GENERAL WELDING TIPS

I. Gas metal arc welding (GMAW) can be divided into four categories based on the mode of metal transfer: (1) spray, (2) pulsed spray, (3) globular, and (4) short circuiting transfer. In the spray, pulsed spray, and globular modes, transfer occurs as distinct droplets that are detached from the electrode, transferring along the arc column into the weld pool. In the short circuiting mode, the metal deposited during frequent short circuiting of the electrode in the molten pool.

II. **Spray Transfer.** The spray transfer mode, for low-alloy steel, is most commonly obtained with argon shielding gas mixtures with up to 5 percent oxygen or carbon dioxide. A characteristic of these shielding gas mixtures is the smooth arc plasma through which hundreds of very fine droplets are transferred to the weld pool each second.

Spray transfer with argon-oxygen or argon-carbon dioxide shielding gas is, primarily, a function of current density, polarity, and resistance heating of the electrode. The high droplet rate (approximately 250 droplets per second) develops suddenly above a critical current level, commonly referred to as the *transition current* (for each size electrode). Below this current, the metal is transferred in drops generally larger in diameter than the electrode at a rate of from 10 to 20 per second (globular transfer). The transition current is also dependent, to some extent, on the chemical composition of the electrode. For 1/16 (1.6mm) diameter low-alloy steel electrodes, a transition current of 270 amperes (direct current electrode positive [DCEP]) is common. Alternating current is not recommended for this type of welding because it does not produce a stable arc.

III. **Pulsed Spray Transfer.** Metal transfer in pulsed spray welding is similar to that of the spray transfer described above, but it occurs at a lower average current. The lower average current is made possible by rapid pulsing of the welding current between a high level, where metal will transfer rapidly in the spray mode, and a low level, where no transfer will take place. At a typical rate of 60 to 120 pulses per second, a melted drop is formed by the low-current arc, which is then "squeezed off" by the high-current pulse. This permits all-position welding.

IV. **Globular Transfer.** The mode of transfer that charcterizes 100 percent CO2 as a shielding gas is globular. Common practice with globular transfer is to use low arc voltage to minimize spatter. This buries the arc and produces deep penetration. Electrodes of 0.045 and 1/16 in. (1.2 and 1.6 mm) diameter normally are used at welding currents in the range of 275 – 400 amperes (DCEP), for this type of transfer. The rate at which droplets (globules) are transferred ranges from 20 to 70 per second, depending on the size of the electrode, the amperage, polarity, and arc voltage.

V. **Short Circuiting Transfer.** This mode of transfer is obtained with small diameter electrodes (0.030 to 0.045 in. [0.8 to 1.2 mm]) using low arc voltages and amperages, and a power source designed for short circuiting transfer. The electrode short-circuits to the weld metal, usually at a rate of from 50 to 200 times per second. Metal is transferred with each short circuit, but not across the arc. Short circuiting gas metal arc welding of low-alloy steel is done most commonly with mixtures of argon and CO2 as the shielding gas, with CO2 alone, and occasionally with mixtures of helium-argon-CO2. Penetration of welds made with CO2 shielding gas is greater than with argon-CO2 mixtures, but mixtures containing substantial amounts of argon or helium generally result in superior weld metal impact properties. Shielding gas mixtures of 50 to 90 percent argon-remainder CO2 or 50 to 90 percent helium-remainder CO2 result in higher short circuiting rates and lower minimum currents and voltages than does CO2 shielding alone. This can be an advantage when welding thin plate or in the achievement of superior impact properties.