

## Chapter 13

## Bus Conductor Design and Applications

The selection of material for bus conductors is usually based on a balance of mechanical and electrical characteristics, economics, and availability. The materials that have been used for bus conductors in large quantity, listed in order of volume conductivity, are: silver, copper, aluminum and iron.

Although silver has the highest volume conductivity, it was used as a bus conductor only during World War II when millions of pounds (mostly 3/4" x 9" bars) were used at various aluminum smelters. The service record was excellent but costs prohibit peacetime use of silver for such applications.

Iron in various forms was also used in large volume for bus conductors during World War II. In recent years its use is primarily for power rails for rapid transit systems and overhead electrical cranes. However, even for these applications its use is declining due to the advantages of aluminum and aluminum-steel combinations (Fig. 13-5 m and n).

Copper has excellent mechanical and electrical characteristics and for many years was the metal of choice for use as bus conductor. However, the trend has been toward wider use of aluminum for all types of bus installation.

Aluminum has less than one-third the density of copper and, making allowance for conductivity, an aluminum bus bar will weigh about half as much as copper for equal conductance. For large installations requiring millions of pounds of metal, bus system designers have used the low cost of aluminum as the basis for optimum economic current density. The purpose of this chapter is to provide technical data on numerous bus conductor shapes and alloys as well as answers to basic questions on design and joining.

Typical physical properties given in figures and tables are not guaranteed and may not be exact. They are intended for general information only and should not be specified as engineering requirements. Minimum properties for various aluminum product forms, sizes and methods of manufacture are available in the Aluminum Association's *Aluminum Standards and Data*.

Many standard works on bus conductor are listed at the end of this chapter, and numbered references in the text relate to this bibliography.

Figures 13-1, 2, 9, 10, 11, 17, 18 and Tables 13-9, 10, 11, 12, 13, 14, 16, 23 have been reprinted with permission from the *Alcoa Aluminum Bus Conductor Handbook* (1957) and other Alcoa Technical Publications; Figures 13-4, 28 and Tables 13-3, 7 from the *Kaiser Aluminum Bus Conductor Technical Manual*.

#### Alloys and Tempers

Pure aluminum has a conductivity of about 65 percent of the International Annealed Copper Standard (IACS). Aluminum can be produced 99.99 percent pure; however, this purity is costly to achieve and the mechanical properties are low.

Aluminum 1350 is a commercial high-purity aluminum with 61 percent conductivity. The tensile strength of each 1350 temper is determined by the amount of work given the metal during fabrication. Today, most 1350 aluminum bus conductors are of -H111 temper for extrusions, -H112 for sawed rolled plate, and -F for cast bars.

After World War II, a new conductor alloy, 6101, was developed which had considerably higher yield strength and better creep resistance than 1350. The alloy contained magnesium and silicon for high mechanical strength without significant reduction in conductivity. The strength of this alloy (6101) is obtained by suitable heat treatments, occasionally combined with some cold work.

Alloy 6063 has been widely used for outdoor high-voltage substation buses because of its excellent mechanical and electrical properties and its availability and economy. Where high strength is desirable and conductivity requirements are lower, alloy 6061-T6 bus is used. Where high conductivity is required, with a minimum sacrifice in mechanical properties, alloy 6101 is used in a variety of shapes.

Other aluminum alloys may be used for bus conductors. However, they should be used with care since conductivity and mechanical properties can be greatly affected by small

# Bus Conductor Design And Applications

**Michal Rosen-Zvi**



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