

A NOTE ON THE SPACING OF STATIONS FOR COMMUTER TRAIN SERVICES

By the Editor

IN THE July 1973 announcement of the Government's proposal to electrify the suburban railway between Papakura and Auckland, the Minister of Works, Mr Watt, mentioned overseas experience that the spacing of stations could be much closer than two-mile intervals "without any great effect on the frequency of service." This of course is quite true, but in the statement as reported he did not observe that the number of stops between terminals can have a considerable effect on the end-to-end journey times, and that an increase in the number of stops does make it more and more difficult to obtain an acceptably high average speed and reasonably short journey times.

To illustrate just what effect the number of stops can have, let us consider a very hypothetical situation where we have a section of railway exactly 20 miles in length from one terminal station to the other, and let us assume that whatever maximum speed

is fixed for the line can be maintained without restriction or variation throughout. Thus, at 50 m.p.h., the 20 miles could be covered in 24 minutes plus whatever additional time is necessary to allow for acceleration from rest and for deceleration to the

stop. For this exercise, we shall consider equipment with which the allowances to cover acceleration and deceleration are 0.5 min. at 50 m.p.h., 0.6 min. at 60 m.p.h., and 0.8 min. at 75 m.p.h. (These are slightly better than those attainable with 3-coach multiple-unit electric trains at Wellington, which have a designed top speed of 60 m.p.h.). Start-to-stop times over our hypothetical 20-mile line therefore would be 24.5, 20.6, and 16.8 minutes respectively. These would be the best times that could possibly be achieved without exceeding the prescribed speeds.

Now, if our hypothetical train is going to make any intermediate stops along the way, we shall need to allow for deceleration and acceleration at each one, together with a reasonable standing time. At Wellington, an average standing time of 30 seconds (0.5 min.) was used when preparing the timetable schedules on the Paekakariki and Hutt Valley lines, but experience suggests that 24 seconds (0.4 min.) is ample, on average, for all normal purposes. So, for each stop, including the allowances for deceleration and acceleration, we shall add a total of 0.9 min. when the running speed is 50 m.p.h., 1.0 min. when it is 60 m.p.h., and 1.2 min. for 75 m.p.h.

If we space our stations an average of two miles apart, there will be nine intermediate stops in the distance of 20 miles, and simple arithmetic will show (if I have done my sums correctly!) that the best possible end-to-end times for an all-stations stopping train then would be 32.6 min. with a top speed of 50 m.p.h., 29.6 min. at 60 m.p.h., and 27.6 min. at 75 m.p.h.

Increasing the number of stops to 14 (an average spacing of about 1.3 miles between stations) lengthens the times to 37.1, 34.6, and 33.6 minutes respectively, and it will be noted that increasing the maximum speed to 75 m.p.h. now results in a saving of only one minute over the whole distance. If we increase the number of stops still further to 19, or an average of one mile apart (the same as at present between Papakura and Auckland), the end-to-end times become 41.6, 39.6, and 39.6 minutes respectively. In these circumstances there is no point whatever in raising the maximum running speed beyond 60 m.p.h.

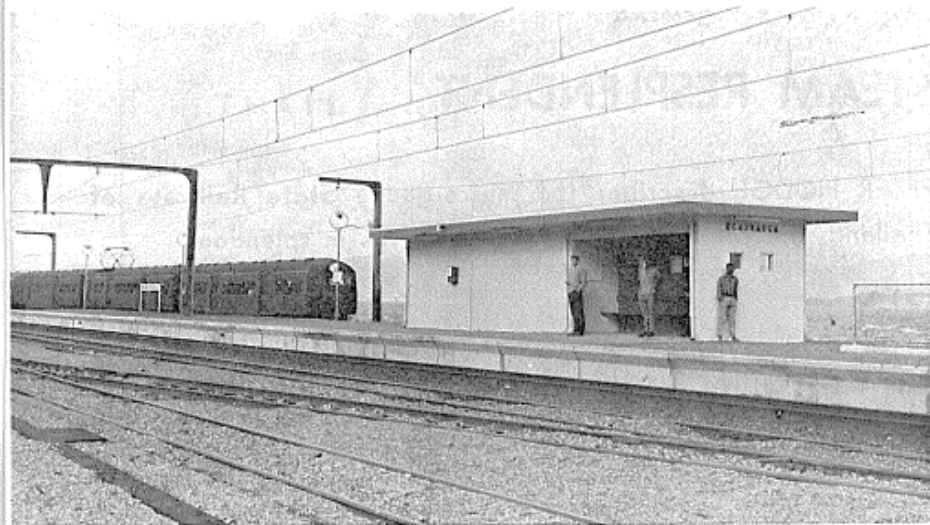
From these figures it will be seen that the planners of the proposed electric train service between Papakura and Auckland

have a nice choice confronting them. They will have to choose between the convenience of relatively short distances between intermediate stations and the commercial desirability of attractive end-to-end times, having regard to other means of travel available to potential customers. If an average speed of 30 m.p.h. is desired, this could be achieved by our hypothetical train on its hypothetical route with an average station spacing of about 1.3 miles and a maximum speed of 50 m.p.h., or with a top speed of 60 m.p.h. and stations averaging one mile apart, though in the latter case with only a few seconds to spare.

If on the other hand an average speed of 40 m.p.h. over the whole distance is sought, requiring the 20 miles to be covered in 30 minutes, including all stops, the number of stops would have to be restricted to nine (an average of two miles apart) with a top running speed of at least 60 m.p.h. or preferably more to give a margin to ensure punctuality. It should be noted that the precise times quoted in paragraphs 4 and 5 are absolute minima for the conditions postulated; they could not be used as a practical timetable.

It is most unlikely that the track alignment over the entire route between Papakura and the new underground stations beneath the Auckland city centre could possibly permit top speed all the way. All hindrances that could possibly be removed no doubt will be, but inevitably topography and geography will introduce some grades and curves that will require moderation of speed over short distances.

It may be of interest, in concluding this note, to observe that a perusal of the "rapid transit" section in *Jane's World Railways* discloses that the reported average station spacing and average scheduled speeds on 16 so-called "rapid" transit systems ranges from 0.46 miles and 18-20 m.p.h. in Toronto to 1.0 mile and 30.0 m.p.h. in Cleveland. The rail transit systems in Leningrad and Moscow are reported as having an average station spacing of 0.9 mile and a scheduled average speed of 24.5 m.p.h. San Francisco's new BART system, which was not yet in use when this summary was compiled, is a special case where the stations are much more widely spaced enabling maximum speeds up to 80 m.p.h. to be attained. It appears that here the average scheduled speed will be in the vicinity of 40 m.p.h.



Photograph: N.Z. Railways Publicity

Ngauranga station, 3 miles from Wellington on the line to Upper Hutt. An electric "unit" from Upper Hutt is arriving on the down line.

In Wellington our present suburban electric train services, with equipment built in the late 1940s, have stations spaced an average of 1.4 miles apart and the scheduled average speed of all-stations stopping trains on the four principal services works out at 24.1 m.p.h.

The three main rail routes out of Wellington have markedly different characteristics. The line from Wellington to Upper Hutt, 20.2 miles, is easily graded and has few speed restrictions. Here the station spacing averages 1.2 miles and the scheduled average speed is 23.3 m.p.h. The timetable was based on a maximum running speed of 45 m.p.h., although 50 m.p.h. is now permissible. There is a considerable margin for recovery of lost time.

The 6.6-mile line to Johnsonville, however, is largely on a gradient of 1 in 40 with frequent 10-chain radius curves that restrict speed to 32 m.p.h. The line maximum is 40 m.p.h. Although the first station out of town is 3.1 miles from the start, the remainder are closely spaced, averaging only 0.5 mile apart. In these conditions the average schedule speed is no more than 18.9 m.p.h.

On the Paekakariki line, 24.2 miles long, geography has introduced some long runs between stops, such as 5.8 miles from Kaiwharawhara to Takapu Road, 3.6 miles Plimmerton-Pukerua Bay, and 4.7 miles Muri to Paekakariki. The latter however is partly down the speed-restricted descent along a spectacular cliff face. Between Takapu Road and Porirua, however, station spacing comes down to an average of only 0.7 mile. The outcome of these conditions is an average spacing of 1.9 miles over the full distance, and a scheduled average speed of 27.9 m.p.h.

At Auckland it will be impracticable to avoid the steep 1 in 45 gradients to Remuera from both north and south, and no doubt the underground circuit beneath the city will involve relatively steep grades and sharp curves with their inevitable limitations on speed. It will be interesting to see the ultimate solution to the problems and the character of the service that is eventually evolved.