WELDING CABLE

WHAT IS WELDING CABLE?

The 2014 National Electric Code® (NEC) Article 630 *Electric Welders* defines welding cable as cable designed for use in secondary circuits of electric welders.[1] Welding cable typically consists of a single, finely stranded conductor that ranges in size from 8 AWG to 500 kcmil and a single layer of EPDM or neoprene thermoset insulation with an operating temperature rating of 90° or 105°C. Welding cable is thermoset (as opposed to thermoplastic) to better resist weld splatter. The cable is typically rated 600 volts but can also be rated 100 volts. Welding cable is known for its flexibility and durability, and many automatic and manual welding applications require the cable to hold up to repeated movement over rough surfaces.

WELDING APPLICATIONS

The two main types of electric welding, as defined in NEC 2014 Article 630, are resistance welding and arc welding. In both welding types, welding cable is used to power the electrode.

Resistance welding is the process where heat used for fusing two overlapping metals together is generated from the resistance of the materials. The metals are placed between two electrodes (also known as welding points) and low-voltage, high-current electricity is passed from one point to the other. The metals resist the flow of the current and the resulting heat fuses the metals together.

Arc welding is the process of using a welding power supply to create an electric arc between the base material (also called the work piece) and the electrode. The electric arc melts the electrode and the remaining metal is used in the weld. The arc is sustained by blowing an inert gas such as argon between the electrode and the weld surface.

WELDING CABLE AMPACITY AND SIZING

Ampacity, also known as current-carrying capacity or current rating, is the maximum amount of current that a cable can safely carry without exceeding its operating temperature rating due to the heat generated from losses and ambient heat around the cable. Welding cable ampacity is a common source of confusion because it is calculated differently than other types of wire and therefore appears to have a higher ampacity than products such as building wire or tray cable , but these ampacities are for welding applications only. When done correctly, cable size selection for welding cable takes into account factors like welder output power, duty cycle and the circuit length.

The rated output of the welding power supply determines the maximum current the power supply will draw during operation. The cable must be sized to handle the maximum current.

Duty cycle is a capacity rating of a welding power source. The duty cycle is the percentage a power source can operate at a given output current level for a 10-minute span without exceeding its thermal limit.[2] If output levels decrease, duty cycle increases until it reaches 100 percent continuous output. The duty cycle rating can be found on the power source's nameplate or in the manufacturer's manual.

The welding circuit is the complete path electricity will travel in a welding application. The circuit typically consists of the welding power supply, the electrode, welding cable and the work cable. The total length of the welding cable and work cable is calculated to determine the circuit length. Ampacity ratings decrease as the length increases due to the additional resistance of longer cable.

The type of welding machinery can impact the duty cycle. The welder's intended use (light, medium or heavy), if it's single phase or three phase, and voltage rating will change the duty cycle rating. NEC 2014 Article 630 *Electric Welders* Part II *Arc Welders* and Part III *Resistance Welders* have different requirements for specifying duty cycles and ampacity.

Cable manufacturers or welding textbooks can provide recommended gauge sizes for welding applications. End-users select the welding power supply's rated output, duty cycle and the circuit length to determine the correct cable size. Table 1 is an example of a welding cable sizing chart.

Welding Machine Rating (Amperes)	Duty Cycle (%)	Lengths up to 50 ft. (AWG)	Lengths 50–100 ft. (AWG)	Lengths 100–150 ft. (AWG)	Lengths 150–200 ft. (AWG)
100	20	8	4	3	2
180	20	5	4	3	2
180	30	4	4	3	2
200	50	3	3	2	1
200	60	2	2	2	1
225	20	4	3	2	1
250	30	3	3	2	1
300	60	1/0	1/0	1/0	2/0
400	60	2/0	2/0	2/0	3/0
500	60	2/0	2/0	2/0	3/0
600	60	3/0	3/0	3/0	4/0
650	60	3/0	3/0	4/0	-
Please note that copper cable sizes are for combined lengths of electrode plus ground (work) cable.					

Table 1: Welding Cable Sizing Chart[2]

APPLICATION RECOMMENDATIONS

Welding cable's flexibility and durability makes it attractive to use in non-welding applications. However, most welding cable is not Listed by a Nationally Recognized Testing Laboratory (NRTL) like UL, meaning it does not meet NEC requirements for fixed wiring. Even UL Listed welding cable that meets UL 1276 *Welding Cables* is not approved for use as fixed wiring or general use portable cord unless it carries an additional Listing.[3] Authorities having jurisdiction (AHJ) can approve the use of welding cable in applications where the installation is judged to be safe, but using welding cable as fixed wiring without discussion with the AHJ can lead to problems.

An alternate solution is to use diesel locomotive cable (DLO), Type W mining cable or another finely stranded Listed cable. Table 2 below lists typical insulation thicknesses and strand counts of these cable types.

DLO, which is 2 kV UL Listed RHH/RHW single conductor with flexible stranding and a CPE jacket extruded over the insulation, is commonly used where the installation or application requires flexibility. DLO is suitable for use in wet or dry areas, conduits, ducts, troughs or cable tray.

Type W mining cable is used in industrial and light-to-medium mining applications, heavy-duty service and as temporary power supply cables in accordance with NEC Article 400 *Flexible Cords and Cables*. The most common mining cable standard is ICEA S-75-381[8]. Type W can also be UL Listed to UL Subject 1650.[4] Type W is rated 2,000 V and can be made in single or multiconductor jacketed constructions.

UL AWM Styles 1283 and 1284 are single-conductor thermoplastic wires that are dual listed MTW, TEW and THHW and are acceptable for flexible applications that are 600 V or less. These wires are commonly used in control cabinets, internal wiring of applications and machine tools where tight spaces require high flexibility and good durability.

Gauge Size (AWG/kcmil)	Welding Cable (600 V)		UL Style 1283 (8–2 AWG)[5] UL Style 1284 (1 AWG–500 kcmil)[6]		DLO (2,000 V)		Type W (2,000 V)	
	Insulation Thickness (in.)*	Strand Count*	Insulation Thickness (in.)	Strand Count (multiple options)*	Insulation Thickness (in.)[7]	Strand Count*	Insulation Thickness (in.)[8]	Strand Count*
8	-	-	0.060	-	0.055 (0.085 w/ jacket)	37	0.060	133
6	0.070	259	0.060	19/133/266	0.055 (0.085 w/ jacket)	61	0.060	133
4	0.070	413	0.060	19/133/420	0.055 (0.085 w/ jacket)	105	0.060	259
2	0.070	651	0.060	19/133/665	0.055 (0.100 w/ jacket)	147	0.060	259
1	0.070	840	0.080	133/259/833	0.065 (0.110 w/ jacket)	224	0.080	259
1/0	0.090	1050	0.080	259/1064	0.065 (0.110 w/ jacket)	266	0.080	259
2/0	0.090	1323	0.080	259/1330	0.065 (0.110 w/ jacket)	323	0.080	259
3/0	0.011	1666	0.080	259/1330/1672	0.065 (0.110 w/ jacket)	418	0.080	259
4/0	0.011	2107	0.080	259/551/2109	0.065 (0.130 w/ jacket)	532	0.080	259
250 (DLO: 262.6)	0.125	2450	0.095	2451	0.075 (0.140 w/ jacket)	646	0.095	427
300 (DLO: 313.3)	0.125	-	0.095	3458	0.075 (0.140 w/ jacket)	777	0.095	427
350 (DLO: 373.3)	0.125	2350	0.095	-	0.075 (0.140 w/ jacket)	925	0.095	427
400	0.125	-	0.095	-	-	-	0.095	427
450 (DLO: 444.4)	0.125	-	0.095	-	0.075 (0.140 w/ jacket)	1110	0.095	427
500 (DLO: 535.2)	0.125	5054	0.095	-	0.075 (0.140 w/ jacket)	1332	0.095	427
* Common construction, subject to change per manufacturer								

Table 2: Insulation Thickness and Strand Count of Common Flexible Cable

REFERENCES

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