



SPOT WELDING DATA & SET-UP GUIDE

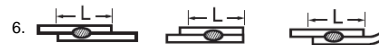
OPTIMUM CONDITIONS SCHEDULES FOR SPOT WELDING LOW CARBON STEEL—SAE 1010

| DATA COMMON TO ALL CLASSES OF SPOT WELDS | | | | WELDING SET-UP FOR BEST QUALITY—CLASS A WELDS | | | | | WELDING SET-UP FOR MEDIUM QUALITY—CLASS B WELDS | | | | | WELDING SET-UP FOR GOOD QUALITY—CLASS C WELDS | | | | | |
|--|-------------------------|---------------|-----------------------------------|---|---------------------------|-------------------------|------------------------|----------------------------|---|---------------------------|-------------------------|------------------------|----------------------------|---|---------------------------|-------------------------|------------------------|----------------------------|--|
| Thick-ness of Each of the Two Work Pieces Inches | Electrode Diam. & Shape | | Min. Weld Spacing (Note 4) Inches | Min. Contacting Overlap (Note 6) Inches | Weld Time (Note 7) Cycles | Elec-trode Force Pounds | Welding Cur-rent Amps. | Diam. of Fused Zone Inches | Average Tensile Shear Strength ±14% Pounds | Weld Time (Note 7) Cycles | Elec-trode Force Pounds | Welding Cur-rent Amps. | Diam. of Fused Zone Inches | Average Tensile Shear Strength ±17% Pounds | Weld Time (Note 7) Cycles | Elec-trode Force Pounds | Welding Cur-rent Amps. | Diam. of Fused Zone Inches | Average Tensile Shear Strength ±20% Pounds |
| | Min. D Inches | Max. d Inches | | | | | | | | | | | | | | | | | |
| .010 | 1/2 | 1/8 | 1/4 | 3/8 | 4 | 200 | 4000 | .13 | 235 | 5 | 130 | 3700 | .12 | 200 | 15 | 65 | 3000 | .11 | 160 |
| .021 | 1/2 | 3/16 | 3/8 | 7/16 | 6 | 300 | 6100 | .17 | 530 | 10 | 200 | 5100 | .16 | 460 | 22 | 100 | 3800 | .14 | 390 |
| .031 | 1/2 | 3/16 | 1/2 | 7/16 | 8 | 400 | 8000 | .21 | 980 | 15 | 275 | 6300 | .20 | 850 | 29 | 135 | 4700 | .18 | 790 |
| .040 | 5/8 | 1/4 | 3/4 | 1/2 | 10 | 500 | 9200 | .23 | 1305 | 21 | 360 | 7500 | .22 | 1230 | 38 | 180 | 5600 | .21 | 1180 |
| .050 | 5/8 | 1/4 | 7/8 | 9/16 | 12 | 650 | 10300 | .25 | 1820 | 24 | 410 | 8000 | .23 | 1700 | 42 | 205 | 6100 | .22 | 1600 |
| .062 | 5/8 | 1/4 | 1 | 5/8 | 14 | 800 | 1600 | .27 | 2350 | 29 | 500 | 9000 | .26 | 2150 | 48 | 250 | 6800 | .25 | 2050 |
| .078 | 5/8 | 5/16 | 1-1/8 | 11/16 | 21 | 1100 | 13300 | .31 | 3225 | 36 | 650 | 10400 | .30 | 3025 | 58 | 325 | 7900 | .28 | 2900 |
| .094 | 5/8 | 5/16 | 1-1/4 | 3/4 | 25 | 1300 | 14700 | .34 | 4100 | 44 | 790 | 11400 | .33 | 3900 | 66 | 390 | 8800 | .31 | 3750 |
| .109 | 7/8 | 3/8 | 1-5/16 | 13/16 | 29 | 1600 | 16100 | .37 | 5300 | 50 | 960 | 12200 | .36 | 5050 | 72 | 480 | 9500 | .35 | 4850 |
| .125 | 7/8 | 3/8 | 1-1/2 | 7/8 | 30 | 1800 | 17500 | .40 | 6900 | 60 | 1140 | 12900 | .39 | 6500 | 78 | 570 | 10000 | .37 | 6150 |

NOTES:

- Low Carbon Steel as hot rolled, pickled, and slightly oiled with an ultimate strength of 42,000 to 45,000 PSI Similar to SAE 1005—SAE 1010.
- Electrode Material is CMW# 3.
- Surface of steel is lightly oiled but free from grease, scale or dirt.
- Minimum weld spacing is that distance for which no increase in welding current is necessary to compensate for the shunted current effect in adjacent welds.

- Radius Face electrodes may be used
0.010 to 0.031 — 2" Radius
0.031 to 0.078 — 3" Radius
0.078 to 0.125 — 4" Radius



- Weld time is indicated in cycles of 60 cycle frequency.

- Tensile shear strength values are based on recommended test sample sizes:

| Direction of Force | Thickness | Width | Length |
|--------------------|----------------|--------|--------|
| | .000" to .029" | 5/8" | 3" |
| | .030" to .058" | 1" | 4" |
| | .059" to .115" | 1-1/2" | 5" |
| | .116" to .190" | 2" | 6" |

- Tolerance for machining of electrode diameter "d" is ±.015" of specified dimension.
- Electrode force does not provide for force to press ill-fitting parts together.



PERMISSIBLE SCHEDULE VARIATIONS FOR SPOT WELDING LOW CARBON STEEL
Low Carbon Steel Spot Welding Data Chart—Single Impulse Welding

| Thick-ness of Thinnest Outside Piece (Inches) | Electrode Diameters and Shape* | | | Recommended Minimum Standard Electrode Size | Weld Force (Lbs.) | Weld Time (Cycles) (60 Cycles per Sec.) | Hold Time (Cycles) Min. | Welding Current (Amps.) (Approx.) | Weld Shear Strength (For Steels Having Ultimate Tensile Strength of 90,000 psi and below) Minimum Strength (Lbs/Weld) | Diameter of Fused Zone (Approx.) Dw (Inches) | Minimum Weld Spacing S (Inches) | Minimum Contacting Overlap L (Inches) |
|---|--------------------------------|-----------------|-------------------|---|-------------------|---|-------------------------|-----------------------------------|---|--|---------------------------------|---------------------------------------|
| | Flat Face | | Radius Face | | | | | | | | | |
| | Maximum d (Inches) | Min. D (Inches) | Radius R (Inches) | | | | | | | | | |
| 0.010 | 0.125 | 1/2 | 2 | 4RW 1MT | 160 | 4 | 5 | 4,000 | 130 | 0.113 | 1/4 | 3/8 |
| 0.021 | 0.187 | 1/2 | 2 | 4RW 1MT | 244 | 6 | 8 | 6,500 | 300 | 0.139 | 3/8 | 7/16 |
| 0.031 | 0.187 | 1/2 | 2 | 4RW 1MT | 326 | 8 | 10 | 8,000 | 530 | 0.161 | 1/2 | 7/16 |
| 0.040 | 0.250 | 5/8 | 3 | 5RW 2MT | 412 | 10 | 12 | 8,800 | 812 | 0.181 | 3/4 | 1/2 |
| 0.050 | 0.250 | 5/8 | 3 | 5RW 2MT | 554 | 14 | 16 | 9,600 | 1,195 | 0.210 | 7/8 | 9/16 |
| 0.062 | 0.250 | 5/8 | 3 | 5RW 2MT | 670 | 18 | 20 | 10,600 | 1,717 | 0.231 | 1 | 5/8 |
| 0.078 | 0.312 | 5/8 | 3 | 5RW 2MT | 903 | 25 | 30 | 11,800 | 2,365 | 0.268 | 1-1/8 | 11/16 |
| 0.094 | 0.312 | 5/8 | 4 | 7RW 3MT | 1,160 | 34 | 35 | 13,000 | 3,054 | 0.304 | 1-1/4 | 3/4 |
| 0.109 | 0.375 | 7/8 | 4 | 7RW 3MT | 1,440 | 45 | 40 | 14,200 | 3,672 | 0.338 | 1-5/16 | 13/16 |
| 0.125 | 0.375 | 7/8 | 4 | 7RW 3MT | 1,760 | 60 | 45 | 15,600 | 4,300 | 0.375 | 1-1/2 | 7/8 |
| 0.156 | 0.500 | 7/8 | 6 | Male or Female Threaded | 2,500 | 93 | 50 | 18,000 | 6,500 | 0.446 | 1-3/4 | 1 |
| 0.187 | 0.625 | 1 | 6 | Male or Female Threaded | 3,340 | 130 | 55 | 20,500 | 9,000 | 0.516 | 2 | 1-1/2 |
| 0.250 | 0.750 | 1-1/4 | 6 | Male or Female Threaded | 5,560 | 230 | 60 | 26,000 | 18,000 | 0.660 | 4 | 1-1/2 |

NOTES:

- Low Carbon Steel as hot rolled, pickled, and slightly oiled with an ultimate strength of 42,000 to 45,000 PSI Similar to SAE 1005—SAE 1010.
- Electrode Material is CMW" 3.
- Surface of steel is lightly oiled but free from grease, scale or dirt.
- Minimum weld spacing is that distance for which no increase in welding current is necessary to compensate for the shunted current effect in adjacent welds.

- Radius Face electrodes may be used
0.010 to 0.031 — 2" Radius
0.031 to 0.078 — 3" Radius
0.078 to 0.125 — 4" Radius



- Weld time is indicated in cycles of 60 cycle frequency.



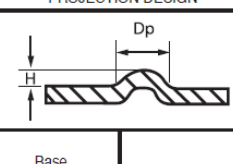
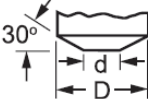
- Tensile shear strength values are based on recommended test sample sizes:

| Direction of Force | Thickness | Width | Length |
|--------------------|----------------|--------|--------|
| | .000" to .029" | 5/8" | 3" |
| | .030" to .058" | 1" | 4" |
| | .059" to .115" | 1-1/2" | 5" |
| | .116" to .190" | 2" | 6" |

- Tolerance for machining of electrode diameter "d" is ± 0.15 " of specified dimension.
- Electrode force does not provide for force to press ill-fitting parts together.



PROJECTION WELDING DATA
DESIGN AND WELDING DATA FOR PROJECTION WELDING LOW CARBON STEELS

| Thickness of Thinnest Outside Piece Inches | PROJECTION DESIGN | | ELECTRODE DIAMETERS (d=2 x Projection Diameter) | | Electrode Force Pounds | Weld Time (Cycles) 60 Cycles per Sec. | Hold Time (Cycles) Minimum | Welding Current Amperes (Approx.) | Diameter of Fused Zone  Dw Inches | Minimum Shear Strength (Single Projection) Pounds Only (For Steels Having Strength of 100,000 psi and below) | Minimum Contacting Overlap  L Inches | | | |
|--|---------------------------------------|-------------------------------|---|---|------------------------|---------------------------------------|----------------------------|-----------------------------------|--|---|---|-----------------------------------|---|-------------------------------------|
| | Base Diameter of Projection Dp Inches | Height of Projection H Inches |  |  | | | | | | | | Welding Current Amperes (Approx.) | Minimum Shear Strength (Single Projection) Pounds | Minimum Contacting Overlap L Inches |
| | | | | | | | | | | | | | | |
| 0.010 | 0.055 | 0.015 | 0.125 | 1/2 | 50 | 3 | 3 | 2,800 | 0.112 | 150 | 1/8 | | | |
| 0.012 | 0.055 | 0.015 | 0.125 | 1/2 | 80 | 3 | 3 | 3,100 | 0.112 | 200 | 1/8 | | | |
| 0.014 | 0.055 | 0.015 | 0.125 | 1/2 | 100 | 3 | 3 | 3,400 | 0.112 | 250 | 1/8 | | | |
| 0.016 | 0.067 | 0.017 | 0.187 | 1/2 | 115 | 4 | 4 | 3,600 | 0.112 | 285 | 5/32 | | | |
| 0.021 | 0.067 | 0.017 | 0.187 | 1/2 | 150 | 6 | 6 | 4,000 | 0.140 | 380 | 5/32 | | | |
| 0.025 | 0.081 | 0.020 | 0.187 | 1/2 | 200 | 6 | 8 | 4,500 | 0.140 | 525 | 3/16 | | | |
| 0.031 | 0.094 | 0.022 | 0.187 | 1/2 | 300 | 8 | 8 | 5,100 | 0.169 | 740 | 7/32 | | | |
| 0.034 | 0.094 | 0.022 | 0.187 | 1/2 | 350 | 10 | 10 | 5,400 | 0.169 | 900 | 7/32 | | | |
| 0.044 | 0.119 | 0.028 | 0.250 | 5/8 | 480 | 13 | 14 | 6,500 | 0.169 | 1,080 | 9/32 | | | |
| 0.050 | 0.119 | 0.028 | 0.250 | 5/8 | 580 | 16 | 16 | 7,100 | 0.225 | 1,500 | 9/32 | | | |
| 0.062 | 0.156 | 0.035 | 0.312 | 7/8 | 750 | 21 | 20 | 8,400 | 0.225 | 2,100 | 3/8 | | | |
| 0.070 | 0.156 | 0.035 | 0.312 | 7/8 | 900 | 24 | 24 | 9,200 | 0.281 | 2,550 | 3/8 | | | |
| 0.078 | 0.187 | 0.041 | 0.375 | 7/8 | 1,050 | 26 | 30 | 10,500 | 0.281 | 2,950 | 7/16 | | | |
| 0.094 | 0.218 | 0.048 | 0.500 | 7/8 | 1,300 | 32 | 30 | 11,800 | 0.281 | 3,700 | 1/2 | | | |
| 0.109 | 0.250 | 0.054 | 0.500 | 7/8 | 1,650 | 38 | 36 | 13,300 | 0.338 | 4,500 | 5/8 | | | |
| 0.125 | 0.281 | 0.060 | 0.500 | 7/8 | 1,800 | 45 | 40 | 15,000 | 0.338 | 5,200 | 11/16 | | | |
| 0.140 | 0.312 | 0.066 | 0.625 | 1 | 2,300 | 60 | 45 | 15,700 | 0.437 | 6,000 | 3/4 | | | |
| 0.156 | 0.343 | 0.072 | 0.625 | 1 | 2,800 | 80 | 50 | 17,250 | 0.500 | 7,500 | 13/16 | | | |
| 0.171 | 0.375 | 0.078 | 0.750 | 1 | 3,300 | 105 | 50 | 18,600 | 0.562 | 8,500 | 7/8 | | | |
| 0.187 | 0.406 | 0.085 | 0.750 | 1 | 3,800 | 125 | 50 | 20,000 | 0.562 | 10,000 | 15/16 | | | |
| 0.203 | 0.437 | 0.091 | 0.875 | 1-1/4 | 4,500 | 145 | 55 | 21,500 | 0.625 | 12,000 | 1 | | | |
| 0.250 | 0.531 | 0.110 | 1.000 | 1-1/4 | 6,600 | 230 | 60 | 26,000 | 0.687 | 15,000 | 1-1/4 | | | |

NOTES:

1. Type of Steel—Low Carbon SAE 1010—0.15% Carbon Maximum.
2. Material free of scale, oxide, paint, dirt, etc.
3. Size of projection determined by thickness of thinnest piece and projection should be on thickest piece.
4. Data is based on thickness of thinnest sheet for two thicknesses only. Maximum ratio between two thicknesses = 3 to 1.
5. See TABLE BELOW for design of punch and die for making projections.
6. Contacting overlap does not include any radii from forming.
7. Projection should be located in center of overlap.
8. Tolerance for Projection Dimensions:

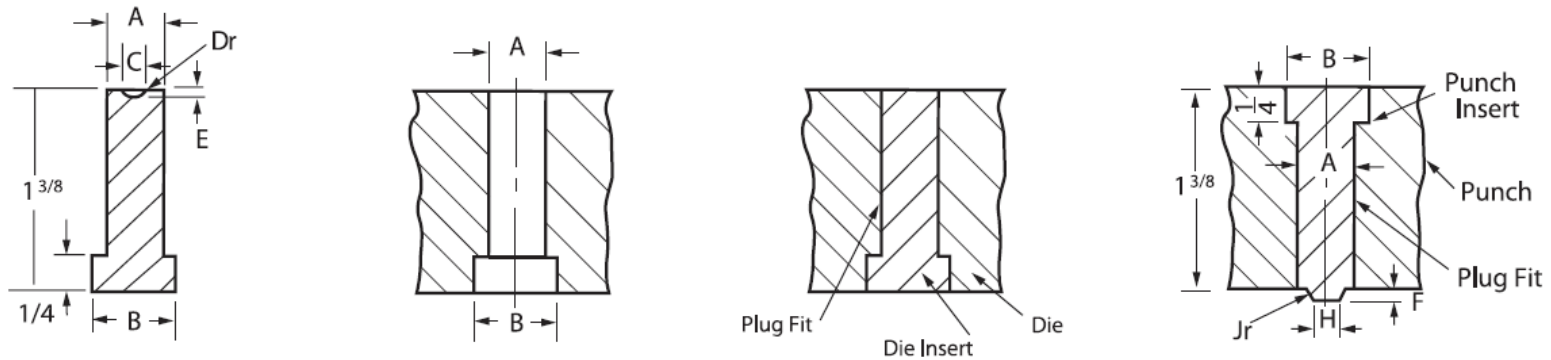
| Dimension | Thickness Up to 0.050" | Thickness Over 0.050" |
|--------------------|------------------------|-----------------------|
| Diameter "D" | ±0.003" | ±0.007" |
| Height "H" | ±0.002" | ±0.005" |

9. Electrode Material:
 CMW*100 ELKONITE*TC-10 ELKONITE*10W3

From American Welding Society "Recommended Practices for Resistance Welding"



PUNCH AND DIE DESIGN FOR FORMING WELDING PROJECTIONS



| Mat Thickness | Pt. No. | A | B | ±.002 C | Dr | ±.001 E | ±.001 F | ±.001 H | Jr |
|---------------|---------|-----|------|---------|------|---------|---------|---------|------|
| 0.010-0.015 | 1 | 3/8 | 9/16 | .055 | .033 | .015 | .015 | .035 | .005 |
| 0.016-0.021 | 2 | 3/8 | 9/16 | .067 | .042 | .017 | .020 | .039 | .005 |
| .025 | 3 | 3/8 | 9/16 | .081 | .050 | .020 | .025 | .044 | .005 |
| .031 | 4 | 3/8 | 9/16 | .094 | .062 | .022 | .030 | .050 | .005 |
| .034 | 5 | 3/8 | 9/16 | .094 | .062 | .022 | .030 | .050 | .005 |
| .044 | 6 | 3/8 | 9/16 | .119 | .078 | .028 | .035 | .062 | .005 |
| .050 | 7 | 3/8 | 9/16 | .119 | .078 | .028 | .035 | .062 | .005 |
| .062 | 8 | 3/8 | 9/16 | .156 | .105 | .035 | .043 | .081 | .005 |
| .070 | 9 | 3/8 | 9/16 | .156 | .105 | .035 | .043 | .081 | .005 |
| .078 | 10 | 3/8 | 9/16 | .187 | .128 | .041 | .055 | .104 | .010 |

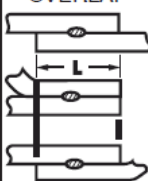
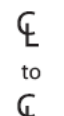
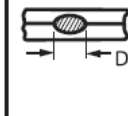
| Mat Thickness | Pt. No. | A | B | ±.002 C | Dr | ±.001 E | ±.001 F | ±.001 H | Jr |
|---------------|---------|-------|-------|---------|------|---------|---------|---------|------|
| .094 | 11 | 1/2 | 11/16 | .218 | .148 | .048 | .065 | .115 | .010 |
| .109 | 12 | 1/2 | 11/16 | .250 | .172 | .054 | .075 | .137 | 1/64 |
| .125 | 13 | 1/2 | 11/16 | .281 | .193 | .060 | .085 | .154 | 1/64 |
| .140 | 14 | 1/2 | 11/16 | .312 | .217 | .066 | .096 | .172 | 1/64 |
| .156 | 15 | 5/8 | 13/16 | .343 | .243 | .072 | .107 | .191 | 1/64 |
| .171 | 16 | 5/8 | 13/16 | .375 | .265 | .078 | .118 | .210 | 1/64 |
| .187 | 17 | 5/8 | 13/16 | .406 | .285 | .085 | .130 | .229 | 1/64 |
| .203 | 18 | 11/16 | 7/8 | .437 | .308 | .091 | .143 | .240 | .020 |
| .250 | 19 | 13/16 | 1 | .531 | .375 | .110 | .175 | .285 | .025 |

Material: Tool Steel. Finish all over and harden to 65-68 Rockwell "C" scale. Note: All working surfaces of die unit must be polished.

From American Welding Society "Recommended Practices for Resistance Welding"



SCHEDULE FOR SPOT WELDING STAINLESS STEEL

| THICKNESS "T" of THINNEST OUTSIDE PIECE (See Notes 1, 2, 3 and 4 Below) INCHES | ELECTRODE DIAMETER AND SHAPE (See Note 5) | | ELECTRODE FORCE LB. | WELD TIME CYCLES (60 Per Sec.) | WELDING CURRENT (Approx.) AMPS | | MINIMUM CONTACTING OVERLAP  IN. | MINIMUM WELD SPACING (See Note 6 Below)  IN. | DIAMETER OF FUSED ZONE  IN. Approx. | MINIMUM SHEAR STRENGTH LB. | | |
|--|---|-----------------|-------------------------------|--|---|---|--|---|--|------------------------------------|---------------------------------|--------------------------------|
| | D, IN., Min. | d, IN., Max. | | | Tensile Strength Below 150000 Psi | Tensile Strength 150000 Psi and Higher | | | | Ultimate Tensile Strength of Metal | | |
| | | | | | | | | | | 70000 Up to 90000 Psi | 90000 Up to 150000 Psi | 150000 Psi and Higher |
| | 0.006 | 3/16 | | | 3/32 | 180 | | | | 2 | 2000 | 2000 |
| 0.008 | 3/16 | 3/32 | 200 | 3 | 2000 | 2000 | 3/16 | 3/16 | 0.065 | 150 | 170 | 210 |
| 0.012 | 1/4 | 1/8 | 260 | 3 | 2100 | 2000 | 1/4 | 1/4 | 0.076 | 185 | 210 | 250 |
| 0.014 | 1/4 | 1/8 | 300 | 4 | 2500 | 2200 | 1/4 | 1/4 | 0.082 | 240 | 250 | 320 |
| 0.016 | 1/4 | 1/8 | 330 | 4 | 3000 | 2500 | 1/4 | 5/16 | 0.088 | 280 | 300 | 380 |
| 0.018 | 1/4 | 1/8 | 380 | 4 | 3500 | 2800 | 1/4 | 5/16 | 0.093 | 320 | 360 | 470 |
| 0.021 | 1/4 | 5/32 | 400 | 4 | 4000 | 3200 | 5/16 | 5/16 | 0.100 | 370 | 470 | 500 |
| 0.025 | 3/8 | 5/32 | 520 | 5 | 5000 | 4100 | 3/8 | 7/16 | 0.120 | 500 | 600 | 680 |
| 0.031 | 3/8 | 3/16 | 650 | 5 | 6000 | 4800 | 3/8 | 1/2 | 0.130 | 680 | 800 | 930 |
| 0.034 | 3/8 | 3/16 | 750 | 6 | 7000 | 5500 | 7/16 | 9/16 | 0.150 | 800 | 920 | 1100 |
| 0.040 | 3/8 | 3/16 | 900 | 6 | 7800 | 6300 | 7/16 | 5/8 | 0.160 | 1000 | 1270 | 1400 |
| 0.044 | 3/8 | 3/16 | 1000 | 8 | 8700 | 7000 | 7/16 | 11/16 | 0.180 | 1200 | 1450 | 1700 |
| 0.050 | 1/2 | 1/4 | 1200 | 8 | 9500 | 7500 | 1/2 | 3/4 | 0.190 | 1450 | 1700 | 2000 |
| 0.056 | 1/2 | 1/4 | 1350 | 10 | 10300 | 8300 | 9/16 | 7/8 | 0.210 | 1700 | 2000 | 2450 |
| 0.062 | 1/2 | 1/4 | 1500 | 10 | 11000 | 9000 | 5/8 | 1 | 0.220 | 1950 | 2400 | 2900 |
| 0.070 | 5/8 | 1/4 | 1700 | 12 | 12300 | 10000 | 5/8 | 1-1/8 | 0.250 | 2400 | 2800 | 3550 |
| 0.078 | 5/8 | 5/16 | 1900 | 14 | 14000 | 11000 | 11/16 | 1-1/4 | 0.275 | 2700 | 3400 | 4000 |
| 0.094 | 5/8 | 5/16 | 2400 | 16 | 15700 | 12700 | 3/4 | 1-1/2 | 0.290 | 3550 | 4200 | 5300 |
| 0.109 | 3/4 | 3/8 | 2800 | 18 | 17700 | 14000 | 13/16 | 1-1/2 | 0.290 | 4200 | 5000 | 6400 |
| 0.125 | 3/4 | 3/8 | 3300 | 20 | 18000 | 15500 | 7/8 | 2 | 0.300 | 5000 | 6000 | 7600 |

NOTES:

- Types of Steel—301, 302, 303, 304, 308, 309, 310, 316, 317, 321, 347 & 349
- Material should be free from scale, oxides, paint, grease and oil.
- Welding conditions determined by thickness of thinnest outside piece "T"
- Data for total thickness of pile-up not exceeding 4 "T". Maximum ratio between two thicknesses 3 to 1.
- Electrode Material, CMW® 3, CMW® 100, or ELKONITE® 10W3
- Minimum weld spacing is that spacing for two pieces for which no special precautions need be taken to compensate for shunted current effect of adjacent welds. For three pieces increase spacing 30 per cent.



SCHEDULE FOR SEAM WELDING STAINLESS STEEL

| THICKNESS "T" OF THINNEST OUTSIDE PIECE (See Notes 1, 2, 3 and 4 Below) | ELECTRODE WIDTH AND SHAPE (See Note 5 Below) | ELECTRODE FORCE LB. | ON TIME CYCLES (60 Per Sec.) | OFF TIME FOR MAXIMUM SPEED (Pressure-Tight) | | MAXIMUM WELD SPEED | | WELDS PER INCH | | WELDING CURRENT (Approx.) AMPS. | MINIMUM CONTACTING OVERLAP (See Note 6 Below) |
|--|---|---------------------------|------------------------------------|--|-------|-----------------------|-------|-------------------|-------|--|---|
| | | | | CYCLES | | IN. PER MINUTE | | | | | |
| | | | | 2 "T" | 4 "T" | 2 "T" | 4 "T" | 2 "T" | 4 "T" | | |
| 0.006 | 3/16 | 300 | 2 | 1 | 1 | 60 | 67 | 20 | 18 | 4000 | 1/4 |
| 0.008 | 3/16 | 350 | 2 | 2 | 2 | 67 | 56 | 18 | 16 | 4600 | 1/4 |
| 0.010 | 3/16 | 400 | 3 | 2 | 2 | 45 | 51 | 16 | 14 | 5000 | 1/4 |
| 0.012 | 1/4 | 450 | 3 | 2 | 2 | 48 | 55 | 15 | 13 | 5600 | 5/16 |
| 0.014 | 1/4 | 500 | 3 | 2 | 3 | 51 | 46 | 14 | 13 | 6200 | 5/16 |
| 0.016 | 1/4 | 600 | 3 | 2 | 3 | 51 | 50 | 14 | 12 | 6700 | 5/16 |
| 0.018 | 1/4 | 650 | 3 | 2 | 3 | 55 | 50 | 13 | 12 | 7300 | 5/16 |
| 0.021 | 1/4 | 700 | 3 | 2 | 3 | 55 | 55 | 13 | 11 | 7900 | 3/8 |
| 0.025 | 3/8 | 850 | 3 | 3 | 4 | 50 | 47 | 12 | 11 | 9200 | 7/16 |
| 0.031 | 3/8 | 1000 | 3 | 3 | 4 | 50 | 47 | 12 | 11 | 10600 | 7/16 |
| 0.040 | 3/8 | 1300 | 3 | 4 | 5 | 47 | 45 | 11 | 10 | 13000 | 1/2 |
| 0.050 | 1/2 | 1600 | 4 | 4 | 5 | 45 | 44 | 10 | 9 | 14200 | 5/8 |
| 0.062 | 1/2 | 1850 | 4 | 5 | 7 | 40 | 41 | 10 | 8 | 15100 | 5/8 |
| 0.070 | 5/8 | 2150 | 4 | 5 | 7 | 44 | 41 | 9 | 8 | 15900 | 11/16 |
| 0.078 | 5/8 | 2300 | 4 | 6 | 7 | 40 | 41 | 9 | 8 | 16500 | 11/16 |
| 0.094 | 5/8 | 2550 | 5 | 6 | 7 | 36 | 38 | 9 | 8 | 16600 | 3/4 |
| 0.109 | 3/4 | 2950 | 5 | 7 | 9 | 38 | 37 | 8 | 7 | 16800 | 13/16 |
| 0.125 | 3/4 | 3300 | 6 | 6 | 8 | 38 | 37 | 8 | 7 | 17000 | 7/8 |

NOTES:

- Types of Steel—301, 302, 303, 304, 308, 309, 310, 316, 317, 321, 347 & 349.
- Material should be free from scale, oxides, paint, grease and oil.
- Welding conditions determined by thickness of thinnest outside piece "T."
- Data for total thickness of pile-up not exceeding 4 "T". Maximum ratio between two thicknesses 3 to 1.
- Electrode material, CMW® 100
- For large assemblies minimum contacting overlap indicated should be increased 30 per cent.

From American Welding Society "Recommended Practices for Resistance Welding"



Spot welding galvanized low-carbon steel

| Material Thickness | Electrode Diameter And Shape | | | Net Electrode Force | Welding Current (Approx.) | Weld Time | Weld Nugget Size | Minimum Tension-Shear Strength | Minimum Weld Spacing | Minimum Contacting Overlap |
|--------------------|------------------------------|------|------|---------------------|---------------------------|-----------|------------------|--------------------------------|----------------------|----------------------------|
| notes 1, 2, & 3 | note 4 | | | | | | | | | |
| | | | | | | | | | | |
| | D | d | Oc | | | | | | | |
| Inches | In. | In. | Deg. | Lb. | Amps. | Cycles | In. | Lb. | Inches | Inches |
| 0.022 | 5/8 | 3/16 | 120 | 300 | 13000 | 8 | 0.15 | 550 | 5/8 | 5/8 |
| 0.030 | 5/8 | 3/16 | 120 | 400 | 13000 | 10 | 0.16 | 1000 | 5/8 | 5/8 |
| 0.036 | 5/8 | 1/4 | 120 | 500 | 13500 | 12 | 0.19 | 1180 | 3/4 | 5/8 |
| 0.039 | 5/8 | 1/4 | 120 | 650 | 14000 | 13 | 0.21 | 1400 | 3/4 | 5/8 |
| 0.052 | 5/8 | 1/4 | 120 | 725 | 14500 | 18 | 0.22 | 1700 | 7/8 | 11/16 |
| 0.063 | 3/4 | 1/4 | 120 | 850 | 15500 | 22 | 0.24 | 2500 | 1-1/8 | 3/4 |
| 0.078 | 3/4 | 5/16 | 120 | 1200 | 19000 | 24 | 0.28 | 3200 | 1-1/4 | 7/8 |
| 0.093 | 3/4 | 3/8 | 120 | 1400 | 21000 | 30 | 0.34 | 4200 | 1-1/2 | 1 |
| 0.108 | 7/8 | 3/8 | 120 | 1750 | 20000 | 37 | 0.40 | 5900 | 1-3/4 | 1-1/8 |
| 0.123 | 7/8 | 3/8 | 120 | 2000 | 20000 | 42 | 0.48 | 7200 | 2 | 1-1/8 |

Projection welding galvanized low-carbon steel

| Material Thickness | Electrode Diameter And Shape | | Net Electrode Force | Welding Current (Approx.) | Weld Time | Weld Nugget Size | Minimum Tension-Shear Strength | Projection Size | |
|--------------------|------------------------------|------|---------------------|---------------------------|-----------|------------------|--------------------------------|-----------------|--------|
| notes 1, 2, & 3 | note 4 | | | | | | (For Single Projections Only) | | |
| | | | | | | | | | |
| | D | d | | | | | | Diameter | Height |
| Inches | In. | In. | Lb. | Amps. | Cycles | In. | Lb. | In. | In. |
| 0.039 | 5/8 | 3/8 | 250 | 10000 | 15 | 0.15 | 925 | 0.187 | 0.041 |
| 0.063 | 5/8 | 7/16 | 400 | 11500 | 20 | 0.25 | 2050 | 0.218 | 0.048 |
| 0.078 | 3/4 | 1/2 | 550 | 16000 | 25 | 0.25 | 2700 | 0.250 | 0.054 |
| 0.093 | 3/4 | 1/2 | 750 | 16000 | 30 | 0.30 | 4300 | 0.250 | 0.054 |
| 0.108 | 7/8 | 1/2 | 950 | 22000 | 33 | 0.31 | 4900 | 0.250 | 0.054 |

NOTES:

1. Material must be free from dirt, grease, paint etc. prior to welding, but may have light oil.
2. Two equal metal thicknesses of each gage.
3. Commercial coating weight is 1.25 oz. per square foot.
4. Electrode Material-RWMA Group A, Class
5. CMW# 3.
6. Water Cooling: 2 gallons per minute.

Projections should be larger in diameter for galvanized than for uncoated material.



Seam welding galvanized low-carbon steel

| Material Thickness | Electrode Width And Shape | | Net Electrode Force | Welding Current (Approx.) | Weld Time | | Welding Speed | Welds Per Inch | Minimum Contacting Overlap |
|--------------------|---------------------------|------|---------------------|---------------------------|-----------|-----------|---------------|----------------|----------------------------|
| | | | | | Heat Time | Cool Time | | | |
| Inches | In. | In. | Lb. | Amps. | Cycles | Cycles | In./Min. | W/In. | Inches |
| 0.015 | 3/8 | 1/4 | 900 | 15000 | 2 | 2 | 120 | 7.5 | 3/8 |
| 0.036 | 1/2 | 1/4 | 1100 | 18000 | 4 | 2 | 60 | 10.0 | 1/2 |
| 0.039 | 1/2 | 1/4 | 1200 | 19000 | 4 | 3 | 60 | 9.0 | 1/2 |
| 0.052 | 1/2 | 1/4 | 1350 | 20000 | 5 | 1 | 90 | 7.0 | 9/16 |
| 0.063 | 1/2 | 5/16 | 1500 | 19800 | 8 | 2 | 54 | 7.0 | 5/8 |
| 0.078 | 5/8 | 5/16 | 1850 | 23000 | 10 | 7 | 30 | 7.0 | 11/16 |

NOTES:

1. Material must be free from dirt, grease, paint etc. prior to welding, but may have light oil.
2. Two equal metal thicknesses of each gage.
3. Commercial coating weight is 1.25 oz. per square foot.
4. Electrode Material-RWMA Group A, Class 2. CMW# 3.
5. Pressure-tight joints require stripping the zinc coating prior to welding.
6. Nominal electrode diameter ranges between 8 to 10 inches.

From American Welding Society "Recommended Practices for Resistance Welding."



**PRESSURE BY FORCE EXERTED BY VARIOUS AIR CYLINDERS AT AIR PRESSURES FROM 30 TO 100 PSI.
PISTON RODS AND PACKING LOSSES NEGLECTED.**

| Cyl. Diam. In. | Cyl. Area Sq. In. | PRESSURE, PSI., GAGE | | | | | | | |
|-------------------|-------------------------|----------------------|--------|--------|--------|--------|--------|--------|--------|
| | | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 1 | 0.7854 | 24 | 31 | 39 | 47 | 55 | 63 | 71 | 79 |
| 2 | 3.1416 | 94 | 126 | 157 | 188 | 220 | 251 | 283 | 314 |
| 2.5 | 4.91 | 147 | 196 | 245 | 295 | 344 | 393 | 442 | 491 |
| 3 | 7.07 | 212 | 283 | 353 | 424 | 495 | 565 | 636 | 707 |
| 3.5 | 9.62 | 289 | 385 | 481 | 577 | 673 | 770 | 866 | 962 |
| 4 | 12.57 | 377 | 503 | 628 | 754 | 880 | 1,005 | 1,131 | 1,257 |
| 4.5 | 15.90 | 477 | 636 | 795 | 954 | 1,113 | 1,272 | 1,431 | 1,590 |
| 5 | 19.64 | 589 | 785 | 982 | 1,178 | 1,374 | 1,571 | 1,767 | 1,963 |
| 6 | 28.27 | 848 | 1,131 | 1,414 | 1,696 | 1,979 | 2,262 | 2,545 | 2,827 |
| 7 | 38.49 | 1,155 | 1,539 | 1,924 | 2,309 | 2,694 | 3,079 | 3,464 | 3,848 |
| 8 | 50.27 | 1,508 | 2,011 | 2,513 | 3,016 | 3,519 | 4,021 | 4,524 | 5,027 |
| 9 | 63.62 | 1,909 | 2,545 | 3,181 | 3,817 | 4,453 | 5,089 | 5,726 | 6,362 |
| 10 | 78.54 | 2,356 | 3,142 | 3,927 | 4,712 | 5,498 | 6,283 | 7,069 | 7,854 |
| 12 | 113.10 | 3,393 | 4,524 | 5,655 | 6,786 | 7,917 | 9,048 | 10,179 | 11,310 |
| 14 | 153.94 | 4,618 | 6,158 | 7,697 | 9,236 | 10,776 | 12,315 | 13,854 | 15,394 |
| 16 | 201.06 | 6,032 | 8,042 | 10,053 | 12,064 | 14,074 | 16,085 | 18,096 | 20,106 |
| 18 | 254.47 | 7,634 | 10,179 | 12,723 | 15,268 | 17,813 | 20,358 | 22,902 | 25,447 |
| 20 | 314.16 | 9,425 | 12,566 | 15,708 | 18,850 | 21,991 | 25,133 | 28,274 | 31,416 |

For Hydraulic pressures, multiply pressure per sq. in. and resultant pressures by 10.