

grounding conductor. Extra-hard usage cables rated not less than 90°C (194°F), 600 volts, listed for both wet locations and sunlight resistance, and having an outer jacket rated to be resistant to temperature extremes, oil, gasoline, ozone, abrasion, acids, and chemicals, shall be permitted where flexibility is necessary between the electrified truck parking space supply equipment and the inlet(s) on the TRU.

**(C) Attachment Plug(s) and Cord Connector(s).** Where a flexible cord is provided with an attachment plug and cord connector, they shall comply with 250.138(A). The attachment plug(s) and cord connector(s) shall be listed, by itself or as part of the power-supply cable assembly, for the purpose and shall be molded to or installed on the flexible cord so that it is secured tightly to the cord at the point where the cord enters the attachment plug or cord connector. If a right-angle cap is used, the configuration shall be oriented so that the grounding member is farthest from the cord. An attachment plug and cord connector for the connection of a truck or trailer shall be rated in accordance with (1) or (2) as follows:

- (1) 30-ampere, 480-volt, 3-phase, 3-pole, 4-wire and intended for use with a 30-ampere 480-volt, 3-phase, 3-pole, 4-wire receptacles and inlets, respectively, or
- (2) 60-ampere, 208-volt, 3-phase, 3-pole, 4-wire and intended for use with a 60-ampere, 208-volt, 3-phase, 3-pole, 4-wire receptacles and inlets, respectively.

**Informational Note:** Complete details of the 30-ampere pin and sleeve attachment plug and cord connector configurations for refrigerated containers (transport refrigerated units) can be found in ANSI/UL1686, *Standard for Pin and Sleeve Configurations*, Figures C2.12 and C2.11. For various configurations of 60-ampere pin and sleeve attachment plugs and cord connectors, see ANSI/UL1686.

## ARTICLE 630 Electric Welders

### I. General

**630.1 Scope.** This article covers apparatus for electric arc welding, resistance welding, plasma cutting, and other similar welding and cutting process equipment that is connected to an electrical supply system.

### II. Arc Welders

**630.11 Ampacity of Supply Conductors.** The ampacity of conductors for arc welders shall be in accordance with 630.11(A) and (B).

**(A) Individual Welders.** The ampacity of the supply conductors shall be not less than the  $I_{1\text{eff}}$  value on the rating plate.

Alternatively, if the  $I_{1\text{eff}}$  is not given, the ampacity of the supply conductors shall not be less than the current value determined by multiplying the rated primary current in amperes given on the welder rating plate by the factor shown in Table 630.11(A) based on the duty cycle of the welder.

**Table 630.11(A) Duty Cycle Multiplication Factors for Arc Welders**

Duty Cycle	Multiplier for Arc Welders	
	Nonmotor Generator	Motor Generator
100	1.00	1.00
90	0.95	0.96
80	0.89	0.91
70	0.84	0.86
60	0.78	0.81
50	0.71	0.75
40	0.63	0.69
30	0.55	0.62
20 or less	0.45	0.55

**(B) Group of Welders.** Minimum conductor ampacity shall be based on the individual currents determined in 630.11(A) as the sum of 100 percent of the two largest welders, plus 85 percent of the third largest welder, plus 70 percent of the fourth largest welder, plus 60 percent of all remaining welders.

*Exception:* Percentage values lower than those given in 630.11(B) shall be permitted in cases where the work is such that a high-operating duty cycle for individual welders is impossible.

**Informational Note:** Duty cycle considers welder loading based on the use to be made of each welder and the number of welders supplied by the conductors that will be in use at the same time. The load value used for each welder considers both the magnitude and the duration of the load while the welder is in use.

**630.12 Overcurrent Protection.** Overcurrent protection for arc welders shall be as provided in 630.12(A) and (B). Where the values as determined by this section do not correspond to the standard ampere ratings provided in 240.6 or where the rating or setting specified results in unnecessary opening of the overcurrent device, the next higher standard rating or setting shall be permitted.

**(A) For Welders.** Each welder shall have overcurrent protection rated or set at not more than 200 percent of  $I_{1\text{max}}$ . Alternatively, if the  $I_{1\text{max}}$  is not given, the overcurrent protection shall be rated or set at not more than 200 percent of the rated primary current of the welder.

An overcurrent device shall not be required for a welder that has supply conductors protected by an overcurrent

device rated or set at not more than 200 percent of  $I_{1\max}$  or at the rated primary current of the welder.

If the supply conductors for a welder are protected by an overcurrent device rated or set at not more than 200 percent of  $I_{1\max}$  or at the rated primary current of the welder, a separate overcurrent device shall not be required.

**(B) For Conductors.** Conductors that supply one or more welders shall be protected by an overcurrent device rated or set at not more than 200 percent of the conductor ampacity.

Informational Note:  $I_{1\max}$  is the maximum value of the rated supply current at maximum rated output.  $I_{1\text{eff}}$  is the maximum value of the effective supply current, calculated from the rated supply current ( $I_1$ ), the corresponding duty cycle (duty factor) ( $X$ ), and the supply current at no-load ( $I_0$ ) by the following equation:

$$I_{1\text{eff}} = \sqrt{I_1^2 X + I_0^2 (1 - X)}$$

**630.13 Disconnecting Means.** An identified disconnecting means shall be provided in the supply circuit for each arc welder that is not equipped with a disconnect mounted as an integral part of the welder.

The disconnecting means shall be a switch or circuit breaker, and its rating shall be not less than that necessary to accommodate overcurrent protection as specified under 630.12.

**630.14 Marking.** A rating plate shall be provided for arc welders giving the following information:

- (1) Name of manufacturer
- (2) Frequency
- (3) Number of phases
- (4) Primary voltage
- (5)  $I_{1\max}$  and  $I_{1\text{eff}}$ , or rated primary current
- (6) Maximum open-circuit voltage
- (7) Rated secondary current
- (8) Basis of rating, such as the duty cycle

**630.15 Grounding of Welder Secondary Circuit.** The secondary circuit conductors of an arc welder, consisting of the electrode conductor and the work conductor, shall not be considered as premises wiring for the purpose of applying Article 250.

Informational Note: Connecting welder secondary circuits to grounded objects can create parallel paths and can cause objectionable current over equipment grounding conductors.

### III. Resistance Welders

**630.31 Ampacity of Supply Conductors.** The ampacity of the supply conductors for resistance welders necessary to limit the voltage drop to a value permissible for the satisfactory

performance of the welder is usually greater than that required to prevent overheating as covered in 630.31(A) and (B).

**(A) Individual Welders.** The rated ampacity for conductors for individual welders shall comply with the following:

- (1) The ampacity of the supply conductors for a welder that may be operated at different times at different values of primary current or duty cycle shall not be less than 70 percent of the rated primary current for seam and automatically fed welders, and 50 percent of the rated primary current for manually operated nonautomatic welders.
- (2) The ampacity of the supply conductors for a welder wired for a specific operation for which the actual primary current and duty cycle are known and remain unchanged shall not be less than the product of the actual primary current and the multiplier specified in Table 630.31(A)(2) for the duty cycle at which the welder will be operated.

**Table 630.31(A)(2) Duty Cycle Multiplication Factors for Resistance Welders**

Duty Cycle (%)	Multiplier
50	0.71
40	0.63
30	0.55
25	0.50
20	0.45
15	0.39
10	0.32
7.5	0.27
5 or less	0.22

**(B) Groups of Welders.** The ampacity of conductors that supply two or more welders shall not be less than the sum of the value obtained in accordance with 630.31(A) for the largest welder supplied and 60 percent of the values obtained for all the other welders supplied.

Informational Note: **Explanation of Terms**

- (1) The *rated primary current* is the rated kilovolt-amperes (kVA) multiplied by 1000 and divided by the rated primary voltage, using values given on the nameplate.
- (2) The *actual primary current* is the current drawn from the supply circuit during each welder operation at the particular heat tap and control setting used.
- (3) The *duty cycle* is the percentage of the time during which the welder is loaded. For instance, a spot welder supplied by a 60-Hz system (216,000 cycles per hour) and making 400 15-cycle welds per hour would have a duty cycle of 2.8 percent (400 multiplied by 15, divided by 216,000, multiplied by 100). A seam welder operating 2 cycles “on” and 2 cycles “off” would have a duty cycle of 50 percent.

**630.32 Overcurrent Protection.** Overcurrent protection for resistance welders shall be as provided in 630.32(A) and (B). Where the values as determined by this section do not correspond with the standard ampere ratings provided in 240.6 or where the rating or setting specified results in unnecessary opening of the overcurrent device, a higher rating or setting that does not exceed the next higher standard ampere rating shall be permitted.

**(A) For Welders.** Each welder shall have an overcurrent device rated or set at not more than 300 percent of the rated primary current of the welder. If the supply conductors for a welder are protected by an overcurrent device rated or set at not more than 200 percent of the rated primary current of the welder, a separate overcurrent device shall not be required.

**(B) For Conductors.** Conductors that supply one or more welders shall be protected by an overcurrent device rated or set at not more than 300 percent of the conductor ampacity.

**630.33 Disconnecting Means.** A switch or circuit breaker shall be provided by which each resistance welder and its control equipment can be disconnected from the supply circuit. The ampere rating of this disconnecting means shall not be less than the supply conductor ampacity determined in accordance with 630.31. The supply circuit switch shall be permitted as the welder disconnecting means where the circuit supplies only one welder.

**630.34 Marking.** A nameplate shall be provided for each resistance welder, giving the following information:

- (1) Name of manufacturer
- (2) Frequency
- (3) Primary voltage
- (4) Rated kilovolt-amperes (kVA) at 50 percent duty cycle
- (5) Maximum and minimum open-circuit secondary voltage
- (6) Short-circuit secondary current at maximum secondary voltage
- (7) Specified throat and gap setting

#### IV. Welding Cable

**630.41 Conductors.** Insulation of conductors intended for use in the secondary circuit of electric welders shall be flame retardant.

**630.42 Installation.** Cables shall be permitted to be installed in a dedicated cable tray as provided in 630.42(A), (B), and (C).

**(A) Cable Support.** The cable tray shall provide support at not greater than 150-mm (6-in.) intervals.

**(B) Spread of Fire and Products of Combustion.** The installation shall comply with 300.21.

**(C) Signs.** A permanent sign shall be attached to the cable tray at intervals not greater than 6.0 m (20 ft). The sign shall read as follows:

CABLE TRAY FOR WELDING CABLES ONLY

## ARTICLE 640 Audio Signal Processing, Amplification, and Reproduction Equipment

### I. General

**640.1 Scope.** This article covers equipment and wiring for audio signal generation, recording, processing, amplification and reproduction; distribution of sound; public address; speech input systems; temporary audio system installations; and electronic organs or other electronic musical instruments. This also includes audio systems subject to Article 517, Part VI, and Articles 518, 520, 525, and 530.

Informational Note No. 1: Examples of permanently installed distributed audio system locations include, but are not limited to, restaurant, hotel, business office, commercial and retail sales environments, churches, and schools. Both portable and permanently installed equipment locations include, but are not limited to, residences, auditoriums, theaters, stadiums, and movie and television studios. Temporary installations include, but are not limited to, auditoriums, theaters, stadiums (which use both temporary and permanently installed systems), and outdoor events such as fairs, festivals, circuses, public events, and concerts.

Informational Note No. 2: Fire and burglary alarm signaling devices are specifically not encompassed by this article.

**640.2 Definitions.** For purposes of this article, the following definitions apply.

**Abandoned Audio Distribution Cable.** Installed audio distribution cable that is not terminated at equipment and not identified for future use with a tag.

**Audio Amplifier or Pre-Amplifier.** Electronic equipment that increases the current or voltage, or both, potential of an audio signal intended for use by another piece of audio equipment. *Amplifier* is the term used to denote an audio amplifier within this article.

**Audio Autotransformer.** A transformer with a single winding and multiple taps intended for use with an amplifier loudspeaker signal output.

**Audio Signal Processing Equipment.** Electrically operated equipment that produces, processes, or both, electronic signals that, when appropriately amplified and reproduced by a loudspeaker, produce an acoustic signal within the range of normal human hearing (typically 20–20 kHz). Within this article, the