Recommended Electrode Materials for Resistance Welding
SIMILAR and DISSIMILAR Metals, Using Conventional Methods

	Tungsten Molybdenum		Magnesium		Zinc		Nickel Alloys		Nickel		Tin		Lead		Stainless Steel		Chrome Plate		Cadmium Plate		Galvanized Iron Zn. Plate		Terne Plate		Tin Plate		Scaly Steel		C.R. Steel		Phosphor Bronze		Silicon Bronze		Nickel Silver		Cupro Nickel		Brass Yellow		Brass Red		Copper		Aluminum Alloys		Aluminum	
Aluminum			C	I	D	(II)	E	II	E	II	E	(II)	H	I	H	(III)	H	II	E	I	D	I	D	I	D	I			E	II	D	II	D	II					D	II	E	V	H	V	C	I	C	I
			I	15	I	56	I	5	I	3	I	5	II	5	I	34	I	38	I	349	I	349	I	349	I	349			I	34	I	5	I	5					I	5	I	2	I	2	I	1	I	1
Aluminum Alloys Duralumin			C	I	D	(II)	E	II	E	II	E	II	E	I	H	(III)	H	II	E	(II)	D	I	D	I	D	I			E	II	D	II	D	II					D	II	E	V	E	V	D	I		
			I	15	I	56	I		I	3	I	5	II	5	I	34	I	38	I	349	I	349	I	349	I	349			I	34	I	5	I	5					I	6	I	2	I	2	I	1		
Copper – Pure	H	II	H	I	H	I	E	II	E	II	H	I	H	I	H	(III)	H	II	H	(II)	H	I	H	I	H	I			H	II	D	II	D	II	D	II	D	II	D	II	E	II	K	V				
	V	3	V	5	V	56	V		V	36	V	5	V	5	V	34	V	34	V	39	V	349	V	349	V	349			V	34	V	56	V	56	V	6	V	6	V	6	V	6	V	2				
Brass – Red 5-25% Zinc			H	I			D	II	D	II	H	I			H	(III)	H	II	H	(II)	H	I	H	(II)	H	I			H	II	D	II	D	II	D	II	D	II	D	II	E	II						
			V				V	6	V	6	V				II		II		II		II	6	II	6	II	6			II	34	II	6	II	6	II	6	II		II		II	56						
Brass – Yellow 25-40% Zinc			E	I	D	I	D	II	D	II	D	I			H	(III)	H	II	E	(II)	E	I	E	(II)	E	I			E	II	C	II	C	II	C	II	C	II	C	II								
			II	5	II	356	IV	6	IV	6	IV				II		II		II	6	II	6	II	6	II	6			IV	34	II	1	II	1	II	1	II	1	II	1								
Cupro – Nickel			D	I			C	II	C	II	D	I	H	I	E	(II)	E	II	E	(II)	E	I	E	(II)	E	I	H	(II)	E	II	C	II	C	II	C	II	B	II								
			II	5			II		II		II	6	II	65	II		II	8	II		II		II		II		II	7	II	3	II	1	II	1	II		II	1								
Nickel – Silver			D	I			C	II	C	II	D	I	H	I	E	(II)	E	II	E	(II)	E	I	E	(II)	E	I	H	(II)	E	II	C	II	C	II	B	II										
			II	5			II		II		II	6	II	6	II		II	8	II		II		II		II		II	7	II	3	II	1	II	1	II	1										
Silicon Bronze			D	1	D	I	C	II	D	II	D	I	H	I	E	(II)	E	II	E	(II)	E	I	E	(II)	E	I	H	(II)	D	II	C	II	B	II												
			II	5	II	35	II		II		II	6	II	6	II		II	8	II		II		II		II		II	7	II	3	II	1	II	1												
Phosphor Bronze Grades A, C & D			E	I	E	I	D	II	D	II	E	I	H	I	E	(II)	E	II	E	(II)	E	I	E	(II)	E	I	H	(II)	D	II	C	II														
			II	5	II	35	II		II		II	6	II	6	II		II	8	II		II		II		II		II	7	II	3	II	1														
C.R. Steel H.R. Steel – Clean	D	II					D	II	D	II	H	I	H	I	B	(II)	B	II	C	II	C	I	B	(II)	C	I	E	(II)	A	II																
	II	3					II	3	II	3	II	65	II	463	II		II	8	II		II		II	6	II		II	7	II	1																
Scaly H.R. Steel	H	II													D	(II)	D	II	D	II	D	I	D	(II)	D	I	E	(II)																	
	(II)	73													(II)	7	(II)	78	(II)	7	(II)	76	(II)	76	(II)	76	(II)	7																	
Tin Plate	E	II	E	I	D	I	D	II	D	II	D	I	D	I	C	(II)	C	II	D	(II)	C	I	D	(II)	D	I																				
	I	9	I	59	II	345	I	39	I	9	I	649	I	649	I		I	8	I	9	I	69	I	69	I	69																				
Terne Plate	E	II	E	I	D	I	D	II	D	II	E	I	E	I	C	II	C	II	C	(II)	C	I	C	I																						
	(II)	9	I	59	I	34 59	I	3	I	9	I	639	I	649	I		I	8	I		I	6	I	6																						
Galvanized Iron Zinc – Plate	E	II	E	I	D	I	D	II	D	II	E	I	E	I	C	II	C	II	C	I	C	(II)																								
	I	9	(II)	69	I	345	(II)	3	II	9	I	639	I	469	I		I	98	I	9	(II)	9																							
Cadmium Plate	E	II	E	I	D	I	D	II	D	II	E	I	E	I	C	II	C	II	C	I																										
	I	9	I	5	I	345	I	3	I	9	I	639	I	3649	I		I	8	I	9																										
Chrome Plate	D	II					D	II	D	II			H	I	B	(III)	B	II																												
	II	8					II	8	II	8			II	834	II	8	II	8																												
Stainless Steel 18-8 Type	D	II					D	II	D	II					A	(III)																														
	(III)	5					(III)		(I)						(III)	1																												
Lead			E	I	D	II	H	II	H	II	H	I	D	I																														
			I	56	I	56	I	356	I	56	I	569	I	65																													
Tin			E	I	D	II	H	II	H	II	D	I																														
			I	56	I	56	I	356	I		I	56																														
Nickel	D	II					C	II	B	II																																		
	II						II	1	II	1																																		
Nickel Alloys Monel-Nichrome (High Res)	C	II					B	II																																				
	II	5					II	1																																			
Zinc			E	I	D	I																																				
			I	56	I	56																																				
Magnesium Alloys			B	I																																						
			I	15																																						
Molybdenum Tungsten	D	II																																								
	II	10																																								

LEGEND

A. BLOCK INTERPRETATION

Weldability	Electrode Against
Electrode Against	Special Information

B. WELDABILITY

A – Excellent
B – Very Good
C – Good
D – Fair
E – Poor
H – Very Poor
K – Impractical

C. ELECTRODES

I - ZIRCONIUM COPPER CLASS 1
II - CHROMIUM COPPER CLASS 2
III - BERYLLIUM COPPER CLASS 3
IV - COPPER TUNGSTEN CLASS 11
V - TUNGSTEN CLASS 13
MOLYBDENUM CLASS 14

(I) Electrode materials in circles are second choice

SPECIAL INFORMATION

1. Good weld strength.
2. May be welded under special conditions.
3. Low weld strength.
4. No actual weld nugget occurs, a "stick" is obtained.
5. Welding conditions must be accurately controlled.
6. Keep electrodes clean to prevent sticking to the work.
7. Good practice recommends cleaning steel before welding.
8. Use one flat tip to minimize distortion or discoloration.
9. Coating may dissolve in other metals or burn away.
10. Should be projection welded.

WELDABILITY INTERPRETATION

It should be understood that any metal, similar or dissimilar, may be joined by resistance welding methods and a strength of bond obtained which may be satisfactory for the purpose intended.

The weldability as expressed in this chart applies only with the use of conventional spot welding methods and is intended to serve as a guide.

Many metal combinations which are expressed as having a "poor weldability" in the chart may be joined by using a special set-up or procedure.

For example, pure copper is expressed as being "impractical to weld" in the chart but it may be joined by such expedients as the insertion of a third metal (as silver solder) between the sheets or plating another metal (nickel, tin) on the surfaces or by welding underwater, etc.

The weldability of any two materials as expressed in this chart was derived after a careful study and survey of the many factors which influence the welding or resultant weld of the metals.

1. Technical research and laboratory tests.
2. Field tests and production.
3. Thermal and electrical conductivity.
4. Metallurgical properties, melting and boiling points.
5. Nature of resultant weld or alloy.
6. Weld strength.
7. Relative accuracy in control of welding conditions necessary.

As a basis for comparison, cold rolled (mild) steel has been chosen and its weldability designated as "excellent".