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MELBOURNE AND METROPOLITAN TRAMWAYS BOARD

INTERIM REPORT

Upon the General Scheme for the future development of Tramways in Melbourne and Suburbs

Melbourne & Metropolitan Tramways Board

With the Compliments of the

Melbourne and Metropolitan Tramways Board.

the adoption of the General Scheme, provided such tramways would, in the opinion of the Board, properly be included in such General Scheme. (Vide Act No. 3074, Section 2).

Parliament has wisely provided that the preparation of a General Scheme should precede any future tramway construction, fully realising that a complete and unified system is more likely to result from expert investigations under competent direction than from an agglomeration of schemes independently devised to meet merely local conditions. The fact cannot be too strongly emphasised that the rejection of any proposal, or its variation in substantial particulars, must of necessity destroy the unity of the scheme, and may seriously detract from its usefulness or even render it abortive.

In devising a Metropolitan passenger transport scheme, facilities have to be provided to meet two distinct requirements, viz:—

(a) To provide sufficient transport facilities to serve all settled portions of the Board's area for a generation ahead. These facilities will include tramways leading to the city, either direct or via other routes to railway stations, and to other objectives, such as industrial centres or recreation resorts, also between those suburbs where the interflow of traffic warrants a cross connecting line;

(b) To provide a sufficient number of routes in the city proper and inner suburbs to carry the estimated future peak loads without undue crowding of passengers on the cars or undue congestion of cars along the route.

In devising a scheme to meet the above conditions, it has been necessary to study the underlying economic and engineering aspects. To provide the data required for this purpose, extensive investigations have been carried out by a special department under the direction of the Chief Engineer.

This work has been divided into two sections, Statistical and Engineering.

The statistical work has included the collection of data relative to the growth and distribution of the population of the metropolis of Melbourne, and existing tramway and railway traffic conditions. Information has also been collected of the population and traffic conditions in other large cities.

This information has been tabulated. By the aid of numerous maps and graphs, studies have been made of the relationship of traffic movements to population, and estimates have been prepared to show the probable growth of population and its future distribution, and the probable future traffic movements.

Although these statistics provide information which determines the theoretical location of tramway routes and other economic factors involved in the preparation of the General Scheme, a considerable amount of civil engineering work has been carried out in order to determine the practical location of routes, the relative costs for constructing tramways in alternative locations, ruling gradients, and many other necessary technical details.

Owing to the lack of suitable thoroughfares in many of the suburbs, a considerable amount of survey work has been necessary on some routes, to determine how the existing short lengths of irregular and narrow streets could be formed into one wide continuous thoroughfare. This has involved investigations into land resumptions, searches against titles, valuations, etc. A large amount of time has been taken up on this class of work, owing to the suburban streets not having been originally laid out on a systematic plan. This applies particularly to the Northern suburbs. On this work over one hundred (100) title searches and property valuations have been made and it has also been necessary to design many bridges and culverts.

One of the difficulties encountered in selecting suitable tramway routes is due to the existence of railway level crossings. Under Clause 7 (b) of the twelfth (12) Schedule of the Board's Act, new lines to be constructed by the Board, "shall not cross over any railway on the same level if it is reasonably practicable to do so at any other level." Apart from legislative enactment, the crossing of railways on the level is undesirable owing to the practical impossibility of maintaining a regular timetable on account of the frequent blockages and delays at gates.

On the tramway lines to be included in the General Scheme, it is estimated that there will be twenty-eight (28) railway crossings of which twenty-one (21) are at present level crossings. The balance will be over or under existing bridges.

In an endeavour to avoid level crossings, a considerable amount of investigation has been carried out, such as designing subways and over-bridges, investigating alternative routes, negotiating with the Railway Department regarding the regrading of railway lines, etc.

It has been necessary to prepare preliminary designs of fifteen (15) bridges and nine (9) subways for crossing streams and railway lines.

Other engineering work carried out in preparation of the General Scheme includes investigations into:—

(a) The selection and survey of sites for proposed future workshops, car depôts, and substations.

(b) The standardization of car bodies, track curves, clearances, and track centres.

In order to meet the traffic requirements of the future, the Board is of opinion that the cable system will have to be converted to electric traction, not so much on account of the defects of the cable system, but owing to the fact that the retention of the cable tramways would prevent the development and subsequent operation of the tramways as a complete and unified system. It is accordingly proposed to proceed with the conversion of certain lines as soon as the tramway rolling stock can be built and additional power obtained from the Electricity Commissioners.

The Royal Commission appointed in November, 1910, reported definitely in favour of the conversion of the Cable System to an

Electric System with overhead trolley wires. The reasons for their decision are set forth in the report, and need not be repeated here in detail. The growth of traffic, the extension of the suburban electric systems, and the twelve years wear and tear of the cable system, since the date of the above report, make the reasons even more weighty to-day.

In minor points the cable system has some advantages, but it is inherently unsuitable for a large and growing city like Melbourne of to-day.

Its inflexibility in operation, and with respect to extensions or alterations, is indicated by the fact that the Melbourne Cable System has remained for over thirty (30) years of the form and extent in which it was originally designed. This reflects the greatest credit upon its designers, but it is an indictment against the system that it has remained stagnant whilst the population of the city has increased by over 60 per cent.

The cost of making extensions has prevented the cable trams from assisting in the development of outer suburbs. This work has been left to the railways, and to the suburban electric tramway systems constructed by various Municipal Tramway Trusts, and now controlled by the Board.

To enable tram passengers from the outer suburbs to reach the city without changing cars, to cope with increasing traffic, and to secure flexibility and economy in operation, it is absolutely necessary to link up the electric systems through the city by gradual conversion of the cable lines.

The limited size of the cable tram units, the lack of facility of control, the impossibility of using loops, and the consequent necessity of shunting, the great cost of constructing and operating shunts or sidings, render the cable trams unsuitable for handling dense traffic whether in the city, at pleasure resorts, football grounds, or racecourses.

The number of cars which can be concentrated on any desired part of an electric system is limited only by the headway on the tracks, as the necessary power can be rapidly made available by installing additional feeder cables (temporary or permanent). On the other hand, the capacity of any section of a cable line once designed is limited by the expensive driving gear, which is cumbersome and difficult of extension. On an electric system cars are

readily transferred from one line to another; new junctions, loops, sidings, or additional tracks, are readily constructed and easily operated. Consequently, the electric system is better adapted for handling dense service in the city or at special points, as is proved by comparison of the traffic carried in Melbourne and in other cities of similar size.

It is owing to its comparative inability to continue to carry out its main functions effectively, rather than to any disadvantages in minor points, that the cable system has been abandoned in every city where it has been installed except in Melbourne and in a few places on grades too heavy for any self-propelled car to negotiate in safety.

No system which cannot be adapted to the needs of a large and growing city can be regarded as permanently satisfactory in Melbourne. The overhead electric system has proved in practice to be the only system meeting all conditions.

In view, however, of the cost of replacing the cable system, and of the popular sentiment in its favour, the Board has considered it desirable to investigate very fully the question whether complete conversion could not be delayed indefinitely, or postponed until the cable system could be replaced at a lower cost.

Three courses appeared to be open:—

(a) The conversion of such small portions of the system as would be necessary to admit of the connecting up of the electric system by routes at present unoccupied.

(b) The conversion of the lines operated by the suburban ropes.

(c) Retention of the cable system in the main City streets only.

All of the three schemes are open to the objections which have been urged against the cable system. They all involve the difficulty that the conversion of every line (except the Toorak line) from the outer end of the track (the only method of conversion possible), destroys the connection between the cable tramway and the car shed of that line, as the tracks for the electric cars cannot be placed in the same position as the cable trams, and the tunnel therefore cannot be allowed to remain, and if it could, would not be central in the track. It would consequently be necessary eventually to construct additional car sheds closer to the City than the present

sheds, and in case (c) within the City itself. In this case also it would be necessary to provide additional power stations in the heart of the City. The cost of making this provision would be cheaper than the cost of complete conversion, but it is pertinent to ask whether any gain, except a sentimental one, would be obtained. The capacity of the whole system would still be limited by that of the cable lines, which is far below that of an electric system. The shunting points would be brought closer to the City, where the resulting congestion would be more objectionable, and would give rise to conditions which would be intolerable. The only solution is the adoption of a system which will permit through routing of cars, and cope with the growing traffic.

The statistics prepared by the Board indicate very clearly that the cable system, as at present constituted, cannot for many years cope with the traffic on the heavily loaded lines, even when assisted by new electric lines. It has been suggested that this difficulty might be met by running more cars or using the large bogie trailers now in use on the Brunswick line. Those offering such suggestions do so in ignorance of the fact that the main power plants have already reached the limit of their capacity, as laid down by the Consulting Engineers, who reported specially on this matter. To add larger cars could only be done by reducing their number and the frequency of the service, or by increasing the power available; to do the latter it would be necessary to supplement the existing power plants with electric motors or to substitute electric drive for steam drive in each station. Supplementing the existing engines involves their replacement in a short time, as the boiler plant is approaching the end of its life. It would furthermore be necessary, if the driving power be increased, to go very carefully through each item of the power transmission system and strengthen it; the cost of the necessary motors and of this strengthening provision, would be comparable with the cost of providing the necessary substation equipment for electric traction.

The rails and tracks of the cable system have already in many places nearly reached the end of their life. Indeed it is questionable whether conversion can take place rapidly enough to overtake the wear on the track system unless a heavy expenditure is incurred in planing the rails. A cable system being inherently less effective than an electric system, any money spent on renovating it, or increasing its capacity, is only waste of capital, as it must ultimately give way to a system providing for through routing to all suburbs.

For these reasons, and as conversion will necessarily take several years, it is evident that the work must be put in hand at an early date.

As then it is clear that the cable system must be rapidly replaced, it is obviously sound policy to start with the conversion which will have the greatest immediate effect, and there is no question that Swanston Street is the proper line to convert as soon as possible. It is the only through route with a direct connection across the river, and it is the most heavily loaded line, and its conversion gives the shortest connecton between the Northern and Eastern electric systems. This connection is essential to facilitate the transfer of cars to and from the repair shops.

Objections have been raised to the conversion of Swanston Street, and although it is evident to tramway experts that no satisfactory tramway system can be evolved for Melbourne which does not utilise this street, it has been thought advisable to give consideration to the possibility of keeping trams out of the central streets by feeding on to a square surrounding the centre of the City.

In its ideal form, neglecting natural or artificial barriers, such a system provides four (4) through routes or eight (8) exits, and would have a capacity which would be adequate for some years. If, however, too large a square be taken, the passengers will be landed at some distance from their destinations, and if, to overcome this, the trams are routed along two sides of the square, junctions are introduced at the intersections, and the capacity of the system halved.

Taking the Post Office as the centre, the obvious square is formed by Latrobe, Russell, Flinders and William Streets, to the use of which no exception could be taken. William Street can be connected through to South Melbourne via Flinders Lane, Market Street, and Queens Bridge, as already suggested in the West Brunswick-City extension proposal. Russell Street, however, has no outlet across the Railway. If, to overcome this difficulty, cars were turned along Flinders Street and across Princes Bridge the capacity of the Richmond line would be reduced, and an awkward junction introduced at Princes Bridge. Alternatively, Russell Street cars could be routed through to Richmond, and St. Kilda Road cars west along Flinders Street, creating another awkward junction at the most congested point of the City.

This arrangement would be inconvenient and inflexible; the only satisfactory arrangement is through routing along the streets leading to the bridges over the river, i.e., Swanston Street, William

Street, and eventually Spencer Street. With normal growth of population and traffic, the three routes across these bridges will be fully loaded by the time the conversion of the cable system can be completed.

The public feeling against overhead wires was originally aroused by the multitude of telegraph, telephone, and lighting and tramway feeder cables erected, frequently without regard to appearance, along the sides of the streets; and still persists in Melbourne against the comparatively inconspicuous trolley wires. The Board has considered all practicable methods, as well as several impracticable suggestions, for dealing with the City transport without using overhead wires.

CONDUIT SYSTEM.

As previously stated, the Royal Commission recommended the trolley system for the converted cable lines, and that their recommendation is sound, is almost self evident to those who have studied the question. It can be stated quite definitely that the existing conduit cannot be used for an electric system. The possibility of using this conduit appears to be the only valid reason for considering that system.

The Board would, therefore, have to incur the enormous first cost of installing an entirely new conduit system, and it is questionable whether any feasible expenditure could provide adequate drainage. Engineers operating conduit systems state that good drainage and cleanliness of the conduits are absolutely essential to success.

In addition to the prohibitive first cost there are many other disadvantages of the conduit system, which in the aggregate, render it far less satisfactory than the overhead system, and it is probably as a consequence of these that two of the three conduit systems in England have been abandoned, and replaced by overhead wire systems, even after the first cost of the conduit has been incurred. Existing conduit systems are not being extended, and it can be safely stated that no new conduit systems will ever be constructed. Even in Princes Street, Edinburgh, the cable system has been replaced by an overhead system. This is one of the noblest streets in the world, and no drainage difficulties exist there as in Melbourne.

SURFACE CONTACT SYSTEM.

Another system which obviates the necessity of using overhead wires, and which is less costly to install than the conduit system, is that known as the surface contact system. This attracted considerable attention in the first ten (10) years of the present century, and at least a score of different systems were devised and patented, and several of these were installed and eventually abandoned. A few, however, met with a partial measure of success, particularly the Lorain system at Wolverhampton which had, however, in the end to give way to the trolley system. The last system which met with any success was that known as the GB. system, which was installed and operated in Lincoln for some time. This system was also installed on a section of tramway in London, from Aldgate to Bow, where it was desired to avoid the use of overhead wires, and not to incur the cost of the conduit system. It was, however, condemned by the Board of Trade, and after about one month's trial was replaced by the trolley system. Surface contact systems are attractive in theory, but prove unsatisfactory in practice.

Any system in which delicate electrical apparatus has to be placed in the roadway is almost certain to fail, and as the contacts have to operate for every car that passes over them, a comparatively small percentage of failures in operation results in serious interference with the traffic. On many systems failures were so numerous that it was necessary to place apparatus on the car to create a short circuit if a stud was left alive after the car passed over it. The fact that this precautionary measure has been so frequently adopted, in itself proves the unsoundness of the system.

As one authority states, "no Engineer who values his peace of mind would willingly put down a system which means the use of a thousand switches per mile of roadway, the failure of any one of which may have fatal results."

BATTERY CARS.

The inherent defect of the battery car is the high weight of the battery per unit of energy stored therein, and in relation to the maximum power available. It follows that the possible schedule speed is low, and the mileage between charges insufficient for a through city service. A typical battery car in City service would, between charges, run only about one-half of the average daily mileage required, and less than one-third of that run by many of the cars

on the Prahran-Malvern system. The adoption of battery cars would, therefore, necessitate the provision of at least twice the rolling stock otherwise required, and each car, owing to the cost of the battery, is far more expensive. The energy used in moving the battery would add at least 25 per cent. to the total consumption without taking into account the low efficiency of batteries, particularly of the Edison type, under working conditions. Even neglecting the high maintenance cost of the battery, the above charges far offset any saving in overhead line and feeders, and the slight gain in the substation plant effected by the better load factor obtainable.

Notwithstanding these inherent defects, battery cars have been given a trial in various cities, but have only been used to any extent in those cities where conduit systems were in operation, and where it was desired to operate new routes without incurring the high cost of the conduit. A number of cars were used in Berlin at one time, but the system proved to be too expensive and the trolley service was substituted, after the Company had lost about £250,000 on the experiment.

Extensive trials have also been made in New York, both with lead batteries and Edison batteries. Fifty (50) cars of the latter type were in operation at one time on the Third Avenue system, but in 1920 they were all converted to suit the ordinary trolley system.

The alternative suggestion which has been put forward, that each car running through the City should be furnished with a battery to operate the car in the City limits and to be charged from the trolley wire outside is so impracticable as to be absurd.

Equally absurd is the suggestion that petrol locomotives should be used to haul the electric cars through the City.

PETROL CARS.

The use of petrol cars running on the existing track has also been suggested. These cars have been used in several places in tropical climates where electricity and coal have not been available, but in every case where they have been tried, they proved to be more expensive to operate than electrically propelled tram cars. Notwithstanding the promising statements made by Mr. Henry Ford, that petrol cars were going to oust tram cars, the Ford Co. advised, in May, 1291, that, "at the present time this project is in its experimental stage only, and far from being a manufacturing proposition." Such cars are expensive in first cost, the power cost is high, especially

in Australia, and the maintenance expenses very heavy. It would be out of the question to run any self-propelled cars on the existing track, and to lay down a track for the purpose of operating petrol cars, is to incur the main capital expenditure of the electric tramway system, and the high operating costs of a petrol bus, without the advantage of the low operating costs of the electric tramway or the mobility of the petrol vehicle. The proposal is inherently unsound.

PETROL ELECTRIC CARS.

Petrol electric cars were developed to overcome many of the mechanical troubles in the clutch and gearing of petrol vehicles, and have proved more satisfactory in operation than the latter. They are, however, necessarily costly, as in addition to the electrical equipment of a tram car, they have to carry a petrol engine. This throws extra weight on the track and extra work on the system generally, as the maintenance cost of a number of petrol vehicles must be higher than that of substation plant, added to which the cost of petrol is high. Like petrol cars, these cars run only in one direction, and require a loop or turntable at every terminal point.

Nevertheless, self-propelled tramway cars have been given a trial on several important systems in England. The London County Council in 1913, in its anxiety to avoid the cost of extending the conduit system, tried four (4) petrol electric cars. These were eventually discarded. Similar trials also took place in Hastings and Dublin, and the only place where self-propelled cars are now running in Great Britain, is on an isolated line of four miles between Morecambe and Heysham in Lancashire.

In the Board's opinion, self-propelled vehicles driven by petrol on rails will never take the place of the electric tram car as an effective substitute.

THE MOTOR BUS FOR CITY TRANSPORT.

That the Motor Bus has a useful field is indicated by the rapid development of this means of transport. Careful consideration of its special features will, however, show that the motor bus cannot replace the electric tram car in City transport. It can only compete successfully when given favoured treatment as to routes, and freedom from the burden of constructing and maintaining suitable roads. A

smooth road surface, which is desirable for all economical transport, is absolutely essential for the satisfactory operation of motor buses.

The success of the motor bus in London and Paris has led many visitors to those cities to believe that tramways are obsolete; this opinion is due to lack of appreciation of the exceptional conditions existing there. Amongst these are:—

(a) The existence, over a wide area of excellent roads, provided partly by the ratepayers and partly by the electric tramways, and,

(b) The exclusion of trams from all streets in a large and important section of the City. This gives the Bus Company a monopoly of the surface traffic of that section, and **prevents through routing of the trams; consequently the buses have an overwhelming advantage along the routes where they parallel tramways.** The latter are moreover burdened with rates and with the cost of an expensive conduit, and with the formation and maintenance of the road surface, which the bus may use without payment. Many of the streets in London are too narrow for satisfactory tramway operation. It is instructive, however, to note that in running through the tramway area, the buses mainly follow the tram routes. They make little use of the freedom which is the feature in which they differ inherently from trams.

The streets in Melbourne are unusually wide, and no good reason exists for excluding electric cars from the City streets.

The conditions in Paris and Berlin are similar to those in London, in that buses can give through routing while tram passengers to and from the prohibited area are forced to change, and therefore prefer to use the bus for the whole journey.

In Paris, where trams and buses are operated by the same authority, the management favours trams as more economical; the same opinion is held by authorities who have operated both in California.

The important advantages claimed for the motor bus are:—

(1) The elimination of the cost of power plant, feeders, overhead line, and track.

(2) Their greater mobility, not only as affecting the selection of a route and the subsequent variation, but for dealing with special traffic and avoiding temporary blocks. Another advantage claimed is the possibility of picking up passengers at the kerb. They are free to use several routes in the one suburb.

(3) To these should be added the greater comfort, resulting from the long wheel base, and the cushioning afforded by the tyres and springs on a smooth pavement.

In regard to the first advantage, the total operating expenses per mile for motor buses are so much greater than for trams, that the difference more than makes up for the fixed charges on the cost of track, etc., provided that the service is reasonably frequent. The conclusion, reached independently by all authorities, is that the field of a motor bus is the infrequent service, and of the tramcar, the dense service; consequently it is not on the main City and suburban services, but only in outlying suburbs and in the less important sections of the City that buses might be economically used. This still implies good road construction in those localities. If instead of the bus mile the passenger mile be taken, the bus is left far behind on account of its smaller accommodation: double decked buses cannot be extensively used in Melbourne on account of the limited head room at Railway Bridges.

It appears then that the other advantages of the motor bus namely, the freedom of movement, and comparative comfort, are very dearly purchased. It is obvious that the freedom of movement must lead to accidents, and statistics show that more accidents occur per passenger carried. By this freedom it must increase rather than diminish congestion in the streets, and congestion in Melbourne arises from vehicular traffic and not from trams.

The fact that buses are not tied to one route is an advantage in those cities where a number of parallel streets are available. In Melbourne, however, the bulk of the travel is to the east and south-eastern suburbs, and must cross the river. The buses, even if distributed over all the streets within the City, must converge on the river crossings and cause great congestion there.

The possibility of changing the routes, without loss to the bus owner, is a disadvantage to the passengers and the people building along tram routes in the suburbs: as pointed out above, little use is made of this feature in London.