momentum of the water against the turbine gates when the flow of water to them must be reduced or closed off suddenly. Ice cover on the water in the tank damages its interior supports in the event of rapid changes of level.

Fuel-operated auxiliary equipment is sometimes installed to supply power in the event of the hydro equipment becoming inoperative from any cause, but so dependable have Canadian hydro-electric installations proven that the central electric station industry, which operates 88 p.c. of Canada's developed water powers, maintains less than 200,000 h.p. of such auxiliary equipment for the more than 7,200,000 h.p. of hydraulic turbines, as shown in Table 3.

The Generation of Electric Energy.—Electric generators in use in Canada are almost exclusively for the production of alternating current, considerably less than 1 p.c. of the more than 6,000,000 kilowatts of generating capacity installed in central electric stations being direct current.

In the generation of alternating current in Canada two frequencies may be said to be standard, 25 and 60 cycles per second. The original developments at Niagara Falls were made with a frequency of 25 cycles and this frequency has been adhered to when additional power for that area has been provided. This frequency is also used in some of the plants supplying the mining areas of northern Ontario but elsewhere in Canada generation at a frequency of 60 cycles is general. Where interconnection is made between the two systems, frequency changers are installed.

Alternating current generators are in operation in Canada up to 55,000 kva., the largest direct current generator in central-station use being 750 kw., although some larger units are in use in electric railway and industrial plants.

Electricity is generated at voltages up to 14,000 and this voltage is raised as circumstances require to varying voltages up to 220,000 for transmission.

The Transmission of Electric Energy.—Until almost the beginning of the present century it was believed that any attempt at the long-distance transmission of electricity would prove uneconomic because of the amount of current absorbed or lost in transmission. The development of the high-tension transformer and of improved insulating materials resulted in the construction, in 1897, between St. Narcisse and Three Rivers, Quebec, of an 11,000-volt line, 18 miles in length, the first high-tension transmission line in the British Empire. Since that time continued technical advances have resulted in a steady growth in transmission distances and voltages in Canada, until at present power is being transmitted, for instance, from the Gatineau River in Quebec to Toronto, a distance of 225 miles, at 220,000 volts. Greatly improved technique has also been developed in switching control and protective equipment.

In general, electricity is generated at voltages between 6,000 and 14,000. The power is then passed through transformers which raise it to a voltage predetermined by considerations of distance, amount of power to be carried, and relation between the value of the power carried and the cost of the transmission line.

Conductors for Transmission Lines.—Copper and aluminium are the principal materials used for conductors for long-distance electric transmission although in some cases, where small amounts of power are to be transmitted, iron wire is used. Copper-clad steel wire is used to a considerable extent for special crossings where great strength is required. Steel-reinforced aluminium cable is in general use when large quantities of power are transmitted as it is much stronger than copper of the same conductivity and weight. The steel core provides the strength and the aluminium cable the conductance.