PRACTICAL WELDING DATA TABLE

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Practical Welding Data Table

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[Spot Welding]

Mild Steel Sheets

Material Thickness *1, 7	Electrode			Min. Weld Spacing *3	Min. Overlap *4	Class A(best condition)				
	d	D	R			Time *5	Electrode Force	Weld Current	Diameter Of Fused Zone	Tension-shear Strength *6
mm	mm			mm		サイクル	kgf	A	mm	kgf
0.25	3.2	10		6	10	4	90	4,000	3.3	105
0.4	3.2	10		6	10	5	115	5,200	4.0	180
0.5	3.5	10		9	11	6	135	6,000	4.3	240
0.6	4.0	10		10	11	7	150	6,600	4.7	300
0.8	4.5	10		12	11	8	190	7,800	5.3	440
1.0	5.0	13		18	12	10	225	8,800	5.8	610
1.2	5.5	13		20	14	12	270	9,800	6.2	780
1.4	6.0	13		23	15	14	305	10,600	6.6	930
1.6	6.3	13		27	16	16	360	11,500	6.9	1,060
1.8	6.7	16		31	17	18	410	12,500	7.4	1,300
2.0	7.0	16		35	18	20	470	13,300	7.9	1,450
2.4	7.8	16		40	20	24	580	15,000	8.6	1,850
2.8	8.5	16		45	21	28	700	16,200	9.4	2,380
3.2	9.0	16	75	50	22	30	820	17,500	10.2	3,130
3.6	10.3	22	100	57	29	41	930	18,200	11.2	3,880
4.0	11.1	22	100	67	32	50	1,030	18,900	11.9	4,450
4.3	11.1	22	100	76	38	61	1,120	19,600	12.9	5,250
4.7	11.9	22	100	83	41	73	1,260	20,200	13.7	6,000
5.1	12.7	22	150	89	45	84	1,320	20,900	14.7	6,690
5.5	13.5	22	150	98	48	95	1,460	21,800	15.5	7,300
5.9	13.5	22	150	108	54	106	1,560	22,300	16.5	7,980
6.4	15.1	25	150	114	57	116	1,710	23,000	17.3	8,570
6.6	15.1	25	250	121	60	127	1,850	23,600	18.0	9,200
7.0	15.1	25	250	133	67	140	1,960	24,400	19.1	9,850
7.9	15.9	25	250	146	73	162	2,200	25,700	20.2	10,900

*1 This mild steel shall be treated with pickling and lightly lubricating after hot rolling, which has a tensile strength of 30 - 32kgf/mm². Material shall be free from scale, grease, oxides and dust.

*2 Electrode material shall be used of clss 2 (conductivity:75% hardness:75 rockwell "B"). The tip shape of the electrode is shown in fig.a. The tolerance for the dimention "d" shall be ±4mm.

*3 Minimum weld spacing is a limitation of which shunted current effect of adjacent welds is negligible in practice. In other words, for a shorter weld spacing, an adequate weld current has to be increased as a compensatinal to the current effect.

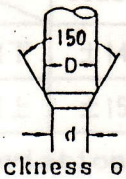


Fig.a.

For material thickness of 3.2mm or less.

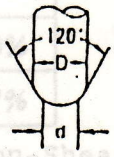
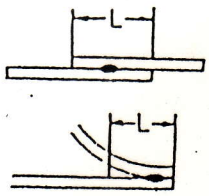


Fig.b.



For material thickness of 3.6mm or more.

Class B(medium condition)					Class C(ordinary condition)				
Time *5	Electrode Pressure	Weld Current	Diameter Of Fused Zone	Tension-shear Strength *6	Time *5	Electrode Force	Weld Current	Diameter Of Fused Zone	Tension-shear Strength *6
サイクル	kgf	A	mm	kgf	サイクル	kgf	A	mm	kgf
5	60	3,700	3.0	90	15	30	3,000	2.8	70
8	75	4,500	3.6	160	20	40	3,500	3.3	125
10	90	5,000	4.0	210	24	45	4,000	3.6	175
12	100	5,500	4.3	280	26	50	4,300	4.0	225
15	125	6,500	4.8	400	30	60	5,000	4.6	355
20	150	7,200	5.4	540	36	75	5,600	5.3	530
23	175	7,800	5.8	680	40	85	6,100	5.5	650
26	210	8,500	6.3	850	46	100	6,600	5.9	780
30	240	9,100	6.7	1,000	50	115	7,000	6.3	920
33	275	9,700	7.1	1,180	54	130	7,500	6.7	1,100
36	300	10,300	7.6	1,370	58	150	8,000	7.1	1,305
44	370	11,300	8.4	1,770	65	180	8,600	7.9	1,685
52	430	12,100	9.2	2,300	72	220	9,400	8.9	2,180
60	520	12,900	9.9	2,940	78	260	10,000	9.4	2,790
72	560	13,600	10.7	3,600	102	280	10,600	10.2	3,380
88	640	14,100	11.4	4,200	125	320	11,000	10.7	3,900
107	720	14,700	12.2	4,780	152	360	11,400	11.4	4,420
128	800	15,300	12.9	5,460	182	400	11,750	11.9	5,030
147	880	15,900	13.7	6,080	210	440	12,200	12.7	5,600
166	970	16,450	14.5	6,680	237	490	12,500	13.2	6,120
186	1,040	17,000	15.2	7,350	265	520	12,900	14.0	6,700
204	1,140	17,600	16.0	7,940	290	570	13,200	14.5	7,240
222	1,230	18,100	16.8	8,500	318	620	13,600	15.0	7,780
245	1,300	18,700	17.5	9,250	350	660	14,000	15.7	8,370
284	1,480	19,800	18.8	10,400	405	740	14,800	17.0	9,440

*4 Minimum overlap is the dimention"L" in Fig.b.
*5 The weld time is shown in the power supply frequency of 60Hz. Therefore, in the case of 50Hz,the weld time is 5/6 of the weld time in 60Hz.
*6The sharing strength is per one spot of weld.
*7 For welding two different thickness materials, apply the electrode on the thinner side. (thickness ratio:within 1:3, convex electrode set at the thinner material side.)
This table is applicable for 4-sheet overlapped welding with the summary of the thickness of 4 times of a sheet.

Material thickness \ Condition	Class A	Class B	Class C
3.2mm以下	±14%	±17%	±20%
3.6mm以上	±15%	±15%	±17%

Table Deviation Rate Of Tention-Shear Strength.

Carbon Steel(0.15～0.6%C) [Spot Welding]

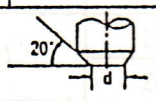
*Outside Thin Material Thickness *1, 2, 4 mm	Electrode d *3, 5 mm	Welding Condition						
		Time(Cycle)				Electrode Force (kgf)		
		Weld	Cooling	Annealing	Total	Class A Weld	Class B Weld	Class C Weld
0.23	3.2	3	6	3	12	100	73	48
0.29	3.2	3	6	3	12	110	80	52
0.35	3.4	4	7	3	14	125	90	58
0.40	3.4	4	7	4	15	145	105	65
0.50	3.8	4	8	4	16	190	140	90
0.60	4.0	4	10	4	18	250	185	120
0.70	4.2	5	11	5	21	330	240	160
0.80	4.8	5	13	5	23	390	295	200
0.90	5.2	6	16	6	28	465	350	235
1.00	5.8	6	20	6	32	535	405	275
1.20	6.8	7	30	10	47	685	510	340
1.40	7.6	9	41	15	65	820	620	415
1.60	8.6	11	52	21	84	965	730	460
1.80	9.5	15	56	28	99	1,160	840	555
2.00	10.5	19	87	36	142	1,250	940	630
2.30	12.0	26	112	48	186	1,460	1,100	730
2.90	14.2	39	205	75	319	1,880	1,420	950
3.20	15.2	46	244	92	382	2,030	1,580	1,060
4.00	16.0	64	352	145	561	2,300	2,000	1,380

*1. This Table should be applied to the equaled thick double sheets lapped carbon steel(C: 0.15 - 0.60%), Tensile strength: 50 - 80kgf/mm^2).

*2. Contact surface of materials should be free from grease, rust, scale and dust.

*3. Electrode material shall be used of class 2. The dimension "d" of the electrode is the diameter of the contacting surface.

*Outside Thin Material Thickness *1, 2, 4 mm	Electrode d *3, 5 mm	Welding Condition Current(A)		Diameter Of Fused Zone 		Minimum Tension-shear Strength	
		Weld	Annealing	$Dm = N\sqrt{T}$ mm	N	*6 kgf	Stress kgf/mm²
0.23	3.2	11,900	9,900	1.9	3.96	140	49.5
0.29	3.2	12,200	10,200	2.2	4.03	160	43.0
0.35	3.4	12,400	10,400	2.4	4.07	190	42.0
0.40	3.4	12,600	10,500	2.6	4.13	205	38.0
0.50	3.8	12,900	10,800	3.0	4.23	250	35.5
0.60	4.0	13,200	11,100	3.4	4.36	300	33.0
0.70	4.2	13,400	11,400	3.8	4.56	370	32.0
0.80	4.8	13,600	11,600	4.2	4.68	450	32.5
0.90	5.2	13,800	11,800	4.7	4.90	560	33.0
1.00	5.8	13,900	12,000	5.1	5.05	690	34.5
1.20	6.8	14,300	12,200	5.9	5.33	975	36.0
1.40	7.6	14,700	12,500	6.7	5.68	1,320	38.0
1.60	8.6	15,100	12,800	7.5	5.95	1,675	38.0
1.80	9.5	15,600	13,200	8.3	6.21	2,100	39.0
2.00	10.5	16,300	13,900	9.2	6.52	2,525	38.0
2.30	12.0	17,500	14,900	10.4	6.94	3,300	39.0
2.90	14.2	20,600	17,400	12.9	7.56	4,875	37.5
3.20	15.2	22,400	18,900	14.1	7.87	5,650	38.0
4.00	16.0	26,300	21,000	17.3	8.65	7,750	39.0



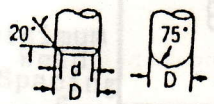
*5. The standard shape of the electrode shows the following illustration. The radius type electrode is allowed.

*6. The tensile strength in this Table shows typical data because the tensile strength is closely relative to the strength of base material.

*7 The minimum lapped width and weld spacing should conform to that of the mild steel.

(Spot Welding)

Austenitic Stainless Steel

Outside Thin Material Thickness *1,2,3,4 mm	Electrode  Minimum D mm	Maximum d mm	Electrode Force kgf	Heating Time (60Hz. P.S) ~	Welding Current Tensile Strength 100kgf/mm^2 or less A	Tensile Strength (100kgf/mm^2 or more A
0.23	6.0	3.0	100	3	2,000	2,000
0.25	6.0	3.0	105	3	2,000	2,000
0.30	6.6	3.3	115	3	2,100	2,000
0.35	7.0	3.5	130	4	2,450	2,150
0.40	7.2	3.6	145	4	2,900	2,450
0.50	7.8	3.9	178	4	3,800	3,000
0.60	8.4	4.2	215	5	4,700	3,700
0.70	8.8	4.4	255	5	5,500	4,350
0.80	9.4	4.7	300	6	6,250	5,000
0.90	10.0	5.0	350	6	7,000	5,500
1.00	10.4	5.2	400	7	7,700	6,100
1.20	11.4	5.7	500	8	9,000	7,200
1.40	12.4	6.2	600	9	10,250	8,250
1.60	13.4	6.7	700	11	11,400	9,200
1.80	14.4	7.2	790	12	12,550	10,150
2.00	15.2	7.6	855	14	13,700	11,000
2.30	16.6	8.3	1,040	16	15,350	12,300
3.20	20.4	10.2	1,510	20	18,800	15,600
4.00	25.5	12.2	1,830	ON OFF 15 6 4	20,700	17,500

*1 This Table should be applied to stainless steels of 301,302,303,304, 308,309,310,316,317,321,347,and349. paint and grease.

*2 Contact surfase of materials should be free from scale,rust,

*3 The Table shows the welding condition for the external thin sheet.

*4 Overlapped material shall not be over 4T.
The maximum ratio of the material thickness of a pair should be 3:1.

*5 Electrode material shall be used of RWMA class 2,class 3 or 11.
Inthe pulsation welding for a 3.5mm thick or more sheet, the class3 or 11 should be applied.

Zinc-Coated Sheets

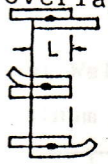
Class *4	Coating	Galvanizing *1		
	Thickness Of Plating(μm)	2 ~ 3	2 ~ 3	2 ~ 3
	Material Thickness (mm)	0.8	1.2	1.6
A	Weld Current(KA)	10	12	14.8
B		8.5	10.5	12
A	Electrode Force(kgf)	270	330	450
B		200	250	320
A	Heating Time(cycle)	8	10	12
B		10	12	15
A	Tension-shear Strength(kgf/mm^2)	460	670	1,150
B		440	650	1,050

*1 Galvanizing: electroplating,mild steel used as the cathode and zinc used as the anode dipped in electrolyte.

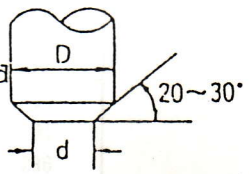
*2 Hot Dip Zinc Coating:mild steel sheets dippet in fused zinc.

*3 Alloyed Zinc Coatimg:galvanealed hot zinc coating.

*4 The class A and B are the order of high current,not authorized.

Minimum Contacting Overlap  mm	Minimum Weld Spacing 6 mm	Diameter Of Fused Zone  Dn (=N√T) mm	N	Minimum Tension-Shear Strength Base Material 49~63 kgf/mm²	63~105 kgf/mm²	105 kgf/mm² 以上	Bulk Fused Zone Shear Stress 注7 kgf/mm² Dn
5.5	5.5	1.5	3.1	50	65	80	28.5
5.8	5.8	1.7	3.4	60	72	90	26.5
6.3	6.6	1.9	3.45	75	95	110	26.5
6.7	7.0	2.1	3.55	95	115	135	27.5
7.2	8.0	2.3	3.65	118	136	165	28.5
8.0	9.5	2.7	3.85	162	190	220	28.5
8.9	11.0	3.0	3.85	210	242	280	29.5
9.7	12.5	3.4	4.05	260	305	350	29.0
10.6	14.0	3.7	4.15	320	375	435	29.0
11.3	15.5	4.0	4.25	380	445	515	30.0
12.0	17.0	4.3	4.30	445	525	615	31.0
13.4	20.0	4.8	4.35	585	700	840	32.5
14.6	22.9	5.3	4.50	740	890	1,085	33.5
15.7	25.8	5.8	4.60	900	1,090	1,340	34.0
16.8	28.8	6.3	4.70	1,070	1,290	1,600	34.0
17.9	31.8	6.6	4.65	1,240	1,500	1,270	36.0
19.3	36.4	7.0	4.60	1,500	1,800	2,260	39.0
22.8	50.5	8.0	4.50	2,250	2,720	3,450	45.0
34.0	48.0	11.3	5.65		3,500	4,555	

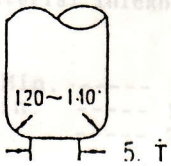
*6 Minimum weld spacing is a limitation of which shunted current effect of adjacent welds is negligible in practice. For a shorter weld spacing, an adequate weld current has to be increased as a compensational to the shunted current to adjacent weld.
In the case of triple overlapped, a 30% increased weld current is required.
*7 The idea is for a shearing strength of base material.
*8 For a 3.5mm or more thick material, the pulsation welding should be applied.



at 50Hz

Hot Dip Zinc Coating *2			Alloyed Zinc Coating *3		
10~15	15~20	20~25	8~12	8~12	8~12
0.8	1.2	1.6	0.8	1.2	1.6
10	12.5	15	10	11.7	13.5
9	11.5	12	8.5	10.5	11.8
270	370	450	270	320	450
170	250	350	200	250	370
8	10	12	8	10	12
10	12	15	10	12	15
500	900	1,300	500	850	1,300
480	870	1,200	480	800	1,200

*5 For the tip of the electrode, a 120°-140° top angle frustum should be recommended.
The tip diameter is given by :5tv T:material thickness in mm.



[Spot Welding On Single-phase]

Aluminum Alloys(MIL Specifications)

	Electrode		Electrode Force	Heating Time	Weld Current	Tension-shear Strength Of Base Material		
						13~20	20~40	40
mm	Dmm	Rmm	kgf	Cycle	A	kgf	kgf	kgf
0.4	16	25-F	160	4	15,000	47	65	72
0.5	16	25-F	170	5	18,000	67	87	95
0.6	16	50-F	195	6	21,000	97	107	125
0.8	16	50-F	250	6	26,000	140	157	175
1.0	16	75-F	300	8	30,700	200	207	230
1.2	16	75-F	330	8	33,000	275	295	320
1.6	16	75-F	375	10	35,900	377	307	460
1.8	16	100	400	10	38,000	437	490	585
2.0	22	100	430	10	41,800	517	577	700
2.3	22	150	475	12	46,000	587	677	850
2.6	22	150	525	15	56,000	635	800	1,025
3.2	22	150	650	15	76,000	700	1,085	1,415

Aluminum Alloys (COMMERCIAL USE)

Material Thickness	Weld Current	Weld Time	Electrode Force	Tension Shear Strength		
(mm)	(A)	(cycle)	(kgf)	(A)	(B)	(C)
0.4	14,000	4	90~180	49	32	23
0.5	16,000	6	135~230	63	45	34
0.6	17,000	6	〃	84	66	50
0.8	18,000	8	180~270	118	95	75
1.0	20,000	8	〃	156	136	102
1.3	22,000	10	230~320	218	186	136
1.6	24,000	10	〃	313	256	181
2.0	26,000	12	270~360	465	345	236
2.6	32,000	12	360~450	693	430	310
3.2	35,000	15	360~550	960	475	355

Note: *1. Time is shown in 60Hz. *2. The tension shear strength of the following material is shown:
(A) Alclad-75S-T, 75S-W, 14S-T, 14S-W, 24S-T, 24S-RT, R301-T, 75S-T, R301-W, 14S-T, R303 24S-T, Clad R303 24S-RT.
(B) 52S-1/4HtoH, 53S-W, 53S-T, 56S-1/4HtoH, 61S-W, 61S-T, 63S-75.
(C) 2S-Alltempers, 3S-Alltempers Annealed (0)

*3. Diameter of fused zone: d=2t+1.6(mm) t=Thickness

Electrode For Aluminum Alloy Spot Welding



R type

CF type

F type

R Type Electrode Radius in mm.

Material	Material Thickness (mm)	~0.5	0.5~0.8	0.8~1.6	1.6~2.4	2.4~3.2
	(C)	50	75	100	100	
	(B)	50	75	75	100	100
	(A)	25	50	75	100	100

CF Type Electrode

α=130°~160°, d=2t+3(mm), t = Material Thickness

F Type Electrode D (mm)

2000A or less, 8 spots or less/Min. ------ 13mm
3500A or less, 15 to 40 spots/Min. ----- 16mm
Over 3500A, over 40 spots/Min. ----- 22 - 32mm

(Projection Welding On Single-phase)

Low-carbon Steel

Material Thickness mm	Projection Dimensions (mm) Shape	Diameter		Height		Minimum Weld Spacing mm		Minimum Weld Overlapping mm		Heating Time (cycle) Schedule *8 A	B	C	Electrode Force *8 (kgf/mm²) Schedule A	B	C	Welding Current Schedule *8 A	B	C	Tension-shear Strength Per Spot Weld (kgf/mm²) A	B	C	Material Thickness mm
0.23	Group A *6					8.0		6.5		5			38			4,900			60	50		0.23
0.29						8.0		6.5		6			52			5,150			90	70		0.29
0.35						8.0		6.5		6			68			5,250			120	90		0.35
0.40						8.0		6.5		6			80			5,300			140	102		0.40
0.50						8.0		6.5		6			105			5,400			190	135		0.50
0.6	Group B *7	2.3		0.62		10.0		6.5		3	6	6	70	70	40	4,500	3,900	3,000	170	150	132	0.6
0.7		2.5		0.70		10.5		7.0		3	6	7	82	75	48	5,400	4,400	3,250	220	190	150	0.7
0.8		2.6		0.75		12.0		8.0		4	7	9	93	80	57	6,200	4,900	3,500	300	240	190	0.8
0.9		2.8		0.85		13.0		8.5		4	8	12	115	87	63	7,000	5,200	3,700	360	290	230	0.9
1.0		2.9		0.90		14.0		9.5		5	10	14	130	93	70	7,700	5,700	3,950	440	350	270	1.0
1.2		3.3		1.0		16.5		11.0		7	14	18	175	120	90	8,800	6,400	4,450	560	460	370	1.2
1.6		3.9		1.15		20.0		13.0		10	20	27	265	175	150	10,600	7,800	5,500	840	720	590	1.6
1.8		4.3		1.20		22.0		13.5		12	24	32	335	210	180	11,400	8,500	6,000	980	860	710	1.8
2.0		4.7		1.25		24.0		14.5		14	27	36	365	250	220	12,200	9,000	6,500	1,140	1,000	840	2.0
2.3		5.3		1.30		27.5		16.5		16	32	43	445	300	270	13,200	9,700	7,200	1,410	1,230	1,050	2.3
2.6		5.9		1.40		30.5		18.0		18	36	49	540	360	320	13,900	10,400	8,000	1,680	1,480	1,260	2.6
3.2		7.2		1.50		37.5		22.5		23	45	62	710	470	440	15,100	11,500	9,400	2,300	1,980	1,710	3.2
4.0	Group C.	8.80	6.90	1.65	1.55	45.0	41.0	24.5	20.5	Slope 15	64	Slope 15	64	Weld 970	Pressurized 1,500	Weld 650	Pressurized 1,250	15,800	11,300	3,450	2,400	4.0
4.5		9.80	7.90	1.90	1.70	48.5	43.0	25.5	21.5	18	82	18	82	1,200	2,300	700	1,350	16,600	12,700	4,300	2,950	4.5
5.0		10.90	8.60	2.15	1.80	52.0	45.5	27.5	23.5	22	100	22	100	1,400	2,650	750	1,460	19,200	14,000	5,250	3,600	5.0
6.0	*7.8	13.00	10.10	2.70	2.20	61.0	51.5	32.5	27.0	29	140	29	140	1,750	3,400	950	1,780	22,600	16,700	7,500	5,100	6.0

*1. This Table should be applied to the mild steel conforming to SAE 1005-1010 with a tensile strength of 28 - 38kgf/mm². Contact surface of materials should be free from scale, rust, paint and grease. Some oil film can be allowed on sheet.

*2. Power supply frequency: 60Hz

*3. The pressure for correcting the adaptation of components is not included in the electrode force.

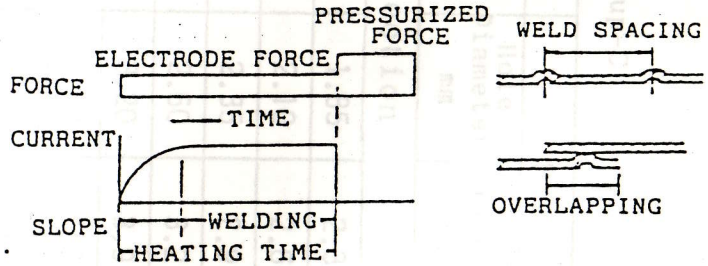
*4. The tensile strength is a typical values depending on the design of the joint.

*5. The schedule-A should be applied to a single spot welding. In addition, it is allowed to be applied to multi- spot welding, but splashing may be caused.
The schedule-B should be applied to 1- or 3-spot welding. More spot may produce splashing.
The schedule-C is for 3-spot welding. For the application of less 3 spots, the welding current should be increased by 15%. For the material thickness group-C, the schedule-A and -B show the nut size. Schedule-A: standard Schedule-B: smaller one allowable.

*6. The dimension of the projection, punch and die for the group-A(thin material), group-B(medium material) and group-C(thick material) are shown.

*7. The welding sequence for the group-C(thick material) is shown in Fig. a.

*8 The minimum weld spacing and overlapping are shown in Fig. b.

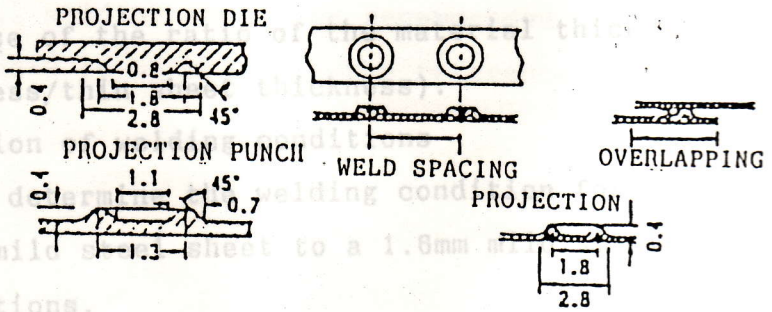


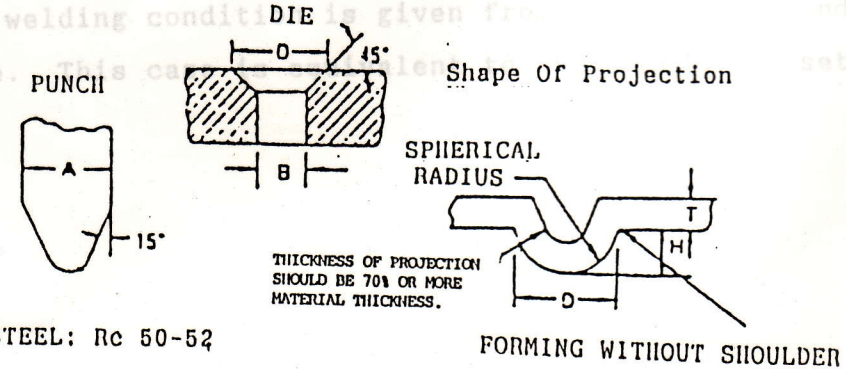
[Projection Welding]

Punch & Die Dimensions For Group-B & Group-C

Material Thickness mm	Projection		Punch		Die		Material Thickness mm
	Height ±2% mm	Diameter ±5% mm	Diameter A mm	Tip Radius ±0.05 mm	Hole Diameter mm	Contact Diameter mm	
Dome Type Standard Projection							
0.6	0.62	2.3	10	0.78	1.85	2.3	0.6
0.8	0.75	2.6		0.95	2.10	2.6	0.8
1.0	0.90	2.9		1.10	2.35	2.9	1.0
1.2	1.00	3.3		1.25	2.60	3.2	1.2
1.6	1.15	3.9		1.56	3.20	3.9	1.6
1.8	1.20	4.3		1.70	3.50	4.3	1.8
2.0	1.25	4.7		1.79	3.80	4.7	2.0
2.3	1.30	5.3		1.95	4.30	5.3	2.3
2.9	1.45	6.5	13	2.22	5.30	6.5	2.9
3.2	1.50	7.2		2.50	5.80	7.2	3.2
4.0	1.65	8.8		3.30	7.20	8.8	4.0
5.0	2.15	10.9		4.35	8.70	10.9	5.0
6.0	2.70	13.0	15	5.15	10.20	13.0	6.0
Small Type Projection For Group-C(thick material)							
4.0	1.5	6.9	15	2.75	4.90	6.9	4.0
5.0	1.7	8.6		3.20	6.20	8.6	5.0
6.0	1.9	9.6		3.80	7.60	8.7	6.0

Projections And Punch & Die Dimensions For Group-A(thin material)





TOOL STEEL: Rc 50-52

FORMING WITHOUT SHOULDER

Practical Notes For Welding

(1) For welding thin sheets, a welder should be provided with the electrode giving small shock in squeezing and excellent follow-up characteristics.

(2) Notes for 4 - 6mm thick materials

a) Pressurized contact should be applied because of preventing porosity.

b) Double step contact pressure should be applied or a projection with a relief groove should be used.
The extruding pressure for the projection with the relief groove is 16 to 17 tons for a 4 to 6mm thick sheet.

c) A slope control should be used because welders become large, which decreases the follow-up capability, resulted in easy splashing.

(3) Different thickness of paired materials

- Thickness ratio 1 : 1 to 3 : 1

a) Either side projection is allowed. For the thick material side projection, the welding condition is not so severe.

b) The projection dimension is determined on the thinner sheet basis.

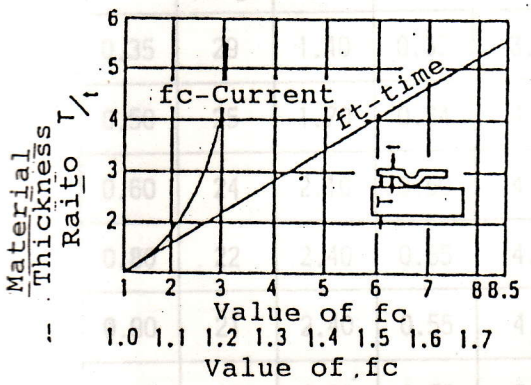
c) Weld current and heating time should be increased with the increase of the ratio of the material thickness(thick sheet thickness/thin sheet thickness).

d) Selection of welding conditions
How to determine the welding condition for welding a 0.9mm thick mild steel sheet to a 1.6mm mild steel sheet with two projections.
i) A welding condition is given from the welding condition Table. This case is equivalent to the schedule-B setting

the welding current in 5200A per a spot, heating time in 8 cycles and electrode force in 87kgf.

ii) The thickness ratio is 1.6/0.9 = 1.75/1

The current constant(fc) and time constant(ft) are given by:



fc = 1.07 ft = 2.2

Correct current: 5200 x 1.07 = 5500A

Correct time: 8 x 2.2 = 18 cycles

Projection: 2 spots

Weld current: 2 x 5500 11000A

Electrode force: 2 x 87 = 174kgf

Heating time: = 18 cycles

- Thickness ratio 3 : 1 to 6 : 1

a) If the thick material is difficult to be provided with the projection, the projection is allowed to the thin side.

b) Some prevention should be arranged in free from dust, foreign matter and oil.

c) Class-1 or Class-2 materials are recommended as an electrode material because of tendency of much burned surface of sheets, however, the combination of electrode materials should be determined in consideration of heat balance.

d) A trial welding should be recommended to find out more accurate data to be set with the reference of the above data.

[Projection Welding]

Austenitic Stainless Steel.

*1,2,3,4		*5	*6	*7	Punch & Die Dimensions				
Material Thickness "T"		Projection D Diameter	Projection H Height	Electrode Minimum Tip Diameter d=2×D	Type	±0.05 C	Dr	±0.025 E	±0.025 F
mm	U.S.S Gauge	mm	mm	mm		mm	mm	mm	mm
0.35	29	1.40	0.33	3.2	1	1.40	0.85	0.35	
0.50	25	1.70	0.34	4.0	2	1.70	1.10	0.45	0.50
0.60	24	2.10	0.50	4.0	3	2.05	1.30	0.50	0.65
0.80	22	2.40	0.55	4.8	4	2.40	1.60	0.55	0.75
0.90	21	2.40	0.55	4.8	5	2.40	1.60	0.55	0.75
1.00	19	3.00	0.70	6.4	6	3.00	2.00	0.70	0.90
1.20	18	3.00	0.70	6.4	7	3.00	2.00	0.70	0.90
1.60	16	4.00	0.90	8.0	8	4.00	2.70	0.90	1.10
1.80	15	4.00	0.90	8.0	9	4.00	2.70	0.90	1.10
2.00	14	4.80	1.05	9.6	10	4.75	3.25	1.05	1.40
2.40	13	5.55	1.20	11.2	11	4.55	3.75	1.20	1.65
3.20	11	7.15	1.50	14.4	13	7.15	4.90	1.50	2.15

*1.Steel material:309,310,317,347 and 349,non-heat treated carbon contain:0.15%

*2 Material should be free from scale,paint,grease and oil.

*3 The projection dimention is determined on the thinner sheet basis. The projection should be extruded to the thicker sheet as much as possible.

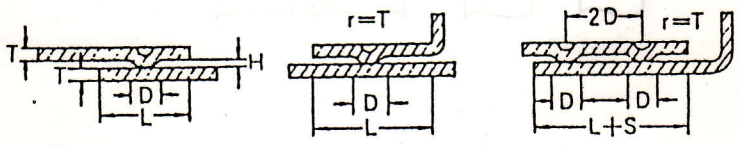
*4 Thickness ratio of double sheets overlapped should be 3:1 or less.

*5 Material Thickness For Diameter 'D'
- -1.27mm or less :0.08mm in tolerance.
- -up to 3.20mm : 0.20mm in tolerance.

*6 Material Thickness For Height 'H'
- -1.27mm or less: 0.05mm in tolerance.
- -up to 3.20mm: 0.13mm in tolerance.

*7 Electrode Material:Malloy 100 or Elconite 10w3

S (Minimum)



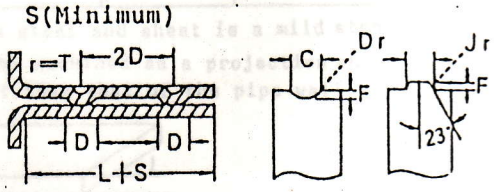
Punch & Die Dimensions			＊8			＊9		＊10
±0.025 H mm	Jr mm	Electrode Force kgf	Heat Time ∿	Hold Time ∿	Welding Current (Approx.) A	Minimum Shear Strength (base material 100kgf/mm² or less)	Nugget Dia. mm	Minimum Contacting Overlap "L" mm
0.90	0.13	140	7	15	4,500	125	2.9	3.2
1.00	0.13	230	10	15	4,750	200	3.6	4.0
1.10	0.13	270	12	15	5,200	270	3.6	4.8
1.30	0.13	320	15	15	5,750	380	4.3	5.6
1.30	0.13	320	17	15	5,900	450	4.3	5.6
1.60	0.13	320	20	15	6,000	590	4.3	7.2
1.60	0.13	450	22	15	6,500	770	5.7	7.2
2.05	0.13	540	25	15	7,500	1,020	5.7	9.6
2.05	0.13	720	27	30	8,800	1,260	7.2	9.6
2.65	0.25	860	30	30	10,000	1,440	7.2	11.2
2.95	0.25	860	30	30	10,000	1,800	7.2	12.7
3.90	0.04	1,260	30	45	14,000	2,560	8.6	17.6

＊8. Heating time is based on the frequency of 60Hz.

＊9. Tension-share strength per spot weld, doubled overlapped test piece for tension-share strength, completely overlapped without any deviation.

Sheet Thickness Range	Test Piece Width	Test Piece Length
0.15～0.74mm	16.0mm	75mm
0.76～1.47mm	25.4mm	100mm
1.49～2.92mm	38.1mm	125mm
2.94～4.83mm	50.8mm	150mm

＊10. A weld spot is put on the center of overlap.



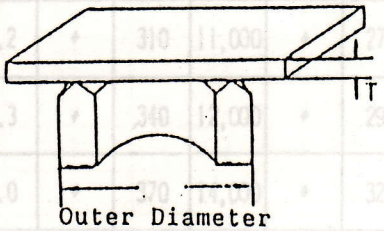
Ring Projection Welding

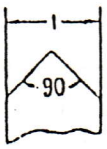
Outer Diameter		Pipe Wall Thickness (t) mm	Sheet Thickness (T) mm	Heat Time (cycle)	Electrode Force kgf	Welding Current A	Tensile Strength
	mm						
1/4"	13.8	2.3	0.8	6	476	21,000	839
			1.6	〃	〃	20,200	1,558
			3.0	〃	〃	19,800	1,678
			6.4	〃	〃	21,500	2,268
			0.8	12	318	17,100	794
			1.6	〃	〃	16,300	1,633
			3.0	〃	〃	15,800	1,682
			6.4	〃	〃	18,900	1,996
1/2"	21.7	2.8	0.8	10	1,000	33,500	1,443
			1.6	〃	〃	35,200	2,812
			3.0	〃	〃	32,600	4,037
			6.4	〃	〃	38,200	5,086
3/4"	27.2	2.8	0.8	6	1,600	46,000	1,724
			1.6	6	1,600	45,200	3,157
			3.0	8	1,600	48,500	5,180
			6.4	10	1,905	52,000	5,897
1"	34.0	3.2	0.8	6	2,019	58,500	2,313
			1.6	8	2,019	57,500	4,391
			3.0	10	1,343	52,000	4,225
			6.4	11	1,687	65,000	6,769

*1. Pipe is made of a low carbon steel and sheet is a mild steel.

*2. The tip of the pipe should be machined as a projection shown as the following illustration.

*3. In larger thickness of sheet than that of the pipe wall, the heat balance control is generally difficult.





[4-spot Projection Nut Welding]

Screw (nominal) mm	Material Thickness mm	A			B			Weld Twisting Strength kgf-cm
		Time (cycle)	Electrode Force kgf	Weld Current A	Time (cycle)	Electrode Force kgf	Weld Current A	
12	1.2	3	450	17,000	6	370	14,000	1,200
	2.3	〃	480	18,500	〃	400	15,000	
	4.0	〃	520	20,000	〃	420	16,500	
8	1.2	3	360	13,500	6	270	9,500	1,000
	2.3	〃	400	15,000	〃	290	10,500	
	4.0	〃	430	16,500	〃	320	12,000	
5	1.2	3	300	10,500	6	240	8,000	700
	2.3	〃	320	11,500	〃	260	9,000	
	4.0	〃	350	12,500	〃	280	9,500	

[3-spot Projection Nut Welding]

Screw (nominal) mm	Material Thickness mm	A			B			C			Weld Twisting Strength kgf-m	Nut Twisting Strength kgf-m
		Time cycle	Electrode Force kgf	Weld Current A	Time cycle	Electrode Force kgf	Weld Current A	Time cycle	Electrode Force kgf	Weld Current A		
10	1.2	3	420	16,000	6	350	13,000	12	280	10,000	15.3	5.5
〃	2.3	〃	450	17,000	〃	370	14,000	〃	300	11,000	〃	〃
〃	4.0	〃	480	18,000	〃	410	15,500	〃	320	12,000	〃	〃
6	1.2	〃	310	11,000	〃	270	9,500	〃	220	7,000	4.5	1.5
〃	2.3	〃	340	12,000	〃	290	10,500	〃	250	8,500	〃	〃
〃	4.0	〃	370	14,000	〃	320	12,000	〃	270	9,500	〃	〃

[Projection Welding On Single-phase] Mild Steel Cross-wire

Mild steel cross wire welding								
Wire Dia mm	Cold Drawing Mild Steel Wire				Hot Drawing Mild Steel Wire			
	Heat Time (cycle)	Electrode Force kgf	Welding Current	Tensile Strength kgf	Heat Time (cycle)	Electrode Force kgf	Welding Current A	Tensile Strength kgf
	15%-swaged				15%-swaged			
1.2	4	40	250	150	4	45	200	100
1.4	5	45	400	180	5	45	350	120
1.6	5	45	600	210	5	50	600	150
1.8	6	45	750	240	6	50	750	170
2.0	7	50	950	270	7	50	950	200
2.3	7	50	1,040	310	7	55	1,230	240
2.6	8	55	1,500	360	8	60	1,500	280
2.9	9	65	1,750	420	9	70	1,800	320
3.2	11	75	2,000	490	11	80	2,100	370
3.5	12	80	2,300	550	12	90	2,400	430
4.0	13	100	2,800	700	13	110	2,900	520
5.0	17	160	3,600	1,000	17	170	3,800	760
6.0	22	230	4,500	1,400	22	230	4,800	1,100
7.0	26	310	5,400	1,900	26	310	5,800	1,500
8.0	31	390	6,300	2,400	31	380	6,700	2,000
9.0	37	470	7,200	3,000	37	460	7,700	2,600
10.0	43	550	8,100	3,700	43	540	8,600	3,300
11.0	50	630	9,000	4,400	50	630	9,600	4,000
12.0	56	720	9,900	5,100	56	710	10,500	4,700
13.0	63	810	10,800	5,800	63	800	11,500	5,500
	30%-swaged				30%-swaged			
1.2	4	60	200	140	4	50	450	140
1.4	5	65	500	170	5	60	680	160
1.6	5	70	750	220	5	65	900	180
1.8	6	75	1,000	250	6	70	1,120	200
2.0	7	80	1,300	290	7	80	1,350	220
2.3	7	95	1,700	360	7	90	1,700	260
2.6	8	110	2,100	430	8	110	2,080	300
2.9	9	120	2,500	500	9	120	2,400	350
3.2	11	140	2,900	590	11	140	2,800	400
3.5	12	160	3,300	680	12	160	3,150	450
4.0	13	190	4,000	840	13	190	3,800	570
5.0	17	270	5,300	1,200	17	290	5,000	800
6.0	22	380	6,700	1,700	22	410	6,400	1,250
7.0	26	510	8,000	2,200	26	550	7,900	1,700
8.0	31	690	9,400	2,800	31	700	9,500	2,250
9.0	37	860	10,700	3,500	37	880	11,100	2,850
10.0	43	1,050	12,000	4,250	43	1,070	12,800	3,550
11.0	50	1,230	13,400	5,000	50	1,270	14,600	4,300
12.0	56	1,420	14,800	5,800	56	1,490	16,400	5,100
13.0	63	1,620	16,100	6,600	63	1,700	18,100	5,850

Mild steel cross wire welding							
Cold Drawing Mild Steel Wire				Hot Drawing Mild Steel Wire			
Heat Time (cycle)	Electrode Force kgf	Welding Current A	Tensile Strength kgf	Heat Time (cycle)	Electrode Force kgf	Welding Current A	Tensile Strength kgf
50%-swaged				50%-swaged			
4	70	400	200	4	70	300	170
5	85	700	230	5	80	650	190
5	100	1,000	260	5	90	1,000	210
6	110	1,300	300	6	100	1,300	230
7	120	1,600	340	7	110	1,600	250
7	140	2,100	400	7	120	2,100	290
8	160	2,600	450	8	140	2,550	340
9	180	3,100	530	9	160	3,100	380
11	200	3,550	600	11	180	3,500	440
12	230	4,000	750	12	200	4,100	500
13	280	4,800	850	13	250	5,000	600
17	400	6,400	1,270	17	370	6,800	920
22	550	8,000	1,800	22	500	8,600	1,300
26	720	9,700	2,450	26	690	10,300	1,650
31	940	11,400	3,100	31	900	12,100	2,400
37	1,200	13,400	3,800	37	1,200	14,000	3,100
43	1,500	15,400	4,500	43	1,500	16,100	3,800
50	1,850	17,300	5,250	50	1,870	18,300	4,550
56	2,200	19,400	6,050	56	2,270	20,500	5,300
63	2,600	21,700	6,900	63	2,680	22,900	6,100

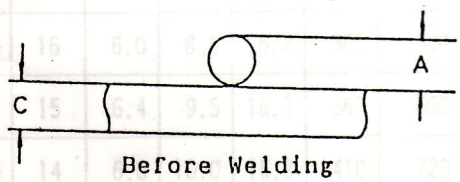
This Table should be applied to the welding joint of the same diameter mild steel(0.20% or less carbon) cross wires.

For a pair of different diameter wires, the welding condition is determined in the smaller diameter wire basis with some additional.

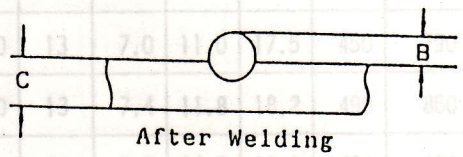
The Table is for the single spot welding.

While, for the multiple spot welding, the condition is given by the following procedure:

- Heat time: data from the above Table
- Welding current: data in the Table x number of spot
- Electrode force: data in the Table x number of spot



Before Welding



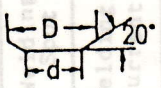
After Welding

$$\text{Swaging} = \frac{A - B}{A} \times 100$$

$$A \leqq C$$

[Seam Welding With Pulsating Heat]

Mild Steel

Common Condition									Hermetically Welding				
Material Thickness		Electrode 			Electrode Force		Minimum Overlap		High Speed Weld				
T mm	USS Gauge	Minimum d mm	Standard d mm	Minimum D mm	Minimum kgf	Standard kgf	For Minimum mm	For Standard mm	Heat Time ∂	Off Time ∂	Welding Speed mm /min	Welding Spot /10mm	Welding Current A
0.23	33	3.2	4.8	9.5	175	175	6.5	9.0	1	1	2,970	6.7	11,500
0.26	32	3.2	4.8	9.8	180	180	6.5	9.5	1	1	2,940	6.8	11,500
0.30	31	3.4	5.0	10.1	180	190	6.5	9.5	1	1	2,910	6.8	11,600
0.32	30	3.4	5.0	10.3	185	200	6.8	9.8	1	1	2,890	6.9	11,700
0.35	29	3.5	5.2	10.5	190	210	7.0	10.0	1	1	2,870	6.3	11,800
0.40	28	3.7	5.3	10.8	200	220	7.2	10.2	2	1	2,830	4.2	12,100
0.45	27	3.8	5.5	11.1	210	230	7.5	10.5	2	1	2,800	4.3	12,400
0.50	26	4.0	5.6	11.4	210	250	7.8	10.8	2	1	2,760	4.4	12,800
0.55	25	4.1	5.7	11.7	220	260	8.0	11.2	2	1	2,730	4.5	13,200
0.60	24	4.2	5.9	11.9	220	280	8.3	11.5	2	1	2,700	4.4	13,600
0.65	23	4.3	6.0	12.2	230	290	8.5	11.8	2	1	2,670	4.5	14,000
0.70	23	4.4	6.2	12.4	230	300	8.8	12.0	2	1	2,650	4.5	14,500
0.75	22	4.6	6.3	12.6	240	320	9.0	12.3	2	1	2,620	4.6	15,000
0.80	22	4.7	6.5	12.8	250	330	9.3	12.5	2	1	2,600	4.6	15,500
0.85	21	4.8	6.6	13.0	250	350	9.5	12.8	2	1	2,570	4.7	16,000
0.90	21	5.0	6.8	13.2	260	370	9.8	13.0	2	2	2,540	3.5	16,700
1.00	20	5.1	7.1	13.6	280	400	10.0	13.5	2	2	2,500	3.6	18,000
1.20	19	5.4	7.7	14.3	300	470	11.0	14.5	2	2	2,430	3.7	19,200
1.40	17	5.8	8.2	15.0	330	530	11.5	15.5	2	2	2,370	3.8	20,700
1.60	16	6.0	8.8	15.7	360	600	12.0	16.2	3	1	2,300	3.9	21,100
1.80	15	6.4	9.5	16.3	380	660	12.5	17.0	3	1	2,230	4.0	21,500
2.00	14	6.6	10.0	16.8	410	720	13.2	17.8	3	1	2,160	4.2	22,000
2.30	13	7.0	11.0	17.5	450	790	14.0	19.0	4	2	2,070	2.9	22,900
2.60	13	7.4	11.8	18.2	490	860	14.8	20.0	4	2	1,970	3.1	24,200
2.90	12	7.7	12.7	18.8	530	930	15.5	21.0	4	2	1,870	3.2	25,800
3.20	11	8.0	13.6	19.5	570	1,000	16.0	22.0	4	2	1,770	3.4	27,700

Hermetically Welding										Pulsating weld with roll spot				
Medium Speed Weld					Low Speed Weld							Welding Speed		
												mm/min		
Heat Time ∮	Off Time ∮	Welding Speed mm/min	Welding Spot ./10mm	Welding Current A	Heat Time ∮	Off Time ∮	Welding Speed mm/min	Welding Spot ./10mm	Welding Current A	Heat Time ∮	Off Time ∮	Maximum	Ordinary	Minimum
2	1	2,040	6.0	7,700	2	3	1,270	5.7	7,300	2	※	12,300	5,100	2,570
2	1	2,030	6.0	8,100	2	3	1,250	5.8	7,500	2	〃	12,200	5,050	2,540
2	1	2,020	6.0	8,500	2	3	1,240	5.8	7,750	2	〃	12,000	5,020	2,500
2	1	2,010	6.0	8,900	2	3	1,220	5.9	8,000	2	〃	11,800	5,000	2,480
2	1	2,000	6.0	9,200	2	3	1,210	6.0	8,300	2	〃	11,600	4,950	2,450
2	2	1,980	4.5	9,700	3	3	1,190	5.1	8,600	2	〃	11,400	4,900	2,400
2	2	1,960	4.6	10,300	3	3	1,170	5.2	9,000	2	〃	11,100	4,850	2,350
2	2	1,940	4.6	10,700	3	3	1,150	5.2	9,400	2	〃	10,800	4,800	2,330
2	2	1,920	4.7	11,200	3	3	1,130	5.3	9,800	2	〃	10,500	4,750	2,300
2	2	1,910	4.7	11,600	3	3	1,120	5.4	10,200	2	〃	10,200	4,700	2,260
3	2	1,890	4.8	12,000	3	4	1,100	4.7	10,600	3	〃	10,000	4,680	2,240
3	2	1,870	4.8	12,400	2	4	1,090	5.5	10,900	3	〃	9,700	4,600	2,200
3	2	1,850	4.9	12,700	2	4	1,070	5.6	11,300	3	〃	9,400	4,550	2,170
3	2	1,840	4.9	13,200	2	4	1,060	5.7	11,700	3	〃	9,100	4,500	2,140
3	2	1,820	5.0	13,600	2	4	1,050	5.8	12,100	3	〃	8,800	4,500	2,110
3	3	1,800	3.3	14,000	2	4	1,030	5.8	12,500	3	〃	8,500	4,450	2,080
3	3	1,770	3.4	14,800	2	4	1,010	6.0	13,200	3	〃	8,000	4,400	2,030
4	3	1,690	3.0	16,000	3	4	960	5.3	14,100	4	〃	6,900	4,200	1,950
4	3	1,620	3.2	17,000	4	4	910	5.0	14,800	4	〃	6,000	4,000	1,850
5	4	1,510	2.7	17,800	4	4	860	5.2	15,400	4	〃	5,300	3,800	1,750
5	5	1,480	2.4	18,500	5	5	820	4.4	15,700	5	〃	4,800	3,700	1,700
5	5	1,410	2.5	19,000	6	6	770	3.9	16,500	5	〃	4,600	3,500	1,570
7	6	1,300	2.1	19,900	6	6	710	4.2	16,800	6	〃	4,100	3,200	1,440
8	6	1,240	2.1	20,500	6	6	660	4.6	17,800	6	〃	3,900	2,700	1,330
10	6	1,190	1.9	21,300	6	6	620	4.8	19,200	6	〃	3,800	2,500	1,230
11	7	1,150	1.8	22,000	6	6	580	5.2	21,000	6	〃	3,600	2,300	1,130

Appropriate selection depending on required spacing.

[Seam Welding With Continuous Heat]

Mild Steel

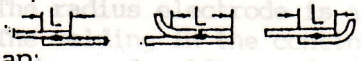
- Full Wave Heat Without Heat Control

Common Condition						
Material Thickness		Electrode		Electrode Force		Minimum Overlap * 4
mm	USS Standard	Minimum d mm	Minimum D mm	Minimum kgf	Standard kgf	
0.23	33	5.0	9.5	180	180	9.5
0.26	32	5.0	10.0	180	180	9.5
0.29	31	5.5	10.5	190	190	10.0
0.32	30	5.5	10.5	190	200	10.0
0.35	29	5.5	11.0	190	210	10.0
0.40	28	6.0	11.0	200	220	10.5
0.45	27	6.0	11.5	200	230	11.0
0.50	26	6.0	11.5	210	250	11.1
0.55	25	6.5	12.0	210	260	11.5
0.60	25	6.5	12.0	210	270	12.0
0.65	24	6.5	12.0	220	280	12.0
0.70	23	7.0	12.5	220	300	12.5
0.75	23	7.0	12.5	230	310	12.5
0.80	22	7.0	12.5	250	320	13.0
0.85	22	7.0	12.5	260	340	13.0
0.90	21	7.5	13.0	270	360	13.0
A heat controlled wave should be applied to sheets of over 1mm in thickness because of preventing the surface defect caused by other heating.						
Continuous heat controlled wave						
1.00	20	7.5	13.0	280	400	13.5
1.20	19	8.0	13.5	310	450	14.0
1.40	17	8.0	13.5	330	500	14.3
1.60	16	8.5	14.0	350	540	14.6
1.80	15	8.5	14.0	380	580	14.9
2.00	14	8.5	14.0	400	630	15.1

*1. This Table should be applied to the pickled oiled hot rolled mild steel with the tensile strength of 29 - 32kgf/mm^2 conforming to SEA 1005 1010.

*2. The electrode material should be a copper alloy conforming to RWMA class 2.

*3. The surface of the mild steel should be thinly oiled, exepting grease, scale, and dust.



*4. Overlap:

Seam Welding								
High Speed Welding			Medium Speed Welding			Low Speed Welding		
Welding Speed mm/min	Welding Spot /10mm	Welding Current A	Welding Speed mm/min	Welding Spot /10mm	Welding Current A	Welding Speed mm/min	Welding Spot /10mm	Welding Current A
12,350	5.28	13,000	6,200	5.8	9,000	4,600	7.7	8,600
12,200	5.91	14,000	6,100	5.9	10,000	4,550	7.9	8,650
12,050	6.00	14,000	6,000	6.0	10,000	4,500	8.0	8,650
11,900	6.05	14,000	5,900	6.1	10,000	4,400	8.2	8,700
11,700	6.16	14,000	5,800	6.2	10,000	4,350	8.3	8,700
11,500	6.28	14,000	5,700	6.4	10,000	4,230	8.5	8,700
11,200	6.41	14,000	5,500	6.5	10,000	4,110	8.8	8,700
11,000	6.55	14,000	5,300	6.8	10,000	3,990	9.0	8,800
10,700	6.73	14,100	5,200	7.0	10,000	3,870	9.3	8,800
10,400	6.90	14,200	5,000	7.2	10,000	3,750	9.6	8,900
10,180	7.05	14,300	4,800	7.2	10,000	3,630	9.8	8,900
9,900	7.31	14,450	4,700	7.7	10,500	3,510	10.3	9,000
9,600	7.50	14,800	4,500	8.0	11,000	3,390	10.6	9,300
9,300	7.74	15,300	4,400	8.3	11,000	3,270	11.0	9,600
9,000	7.99	15,800	4,200	8.6	11,500	3,130	11.5	9,800
8,700	8.31	16,300	4,000	8.9	12,000	3,000	12.1	10,000
A heat controlled wave should be applied to sheets of over 1mm in thickness because of preventing the surface defect caused by other heating.								
8,000	9.01	17,600	3,740	9.64	12,500	2,720	13.2	10.400
5,800	10.6	20,300	3,100	11.60	13,000	2,300	13.6	10,570
5,850	12.3	21,400	2,500	14.40	14,000	2,000	18.6	11,900
4,820	14.9	22,000	1,900	18.90	15,000	1,520	23.6	13,400
3,800	19.0	22,200	1,250	28.80	16,000	1,080	33.5	14,800
2,800	25.7	22,300	600	59.90	18,000	750	48.3	16,300

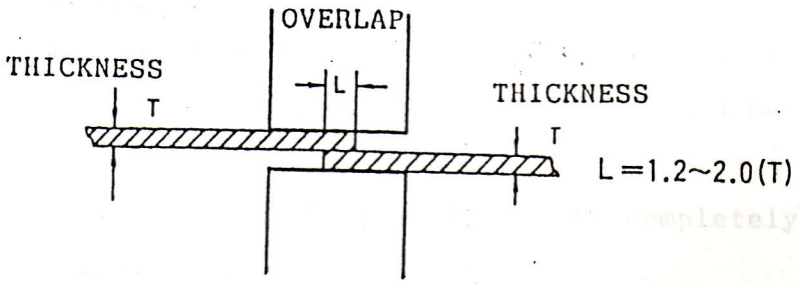
*5. The current shown in the Table is for 60Hz.
*6. In adaptation error, the electrode force should be increased to compensate other conditions.
*7. For welding big components, the minimum spacing should be increased by approx, 30% to improve the work efficiency and the welding speed should be low for easy manipulation.
*8. The radius electrode is allowed to be used.
*9. The welding in the continuous heat is 1 spot per 1/2 cycles in the high speed welding and 1 spot per 1 cycle in the low speed.

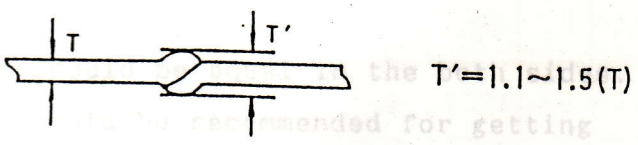
[Seam Welding]

Mild Steel, Different Thickness Pair

Material Thickness mm		Welding Speed	Welding Current	Weld Time (cycle)		Electrode Force D=12.7mm R= 150mm T= 6.4mm kgf
Thin Sheet	Thick Sheet	mm/min	A	Heat	Off Time	
0.8	2.0	1,830	16,000	3	2	270
0.8	2.0	3,610	22,000	2	1	360
0.8	1.3	1,830	17,000	3	2	360
0.8	1.3	3,610	20,000	2	1	315
1.3	2.0	1,530	22,000	4	3	540
1.3	2.0	3,050	22,000	3	1	540

SAE 101 material: Electrode*RWMA Class 2: surface pickling.





* Resistance Welder Manufacture Association.

[Mash Seam Welding With Continuous Heat]

Low Carbon Steel, Hermetically Welding

Material Thickness (*1 3)		Electrode Force	Initial Overlap (*4)	Welding Speed	Welding Current (*8)	Heat Control Range (*7,8)
mm	inch.	kgf	mm	mm/min	A	%
0.53	0.021	270	0.79	4,070	10,500	70~80
0.76	0.030	410	1.17	3,300	13,000	70~90
0.91	0.036	532	1.52	2,640	14,700	60~80
1.22	0.048	680	1.90	2,030	16,000	50~70
1.52	0.060	880	2.15	1,620	17,400	50~70
1.90	0.075	1,130	2.46	1,400	19,000	45~60
2.30	0.090	1,400	3.00	1,200	20,700	45~60

Note:

*1. This Table should be applied to the mild steel hot-rolled before pickled and lightly oiled, which has a tensile strength of 32 - 35kg/mm^2.

*2. The electrode should be RWMA class 3, 200mm in diameter.

*3. The surface of the mild steel to be welded should be free from scale, grease and dust.

*4. Contacting overlap should be prespotted, or completely clamped during seam welding.

*5. The thickness of the final welded is to be 150% of a single sheet thickness.

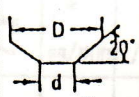
*6. The mashing degree should be equal in the both sides.

*7. The phase control should be recommended for getting excellent welding result and fine finish.

*8. For welding thicker material, approximately doubled welding current in this Table is required.

[Seam Welding]

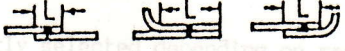
- Austenitic Stainless Steel (on single-phase)

Common Condition									Hermetic Weld				
Material Thickness		Electrode 		Electrode 		Electrode Force * G		*Minimum Overlap	High Speed Weld				
T mm	U.S.S Gauge	d mm	Minimum D mm	R mm	Minimum D mm	Minimum kgf	Standard kgf	mm	Heat Time *5	Off Time *5	Welding Speed mm/min	Welding Spot /10mm	Welding Current A
0.23	33	5.0	10.0	40	5.0	160	180	7.0	1	1	2,290	7.9	6,500
0.26	31	5.0	10.0	40	6.0	175	200	7.5	1	1	2,270	7.9	6,600
0.29	31	5.5	11.0	40	6.0	180	210	7.5	2	1	2,240	5.1	6,700
0.35	29	6.0	12.5	40	7.0	220	240	8.5	2	1	2,190	5.5	7,200
0.4	28	6.0	13.0	40	7.5	240	270	9.0	2	1	2,160	5.6	7,600
0.5	26	6.5	13.5	40	8.5	280	320	10.0	2	1	2,090	5.7	8,700
0.6	24	7.0	13.5	80	9.0	320	360	11.0	2	2	2,020	4.5	10,700
0.7	23	7.0	13.5	80	10.0	360	420	11.5	2	2	1,950	4.6	12,600
0.8	22	7.0	14.0	80	10.5	400	470	13.0	2	2	1,890	4.8	13,500
0.9	21	7.5	14.0	80	11.0	430	520	14.0	3	2	1,840	3.9	14,100
1.0	20	7.5	14.0	80	11.5	470	570	14.5	3	2	1,790	4.1	14,500
1.2	19	8.0	14.5	80	12.5	530	670	15.0	3	2	1,690	4.3	15,200
1.6	16	9.5	15.5	80	15.0	660	870	16.0	3	2	1,530	4.7	16,200
1.8	15	10.0	16.0	80	16.0	720	970	17.5	4	3	1,470	3.5	16,500
2.0	14	10.5	16.5	80	17.0	780	1,040	17.5	4	3	1,420	3.6	16,700
2.3	13	11.0	17.0	80	18.5	830	1,160	19.0	5	3	1,380	3.3	16,900
2.6	12	12.0	18.5	80	19.0	850	1,270	20.0	5	3	1,340	3.3	17,200
3.2	11	13.5	19.5	80	19.5	900	1,500	22.5	5	4	1,270	3.2	17,800
4.0	10	14.5	21.0	80	20.0	970	1,850	25.5	5	4	1,170	3.4	18,500

*1 This Table should be applied to stainless of 301, 302, 303, 304, 308, 309, 310, 316, 317, 321, 347, and 349.

*2 The electrode materia should be a copper alloy conforming to RWMA class 3.

*3 The sheet surface should be free from grease, scale and dust.

*4 Overlap: 

Hermetic Weld										Pulsating weld with roll spot ※				
Medium Speed Welding					Low Speed Weld									
Heat Time *5	Off Time *5	Welding Speed mm/min	Welding Spot /10mm	Welding Current A	Heat Time *5	Off Time *5	Welding Speed mm/min	Welding Spot /10mm	Welding Current A	Heat Time *5	Off Time *5	Welding Speed mm/min Maximum	Welding Speed mm/min Average	Welding Speed mm/min Minimum
1	2	1,520	7.9	4,800	2	2	1,090	8.3	4,200	3	※	4,140	3,040	2,130
1	2	1,500	8.0	5,200	3	2	1,085	6.6	4,600	3	〃	4,120	3,000	2,125
2	2	1,480	6.1	5,400	3	3	1,080	5.6	4,800	3	〃	4,100	2,960	2,125
2	2	1,440	6.3	6,200	3	3	1,070	5.6	5,500	3	〃	4,050	2,880	2,110
2	2	1,410	6.4	6,700	3	3	1,060	5.7	6,000	3	〃	4,000	2,820	2,100
2	2	1,360	6.6	7,700	3	3	1,045	5.8	6,900	4	※	3,920	2,710	2,060
2	2	1,310	6.9	8,600	3	5	1,030	4.4	7,800	5	〃	3,840	2,610	2,010
2	2	1,270	7.1	9,700	3	5	1,015	4.5	9,000	5	〃	3,760	2,530	1,940
2	3	1,220	5.9	10,700	3	5	1,000	4.5	10,200	5	〃	3,680	2,440	1,885
3	4	1,180	4.4	12,000	3	6	980	4.1	11,500	6	〃	3,600	2,370	1,830
3	4	1,150	4.5	12,900	3	6	960	4.1	12,300	6	※	3,520	2,300	1,780
3	4	1,090	4.7	14,000	4	6	930	3.9	13,200	7	〃	3,360	2,200	1,690
3	5	1,030	4.4	15,400	4	6	860	4.2	14,800	8	〃	3,050	2,060	1,510
4	5	1,020	3.9	15,900	4	8	840	3.6	15,700	10	〃	2,930	2,050	1,400
4	6	1,020	3.5	16,300	4	9	800	3.5	16,200	11	〃	2,840	2,040	1,260
5	5	1,010	3.5	16,600	5	8	760	3.7	16,600	12	※	2,740	2,020	1,050
5	6	1,000	3.3	16,800	5	10	700	3.4	16,800	13	〃	2,660	2,000	880
5	6	980	3.3	17,000	6	13	610	3.1	17,000	15	〃	2,550	1,960	630
5	6	950	3.4	17,300	6	14	460	3.9	17,300	18	〃	2,000	1,910	390

*5 The heat time and off time shown in the Table is for 60Hz.
*6 In adaptatioh error, the electrode force should be increased to compensate other conditions. Reqired pressure for such adaptation is not increased in this table
*7 For welding cold - treated material with a tensile strength of 105kgf/mm^2 or more, the maximum force should be applied to the electrode
*8 For welding big components, the minimum spacing should be increased by approx, 30% to improve the work efficiency and the welding speed should be low for easy manipulation.
*9 The radius electrode should be used for fine weld finish.

* The off time is properly selected depending on reqired weldspacing.

[Seam Welding]

Zinc Coated Sheets

Material Thickness mm	Galvanized Sheets			Hot Dip Zinc Coated Sheets		
	0.8	1.2	1.6	0.8	1.2	1.6
Electrode Tip Diameter "d" mm	5.0	5.5	6.5	5.0	5.5	6.5
Welding Speed cm/min	250	230	200	250	230	200
Welding Current A	16,000	17,000	19,000	18,000	19,000	21,000
Electrode Force kgf	350	280	450	400	430	500
Heat Time ∿	3	3	4	3	3	4
Off Time ∿	2	2	1	2	2	1

[Seam Welding On Single-phase]

Aluminum Alloy, Hermetically Welding

Material Thickness mm	Welding Spot Spot/10mm	Heat Time + Off Time (cycle) *1	Welding Speed *2 m/min	Heat Time ∿ *3 Minimum	Heat Time ∿ *3 Maximum	Electrode Force kgf	Welding Current *4 A	Width Of Fused Zone mm
0.25	10	3.5	1.03	0.5	1	190	10,500	2.00
0.41	8.5	3.5	1.25	0.5	1	230	22,000	2.30
0.51	8	4.5	1.00	0.5	1.5	250	24,000	2.50
0.64	7	5.5	0.92	1	1.5	270	26,000	2.75
0.81	6.5	5.5	1.04	1	1.5	310	29,000	3.25
1.02	5.5	7.5	0.88	1.5	2.5	350	32,000	3.50
1.30	5	9.5	0.79	1.5	3	390	36,000	4.00
1.63	4	11.5	0.79	2	3.5	440	38,000	4.75
2.06	3.5	15.5	0.64	3	5	490	41,000	5.50
2.59	3	20.5	0.55	4	6.5	560	43,000	6.50
3.25	3	28.5	0.46	5.5	9.5	610	45,000	8.00

*1. The timer should be so controlled that the start of the timer is started from a reversed half cycle or from the phase added a half cycle to this data.

*2. The welding speed is determined the number of spot per unit length.

*3. The heat time is within the power supply + off time.

*4. The electrode force and welding current are adjusted to get specified fused zones.

*5. The data in this Table is for the material conforming to 52S-1/2H. For materials of 52S-0 or 2S-1/2H, the electrode force is decreased

Spot Welding

Electrode Material Selection Table

a) For Same Metal Welding

Steel	Tin-plated steel		Tin alloy plated steel		Zinc coated steel		Cadmium plated steel		Chrome plated steel		Stainless steel 18-8		Scale coated steel		Cold rolled steel / Hot rolled pickled steel	
	B	I	A	I	A	I②	B	I	A	II	A	III②	B	I②	A	II
	I	3	I	3	I②	3	I	3	II	3	III②		I②	2	II	

Nonferrous metals	Aluminum		Duraluminum-aluminum alloy		Cupola nickel		Nickel silver		Nickel		Nickom monel nickel alloy		Brass 40Zn		Bronze phosphate	
	B	I②	B	I②	A	II	B	II	A	II	B	II	B	II	B	II
	I②	2	III	2	II		II		II		II		II		II	

b) For Different Metal welding

Steel	Stainless steel 18-8		Chrome plated steel		Cadmium plated steel		Zinc coated steel		Tin alloy plated steel		Tin plated steel	
Cold rolled steel / Hot rolled pickled steel	A	II③	A	II	B	II	B	I	A	I②	B	I
	II		II	3	II	3	II	3	II	3	II	3
Tin plated steel	B	II③	B	II	B	I②	B	I	B	I②		
	I		I	3	I	3	I	3	I	3		
Tin alloy plated steel ④	B	II	B	II	B	I②	B	I				
	I	3	I	3	I	3	I	3				
Zinc coated steel	B	II	B	II	B	I						
	I	3	I	3	I	3						
Cadmium plated steel	B	II	B	II								
	I	3	I	3								
Chrome plated steel	A	III②										
	II	3										

Note: This recommended electrode is valid only when time, current and pressure are adequately kept.

For welding different metals pair, refer to data in the crossed frame of each item.(For welding the same metals pair, refer to data in the frame under the above.)

- Electrode, RWMA standard

I ·····Group A Class 1
II ·····Group A Class 2
III ·····Group A Class 3

The O-marked electrode should be recommended in the next.

Data in the frame

* (a)	* (c)
* (b)	Note

- Note:

1. A special condition is required.
2. It should be cleaned before welding.
3. For thick plating, the tensile strength check is required.
4. Alloy of tin, lead and zinc.

*a Welding capability

*b Electrode for metals shown in the left item.

*c Electrode for metals shown in the above item.

Working Hour Table

Second / Welding Spot	Welding Spot / Minute	Welding Spot / Hour	Welding Spot / 7 Hours	Welding Spot / 8 Hours	7 Hours x 21 days	8 Hours x 21 days	7 Hours x 22 days	8 Hours x 22 days
1	60	3,600	25,200	28,800	529,200	604,800	554,400	633,600
2	30	1,800	12,600	14,400	264,600	302,400	277,200	316,800
3	20	1,200	8,400	9,600	176,400	201,600	184,800	211,200
4	15	900	6,300	7,200	132,300	151,200	138,600	158,400
5	12	720	5,040	5,760	105,840	120,960	110,880	126,720
6	10	600	4,200	4,800	88,200	100,800	92,400	105,600
7	8.57	514	3,600	4,114	75,600	86,400	79,200	90,514
8	7.50	450	3,150	3,600	66,150	75,600	69,300	79,200
9	6.67	400	2,800	3,200	58,800	67,200	61,600	70,400
10	6	360	2,520	2,880	52,920	60,480	55,440	63,360
11	5.45	327	2,291	2,618	48,109	54,982	50,400	57,600
12	5	300	2,100	2,400	44,100	50,400	46,200	52,800
13	4.62	277	1,938	2,215	40,708	46,523	42,646	48,738
14	4.29	257	1,800	2,057	37,800	43,200	39,600	45,257
15	4	240	1,680	1,920	35,280	40,320	36,960	42,240
16	3.75	225	1,575	1,800	33,075	37,800	34,650	39,600
17	3.53	212	1,482	1,694	31,129	35,576	32,612	37,271
18	3.33	200	1,400	1,600	29,400	33,600	30,800	35,200
19	3.16	189	1,326	1,516	27,853	31,832	29,179	33,347
20	3	180	1,260	1,440	26,460	30,240	27,720	31,680
21	2.86	171	1,200	1,371	25,200	28,800	26,400	30,171
22	2.73	164	1,145	1,309	24,055	27,491	25,200	28,800
23	2.61	157	1,096	1,252	23,009	26,296	24,104	27,548
24	2.50	150	1,050	1,200	22,050	25,200	23,100	26,400
25	2.40	144	1,008	1,152	21,168	24,192	22,176	25,344
26	2.31	138	969	1,108	20,354	23,262	21,323	24,369
27	2.22	133	933	1,067	19,600	22,400	20,533	23,467
28	2.14	129	900	1,029	18,900	21,600	19,800	22,629
29	2.07	124	869	993	18,248	20,855	19,117	21,848

Second / Welding Spot	Welding Spot / Minute	Welding Spot / Hour	Welding Spot / 7 Hours	Welding Spot / 8 Hours	7 Hours x 21 days	8 Hours x 21 days	7 Hours x 22 days	8 Hours x 22 days
30	2	120	840	960	17,640	20,160	18,480	21,120
31	1.94	116	813	929	17,071	19,510	17,884	20,439
32	1.88	113	788	900	16,538	18,900	17,325	19,800
33	1.82	109	764	873	16,036	18,327	16,800	19,200
34	1.76	106	741	847	15,565	17,788	16,306	18,635
35	1.71	103	720	823	15,120	17,280	15,840	18,103
36	1.67	100	700	800	14,700	16,800	15,400	17,600
37	1.62	97	681	778	14,303	16,346	14,984	17,124
38	1.58	95	663	758	13,926	15,916	14,589	16,674
39	1.54	92	646	738	13,569	15,508	14,215	16,246
40	1.50	90	630	720	13,230	15,120	13,860	15,840
41	1.46	88	615	702	12,907	14,751	13,522	15,454
42	1.43	86	600	686	12,600	14,400	13,200	15,086
43	1.40	84	586	670	12,307	14,065	12,893	14,735
44	1.36	82	573	655	12,027	13,745	12,600	14,400
45	1.33	80	560	640	11,760	13,440	12,320	14,080
46	1.30	78	548	626	11,504	13,148	12,052	13,774
47	1.28	77	536	613	11,260	12,868	11,796	13,481
48	1.25	75	525	600	11,025	12,600	11,550	13,200
49	1.22	73	514	588	10,800	12,343	11,314	12,931
50	1.20	72	504	576	10,584	12,096	11,088	12,672
51	1.18	71	494	565	10,376	11,859	10,871	12,424
52	1.15	69	485	554	10,177	11,631	10,662	12,185
53	1.13	68	475	543	9,985	11,411	10,460	11,955
54	1.11	67	467	533	9,800	11,200	10,267	11,733
55	1.09	65	458	524	9,622	10,996	10,080	11,520
56	1.07	64	450	514	9,450	10,800	9,900	11,314
57	1.05	63	442	505	9,284	10,611	9,726	11,116
58	1.03	62	434	497	9,124	10,428	9,559	10,924
59	1.02	61	427	488	8,969	10,251	9,397	10,739
60	1	60	420	480	8,820	10,080	9,240	10,560