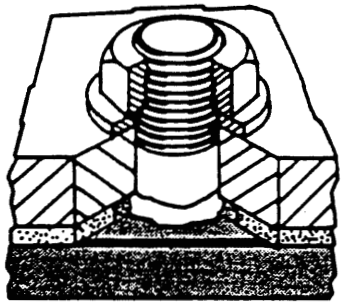
COUNTER BORE OR COUNTER SINK METHODS

When an arc stud is welded, a fillet forms around its base with the fillet dimensions being closely controlled by the design of the ferrule used. Since the diameter of the fillet is generally larger than the diameter of the stud, some consideration is required in the design of mating parts. Counter bore and counter sink methods are commonly used. Dimensions will vary with studs and ferrules. Additional methods of accommodating fillet include over sized clearance holes, use of a gasket material around the fillet or use of a dog type construction.

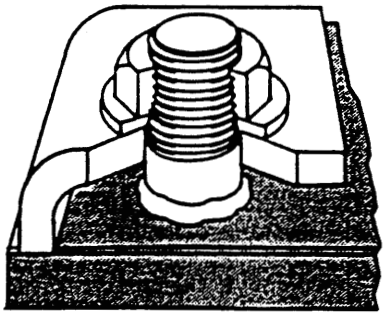
SEVERAL OPTIONAL METHODS OF FILLET ACCOMMODATION:



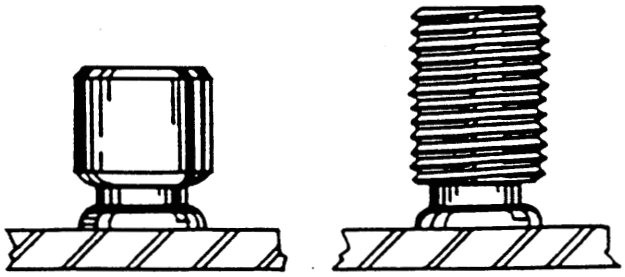
(A) OVERSIZE CLEARANCE HOLE



(B) GASKET MATERIAL



(C) DOG CLAMP



IF AN OVERSIZE FILLET DOES NOT MEET THE APPLICATION:

Welded studs designed with a reduced weld base are available so that the weld fillet does not exceed the maximum diameter of fastener. This design is not recommended if full fastener strength is important.

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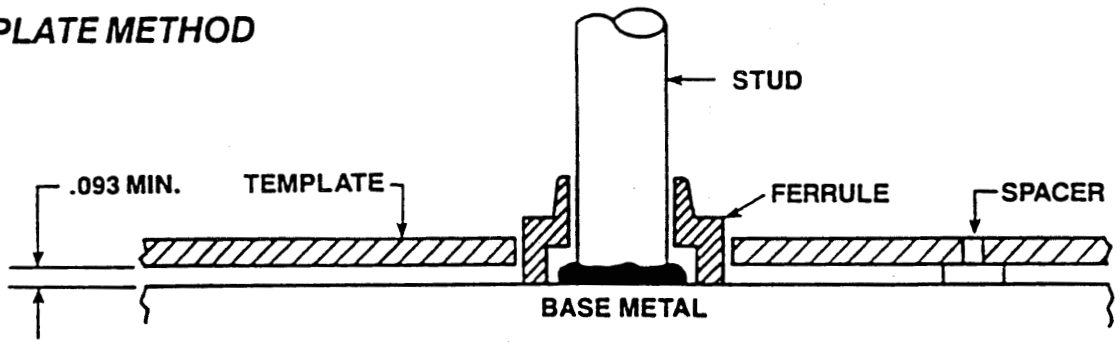
STUDS (General Information)

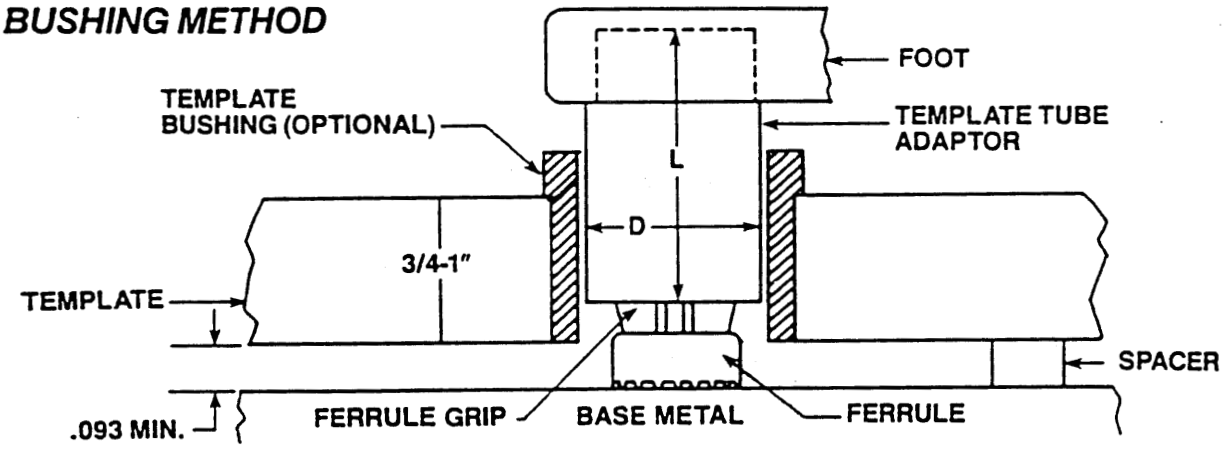
ARC STUD LOCATION TEMPLATE & BUSHING DESIGN

TEMPLATE METHOD



This method of templating is recommended for use with F ferrules. The template is usually a steel plate 3/32″ to 3/16″ thick. Spacers are required to allow the gases to escape during the welding cycle. The ferrule can be held by a standard ferrule grip or where clearance is prohibitive a tube type set-up can be used. The recommended hole sizes on the template to locate the ferrules should equal the maximum outside diameter of the ferrule plus 1/32″. Holes may be drilled or bored at required locations. See stud specification sheets for ferrule details.

BUSHING METHOD



This method of templating is recommended for use with all arc stud styles. The design makes it possible to accurately hold angular alignment of the studs as well as stud location. The template should be made of ebonite or masonite of a thickness sufficient to afford good alignment. Template bushings may be used to insure greater accuracy and extend the life of the template. Standard ferrule grips are used with the tube adaptor. This permits standardization of templates since it is only necessary to change the ferrule grip to weld studs of different diameters. The hole diameter of the bushing or template should be approximately .010 larger than the maximum outside diameter of the template tube adaptor.

STUD Size	*D*	*L*
1/2″ and under	1.250	2.000
5/8″ and 3/4″	1.562	2.500
7/8″ and larger	2.125	2.500

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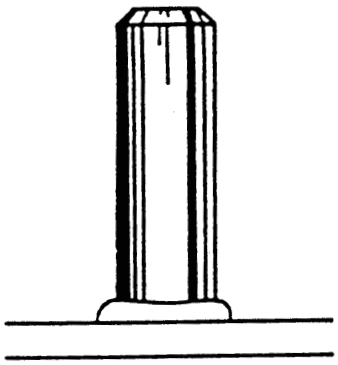
STUDS (General Information)

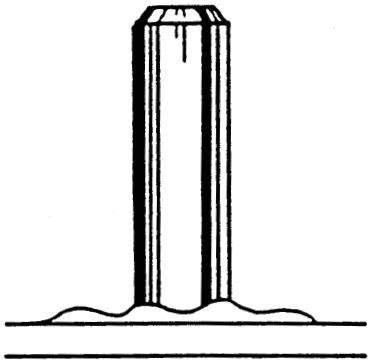
ARC STUD WELD INSPECTION (VISUAL)

The ARC stud weld can be visually inspected by observing the fillet at the base of the stud. The illustrations and comments below will assist you in visually judging the quality of the weld.



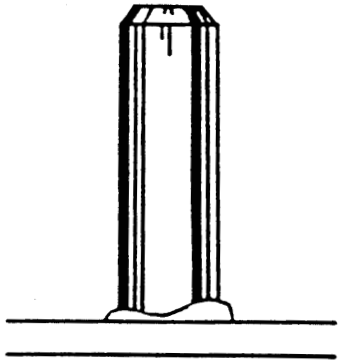
GOOD WELD

Full, even, shiny fillet all around stud.



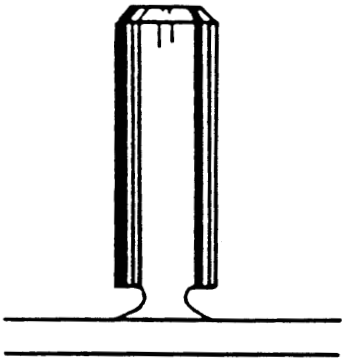
HOT WELD

Very shiny, low profile fillet extending beyond outside of ferrule.



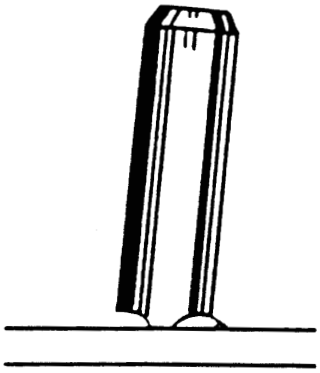
COLD WELD

Small, uneven, dull appearing fillet with fingers of metal extending through vents of ferrule.



SHORT PLUNGE OR HANG-UP

No fillet, no stud burn-off, or undercut base.



MISALIGNMENT

Partial or no fillet, undercut, stud not perpendicular to base metal.

ARC STUD WELD TESTING (PHYSICAL)

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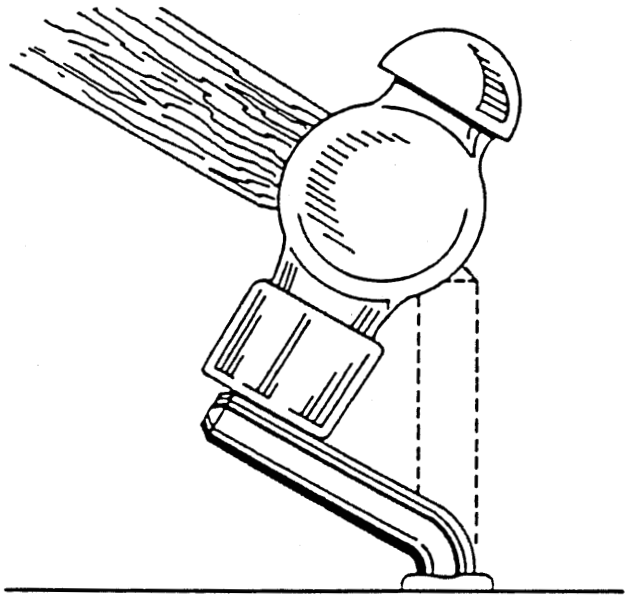
STUDS (General Information)

CD AND ARC STUD WELD TESTING (PHYSICAL)

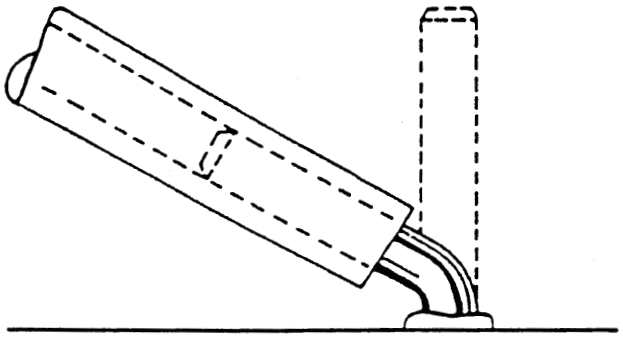
If, after visual inspection the weld quality is still questionable, or specifications require, the welded stud can be submitted to additional testing. The following are suggested physical tests.



BEND TEST WITH HAMMER.

BEND TEST: (See illustrations) By striking the stud with a hammer, or by sliding a length of pipe or tube over the stud, the stud can be bent a minimum of 30° away from its axis, or until failure occurs. Satisfactorily welded studs should exhibit a complete 90° bend without failure.

TORQUE TEST: The stud may be torqued with conventional torque testing equipment by applying torque until a predetermined torque or proof load is reached or until failure occurs.



BEND TEST WITH PIPE.

TENSILE TEST: The stud may be tested with conventional tensile testing equipment until a predetermined load is reached or until failure occurs.

OTHER: The stud and weld can be submitted to other conventional forms of destructive or non-destructive testing as specifications may require.

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STUDS (General Information)

GENERAL SPECIFICATIONS

	CAPACITOR DISCHARGE	ARC
MATERIAL	Standard in low carbon steel, 302/304/305 stainless, and 1100, 6061, & 5000 series aluminum. Brass and other grades of stainless steel are also available.	Standard in low carbon steel and 302/304/305 stainless. Aluminum, monel, inconel, and other grades of stainless steel are available.
PLATING	Copper plating is standard. Nickel, Zinc, and other platings are available.	Nickle Plating, Copper Plating, zinc to ASTM-B 633 (formerly A 164) and other platings are available. Non-weldable plating is removed from the weld end to avoid contamination of the weld.
ANNEALING	All low carbon steel and stainless steel studs are annealed upon request.	Low carbon steel can be annealed to a maximum of 75 Rockwell B and stainless steel to a maximum of 90 Rockwell B.
THREADS	UNC-2A is standard for external threads prior to plating and UNC-2B for internal threads. Metric and other thread sizes are available.	
WELD BASE	Flanged, small-flanged, and non-flanged are available.	1/4" dia. and over have solid flux. Diameters under 1/4" are standard pointed, and flux is optional.
STUD LENGTH	CD studs have no appreciable length reduction after welding.	The arc stud length designations are BEFORE WELD; AFTER WELD lengths are shown in the table below.
FERRULES	Does not apply to CD	All orders include ferrules when they are required.

STUD DIAMETER	APPROX. REDUCTION
3/16" thru 1/2"	1/8"
5/8" thru 7/8"	3/16"
7/8" and over	1/4"
1/8" wide rectangulars	1/8"

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STUDS (General Information)

ARC STUD WELDING RECOMMENDED MINIMUM BASE METAL THICKNESS

STUD WELD BASE DIA. (in.)	STEEL		ALUMINUM	
	WITHOUT BACKUP (in.)	(gage)	WITHOUT BACKUP (in.)	WITH BACKUP (in.)
0.187	0.0359	20	0.125	0.125
0.250	0.0478	18	0.125	0.125
0.312	0.0598	16	0.187	0.125
0.375	0.0747	14	0.187	0.187
0.437	0.0897	13	0.250	0.187
0.500	0.1196	11	0.250	0.250
0.625	0.148	9		
0.750	0.187			
0.875	0.250			
1.000	0.375			

ARC STUD WELDING DC POWER SUPPLY REQUIREMENTS

All arc welding studs, regardless of material, composition, style or size, are welded with DC power sources. Power requirements vary in proportion to the square of the stud diameter; length of the fastener has no appreciable effect.

Standard NEMA 400 amp motor generators are generally sufficient to weld 3/8" diameter studs. Conservative power requirements are listed below.

Arc Stud Welding Current Requirements	Weld Base Diameter	Aproximate required Current (amps)*
Note: When welding stainless steel studs, increase amperage setting by 10%	.875 (7/8")	2000
	.750 (3/4")	1600
	.625 (5/8")	1450
	.500 (1/2")	900
	.437 (7/16")	725
	.375 (3/8")	575
	.312 (5/16")	500
	.275 (17/16")	440
	.250 (1/4")	425
	.217 (7/32")	400
	.187 (3/16")	320
	.135 (9/64")	155

* Initial Surge Current (maximum one second)

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STUDS (General Information)

ARC STUDS WEIGHT CHARTS (STEEL)

ESTIMATED WEIGHTS OF THREADED STUDS IN POUNDS PER 1000 PIECES								
LENGTH	**1/4-20**	**5/16-18**	**3/8-16**	**7/16-14**	**1/2-13**	**5/8-11**	**3/4-10**	**7/8-9**
3/4	8.3	12.8	18.8	25.5	34.5			
1	11.0	17.0	25.0	34.0	46.0	70.0		
1-1/4	13.8	21.3	31.3	42.5	57.5	87.5	133.8	
1-1/2	16.5	25.5	37.5	51.0	69.0	105.0	160.5	243.8
1-3/4	19.3	29.8	43.8	59.5	80.5	122.5	187.3	284.4
2	22.0	34.0	50.0	68.0	92.0	140.0	214.0	325.0
2-1/4	24.8	38.3	56.3	76.5	103.5	157.5	240.8	165.6
2-1/2	27.5	42.5	62.5	85.0	115.0	175.0	267.5	406.3
2-3/4	30.3	46.8	68.8	93.5	126.5	192.5	294.3	446.9
3	33.0	51.0	75.0	102.0	138.0	210.0	321.0	487.5
3-1/4	35.8	55.3	81.3	110.5	149.5	227.5	347.8	528.1
3-1/2	38.5	59.5	87.5	119.0	161.0	245.0	374.5	568.8
3-3/4	41.3	63.8	93.8	127.5	172.5	262.5	401.3	609.4
4	44.0	68.0	100.0	136.0	184.0	280.0	428.0	650.0
4-1/4	46.8	72.3	106.3	144.5	195.5	297.5	454.8	690.6
4-1/2	49.5	76.5	112.5	153.0	207.0	315.0	481.5	731.3
4-3/4	52.3	80.8	118.8	161.5	218.5	332.5	508.3	771.9
5	55.0	85.0	125.0	170.0	230.0	350.0	535.0	812.5
EACH ADD'L. INCH	**11.0**	**17.0**	**25.0**	**34.0**	**46.0**	**70.0**	**107.0**	**162.5**
"P" FERRULE	**1.8**	**2.8**	**3.1**	**4.5**	**5.9**	**10.8**	**21.9**	**39.0**

ESTIMATED WEIGHTS OF NO-THREAD STUDS IN POUNDS PER 1000 PIECES									
LENGTH	**3/16 dia.**	**1/4 dia.**	**5/16 dia.**	**3/8 dia.**	**7/16 dia.**	**1/2 dia.**	**5/8 dia.**	**3/4 dia.**	**7/8 dia.**
3/4	6.0	10.5	16.4	23.5	31.9	41.7			
1	8.0	14.0	21.8	31.3	42.5	55.6	86.6		
1-1/4	10.0	17.5	27.3	39.1	53.1	69.5	108.3	156.0	
1-1/2	12.0	21.0	32.7	47.0	63.8	83.4	129.9	187.2	225.0
1-3/4	14.0	24.5	38.2	54.8	74.4	97.3	151.6	218.4	297.5
2	16.0	28.0	43.6	62.6	85.0	111.2	173.2	249.6	340.0
2-1/4	18.0	31.5	49.1	70.4	95.6	125.1	194.9	280.8	382.5
2-1/2	20.0	35.0	54.5	78.3	106.3	139.0	216.5	312.0	425.0
2-3/4	22.0	38.5	60.0	86.1	116.9	152.9	238.2	343.2	467.5
3	24.0	42.0	65.4	93.9	127.5	166.8	259.8	374.4	510.0
3-1/4	26.0	45.5	70.9	101.7	138.1	180.7	281.5	405.6	552.5
3-1/2	28.0	49.0	76.3	117.4	148.8	194.6	303.1	436.8	595.0
3-3/4	30.0	52.5	81.8	125.2	159.4	208.5	324.8	468.0	637.5
4	32.0	56.0	87.2	125.2	170.0	222.4	346.4	499.2	680.0
4-1/4	34.0	59.5	92.7	133.0	180.6	236.3	368.1	530.4	722.5
4-1/2	36.0	63.0	98.1	140.9	191.3	250.2	389.7	561.6	765.0
4-3/4	38.0	66.5	103.6	148.7	201.9	264.1	411.4	592.8	807.5
5	40.0	70.0	109.0	156.5	212.5	278.0	433.0	624.0	850.0
EACH ADD'L. INCH	**8.0**	**14.0**	**21.8**	**31.3**	**42.5**	**55.6**	**86.6**	**124.8**	**170.0**
"F" FERRULE	**2.0**	**2.9**	**4.3**	**5.0**	**5.2**	**7.4**	**15.5**	**30.1**	**49.0**

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Concrete Anchor - Shipping Weight Chart

Stud Diameter	Stud Length	Lbs. Per 1000	Pieces Per Box	Pounds Per Box	Pieces Per Pallet	Pounds Per Pallet
1/4	1-1/8	22	2,000	48	54,000	1,296
	2-11/16	43	1,000	45	27,000	1,215
	3-1/8	50	1,000	51	27,000	1,377
	4-1/8	63	600	38	16,200	1,026
3/8	1-1/4	65	1,000	67	27,000	1,809
	1-3/8	68	1,000	70	27,000	1,890
	1-5/8	77	1,000	79	27,000	2,133
	2-1/8	92	700	67	18,900	1,809
	2-5/8	111	600	66	16,200	1,782
	3-1/8	124	500	62	13,500	1,674
	4-1/8	154	350	55	9,450	1,485
	5-1/8	185	300	56	8,100	1,512
	6-1/8	212	200	44	5,400	1,188
	8-1/8	274	250	69	2,250	1,863
1/2	1-1/8	112	600	68	16,200	1,836
	1-3/8	125	500	65	13,500	1,755
	1-1/2	132	500	68	13,500	1,836
	1-5/8	138	450	64	12,150	1,728
	2-1/8	166	400	70	10,800	1,890
	2-5/8	198	350	71	9,450	1,917
	3-1/8	223	300	69	8,100	1,863
	3-5/8	246	200	51	5,400	1,377
	4-1/8	277	200	56	5,400	1,512
	4-3/8	290	200	58	5,400	1,566
	5-1/8	326	150	45	4,050	1,215
	5-5/16	339	150	53	4,050	1,431
	6-1/8	388	125	50	3,375	1,350
	8-1/8	495	100	50	2,700	1,350
5/8	1-7/16	208	400	85	10,800	2,295
	1-11/16	227	325	77	8,775	2,079
	1-15/16	248	300	78	8,100	2,106
	2-1/8	264	250	68	6,750	1,836
	2-3/16	270	250	71	6,750	1,917
	2-11/16	319	250	81	6,750	2,187
	3-3/16	363	200	75	5,400	2,025
	3-11/16	398	150	62	4,050	1,674
	4-3/16	444	150	69	4,050	1,863
	4-11/16	487	125	63	3,375	1,701
	5-3/16	528	100	55	2,700	1,485
	6-3/16	604	90	55	2,430	1,485
	6-9/16	646	80	52	2,160	1,404
	8-3/16	781	50	40	1,350	1,080
	10-3/16	946	100	98	900	882

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Shear Connector - Shipping Weight Chart

Stud Diameter	Stud Length	Pounds Per 1000 Pieces	Pieces Per Box	Pounds Per Box	Pieces Per Pallet	Pounds Per Pallet
3/4	2-3/16	352	200	71	9,600	3,408
	2-11/16	414	150	62	7,200	2,976
	3-3/16	478	125	60	6,000	2,880
	3-11/16	548	100	55	4,800	2,640
	4-3/16	600	100	62	4,800	2,976
	4-11/16	672	75	51	3,600	2,448
	5-3/16	735	60	44	2,880	2,112
	5-11/16	797	60	48	2,880	2,304
	6-3/16	852	60	50	2,880	2,400
	6-11/16	905	70	64	1,890	1,728
	7-3/16	968	60	59	1,620	1,593
	8-3/16	1,105	50	56	1,350	1,512
	9-3/16	1,222	100	126	900	1,134
	10-3/16	1,339	100	137	900	1,233
7/8	3-3/16	631	100	66	2,700	1,782
	3-11/16	709	100	74	2,700	1,998
	4-3/16	796	100	82	2,700	2,214
	4-11/16	878	80	72	2,160	1,944
	5-3/16	961	75	75	2,025	2,025
	5-11/16	1,067	60	65	1,620	1,755
	6-3/16	1,137	50	57	1,350	1,539
	6-11/16	1,236	50	63	1,350	1,701
	7-3/16	1,306	45	59	1,215	1,593
	8-3/16	1,496	40	59	1,080	1,593
	9-3/16	1,666	75	125	675	1,125
	10-3/16	1,836	75	139	675	1,251
1	3-1/4	894	75	70	2,025	1,890
	4-1/4	1,079	50	57	1,350	1,539
	5-1/4	1,302	50	67	1,350	1,809
	6-1/4	1,514	40	63	1,080	1,701
	7-1/4	1,737	85	154	765	1,350
	8-1/4	1,978	85	171	765	1,539
	9-1/4	2,193	50	111	360	819
3/4 Thru-Deck	3-3/8	500	125	62	6,000	2,976
	3-7/8	567	100	58	4,800	2,784
	4-3/8	625	100	62	4,800	2,976
	4-7/8	683	75	51	3,600	2,448
	5-3/8	754	60	45	2,880	2,160
	5-7/8	810	60	49	2,880	2,352
	6-3/8	925	60	56	2,880	2,688

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DEFORMED BAR ANCHOR - SHIPPING WEIGHT CHART

Diameter	Length	Pieces Per Box	Boxes Per Pallet	Pieces Per Pallet	Box Weight	Pallet Weight	1,000 Piece Weight
3/8	10-1/8	150	18	2,700	46 lbs.	828 lbs.	288 lbs.
3/8	12-1/8	150	18	2,700	55 lbs.	990 lbs.	344 lbs.
3/8	18-1/8	150	12	1,800	80 lbs.	960 lbs.	515 lbs.
3/8	24-1/8	150	8	1,200	108 lbs.	864 lbs.	685 lbs.
3/8	30-1/8	150	7	1,050	130 lbs.	910 lbs.	897 lbs.
3/8	36-1/8	150	6	900	156 lbs.	936 lbs.	1,029 lbs.
3/8	48-1/8	150	6	900	208 lbs.	1,248 lbs.	1,394 lbs.
1/2	8-1/8	100	18	1,800	44 lbs.	792 lbs.	451 lbs.
1/2	10-1/8	100	18	1,800	54 lbs.	972 lbs.	529 lbs.
1/2	12-1/8	100	18	1,800	67 lbs.	1,206 lbs.	680 lbs.
1/2	18-1/8	100	12	1,200	98 lbs.	1,176 lbs.	972 lbs.
1/2	24-1/8	100	8	800	128 lbs.	1,024 lbs.	1,292 lbs.
1/2	30-1/8	100	7	700	160 lbs.	1,120 lbs.	1,560 lbs.
1/2	36-1/8	100	6	600	192 lbs.	1,152 lbs.	1,879 lbs.
1/2	42-1/8	100	6	600	222 lbs.	1,332 lbs.	2,174 lbs.
1/2	48-1/8	100	6	600	256 lbs.	1,536 lbs.	2,502 lbs.
5/8	12-3/16	50	18	900	51 lbs.	918 lbs.	997 lbs.
5/8	18-3/16	50	12	600	76 lbs.	912 lbs.	1,633 lbs.
5/8	24-3/16	50	8	400	102 lbs.	816 lbs.	2,136 lbs.
5/8	30-3/16	50	7	350	126 lbs.	882 lbs.	2,666 lbs.
5/8	36-3/16	50	6	300	151 lbs.	906 lbs.	3,196 lbs.
5/8	42-3/16	50	8	400	176 lbs.	1,408 lbs.	3,482 lbs.
5/8	48-3/16	50	6	300	197 lbs.	1,182 lbs.	3,962 lbs.
3/4	12-3/16	40	18	720	60 lbs.	1,080 lbs.	1,525 lbs.
3/4	18-3/16	40	12	480	87 lbs.	1,044 lbs.	2,276 lbs.
3/4	24-3/16	40	8	320	115 lbs.	920 lbs.	3,027 lbs.
3/4	30-3/16	40	6	240	142 lbs.	852 lbs.	3,778 lbs.
3/4	36-3/16	40	6	240	175 lbs.	1,050 lbs.	4,529 lbs.
3/4	42-3/16	40	6	240	205 lbs.	1,230 lbs.	5,125 lbs.
3/4	48-3/16	40	6	240	226 lbs.	1,356 lbs.	5,650 lbs.

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STUDS (General Information)

STUD WELDING PROCESS SELECTION

LEGEND	A — APPLICABLE S — SPECIAL application*	L — LIMITED application N — NOT applicable

FACTORS TO BE CONSIDERED	CD STUD WELDING		ARC STUD WELDING
	Contact/Gap	Drawn Arc	
STUD SHAPE:			
Round	A	A	A
Square	A	A	A
Rectangular	A	A	A
Other	A	A	A
STUD DIAMETER (or AREA):			
1/16″ — 1/8″ Diameter	A	A	N
1/8″ — 1/4″ Diameter	A	A	L
1/4″ — 1/2″ Diameter	S	S	A
1/2″ —1″ Diameter	N	N	A
Area up to 0.05 in.²	A	A	L
Area over 0.05 in.²	N	N	A
STUD METAL:			
Mild Steel	A	A	A
Stainless Steel	A	A	A
Aluminum	A	S	S
Brass	A	A	L
BASE METAL:			
Mild Steel	A	A	A
Stainless Steel	A	A	A
Aluminum	A	S	S
Brass	A	A	L
BASE METAL THICKNESS:			
under 0.025″	S	S	N
0.025″ — 0.062″	A	A	L
0.063″ — 0.125″	A	A	S
0.126″ & over	A	A	A
DESIGN CRITERIA:			
Heat effect on materials	A	A	S
Reverse side marking	A	A	L
Weld fillet clearance	A	A	S
Strength of stud	A	A	A
Strength of base metal	A	A	A

*May be applicable with special equipment or special techniques if deemed necessary.

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