Substation Equipment for St. Paul's New Electrification

The Spokane River Hydraulic System Supplies Power to This Substation at 102,000 Volts, Using Three-Phase Alternating Current

THE substation equipment for the Columbia River division of the Chicago, Milwaukee & St. Paul Railway, now being electrified, will be similar to that used on the original Montana electrification of this railway. The modifications which will be made have been shown by experience to be desirable or necessitated by the difference in operating conditions.

Power for this division will be supplied in the form of three-phase, 60-cycle, 102,000-volt alternating current from the Spokane River hydroelectric system of the Washington Water Power Company. The high-tension line will parallel the railroad and, looping into the substations, will form the high-tension bus for each station. In the stations the current will be stepped down to 2300 volts and then transformed by motor-generator sets into 3000-volt direct current for train operation. There are to be three substations altogether, spaced approximately 30 miles apart and located at Taunton, Doris and Kittitas respectively. The equipment in each will be practically the same.

The incoming high-tension line will enter the substation through condenser-type bushings and will be controlled by a 3-pole Westinghouse type GA oil circuit breaker, arranged for remote mechanical operation and providing automatic protection against overloads and reverse power.

The transforming equipment is designed on the unit basis; that is, there will be a transformer for each motor-generator set, and no low-tension buses will be provided. The Taunton station will have two such units, to be immediately installed, giving it a capacity of 4000 kw., and the other two stations will each ultimately have three units, providing a capacity of 6000 kw. each.

The transformers will be of the oil-insulated, tubular, air-cooled, shell type, connected star-delta, with several full-capacity high-tension taps to provide the necessary flexibility. The normal capacity of each transformer will be 2500 kva., but they are especially arranged to carry the high overloads encountered in railway service. The ventilating ducts and the coils are vertical, so that the oil in absorbing heat from the coils flows upward in the natural direction, thus preventing the formation of hot spots under short-time heavy peak loads. Each transformer bank will have a type GA circuit breaker which provides overload protection.

The motor-generator sets will each consist of a 2800 hp., 2300-volt, 14-pole synchronous motor of 514 r.p.m., coupled to two 1000-kw., 1500-volt direct-current generators connected in series. Both the motor and the generators will be separately excited by means of direct-connected exciters.

The normal rating of the sets will be 2000 kw., but they are designed to carry 3000 kw. for two hours and 6000 kw. for five minutes. These very severe overload conditions make good commutation an absolute essential for satisfactory operation. As a 6-pole generator possesses inherently the best commutating characteristics and will handle excessive currents without flashing, this type was adopted for these sets. It is recognized, however, that a short-circuit on the direct-current line at or near the substation will result in currents that would ordinarily cause flashing, but special arrangements have been made that will suppress flashing even under these extreme circumstances. The method employed was fully described in the ELECTRIC RAILWAY JOURNAL of May 4, page 858.

Because of the use of regenerative braking by the locomotives, the generators will at times operate as motors. For this reason they will be shunt wound so as to avoid the difficulty of operating differentially-wound motors in parallel, and to obtain satisfactory division of a heavy regenerating load without careful attention on the part of the operators.

The load factor on these substations will be comparatively low, so that it is desirable to eliminate as many continuous losses as possible. An interesting means for accomplishing this result is the use of separate motor-driven blowers which are automatically started when the temperature of the motor-generator sets reaches a predetermined degree. During periods of light loads or short-time peaks, the motor-generators will operate well within safe temperature limits without forced ventilation, but when the loads are heavy the necessary ventilation will be provided. In this way the expense of operating the ventilating sets during light-load periods is avoided.

In order to provide maximum protection to the operators, the control of the 3000-volt direct current has been designed in accordance with high-tension alternating-current practice. The circuits will be completely separated; all breakers and switches will be controlled from a gallery above the operating board; and it will be possible to isolate the station from the railroad operating system by means of remote controlled switches in the feeder circuits which can be opened under load. The normal control of the outgoing feeders will, however, be by type GA circuit breakers with overload and reverse power protection. Electrolytic lightning arresters will be mounted on the roof of each of the substation buildings.

All the equipment for these stations is being supplied by the Westinghouse Electric & Manufacturing Company.

Convict Labor Rebuilds Power Plant

The United Gas & Electric Engineering Corporation has recently completed the rebuilding of a plant in Leavenworth, Kan. This work was carried on under difficult conditions as regards labor. The construction dragged very slowly until the Leavenworth company succeeded in obtaining permission from the Governor of Kansas to use labor from the State penitentiary at Lansing. The convicts were very glad to get a chance at work of this kind affording much more freedom and enjoyment than the humdrum prison life and it made the early completion of the work possible. In rebuilding the plant new equipment was installed consisting of stokers, boilers, a 1500-kw. turbine, a new concrete stack and a new condensing equipment consisting of a pumping pit in the river connected to the plant by 1500-ft. pipe lines.