

Supplement
to
AWS D8.5-66
RECOMMENDED PRACTICES
for
AUTOMOTIVE PORTABLE-GUN
RESISTANCE-SPOT WELDING
on
**Electrode and Force
Recommendations**
for
**Two and Three
Loose Metal
Thicknesses**

AMERICAN WELDING SOCIETY

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AWS D8.5-66

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Recommended Practices for
Automotive Portable-Gun
Resistance-Spot Welding
on
Electrode and Force
Recommendations
for
Two and Three
Loose Metal Thicknesses

Prepared by
AWS Automotive Welding Committee

Under the direction of
AWS Technical Activities Committee

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FOREWORD

This document was developed to provide for the application of "Weldability Lobes" in *Recommended Practices for Resistance-Spot Welding*, AWS D8.5-66, to two and three unequal metal thickness combinations. Combinations of two and three unequal metal thicknesses constitute the majority of applications of the resistance-spot welding process. Resistance-spot welding two equal metal thicknesses of cold rolled sheet metal is the exception rather than the rule in today's industry.

Results of investigations are summarized in chart form, labeled "Selection of the Governing Metal Thicknesses to be used for Determining Electrode Force and Diameter Requirements for Welding Two and Three Metal Thickness Combinations." This chart is to serve as an aid in selecting the one metal thickness (from a given combination of metal thicknesses) that can be used as the governing reference to welding force and electrode geometry.

In those instances where a larger flat electrode is specified to benefit heat balance and/or surface marring, it will influence the governing metal thickness as evidenced by the chart data. Conditions other than those presented in the chart should not be read into the data. The 5/8 diameter flat electrode referenced is not and should not be considered the same as a flat copper backup or button type electrode.

The report is based on experimental data. New data will be considered when available. To this end, comments and reports of experience will be most welcome. Inquiries on the recommendations contained herein are also welcome. Address all communications to Secretary, AWS Automotive Welding Committee, American Welding Society, 345 East 47th Street, New York, New York 10017.

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SECTION 1. General Recommendations for Selecting Electrode Tip Sizes and Electrode Force

The recommendations from this investigation are summarized in the chart "Selection of the Governing Metal Thickness to be Used for Determining Electrode Force and Diameter Requirements for Welding Two and Three Metal Thickness Combinations". This chart and how to use it are explained below. The five general rules referred to on the chart are also listed.

(A) Explanation of Governing Metal Thickness Selection Chart

Shown in the left-hand column are all ten possible combinations and arrangements of two and three metal thicknesses. For example: (0.035 - 0.059) is a two unequal metal thickness combination shown in illustration No. 2 on the chart. Also (0.047 - 0.059 - 0.067) is a three unequal metal thickness combination with a medium gage in the center shown in illustration No. 6 on the chart. Any combination and arrangement of two or three metal thicknesses can be classified in terms of one of the ten illustrations shown in the left-hand column of the chart.

Across the top of the Governing Metal Thickness Selection Chart are illustrated the three possible arrangements of electrodes; (A) both tips pointed, (B) one tip pointed and the opposite tip flat, and (C) opposite arrangement from (B). The flat tip shown under (B) and (C) *must* be considered as only a 5/8-inch diameter flat tip or a 5/8-inch diameter flat backup button, and does *not* include any other size or form of flat backups, coppers or the like. The values listed in the Governing Metal Thickness Selection Chart opposite the variants (1) through (10) in the left hand column and under the (A) (B) (C) illustrated electrode arrangements across the top of the Governing Metal Thickness Selection Chart are given in terms of the governing metal thickness of the particular metal combination selected.

(B) Use of Governing Metal Thickness Selection Chart

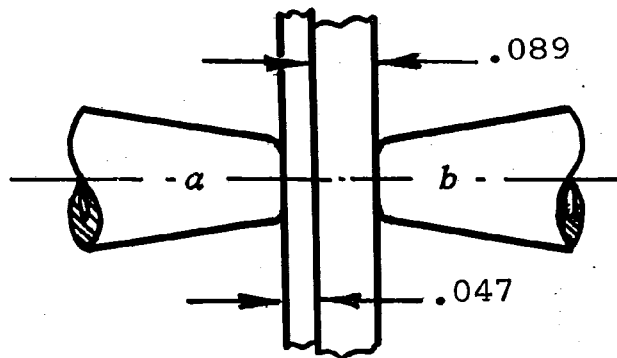
- (1) Select the applicable metal combination and arrangement from the left-hand column, (1) through (10).
- (2) Select the applicable electrode arrangement from across the top of the Governing Metal Thickness Selection Chart; (A), (B), (C).
- (3) In the box of the selected metal and electrode arrangement are listed the governing metal thicknesses for selection of sizes of tip (a), tip (b), electrode force, and the maximum thickness ratio.

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- (4) These governing metal thicknesses are then used to refer back to standard weld schedules (see AWS D8.5-66 – *Recommended Practices for Automotive Portable-Gun Resistance-Spot Welding*) to determine the actual tip sizes and electrode forces required to weld the metal combination in question.

For the purpose of illustrating these steps the following two examples are presented:

EXAMPLE 1



Column A, opposite illustration 2, shows the following:

d_a	d_b	Electrode Force	Maximum Thickness Ratio
X	Y	X	$\frac{X}{Y} = \frac{1}{4}$

From figure (2), $X = 0.047$ inch, $Y = 0.089$ inch, and referring to the above and AWS D8.5-66 (*Recommended Practices for Automotive Portable-Gun Resistance-Spot Welding*) it is found that:

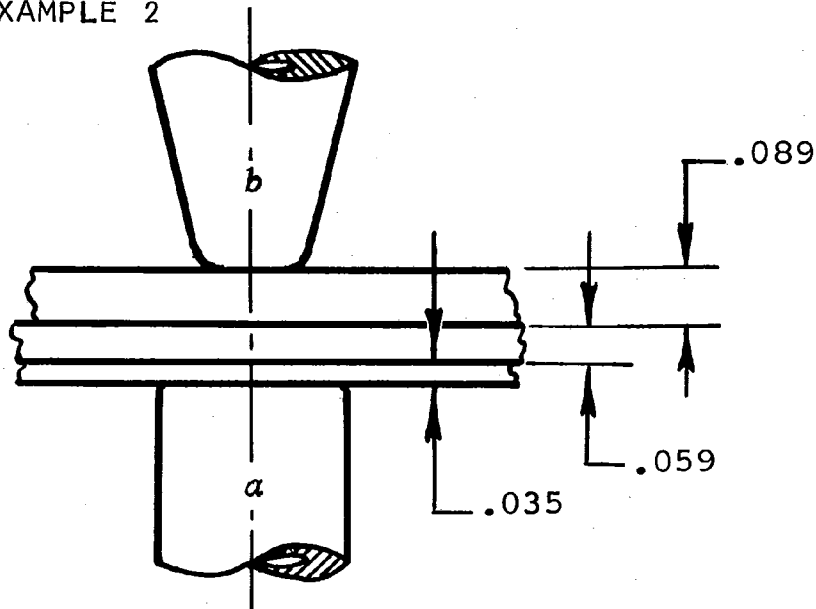
Diameter of tip (a) for metal thickness 0.047 inch = $1/4$ inch

Diameter of tip (B) for metal thickness 0.089 inch = $3/8$ inch

Electrode force for metal thickness 0.047 inch = 750 pounds

$$\text{Maximum thickness ratio} = \frac{0.047}{0.089} \text{ (within 1:4)}$$

EXAMPLE 2



Column C, opposite illustration 6, shows the following:

d_a	d_b	Electrode Force	Maximum Thickness Ratio
5/8 Flat	Z	Z	$\frac{X}{Z} = \frac{1}{4}$

From figure (6) $X = 0.035$ inch, $Y = 0.059$ inch, $Z = 0.089$ inch. Thus referring back to AWS D8.5-66

Tip (a) = 5/8 inch diameter flat

Tip (b) = 3/8 inch diameter flat (for thickness $Z = 0.089$ inch)

Electrode force = 1500 pounds

$$\text{Maximum thickness ratio} = \frac{0.035}{0.089} \text{ (within 1:4)}$$

4 | Supplement to AWS D8.5-66**SECTION 2. General Rules****(1) Force recommendations for portable guns**

Minimum force to be used for any three metal thickness weld is 800 lbs. In those cases where an option of force selection exists choose the higher force.

(2) Force recommendations for press welding guns

In those press electrode setups where few guns are being used and where adverse metal fit up and highly restrained joints are expected, forces in excess of the recommended minimum are suggested.

(3) Metal thickness ratio limitation

The welding of a three metal thickness combination with pointed electrodes is limited to those combinations in which the outer metal thickness ratio does not exceed 1 to 2-1/2. For welding metal combinations with higher ratio, the electrode size must be altered to suit these conditions.

(4) Minimum spacing between two spots for three metal thickness welds

Minimum recommended spacing for a three metal thickness weld is 30% greater than that spacing required for the heaviest outer metal.

(5) Effects of flat electrode

The use of flat electrodes results in size and shape variations of the weld nugget depending upon the thick to thin stacking arrangement of the metal in the pile-up. As the thickness ratio increases and the flat electrode contacts the heavier metal, the greater unbalance results in less desirable welding conditions. On the contrary, better welding conditions exist when the flat electrode contacts the thinner metal, although, increased currents and electrode forces are necessary.