municipal debentures will command a higher price in the money markets if issued under the former method on account of being a safe investment to the purchaser, and they are certainly less worry and trouble to the municipality as the investment of the sinking fund is more or less an uncertain question.

With the unsettled condition of the financial world as at present caused by the European war, the time is most unfavorable for the floating of loans of this nature by municipalities. Indeed, negotiations to that end could be effected only at a great loss and sacrifice to the municipality. But with the restoration of peace, which we sincerely hope will not be too far distant in the future, the financial atmosphere will clear and conditions will assume a more normal state. Then, no doubt, investors will be looking for the opportunities of safe investments that the municipalities of this province with such excellent security affords.

CONSTANT VOLTAGE OPERATION OF A HIGH VOLTAGE TRANSMISSION SYSTEM.

THE electrical section of the Canadian Society of Civil Engineers, at its meeting on March 18th, heard a paper on constant voltage operation of a high voltage transmission system. The authors, Prof. L. A. Herdt and Mr. E. G. Burr, referred to the system of the Point du Bois hydro-electric plant of the City of Winnipeg Light and Power Department. The line is 77 miles in length and extends from the plant to the terminal station in Winnipeg. It consists of two 3-phase circuits on one steel tower line of stranded aluminum cable operated at a nominal receiver voltage of 55,000 volts. The reader is referred to an anticle which appeared in January 19th, 1911, issue of *The Canadian Engineer*, for a description of this plant. A much fuller treatment of the development appears in a paper in the Proceedings for 1911 of The Canadian Society of Civil Engineers, the paper having been presented by Mr. W. G. Chace.

The original installation consisted of five generators driven by water wheels capable of each giving a maximum generator output of 3,750 k.w. at full-gate opening normal head, that is, a full-gate opening output of 18,750 kilowatts. The power house building originally constructed provides accommodation for seven generators with exciters and also a testing flume. The maximum full-gate opening load rating of each transmission circuit was 11,250 k.w. at the power house (3—3,750 k.w. units), and the transmission right-of-way is suitable for carrying four such circuits on two steel tower lines. The present installation consists of two circuits only, on one steel tower line.

In the year 1913 the growth of the load on the plant demanded additions to the generator equipment. At this time, in view of improvements in the design of waterwheels, consideration was given to the possibility of using larger wheels in the same wheel pits, and so increasing the ultimate output of the plant. After due investigation it was decided to add three more generators, with a maximum output of 5,100 k.w. each, at full-gate opening. These could all be housed in the original building as one of the original units had been installed permanently on the testing flume.

Two of these units are now in operation, and the third is ready for installation. Further increase in load can be conveniently provided for without extra buildings or hydraulic construction work by replacing the present small units by the larger ones, which would bring the ultimate output from the present building to eight units of 5,100 k.w. maximum each, or a total of 40,800 k.w. at full-gate opening. This represents one-half of the final development.

The present lines are not capable of carrying load in excess of that for which they were originally designed when transmitting the power at the power factor of the load. The increase of ultimate power house output for the final development would require a total of six circuits at the nominal receiver voltage of 55,000. The right-of-way is not suitable for the three tower lines which would be required, unless a vertical arrangement of conductors and small spans was resorted to which would mean complete reconstruction of the present line and great expense for foundations. The acquirement of additional right-of-way was also out of the question.

For the above reasons it was necessary to consider schemes for increasing the capacity of each circuit, and this problem required early solution in view of the fact that the load on the system was rapidly increasing, and in the near future trouble on one circuit would necessitate the dropping of some load at the peak, as the maximum load at the terminal station would be beyond the regulation limit of one circuit. It was tentatively decided to achieve this requisite increase of capacity by raising the voltage of the system in the future to 100,000 volts, at which voltage four circuits would be sufficient for the ultimate output of the plant.

Immediate requirements would be provided for by the construction of a new two-circuit tower line suitable for 100,000-volt operation, but to be operated in the immediate future at 60,000 volts in multiple with the present line. When conditions of load required it, the new line would have been raised to its full voltage, and then reconstruction of the present line started for the increased voltage using the present tower foundations. This scheme was found feasible and sufficient room was available on the right-of-way.

An alternative to increased line voltage presented itself in the scheme of controlling line-voltage drop by power factor or phase control of the receiver load using unloaded synchronous motors to supply lagging or leading current as the requirement may be. With apparatus of this type, both power house and terminal station voltages may be maintained constant, with a constant voltage difference.

In view of the small power loss of the present lines, such a scheme looked attractive, as if the regulation or change of voltage with load was in this way eliminated, the amount of power which could be carried on a circuit would be limited only by consideration of loss, and the necessity of using a higher line voltage would be obviated.

Further, in view of financial conditions, postponement of the construction of another transmission line at an estimated cost of $750,000 was advisable, while service conditions demanded that extra line capacity should be available at once.

After due consideration, two 6,000 k.v.a. synchronous motors running at 600 r.p.m., 6,600 volts, with three-phase transformers, with starting taps for connection to the terminal station, 12,000-volt bus were ordered, with automatic regulator equipment and exciters.

The transformers are provided with H. V. taps to allow of change of voltage at which bus is operated without changing the voltage on the motors. These sets are now in operation.