Soil Resistivity as Related to Underground Corrosion and Cathodic Protection*

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ABRIDGMENT

•CORROSION data are based on measurements made on about 4,500 specimens of commonly used plain ferrous materials which had been buried in backfilled trenches at 86 National Bureau of Standards sites for periods up to 17 yr. The metals exposed consisted of open hearth iron, hand-puddled and mechanically puddled wrought irons, and open hearth and Bessemer steels, all without alloying constituents. The soils ranged in resistivity from 50 to 54,000 ohm-cm and in pH from 2.6 to 10.2.

For periods of exposure up to 5 yr, the maximum pit depths are on the average deeper in soils with resistivities up to 500 ohm-cm than in soils with higher resistivities. In the higher resistivity soils (> 500 ohm-cm), there appears to be no regular variation between maximum pit depth and soil resistivity. However, for periods of

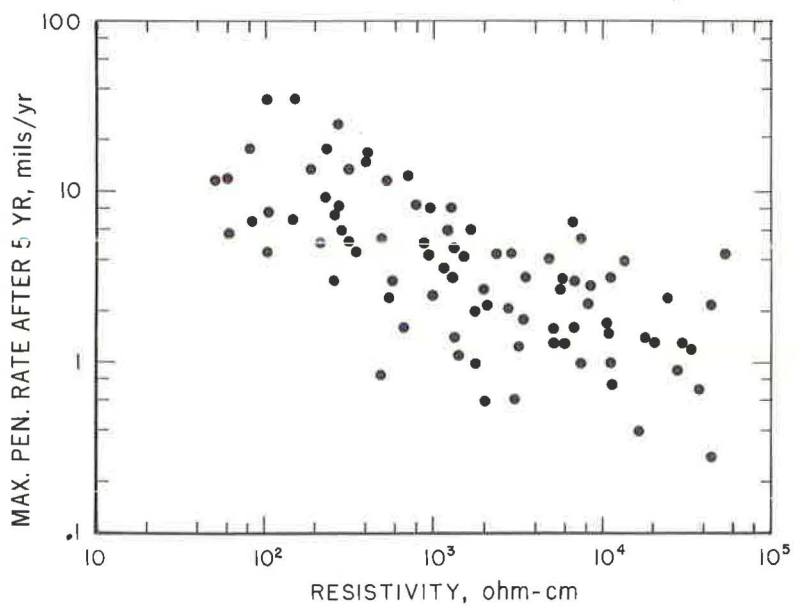

Figure 1. Rates of penetration of specimens based on maximum pit depth-time curves, from 5 yr to from 12 to 17 yr (for majority of soils).

*The complete paper, on which this abridgment is based, has been published in the Journal of Research of the National Bureau of Standards, Vol. 69C, No. 71, Jan.-Mar. 1965.

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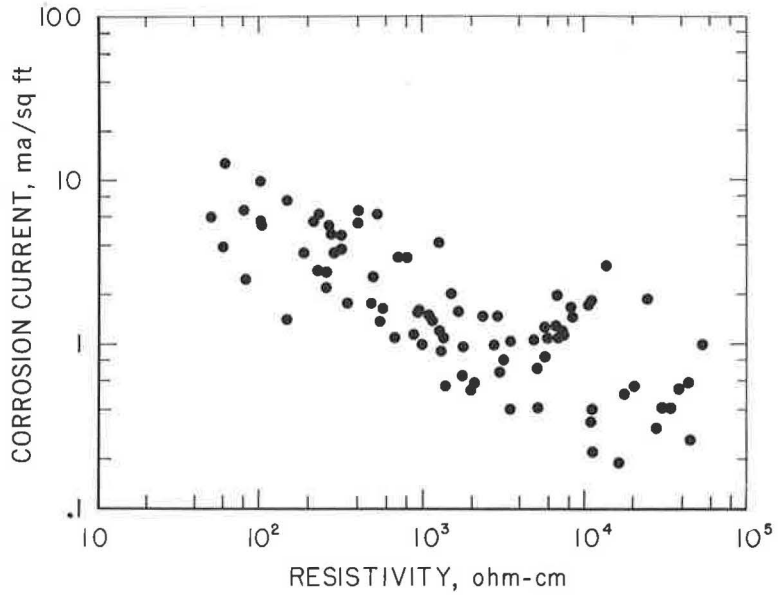

Figure 2. Calculated corrosion current densities based on weight loss rates between 5 and 12, and between 5 and 17 yr of exposure for majority of soils.

exposure longer than 5 yr, the rate of maximum penetration, in general, decreases as the soil resistivity increases, as shown in Figure 1. According to an empirical equation, increasing the area of metal exposed from that of the specimens (0.4 sq ft) to that equivalent to the exterior surface (45.16 sq ft) of a bare 20-ft length of 8-in. diameter pipe approximately doubles the maximum penetration rates given in Figure 1.

The weight losses on the same specimens were converted to corrosion current densities. The corrosion rates after 5 yr are shown in Figure 2. The pattern is similar to that of Figure 1, indicating a correlation between weight loss and maximum pit depth.

The current densities required for cathodic protection are usually greater than the current densities associated with corrosion. The data (Fig. 2) can be adjusted to give an estimate of the current densities probably necessary for the cathodic protection of bare metal surfaces similarly exposed. This does not imply that current density is being substituted for polarization requirements as a criterion for cathodic protection, but that current densities might be estimated to fulfill the polarization requirements. A factor of 1.5 is suggested for soils with resistivities up to 5,000 ohm-cm, 2.0 for soils from 5,000 to 10,000 ohm-cm, and a factor of 3.0 for soils with resistivities greater than 10,000 ohm-cm. The higher corrosion rates existing during the first few years of exposure indicate that it is probably economically feasible to wait for about 2 yr before measuring current densities necessary for cathodic protection.