

VICTORIAN



RAILWAYS.

GENERAL STATEMENT

Showing

Progress of Works

(As at 31st March, 1916)

In Connection with the

Electrification

OF THE

Melbourne Suburban Railway System

AND THE

Subsidiary Schemes associated

therewith.

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ELECTRIFICATION OF THE MELBOURNE SUBURBAN RAILWAY SYSTEM.

GENERAL NOTES.

After considerable attention had been devoted to the question of converting the Melbourne and Suburban Railways to electric traction, including investigation by Parliamentary Commissions, the Government authorised the then Premier, the late Sir Thomas Bent, and Sir Thomas Tait, the then Chairman of the Railways Commissioners, when they were in England in 1907, to select an expert Consulting Engineer to report upon the matter, and the choice fell upon Mr. C. H. Merz, who visited Melbourne at the end of 1907 and submitted a comprehensive report in July, 1908.

Brief history
of the
Scheme.

The Commissioners, after exhaustively analysing the report, advised against the adoption of the scheme, because (a) there was a doubt whether the third rail direct current system projected was the most suitable; (b) the estimated financial results showed that a loss of £76,716 would occur in the first year of complete electrical operation by comparison with the costs of continuing the steam service; and (c) in view of the estimated financial results it was deemed prudent to defer the matter in order to obtain the benefit of the more extended experience of other countries.

It was also considered that the whole of the Suburban system should be regarded as an entity, and be electrified only when a final and satisfactory system had been approved, and the estimated financial results justified its adoption.

The matter was not, however, allowed to remain in abeyance, and in November, 1910, the Government appointed the Metropolitan Traffic Commission to consider and report upon the transportation arrangements of the metropolis, before which the Commissioners gave evidence adverse to the conversion to electric traction of the Suburban lines, because they were not satisfied that the time had arrived for it to be undertaken; but both the Metropolitan Traffic Commission and the Parliamentary Standing Committee recommended the Electrification of the Melbourne Suburban Railways.

As a consequence, the Government, early in 1912, engaged Mr. Merz to review his original scheme, and he personally submitted his revised report in August, 1912. As the financial position disclosed therein was markedly improved, and the scheme of Electrification was in all essential respects distinctly superior to the original scheme, the Commissioners recommended that it be gone on with.

The Government thereupon proposed in Parliament the adoption of the scheme, and after a searching investigation by a Select Committee of the Legislative Assembly, exhaustive discussions in that Chamber, and the taking of evidence from Mr. Merz and others in the Legislative Council, Parliament in December, 1912, approved of the scheme in the following terms:—

“That, in the opinion of this House, it is desirable that the Electrification of the Metropolitan Railway System be proceeded with, and the House hereby authorises the Government to take all necessary steps in that direction, provided that no tenders for the supply of electric energy shall be invited or accepted for tractive purposes without the sanction of Parliament.”

The Melbourne Conversion Scheme is much greater than any other similar Scheme previously undertaken in the world, and its magnitude and complexity, together with the difficulty of carrying it out whilst still maintaining the operation of one of the largest suburban railway systems, not only taxes the ingenuity and resources of the Consulting Engineer and his Staff, but imposes a very heavy burden upon the Railway Department.

The natural difficulties inseparable from such a great work have also been accentuated by the conditions arising from the war, which have not only impeded the execution of the large contracts entered into, but have seriously interfered with the important sections of the scheme which were undertaken by the Department.

Estimated
cost of
complete
scheme.

The financial position was stated in Mr. Merz's 1912 report as under:—

ESTIMATED GROSS COST—				£	£
Power Station	...	...	...	875,780	
Transmission System, Cables to Sub-stations, etc.	...	...	...	167,863	
Sub-stations	...	...	...	378,605	
Track Equipment (overhead line, bonding, etc.)				562,280	
Car Repair Shed, Bridge alterations, Tele- graph and Telephone Line alterations, Inspection Pits, etc.	...	...	...	99,350	
Rolling Stock—Electrical	...	...	...	947,232	
„ —Other	...	...	...	960,250	
					3,991,360
Less estimated cost of continuing steam traction					1,315,000
ESTIMATED NET COST OF ELECTRIFICATION					<u>£2,676,360</u>

As the result of inquiry by the Parliamentary Select Committee during the period of Mr. Merz's visit to Melbourne, it was disclosed that, owing to various adjustments, the estimated cost would be increased by £75,410, making the estimated net cost of Electrification at the date of Parliamentary approval £2,751,770.

The estimated net cost, however, while representing the true position at the time for comparative purposes, will not work out in actual practice, in the manner indicated, as the amount calculated for continuing the steam service includes a proportion in respect of locomotives, cars, etc., which will not be expended, and will not, therefore, be available for deduction.

The appropriations actually required on the basis of the foregoing figures would be approximately as under:—

	£
For new electrical work, excluding rolling stock	3,031,110
Plus net extra cost as ascertained at the Parliamentary enquiry	75,410
Plus cost of new Suburban coaches, underframes, bogies, and alterations to existing stock to adapt it to electrical requirements, (which cannot be stated at present)	—
Less estimated cost of continuing steam traction	—
TOTAL COST DEBITABLE TO ELECTRIFICATION	<u>—</u>

and only when the scheme is completed will it be possible to strike a correct balance with the estimates included in Mr. Merz's report.

The result of developments since the scheme was approved will be to further increase the total cost of the undertaking. There has been a considerable rise in wages, and in the price of materials throughout the world, particularly of copper and steel, while the increased Customs duties due to the revision of the Tariff in December, 1914, which will require to be met by the Department, and the conditions arising from the war, will also adversely affect the expenditure.

The approximate total amount of the contracts let in connection with the undertaking—exclusive of the Automatic Signalling and the subsidiary schemes—is £2,404,446, while the actual expenditure at 31st March, 1916, was £1,509,901.

In order that an approximate comparison might be made between the estimated and the probable cost of Electrification, Mr. Merz was asked for the principal details of the estimates shown in his Report. This information, together with the amounts of the respective contracts entered into, and the Departmental figures for the sections of the work which are being executed by the Commissioners, will be used as a basis, and steps taken to establish a suitable permanent record of the actual cost of each section of the scheme as compared with the estimated cost.

It was calculated on the basis of the traffic estimated for 1915 (which was the only period for which a comparison was prepared) that the operating costs under electric traction, excluding all expenditure common to both steam and electric conditions, would be	£235,416	Estimated financial results.
and the corresponding operating costs for steam traction	...	...	...	360,431
leaving a difference in favor of electric operation of	...	...	...	£125,015

After allowing for interest charges on the additional capital cost and for Antiquation Fund provision, the annual saving from electric traction (on the basis of the 1915 traffic, and independent altogether of the increased revenue induced through higher speed and greater frequency) would be	...	£20,174
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This represents the estimated saving after allowing for an increase of twenty-nine per cent. in the train mileage and of thirty-one per cent. in the average speed, and includes provision for carrying ten per cent. more passengers than estimated in the above cost (£360,431) for steam traction.

Electrification of railways elsewhere has resulted in additional traffic, and the extra frequency and speed and other advantages of electric traction will develop increased traffic on the Melbourne Suburban system. Mr. Merz estimated the increased revenue at 25 per cent., but if only 10 per cent. be obtained, it will represent per annum about	...	£113,000
or, including the saving on operation above mentioned of	...	20,174
a net annual gain of	...	£133,174

If Mr. Merz's estimate of increased revenue were adopted, the profit, as a result of Electrification, after allowing for Interest and Antiquation Fund, would, on the basis of the 1917 traffic, exceed £350,000 per annum.

These figures prove that it was in the best interests of the whole State that the Electrification scheme should be adopted, and as the Suburban traffic increases with the growth of the city, the gain from electrical operation will also increase.

Estimated
annual
appropriations.

The annual appropriations estimated in Mr. Merz's report, were:—

					£
1913	...	...	...	...	500,000
1914	...	...	...	...	700,000
1915	...	...	...	...	500,000
1916	...	...	...	...	500,000
1917	...	...	...	...	250,000
1918	...	...	...	...	150,000
1919	...	...	...	...	76,860
					£2,676,360

but owing to the authority for the work being withheld longer than was anticipated, and the necessity to revise the progress programme and the disturbance caused by the war, the amounts actually provided required considerable modification, and the following appropriations showing the amounts estimated to be necessary in each year, were, after consultation with Mr. Merz, provided for in the Loan Application Acts, 1913 to 1916 respectively, viz.:—

Year.	Electrification.	Automatic and Power Signalling.	Auxiliary Schemes.	Total.
	£	£	£	£
1913	300,000	—	—	300,000
1914	649,863	25,000	3,000	677,863*
1915	1,289,003	58,000	50,500	1,397,503*
1916	675,000	89,000	33,000	797,000

* Exclusive of re-votes.

Mileage and
lines to be
electrified.

The mileage of Suburban lines included in the scheme is as under:—

Route miles	...	...	150½
Track miles of running roads	...	...	289½
Sidings, etc.	...	...	34½

which includes some 26 miles of route—making 60 miles of single track—and some 8 miles of sidings, in addition to those covered in Mr. Merz's 1908 Report.

The following lines are to be converted:—

Sandringham	to Broadmeadows, including the Flemington Racecourse Line
Melbourne	to Williamstown, including the Williamstown Racecourse Line
Melbourne	to Port Melbourne, including Port Melbourne to the Mail Steamer Berths on new and old piers
Melbourne	to St. Kilda
Melbourne	to Fawkner
Melbourne	to St. Albans
Melbourne	to Dandenong, including the Spring Vale Cemetery Line
Caulfield	to Frankston
Melbourne	to Preston Reservoir
Clifton Hill	to North Fitzroy, including North Fitzroy to Royal Park Junction
Clifton Hill	to Eltham
Melbourne	to Ringwood
Hawthorn	to Kew
Burnley	to Darling
Camberwell	to Ashburton and Deepdene

System
adopted.

The Power Station at Newport will generate three-phase current, which will be transmitted at a pressure of 20,000 volts to fifteen traction Sub-stations, where it will be converted to direct current at 1,500 volts and conveyed to the lines by overhead conductors, from which it will be drawn for propulsion purposes by pantograph collectors of the slider type mounted on the roofs of the motor coaches, and will return along the track rails to the Sub-stations.

The height of the overhead conductors above the track level will vary somewhat on account of the expansion and contraction due to changes of temperature, but at public road crossings and terminals the minimum will be 18 feet. In the open country the height will vary from 15 ft. 4 in. to 17 ft. 8 in. according to the spacing of the masts and the temperature.

The structures to support the overhead conductors will be of latticed steel construction, located at intervals of about 300 ft. along the tracks, except on curves or at other places, where special conditions necessitate closer spacing.

The multiple control system has been adopted. The trains will be composed of units each comprising one motor and one trailer, and the maximum size of the trains at the outset will be six (6) coaches, but provision has been made for a possible ultimate increase to 10 coaches.

The motor coaches will have motors on each axle, i.e., four on each motor coach.

All the coaches will be electrically lighted.

The average speed will be 21 miles per hour (as compared with 16 miles per hour at present) or an increase of 31 per cent. The acceleration will be about 1.5 miles per hour per second, or approximately more than twice the rate with the existing DDE Suburban locomotives.

Speed and frequency of trains.

The maximum frequency contemplated on the most important lines at the outset is as under:—

LINE.	MAXIMUM FREQUENCY.
Camberwell	3 and 4 minutes alternately
Caulfield	3 and 4 minutes alternately
Brighton	3 and 4 minutes alternately
Clifton Hill	4 minutes
Essendon	5 minutes
St. Kilda	5 minutes
Williamstown	7 minutes

and the train mileage provided for in the calculations of operating cost contained in the scheme which were based on the traffic estimated for the year 1915, is 29 per cent. greater than it was considered would be afforded during the same year under steam conditions.

The Sub-station equipment has, however, been laid out so as to admit of the train services being ultimately increased, as shown below, without appreciable additional capital expenditure on electrical equipment:—

Line.	Maximum Frequency. Minutes.	No. of Coaches.
Flinders Street-Port Melbourne	4	6
Flinders Street-St. Kilda	2½	6
Flinders Street-Newport	3½	6
Newport-Williamstown Pier	4	6
Newport-Williamstown Racecourse	2½	6
Flinders Street-Coburg	8	6
Coburg-Fawkner	20	6
Flinders Street-Sunshine	3	6
Sunshine-St. Albans	12	6
Prince's Bridge-Clifton Hill	1½	8
Clifton Hill-Heidelberg	4	6
Clifton Hill-Reservoir	1½	6
Heidelberg-Eltham	15	4
Clifton Hill-North Fitzroy	10	6
North Fitzroy-Royal Park Junction	10	6
Broadmeadows-Essendon	2	6
Flinders Street-Essendon	2	6
Flinders Street-Brighton Beach	3	6
Brighton Beach-Sandringham	6	6
Hawthorn-Kew	14	6
Box Hill-Ringwood	3	6
Burnley-Darling	15	4
Ashburton-Deerpden	4	6
Flinders Street-Box Hill	3	6
Flinders Street-Caulfield	1½	6
Caulfield-Oakleigh	4	6
Oakleigh-Dandenong	10	6
Caulfield-Mordialloc	5	6
Mordialloc-Frankston	10	6
Spring Vale-Spring Vale Cemetery	10	6
Flinders Street-Flemington Racecourse	1½	8

A larger number of coaches per train can be operated by increasing the headway or reducing the speed, and a greater frequency of trains can be afforded at some reduction in the average schedule speed of 21 miles per hour.

The conduct of the train services extending beyond the Electrified area, which are now run by Suburban cars, has been considered, and, generally speaking, all these extensions will be continued under Electrification conditions, but the method of giving effect to them will be decided when the time arrives.

Inauguration of Electric Traction.

The Sandringham-Essendon line is the first to be converted, and it was expected to be electrically operated in June, 1915, but owing to the necessity to re-invite tenders for the switch-gear, which is a large and important section of the scheme, this estimate was subsequently altered to November, 1915. The outbreak of war has, however, caused considerable delay in the supply of electrical equipment, and the conversion of the first line has unavoidably had to be further deferred, and a reliable estimate cannot at present be formed as to when electrical operation can be inaugurated.

It was originally proposed to convert the Coburg and St. Albans lines immediately after the Williamstown group, but before electric trains can be run on the St. Albans line the electrical equipment of the Albion Sub-station must be completed, as well as the high tension power transmission cables between it and the Newport Power Station; while in the case of the Coburg line the North Fitzroy Sub-station must be put into commission, and the cables laid between it and the Newmarket Sub-station. In view of the uncertainty as to when sufficient electrical apparatus will be available for these two Sub-stations, and the desirability of obtaining as soon as possible some return upon the capital expended, the Port Melbourne and St. Kilda lines, which can be operated from the Prince's Bridge Sub-station, will probably be the next dealt with, and they will be followed by the Coburg line.

The principal works which it is essential to complete before the Sandringham-Essendon and Flemington Racecourse lines can be electrically operated comprise the Power Station, the Sub-stations at Prince's Bridge, Middle Brighton, Newmarket, and possibly at Glenroy, the Jolimont Car Shed, the Overhead Equipment of the Sandringham-Essendon line, and the Flemington Racecourse line, including sidings at Flinders Street, Spencer Street, and other Stations, the laying of sufficient high tension transmission cables from the Power Station to the Sub-stations, the provision on these particular lines of increased clearance at overhead bridges, and at platform verandahs, and the complete electrical equipment of 170 coaches.

It would appear from present indications that the sections of the undertaking which will prove the determining factor in inaugurating electric traction, will be the supply of the electrical equipment for the Sub-stations and of the switchgear for both the Sub-stations and the Power Station. Messrs. Siemens Bros.' Dynamo Works Ltd., who are the contractors for these sections, have been compelled to suspend operations on all civil work, including their Electrification contracts, in order to concentrate their resources on the manufacture of munitions, and the question of making such arrangements as will enable at least the first lines to be electrically operated is under consideration by the Commissioners and Mr. Merz.

Order of conversion.

The order in which it is now proposed to convert the respective lines to electric traction is shown hereunder, but some adjustments may be found desirable as the work proceeds:—

1. Sandringham to Essendon (including Flemington Racecourse). The equipment of the Essendon-Broadmeadows section will not be proceeded with until a later stage.

2. Melbourne to Williamstown and the Williamstown Racecourse.
3. Flinders Street to St. Kilda and Port Melbourne.
4. Flinders Street to Coburg.
5. Footscray to St. Albans.
6. Flinders Street to Caulfield, Dandenong and Frankston.
7. Prince's Bridge to North Fitzroy, Reservoir, Heidelberg and Eltham.
8. Flinders Street to Hawthorn and Kew, Burnley to Glen Iris, Outer Circle, and East Camberwell to Ringwood.
9. Power Street, Hawthorn, to East Camberwell (reggraded section).

It has been found an advantageous proposition by some steam railroads in other parts of the world to electrify instead of regrade heavy sections, and the question whether a similar course might not give satisfactory financial results in the case of lines such as that between Broadmeadows and Seymour is noted for examination when the present Electrification scheme has been completed. Until then, however, it will not be expedient to undertake additional conversions.

Electrification of lines having heavy grades.

REGRAIDING OF THE CAMBERWELL LINE.—The original intention was to electrify the Camberwell line after the lines which cross the Flinders Street Viaduct had been dealt with, but the decision to regrade the section between Power Street, Hawthorn, and East Camberwell, has resulted in the Camberwell line being placed last on the list for conversion.

Important works affecting Electrification.

REGRAIDING OF THE NORTH-EASTERN LINE.—If a proposal to regrade the line between Essendon and Broadmeadows, which is now under consideration, be ultimately adopted, an alteration in the contemplated order of conversion for this section will be necessary, and its equipment for electrical operation has consequently been deferred for the present.

DUPLICATION AND REGRAIDING OF THE CAULFIELD LINE.—The four tracks, buildings, platforms, etc., on the Caulfield line having been completed, this work will not interfere with the erection of the Electrification equipment.

DUPLICATION OF THE FLINDERS STREET VIADUCT.—The reconstruction of the Flinders Street Viaduct will be completed so as to fit in with the Electrification arrangements in respect of the Sandringham-Essendon line.

RE-ARRANGEMENT OF TRACKS IN THE FLINDERS STREET AND JOLIMONT YARDS.—The re-arrangement of tracks in the Flinders Street and Jolimont Yards necessitated by the duplication of the Viaduct, has been completed, and the Sandringham-Essendon line will therefore be electrified in its permanent location.

DUPLICATION WORKS FROM THE SPENCER STREET END OF THE VIADUCT TO FRANKLIN STREET JUNCTION.—These works are dependent upon the erection of the New Shipping Shed at Montague, and the removal of the existing Shipping Shed at Spencer Street, and it is unlikely, therefore, that they will be completed for several years, so that the Suburban services which cross the Viaduct, and which will be electrified in the meantime, will require to be run on the present double track between the Viaduct and Franklin Street for some time.

LIST OF CONTRACTS.

Statement showing the contracts entered into through Mr. Merz and the commitments thereunder to date:—

Name of Contractors.	Description of Work or Material.	Place of Manufacture.	Approx. cost including Options exercised and Extras approved.	Date Options Expire.
NEWPORT POWER STATION.				
Babcock and Wilcox	Erection of Power Station buildings, cranes, boiler house equipment, and coal and ash handling plant	Great Britain	£435,408	1/1/17.
C. A. Parsons and Company	Provision of six 10,000 kilowatt sets of Turbo-alternators and Transformers	Great Britain	£207,730†	1/1/17.
Siemens Bros. Dynamo Works, Limited	Manufacture and erection of Switchgear and Accessories for the Power Station and Sub-stations	Great Britain	£181,635†	14/5/18
G. Weymouth Pty. Limited	Supply and erection of Condensing Plant, Circulating Water Pumps, Motors and Accessories	Victoria	£87,359	20/1/18
Herbert Morris and Company	Manufacture and supply of Overhead Cranes for the Power Station and Sub-stations	Great Britain	£3,623†	3/12/17.

NOTE.—All the material required for the Switchhouse, Transformer House and Offices, and for the Foundation Works, Circulating Water System, and other sections of the Power Station which are being carried out by the Department, is being obtained from local contractors.

SUB-STATIONS.

Siemens Bros. Dynamo Works, Ltd.	Supply and erection of Rotary Converters, Transformers, Switchgear, and other Sub-station Equipment	Great Britain	£240,140†	1/1/17.
Siemens Bros. Dynamo Works Ltd.	Extension to Cover Signaling Motor Generators, Batteries and Accessories	Great Britain	—	22/4/18.

The total amount of the Switchgear contract, which includes a proportion for the apparatus to be installed in the Sub-stations, is shown under Power Station.

The fifteen Sub-station Buildings are being erected by the Department by day labor or by contract, as may be decided.

Herbert Morris and Company	Supply of Overhead Cranes for the Princes Bridge, Newmarket, Middle Brighton, and Elwood Sub-stations	Great Britain	—	—
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The total amount of this contract as shown under Power Station is £3,623, of which £2,238 is for traction Sub-station Cranes, and £182 for the Elwood Sub-station Crane.

POWER TRANSMISSION SYSTEM.

British Insulated and Helsby Cables Limited	Manufacture and Supply of 20,000 volt Feeder Cables, 1,500 volt Track Cables, etc.	Great Britain	£292,895†	16/9/18
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† Includes proportion debitable to other sections of the scheme.

LIST OF CONTRACTS—CONTINUED.

Name of Contractors.	Description of Work or Material.	Place of Manufacture.	Approx. Cost including Options and Extras.	Date Options Expire.
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TRACK EQUIPMENT.

British Insulated and Helsby Cables Limited	Supply of Overhead Equipment for the Permanent Way and Overhead Transmission Mains	Great Britain	£278,286†	30/7/20
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† Includes £46,200 debitable to the Transmission System.

The steel latticed masts and bridging from which the overhead contact wires will be supported are being manufactured locally, and their erection is being carried out by the Department.

TRACK BONDING.

British Insulated and Helsby Cables Limited	Supply of Track Bonding Material	Great Britain	£18,684	15/12/18
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This represents the value of the material definitely ordered. The total cost of the material necessary for the bonding of all the tracks is estimated at £22,549.

A contract entered into with the Allgemeine Elektricitäts Gesellschaft, of Germany, was cancelled by the war after material to the value of £1,052 had been delivered, of which, however, only 90 per cent. has been paid.

JOLIMONT CAR SHED.

Chambers, Scott and Company	Supply and delivery of two 25-ton and two 15-ton Electric Overhead Traveling Cranes	Great Britain	£4,713	4/1/19
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The Jolimont Car Shed building is being erected by the Department by day labor, and all the materials required for the purpose are being obtained locally. Tenders have also been invited locally for all the machine tools, fire protection appliances, and other equipment to be installed in and about the Car Shed.

ROLLING STOCK.

General Electric Company of U.S.A. and England	Supply and Installation of Electrical Equipments for 400 Motor and 400 Trailer Coaches	England and U.S.A.	£738,154	1/1/17
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This apparatus is being fitted to the coaches at the Jolimont Car Shed.

In addition, an extensive car construction and alteration programme for the provision of electric rolling stock is being carried out at the Newport Workshops by the Departmental staff.

AUTOMATIC SIGNALLING.

Siemens Bros. Dynamo Works Limited	Provision in Sub-stations of Generating Sets for Signalling purposes and Switchgear, including four Oil-driven Generating Sets to enable the Automatic Signalling Installation to be operated during the transition period	Great Britain	£37,249	22/4/18
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This material was ordered under the optional provisions of the contracts (2) entered into with Siemens Bros. in connection with the main Electrification scheme, and is included in the totals of their contracts for Sub-station Equipment and Switchgear previously mentioned.

LIST OF CONTRACTS—CONTINUED.

Name of Contractors.	Description of Material to be Supplied.	Place of Manufacture.	Approx. Cost including Options and Extras.	Date Options Expire.
A. Reyrolle and Co.	Track Feed Boxes and Transformers	Great Britain	£17,260	23/12/17
British Pneumatic Signal Co.	Impedance Bonds	U.S.A.	£8,023	3/12/17
British Pneumatic Signal Co.	Track Relays	U.S.A.	£8,094	3/12/17
McKenzie Holland & Westinghouse Co.	Track Resistances	Great Britain	£1,548	3/12/17
Ferranti Limited	Signalling Transformers	Great Britain	£789	15/7/18
R. W. Cameron and Co.	"Kerite" Insulated Wire	U.S.A.	£4,755†	—
Western Electric Co. of Australia Limited	300 miles of Twin Wire Insulated Cable	Great Britain	£18,600†	—
Australian General Electric Co.	Track Transformers	U.S.A.	£351†	—
McKenzie and Holland Ltd.	Electric Point and Lock Detectors	Australia	£3,988	—
Australian General Electric Co.	220 Relays for Point Indication	U.S.A.	£2,979†	—
R. W. Cameron and Co.	300 Electric Signalling Machines	U.S.A.	£15,964†	—
R. W. Cameron and Co.	300 3-position 2 element Alternating Current Relays	U.S.A.	£3,863†	—
R. W. Cameron and Co.	300 Electric Train Stop Machines	U.S.A.	£9,908†	—
R. W. Cameron and Co.	Fuse Blocks, Porcelain Base and Fuse Clips	U.S.A.	£494†	—

† Arranged locally by the Department and material inspected by Mr. Merz's engineers before shipment.

The installation of this equipment will be carried out by the Department.

SUBSIDIARY SCHEMES.

British Westinghouse Electric and Manufacturing Company	Manufacture and supply of Rotary Converters and Frequency Changers for the Spencer Street and Elwood Sub-stations	Great Britain	£15,502	24/8/19
C. A. Parsons and Company	Manufacture and supply of Electrical Equipment for the Spencer Street and Newport Workshops Sub-stations	Great Britain	£6,534†	—
J. H. Holmes and Company	Manufacture and supply of Motors for driving Workshop Machinery	Great Britain	£8,642	28/7/18

† This apparatus is being obtained under the optional provisions of the Main Electrification Contract, and is included in the total previously quoted.

BRIEF SUMMARY SHOWING THE STAGE REACHED IN CONNECTION WITH WORKS IN HAND BY THE DEPARTMENT.

POWER STATION.—The construction of the foundations and circulating water system, provision of sidings, the erection of the switch house and offices, oil store, and the screening pits and test tank buildings, and of the armored plaster walls of the engine house and the pump house has been completed, with the exception of minor details, while the foundations of the entrance lodge have been commenced. It is expected that the walls of the No. 1 boiler house will be finished at an early date. The Department's work has been co-ordinated with that of the respective Contractors for the erection of the main buildings and the different sections of the machinery, the progress of which towards completion, is described under appropriate headings in this Report.

CAR REPAIR SHED.—The Workshops and Running Bays have been finished, while the Painting Bay and the Car Shed Sub-station are approaching completion.

One 25-ton and two 15-ton electric overhead cranes have been erected in the Workshop Bay, and the remaining 25-ton crane is being assembled. The question of obtaining a supply of power to operate one of the cranes pending the availability of current from the Newport Power Station is under investigation.

The design of the heating plant that will be required in the Painting Bay in connection with the painting and varnishing of the coaches is being determined.

The machine tools and motors to operate them necessary for the Workshop Bay have been arranged for.

The laying of the tracks leading into the Car Shed will shortly be completed. This will involve the removal of the existing Rolling Stock Repair Shop and the transfer of the work now done therein to the Car Shed.

The installation of the lighting and other sections of the Car Shed Equipment will be commenced as soon as the requisite materials are available.

CAR SHED WATER SUPPLY AND FIRE PROTECTION ARRANGEMENTS.—A special 9-in. main to the Car Shed connected with the Metropolitan Water Supply system has been laid along Wellington Parade. The reticulation inside the Car Shed has been completed as far as practicable, and suitable provision made for fire protection purposes. A tender has been accepted for the installation of Automatic Sprinklers.

SUB-STATIONS.—The Prince's Bridge, Newmarket, Middle Brighton, Glenroy and Newport Sub-station buildings are ready for the installation of the electrical equipment, whilst those at Albion and North Fitzroy are in process of erection.

ROLLING STOCK.—The following work has been or is being carried out at the Newport Workshops:—

The Bodies of 346 of the existing coaches have been altered so as to adapt them for electrical operation.

120 new Sliding Door Motor Coaches are in various stages of construction, 98 having been completed. Of these, 90 have been placed in steam service for the present, and the balance are being fitted with the electrical apparatus at the Jolimont Car Shed. As new cars are turned out in future they will be similarly equipped.

98 new Underframes for Sliding Door Motor Coaches have been completed, and 22 are under construction.

75 new Underframes for Swing Door Motor Coaches have been completed, and 13 are under construction.

358 new Bogies for Sliding and Swing Door Coaches have been completed, and 63 are under construction.

INSTALLATION OF THE ELECTRICAL APPARATUS IN THE COACHES.—This work is being proceeded with by the Contractors (The General Electric Company of U.S.A.) at the Jolimont Car Repair Shed.

VEHICLES FOR THE ERECTION OF THE OVERHEAD EQUIPMENT.—Four Construction Trains for the erection of the Overhead Equipment are being prepared at the Newport Workshops, and the first two have been put into service.

PROVISION AT PLATFORM VERANDAHS OF ADDITIONAL CLEARANCE FOR THE PANTOGRAPH COLLECTOR.—The verandahs at stations on the Sandringham-Essendon and Williamstown lines have been altered so as to conform to Electrification requirements. The other lines will be dealt with in the order of their conversion to electric traction.

CABLE LAYING.—The laying of the high tension transmission cable between the Power Station and the Prince's Bridge, Newmarket, Middle Brighton and Newport Sub-stations is being proceeded with, and routes for the cables have been selected to the following additional Sub-stations:—Caulfield, North Fitzroy, and Albion, that to the latter place being overhead along the Braybrook Loop line. Routes have also been chosen for the cross-country connections between Footscray and the terminal of the Flemington Racecourse line, and between the Caulfield Sub-station and Darling station.

TRACK BONDING.—Considerable supplies of material for bonding the tracks have been received, and the work of installation is proceeding.

LEVEL CROSSINGS WITHIN THE ELECTRIFIED AREA.—Most of the level crossings on lines within the Electrification area have been inspected to determine the provision which it is essential to make thereat prior to electrical operation, and the interlocking, etc., approved at various places is being installed.

LECTURE ROOM FOR STAFF TRAINING PURPOSES.—This building has been completed, and a fully equipped underframe installed, and action is now being taken to provide the requisite apparatus for training the Motormen, Guards and Shunters, who will require to handle the electric trains.

ACCOMMODATION ROOM FOR MOTORMEN.—This building is approaching completion.

SUPPORTS FOR THE OVERHEAD WIRES.—Complete cross sections and plans showing the lay-out of the masts for the Sandringham-Essendon, Flemington Racecourse, and Williamstown lines have been received. The construction of the foundations for the track structures is progressing, and the construction of the masts and bridging is in hand, partly by Contractors and partly by the Department.

A commencement has been made with the erection of the overhead equipment along the Sandringham-Essendon line. The equipment of the Flemington Racecourse line has been practically completed.

Storage facilities for the overhead equipment material have been provided at North Melbourne, where a central depot has been established.

TESTS OF SAMPLE MASTS.—Tests of sample structures for the overhead equipment were conducted at North Melbourne in March, 1915, and were thoroughly satisfactory.

CLEARANCE UNDERNEATH OVERLINE STRUCTURES.—The bridges on the Sandringham-Essendon and Williamstown lines have nearly all been altered or superseded by subways, so as to provide the requisite clearance for electrical operation.

LOWERING OF TRACKS AND PLATFORMS UNDER THE SWANSTON STREET BRIDGE.—This work, which was one of some difficulty, on account of the heavy traffic, has been completed.

The Electrification Scheme is being carried out under the direction in Melbourne of Mr. E. P. Grove, Mr. Merz's Chief Superintending Engineer.

Chief Super-
intending
Engineer.

This Statement does not include a description of the Electrification Scheme from the technical aspect. This Mr. Merz proposes to deal with personally, and in due course will prepare a conspectus containing all information of scientific interest appertaining to the scheme.

Technical
description
of the
Scheme.

A summary of the principal matters dealt with or under consideration in connection with the Electrification Scheme is contained in the attached Statement. The particulars are necessarily condensed, but details, or information respecting minor matters not included, can be furnished from the Papers and the Minutes of the Electrification Committee.

Progress of
work.

POWER STATION.

Selection of Site.

When Mr. Merz visited Melbourne in 1907, he chose a site at Yarraville on the west side of the river, between the Coode Canal and the old bed of the River Yarra, as satisfactory from the aspects of centrality, formation and proximity to water frontage, and when he again visited Melbourne in 1912 in connection with his revised report, he confirmed this selection.

Subsequently, however, Departmental officers, realising that the revised scheme provided for a Power Station twice the size of that originally proposed, viz., 6 sets of 10,000 kilowatts capacity, or a total of 60,000 kilowatts, as compared with 8 sets of 3,750 kilowatts capacity, or a total of 30,000 kilowatts, questioned whether the outflow of heated water from such a large station would not prejudicially affect the intake water, which must be at a sufficiently low temperature to yield economic operating results, and the question was raised with Mr. Merz.

After obtaining additional information, Mr. Merz stated that to ensure satisfactory provision it would be advisable to construct an outlet conduit from the Yarraville site to discharge the heated water into the River Yarra below the Coode Canal, so that it would be carried away from the intake area, and that with such a conduit, which would cost an additional sum of from £65,000 to £70,000, the Yarraville site would be suitable for a Power Station of a total capacity of about 80,000 kilowatts.

The Commissioners thereupon considered the selection of a new site, and after reviewing several areas, ascertained that the site at Newport, at the mouth of the River Yarra, whilst being eminently suitable in other respects, afforded all the water facilities required, and after being advised by Mr. Merz that the extra cost for the transmission cables from this site, which is situated at a greater distance than the Yarraville site from the centre of the system, would be about £65,000, determined, with the approval of the Government and the concurrence of Mr. Merz, to adopt it.

The cost of the site works at Newport, including the acquisition of land, is estimated to be less than would have been incurred had the Yarraville site been confirmed, while the extra cost of the transmission cables from Newport was offset by the cost of the outlet conduit that would have been necessary at Yarraville. The Newport site affords water facilities that will enable the Power Station, if necessary hereafter, to be increased to twice its present size, or to a total capacity of 120,000 kilowatts.

The branch line to the Yarraville site was completed before the change of location for the Power Station was finally dealt with, and consideration is now being given to the question of utilising it to afford accommodation for various manufacturers in the neighbourhood, by whom representations have from time to time been made to the Commissioners in regard to the provision of siding facilities.

The expenditure actually incurred in connection with the Yarraville site, including preparation of site plans, cost of boring and laying of branch line, was £16,003.

Progress Summary.

The work of erecting the buildings, circulating water system, and the site works generally, is in a satisfactory position, while the contracts for the Boiler, etc., Equipment, the Turbo-alternator Sets, and the Condensing Plant are progressing well considering the many difficulties encountered, due to the war, and subject to no unforeseen contingency arising, and to the receipt as expected of the rotor for the second turbo-alternator, as well as of various minor details of the Power Station plant, it is estimated that in about two months from date it will be practicable, if switchgear be available, to operate

the No. 1 Boiler House, and two out of the six 10,000 kilowatt turbo-alternators to be ultimately installed. Two additional turbo-alternator sets have also been completed at the workshops of the manufacturers, notwithstanding the difficulty experienced in getting the work executed owing to the demands made upon their resources for Governmental purposes. The condensing plant, which is to operate in conjunction with the first two turbo-alternators, has been practically finished, while the circulating water pumps and piping will be available for use in about six weeks' time, thus completing the component elements of the first two turbo-alternator sets.

The practical utilisation of the Power Station for generating and transmitting electric power depends, however, upon the supply of the switchgear, the manufacture of which is at present in an uncertain position, as explained on page 23.

A contract was let to Messrs. Babcock & Wilcox for the Power Station buildings and Boiler House equipment, the amount being £258,220 for the definite section, and £169,500 for the optional section, consisting of a second Boiler House and equipment. Including extras of £239 for re-arranging the Stoker drive, £6,200 for screening plant, £2,245 for double lining the roof of the Engine House, and £866 for spare plant, and allowing for deductions for the omission of starting switches £23, of certain machine tools and shafting £1,125, and of tiling for the Engine House and Pump House floors £714, the total commitments under the contract are £435,408.

Buildings
and Boiler-
house equip-
ment.

The Power Station occupies a site of 36 acres, and the buildings consist partly of three stories and partly of two stories, and are of steel construction with reinforced concrete walls. All the steel work for the buildings, as well as the 24 boilers and economisers, the 48 automatic stokers, and the electric cranes for the Engine House, Pump House and Fitting Shop, besides a large quantity of miscellaneous material has either been received at Melbourne, or is awaiting shipment. Generally speaking it may be said that all the material necessary to enable the No. 1 Boiler House plant to be put into operation has come to hand.

In addition, considerable progress has been made with the erection of the No. 2 Boiler House in which all the boilers, with the exception of two, have been installed, while work is in progress on the automatic stokers, piping, coal handling, and other incidental plant.

The erection of the Engine House and of the 60-ton electric crane therein, and also of the Pump House, has been completed.

As the additional cost involved was comparatively small, it was arranged that the sixteen main columns of the Engine House should be encased in solid concrete to the height of the overhead crane girders, so as to obviate the possibility of corrosion.

It will be necessary to have available, under operating conditions, diagrams showing the extensive steam and water piping systems, and these are now in preparation by one of Mr. Merz's local staff.

The walls of the Power Station are to be filled in with armoured concrete, the metal lathing for which is being supplied by the contractors. The work is being carried out by the Department, and a commencement was made in July, 1915, with the walls of the Engine House, delays having been caused by the non-receipt of lathing.

Walls.

The walls of the Engine House and the Pump House are practically completed, and it is expected that those of the No. 1 Boiler House, the Fitting Shop, the Tank House, and the Air Ducts will shortly be finished, while a start has been made with the erection of the metal lathing at the No. 2 Boiler House.

The outer coats of the walls are being applied with a cement gun, which has proved very successful in operation, and will facilitate the economical completion of the work. After the Electrification works are completed, the cement gun will be utilisable on ordinary railway works.

In connection with his 1912 report, Mr. Merz estimated £6,782 for corrugated iron walls, but as the Power Station would be a prominent object in the landscape, the Commissioners decided to allot an additional £20,000 to improve its architectural features. The actual cost is now estimated at £27,230, including £6,296 for the metal lathing supplied by Messrs Babcock and Wilcox. The cost of the cement will, however, be £1,095 above what it would have been at pre-war rates, and consequently the figure comparable with the original allocation of £26,782 is £26,135. This does not, however, take into account a modification of the Power Station steel work, in regard to which an adjustment will be necessary with Messrs. Babcock and Wilcox.

Roofs and Floors.

Arrangements were made with Messrs. Babcock and Wilcox for Malthoid to be substituted for the asphalt specified in the contract for the flat roof of the Workmen's accommodation, Ash Hopper building, and Pump and Tank House, the former material being considered more suitable for local conditions, and the covering of the buildings is in hand.

The contract with Messrs Babcock and Wilcox provided for the concreting of the Power Station roofs and floors to be carried out by the Contractors, but as a more convenient arrangement it was agreed that the Department do the work—including the fixing of the reinforcing material which will still be supplied by the Contractor at a rate mutually fixed—and it is now completed, except in the No. 2 Boiler House where progress is being made.

With the object of ensuring cleanliness with the least possible labor, the floors of the Workmen's accommodation will be tiled, and the walls to a height of 8 ft. finished with glazed tiles.

In order that tiles of local manufacture might be utilised, it was arranged that the Department take over from Messrs. Babcock and Wilcox the laying of the floors of the Engine Room and Pump House, and a tender has been accepted for the requisite tiles. The work will be put in hand when the erection of the turbo-alternators and condensing plant is sufficiently advanced, which is expected to be about a month hence.

To enable water to drain quickly from the Boiler and Engine House Basement Floors, and also to prevent a dirty appearance from oil, etc., a special make of brick is required, and Mr. Merz recommended that Blue Staffordshire or similar bricks be used. Arrangements were, however, made for the 130,000 bricks of special shape and quality required to be obtained locally, and the laying of the floor has been completed in the No. 1 Boiler House, and is approaching completion in the Engine House and Pump House.

The floors of the Fitting Shop and Unloading Bay, and also of the Jolimont Car Shed will be covered with wooden paving blocks of which about 350,000 will be required, and they are now being delivered at the site.

Painting.

The following colors have been adopted for the Power Station roof and machinery:—

Inside roof of engine house	...	Light Buff.
Walls of engine house	...	Buff.
Steel work, cranes, etc.	...	Grey.
Turbo-alternators and condensers	...	Dark blue, with black bands.
Steam and water pipes	...	Distinctively colored.

The colors proposed for the Boiler Houses and plant, coal handling equipment and other sections, as well as for the outside of the roof, have also been selected.

Site works.

The Commissioners undertook to carry out all the site works, including excavations, concrete foundations, drainage, fencing, etc., and all the important sections have been completed. The first section of the foundations was available at the due time, viz., May, 1914, for the contractors for the Power Station buildings and Boiler House plant, and the remaining portions were ready as required.

The construction of the circulating water canals, conduits, screening pits and building, penstocks and the protective fencing, etc., has been completed.

Circulating water arrangements.

The erection of the rotary screens will be commenced by the Contractors, Messrs. Babcock and Wilcox, in due time.

The dredging of the area in the river around the mouths of the canals is being proceeded with by the Melbourne Harbor Trust, and will be completed in about three weeks.

Between five and six million gallons of circulating water per hour will pass through the condensers, and this will be taken from the Bay on the west side of the training wall, while the outlet water will be discharged on the east side of the training wall.

A floating boom will be provided at the inlet end of the intake canals to prevent craft entering them.

The road bridges in the Strand Road, over the suction canals, have been constructed by the Department.

Numerous bores were sunk to test the underlying strata and ascertain whether the conditions from a foundation point of view were such as to necessitate special action. The results were satisfactory.

Test of underlying strata at Power House site.

A plan illustrating the sections and locality of each of the bores sunk at the Power Station site to test the foundations has been prepared while a model to scale, showing samples of the strata, has been constructed and placed in the office of the Chief Electrical Engineer.

A scheme was approved for the provision of a fresh water supply for the boilers and for fire protection purposes, and arrangements were made with the Melbourne and Metropolitan Board of Works to lay along North Road and Elphin Street respectively, two separate 6-inch mains connected with the Board's system, so as to preclude the possibility of any failure in the supply; and the latter work has been completed. The installation of the reticulation system inside the Power Station boundary is approaching completion.

Fresh water supply and fire protection arrangements.

In addition to the usual equipment of pillar millcocks, hydrants, etc., provision has been made for pumps to raise the pressure of the water drawn from the Board's mains in the event of an outbreak of fire occurring, and arrangements are in train with Messrs. Babcock and Wilcox for this high-pressure service to be extended to certain points outside the buildings.

The question of payment by the Department for water was raised by the Board, but as it was pointed out that the quantity consumed at the Power Station will be considerably less than that used by the existing Suburban locomotives, the Board agreed to waive any claim for the present.

Suitable arrangements are being made with the Metropolitan Fire Brigade for the suppression of any outbreak that may occur at the Power Station, Jolimont Car Shed or at any of the Sub-stations within the Brigade's territory. This was done to prevent serious consequences arising through the indiscriminate use of water to quell fires due to electrical causes. The Chief Electrical Engineer is considering what precautions should be adopted at outlying Sub-stations.

The Switch House, Transformer House and Offices, which adjoin the Engine House, and are of brick construction, have been completed, with the exception of some outside plastering and minor details, together with the cranes located therein. The work was carried out by the Department.

Switch and Transformer House and Offices.

A properly equipped laboratory is considered by Mr. Merz to be a necessary adjunct to the Power Station to ensure economical operation, and this will be provided on the second floor of the Switch House. Arrangements have been made to obtain all the testing instruments, etc., required, either locally or through Mr. Merz, who has been requested to have them checked at the National Physical Laboratory, England, where necessary.

Laboratory.

Oil Store.

A brick building with siding accommodation has been erected by the Department for the storage of the large quantities of oil that will be required to replenish the transformers at the Power Station and the respective Sub-stations, and also for the lubricating oils for the machinery.

The oil will be conveyed between the Power Station and the Sub-stations in special tank trucks fitted with motor pumps, which are under construction at the Newport Workshops.

Lightning Conductors.

The question whether it would be more advantageous for the Department or Messrs. Siemens Bros., Dynamo Works Limited to erect the lightning conductors, earth plates and other protective devices at the Power Station and Sub-stations, is engaging consideration, with a view to adopting the best available methods, considerable improvements in this direction having lately been developed.

Sewering and hot and cold water services.

In connection with the sewerage of the Power Station, it was agreed with the Melbourne and Metropolitan Board of Works that the Department construct a junction between the Board's sewer and the Power Station, and it has been completed. The sewerage and drainage connections inside the Power Station area are well in hand.

Arrangements have been made in connection with the workmen's accommodation for hot and cold water services to be installed.

Coal storage

To preclude the possibility of any shortage of fuel, storage accommodation for 20,000 tons of slack coal will be provided, and tests have been conducted as to the heating characteristics of stored Wonthaggi coal, to determine its suitability, the results being considered satisfactory.

The question of erecting a wall around the coal storage areas has been postponed indefinitely, while a special floor for the coal storage areas was considered to be unnecessary.

The construction of the filler pits, coal conveyer tunnels, and coal handling appliances is approaching completion.

Main entrance and gardening arrangements.

The main entrance to the Power Station will be situated in the Strand Road, facing the river. The design has been approved and a commencement made with the foundations. Copies of the drawings have been despatched to Mr. Merz for incorporation in his final plans and elevations of the Power Station.

It was Mr. Merz's intention to lay out a garden around the Power Station, but in view of the altered arrangements it has now been agreed that this shall be done by the Departmental officers, in conjunction with his Superintending Engineer (Mr. Grove), and that the scheme shall harmonise with the main entrance arrangements.

Fencing.

A six-foot picket fence has been erected around the Power Station area, which is also being surrounded by a hedge, the planting of which has been suspended until next season, and it is intended to allow the trees to grow to a fair height.

Branch line and sidings.

The branch line from Spotswood and the Power Station sidings have been completed.

Land.

The arrangements for the acquisition of private land have, except in a few cases, been completed. The cost of the land will be £15,353, or £4,647 less than the estimate.

A settlement has also been reached with the Williamstown Council in respect of questions that had arisen through the road diversions necessitated by the establishment of the Power Station. The Commissioners agreed to supply the Council with sufficient spalls and metal from the Power Station to enable it to make the roadway in the vicinity of the Railway crossing in Douglas Parade for a total length of 1,000 feet, equal to about 1,500 cubic yards of metal.

Steps have been taken to have the areas of Crown and Harbor Trust land respectively, comprised within the limits of the Power Station and sidings, formally transferred to the Commissioners.

A recommendation has been made to the Government that the unalienated Crown land in the vicinity of the Power Station, which is suitable for manufacturing, be retained pending settlement of the question of providing a supply of energy from the Power Station for manufacturing purposes. The Power Station now under construction will, however, be sufficient at the period of peak load only for the demands of the Railways and other Public Departments.

Reservation
of Crown
land.

The Lands Department has been informed that the area originally reserved at Yarraville will not now be required for a Power Station, and that a further intimation will be given as to what portion of it (if any) is needed for railway purposes. This is dependent on the use to be made of the Branch line, which question is under consideration.

Acquisition
of Crown
land forming
original
Yarraville
site.

Direct siding access is being afforded to both the Engine House and the Transformer House, and it will consequently be practicable to dispense with turntables until the second Power Station is erected.

Turntables.

It is the practice to provide a weighbridge at large Power Stations for the purpose of weighing stores, coal, oil, ashes, etc., and one has accordingly been earmarked for Newport for installation when the time arrives, and its location decided upon.

Provision of
weighbridge.

The earthenware pipes required at the Power Station to enclose the Power Transmission Cables were obtained by contract, while the concrete bends were made on the site by the Department; a large number were required, and the laying of them has been completed.

Pipes for
cables.

Provision was included in Mr. Merz's estimates for an electric locomotive to shunt trucks into and about the Power House, but after the matter had been gone into with Mr. Merz it was decided that, in view of the prevailing industrial conditions in England due to the war, it would be advisable to defer the matter for about twelve months, when it will be reconsidered.

Electric
yard
locomotive.

Since July, 1914, a "T" class locomotive, altered at the Newport Workshops to enable it to traverse the 160 feet curves, has been in use at the Power Station, and this will be adequate for requirements for some time to come.

A contract was let to Messrs. C. A. Parsons & Company, England, for the turbo-alternators and transformers, the contract price for the definite order of four 10,000 kilowatt sets being £122,235, and for the optional portion, viz., two additional sets, which have since been ordered, £60,141, making a total of £182,376. Two sets of 350 kilowatt turbo-alternators for starting-up purposes and to simplify the condensing plant arrangements, at a cost of £5,400, nine additional 1,000 K.V.A. transformers at a cost of £11,762, spare plant to the value of £4,806, and voltage regulators costing £1,025, have also been ordered, which, with various minor extras and adjustments, have brought the total commitments under this contract to £207,730.

Turbo-
alternators
and trans-
formers.

As transformers of the requisite capacity were not obtainable under the optional provisions of Messrs. Siemens Bros., Dynamo Works Ltd. contract, Mr. Merz ordered under the contract with Messrs. Parsons & Co. nine additional transformers, which were required, as under:—Jolimont Car Shed, 2; Newport Workshops, 2; Spencer Street, 3; and the Power Station, 2. The cost of this apparatus, viz., £11,762, is included in the above total, but £9,148 is debitable to the Jolimont Car Shed Sub-station and the subsidiary schemes.

The erection at the Power Station of the No. 1 10,000 kilowatts turbo-alternator set has been completed, with the exception of details. The No. 2 set has also been erected, but the alternator rotor has not been placed in position, it having been retained by the Contractors for the purpose of testing the No. 3 and the No. 4 turbo-alternators. Its delivery, however, is shortly expected. Supplies of accessories and auxiliary plant to complete these four sets are coming forward as completed, and as shipping facilities become available.

Advice has been received that the No. 3 and the No. 4 turbo-alternators have undergone the tests prescribed in the contract, and have been passed for shipment.

After the outbreak of war Mr. Merz reported that the Contractors expected delay to occur in the delivery of the last four 10,000 kilowatts turbo-alternators, but that every effort would be made to complete them at the earliest possible date. Later advices indicate that the Contractors are meeting with great difficulties in getting the electrical work executed, owing to the demands that are being made upon their resources by the war authorities, and this will further affect the delivery of the last two sets.

Testing tanks, protected by a suitable building, will be provided to enable the turbines to be periodically tested, so as to ensure continuous economical operation.

In regard to the automatic voltage regulators, which have been ordered as an extra under this contract, it may be stated that provision for this apparatus was made by Mr. Merz when the contract was drafted, but that the type has only recently been settled. These regulators are for the purpose of maintaining a uniform voltage with a varying load.

When the erection of the first Turbine was about to be commenced, arrangements were made to secure and record the exact measurements necessary to enable any deformation of the electrical plant that might arise during operation to be detected.

Maintenance and repair of Power and Sub-station electrical equipment.

Mr. Merz was asked to indicate the provision contemplated for repairing the mechanical and electrical portions of the larger rotary converters and transformers, so that the requisite facilities may be provided if the existing ones are insufficient. It will probably be found practicable to carry out any work necessary at the Newport Workshops.

Tools and spare-plant.

The spare turbo-alternator parts to the value of £4,806, which it will be necessary to have on hand at the commencement of operation, have been ordered under the optional provisions of the contract, from Messrs. Parsons and Co., and ultimately additional spares to the value of £22,549 will be required.

Spare parts for the Boiler House Plant, costing £866, have also been ordered from Messrs. Babcock and Wilcox by exercise of option, and later, additional spares to the value of £5,388 will require to be obtained.

It has been arranged that in the first instance the value of the spare plant for the different sections of the scheme, together with that of the miscellaneous other equipment with which they will be included on shipment, shall be debited to Electrification capital, but that after the exact proportion for spares has been determined, which will be done as soon as possible in each case, it shall be transferred to the Stores Suspense Account, and charged out to working expenses when the spares are brought into use. Arrangements have also been made for the storage and custody of the spare plant in conformity with existing Departmental regulations.

Under the contract, Messrs. Babcock and Wilcox were required to provide certain shafting and tool equipment in the Fitting Shop, but it has been agreed that in consideration of being credited with the sum of £1,125 the Department shall make the necessary arrangements, and this is being done.

The tender of Messrs. Herbert Morris, England, at £3,102 was accepted for the supply of six overhead cranes and two pulley blocks for the Power Station, and for overhead travelling cranes at the Prince's Bridge, Newmarket, Middle Brighton and Glenroy Sub-stations. The proportion of the cost debitable to the Power Station is £1,203. The Power Station lifting tackle, and the cranes for the Prince's Bridge, Newmarket and Middle Brighton Sub-stations have been received and erected, while the crane originally ordered for the Glenroy Sub-station will, it has recently been decided, be utilised at the Elwood Sub-station, and one of larger capacity substituted at Glenroy. Arrangements were made with this firm to supply, at a cost of £521, a crab for the Newport Sub-station crane (the girder and end carriages to be manufactured locally), which brought the total commitments under the contract to £3,623. Tenders are to be called for the local manufacture of the balance of the Sub-station cranes.

Supply of
cranes.

A contract for the supply of six sets of twin surface condensers, air and water extraction pumps, circulating water pumps, sump pump, and all accessories, at a total cost of £85,252, was placed with Messrs. G. Weymouth Proprietary Ltd., Melbourne. To minimise corrosion troubles, gun-metal impellers were arranged for the circulating water pumps at an additional cost of £594, and, as a further safeguard of the circulating water supply, improvements to enable four machines to be run from one suction pit were effected at an extra cost of £1,397. These additions, with minor adjustments, have increased the total amount of this contract to £87,359.

Condensing
plant and
pumps.

This equipment is being manufactured at the firm's workshops at Richmond, and the position of the work is as follows:—Two of the condensing sets, as well as two of the air and water extraction pumping sets, have been completed. In addition, the remaining four sets of condensers and air and water extraction pumps are in course of erection, beside four of the circulating water pump motors, etc.; the balance, consisting of two motors, being on the site. Summed up, the condensing plant, which will operate in conjunction with the first two turbo-alternators, has been erected, while the circulating pumps and piping necessary to enable the turbo-alternators to be operated will also be completed in about a month.

None of the tenders originally submitted for switchgear was considered suitable, and after Mr. Merz's return to England further tenders were invited for switchgear for both the Power Station and the Sub-stations, that of Messrs. Siemens Bros.' Dynamo Works Ltd. being accepted. The total amount of this tender is approximately £181,635, of which it is estimated that £150,996 is debitable to the Power Station and the Traction Sub-stations; £16,027 to Automatic Signalling, £11,855 to Subsidiary Schemes, and £2,757 to the Jolimont Car Shed. These figures are, however, subject to revision when further details are available.

Switchgear.

The position is unsatisfactory in connection with the manufacture and supply of switchgear, and from present indications this section of the scheme will probably prove the factor that will determine the date at which electrical operation can be commenced, inasmuch as before power can be generated at, or transmitted from, the Power Station it is essential that sufficient switchgear be in position to control the power both there and at the Sub-stations on the Sandringham-Essendon line. The latest advice received from the Agent-General was to the effect that the manufacture of switchgear had been suspended, and that there is uncertainty as to when skilled labor can be released from war work to enable the Electrification contracts to be proceeded with. The matter is engaging the serious attention of the Commissioners and Mr. Merz.

A photographic record is being kept of the progress of the Power Station, Jolimont Car Shed, Sub-stations, overhead equipment, cable laying, and in connection with the equipment of the rolling stock at the Jolimont Car Shed. Copies are supplied to Mr. Grove, and are also filed for future reference in

Photographs

POWER TRANSMISSION SYSTEM.

Progress
summary.

The high tension underground cables for the transmission of power are being laid between the Power Station and the Prince's Bridge, Newmarket and Newport Sub-stations, and between the Prince's Bridge and Middle Brighton Sub-stations. As all the cables that will ultimately be necessary are not available owing to war conditions, sufficient only are being laid at the outset for the operation of the Sandringham-Essendon and Flemington Racecourse lines. All the cable required for the Prince's Bridge-Middle Brighton section has not yet been received, although advices indicate that the Contractors have it in hand and expect to make further shipments, commencing at an early date. The Contractors are, however, experiencing difficulty in obtaining supplies of essential materials owing to Governmental demands.

Under-ground and
overhead
cables.

The tender of the British Insulated and Helsby Cables Limited has been accepted for the supply of the 20,000 volt transmission cables, 1,500 volt track cables, telephone cables, telephone instrument equipment and accessories, etc., the amount with sundry adjustments being £292,895, which includes provision for the following items which were not contained in the original estimates, viz.:—Greater extent of undergrounding cables within the more thickly populated suburbs, £128,000; extra cost of cables through change of site for the Power Station, £64,700; and the duplication of feeder cables to all Sub-stations and installation of the split conductor protective system, £21,000. The contract provides for the Department to make available all labor and materials necessary for the laying of the cables.

Options for signalling cables provided for in the contract have been exercised to the extent of £13,981, and for the cable connections to the Newport Workshops and the Jolimont Car Shed amounting to £3,780, and are included in the above total. These amounts do not, however, include the cost of laying the signalling cables, which is also to be done by the Contractors.

The prices have been calculated on the contract basis of £70 per ton for copper and £20 per ton for lead, and they are subject to adjustment on the basis of the market prices ruling at the time of the order. On the recommendation of Mr. Merz, and with the approval of the Government, the Contractors were instructed to reserve copper for the first section of the equipment prior to the Order-in-Council ratifying the contract being finally dealt with. This enabled copper to be obtained at less than the figure on which the contract price was based. Since then copper has advanced considerably beyond that figure.

The proportion of the contract amount estimated to be debitable to Underground Power Transmission is £259,462, to Overhead Equipment £15,672, to Automatic Signalling £13,981, to Subsidiary Schemes £1,992, and to the Jolimont Car Shed £1,788. The sum of, approximately, £27,032 included in the Overhead Track Equipment contract is also properly chargeable to the High Tension Overhead Transmission System.

The 20,000 volt transmission between the Power Station and the Sub-stations is by means of underground cables through the more populous suburbs having a heavy train service, and thence by overhead conductors to the outlying Sub-stations. In order to ensure greater safety to the public and security against interruptions to traffic, as well as to reduce the annual maintenance charges, it was decided, with the approval of the Government, to extend the underground zone to the following places, viz., Newport, Westgarth, West Footscray, Essendon, East Camberwell, Middle Brighton, and Caulfield, at a cost estimated at £128,000 in excess of the provision in Mr. Merz's Report. The original scheme provided for undergrounding only from the Power Station to Prince's Bridge, Richmond, and North Fitzroy.

To still further increase the security of the supply of power to the trains, all feeder cables between the Power Station and the Sub-stations will be in duplicate, while to provide for the cutting out of faulty feeders which incidentally adds to the safety of the system to the public and the staff in the event of an overhead conductor breaking, the split conductor protective system for high tension transmission has been adopted. The additional cost of these improvements was estimated at £21,000.

With the view of securing a direct route from the Power Station at Newport to Flinders Street, Mr. Merz suggested that some of the cables be carried under the river, but this was not favored by the Commissioners. Cableroutes

It was originally contemplated to lay the cables along both sides of the Williamstown line, but on account of the obstructions met with and the area available being limited, this course was found to be impracticable.

Routes have accordingly been selected along public roads for the high tension cables between the Power Station and the Prince's Bridge, Newmarket, Newport, and Newport Workshops Sub-stations. Agreement has been reached with the Lands Department, the Melbourne Harbor Trust Commissioners and the other bodies concerned, including the municipalities, both in regard to the routes and the arrangements proposed for carrying the cables across the Stony Creek, the Hopetoun Bridge over the Maribyrnong River, and the proposed new bridge over the same river at the north-west boundary of the Flemington Racecourse. Copies of the route plans and cross sections have been supplied to all the public bodies interested, including the Harbor Trust, the Postal Department and the Melbourne and Metropolitan Board of Works, and, where necessary, their engineers are consulted by the Department's Chief Electrical Engineer before operations are commenced.

Routes for the cables between Prince's Bridge and the Middle Brighton and Caulfield Sub-stations, and between Newmarket and Prince's Bridge, looping in at the Spencer Street Electric Light Station, and for the 1,500 volt line from Newmarket junctioning with the North Fitzroy overhead line near Flemington Bridge, have also been selected, and the public bodies concerned informed of the proposals. This involves traversing the park land between Melbourne and Richmond with the cables, which, however, will be laid underground and will not interfere with the utility of the park.

In order to equalise the distribution of power, and thus combine efficiency and economy, it has been agreed that cross country 1,500 volt transmission cables be provided between the Caulfield and the Darling lines, and between the Flemington Racecourse line terminal and Footscray, and the routes for these cables are being dealt with in connection with the general power transmission scheme.

It has been necessary to provide special structures to take the cables over the Moonee Ponds Creek, the Tidal Channels and the Stony Creek, and at the latter place also to construct a causeway approach. A cableway is also being constructed through the Swanston Street Bridge for the cables leading into the Prince's Bridge Sub-station.

In order to avoid, as far as possible, additional expenditure in connection with the Transmission System during the years immediately following its completion, consideration is being given, in all cases, to railway duplication possibilities when selecting routes for the cables.

The high tension conductors between the Newport Power Station and the Albion Sub-station will be taken overhead along the Braybrook loop line. This will enable a saving of £6,000 to be effected as compared with the original proposal of underground cables. It was suggested by Mr. Grove that the structures for supporting the conductors could form part of the overhead equipment should the line be electrified at a later stage, and arrangements are being made accordingly.

The overhead high tension conductors in the outer area will be carried on each side of the tracks on the structures to be erected for the support of the contact wires from which the trains will be supplied with power. Structures for overhead cables.

Supply of
cables.

The minimum quantity of High Tension Cable required to enable the Sandringham-Essendon and the Flemington Racecourse lines to be electrically operated is 35 miles of 0.15 sq. in. section and 17 miles of 0.1 sq. in. section. The quantity of 0.15 cable actually shipped is nearly 41 miles, which is more than sufficient of this class of cable; but only six miles of 0.1 cable have been shipped. Advices indicate that the manufacture of the latter cable is proceeding as fast as circumstances admit, and that an additional eight miles is awaiting shipment.

In addition cable has been delivered for the connections to the Newport Traction and the Newport Workshops Sub-stations.

Cable laying
operations.

The laying of High Tension Cable was commenced at Newmarket on 15th February, 1915, and at the present time work is proceeding on the routes between the Newport Power Station and the Prince's Bridge, Newmarket and Newport Sub-stations, and on the direct route between the Prince's Bridge and Newmarket Sub-stations, and also between the Prince's Bridge and Middle Brighton Sub-stations.

Owing to the slow rate at which cable is being received from the manufacturers, it has been possible to lay at the outset along the Power Station—Prince's Bridge Sub-station route only a sufficient number of cables to operate the Sandringham-Essendon and the Flemington Racecourse lines, but the full number (8) has been laid across the Stony Creek, Footscray, and along the Yarra bank, opposite the St. Kilda platform, and through the cableway underneath and the Swanston-street bridge, as it is undesirable to disturb the new embankments that have been made. On the sections between the Power Station and the Hopetoun Bridge, where rock was met with in the excavations, and blasting necessitated, the full width of the trench was taken out, and the part for which cables are not at present available filled in again with loose material for the present.

Reinstatement of
cable
trenches.

Arrangements have been made with the Melbourne City Council to undertake the reinstatement of the cable trenches within the Council's boundaries for a payment of 1s. per square yard for macadamised roads, and the actual cost of labor and material used for reconstruction purposes plus 10 per cent. for blocked or paved roads. This is regarded by both the Department and the Council as the most satisfactory procedure.

Supervision
arrange-
ments.

The arrangement made by Mr. Merz with the British Insulated and Helsby Cables Limited, for the supervision of their contracts, was for the Company to provide one Chief Supervising Engineer for both the cable and the overhead equipment contracts, with a Chief Assistant for the cable contract and another Chief Assistant for the overhead equipment contract. Mr. W. P. Ward, who is now established in Melbourne, is the Contractors' Chief Supervising Engineer.

As the maintenance of the Power Transmission System will be under the Electrical Engineering Branch, the general Departmental arrangements in connection with the carrying out of the cable contract have been placed under the supervision of the Chief Electrical Engineer.

Protection
of under-
ground
cables.

It was originally contemplated to use concrete slabs to protect the underground cables, but, as the tests of a number of samples proved to be unsatisfactory, redgum planks, 9 inches in width, have been adopted throughout, and about 150 miles will ultimately be required.

Newport
Workshops
and Jolimont
Car Shed.

Power for operating the tool equipment at the Newport Workshops and the Newport Signal Shops will be required as soon as production is commenced at the Power Station, and the question of the arrangements necessary is being kept in view, especially as regards the supply of cable and the installation in the Newport Traction Sub-station of the switchgear apparatus.

The British Insulated and Helsby Cables Ltd. have been instructed to put in hand additional cables and accessories ordered under the optional provisions of their contract, which are required in connection with the Newport Workshops and the Jolimont Car Shed Sub-stations.

A building in which to store securely the cable materials coming to hand has been erected by the Department at Arden Street, North Melbourne, and rented to the Contractors, the British Insulated and Helsby Cables Ltd. This building has been placed adjacent to the store already provided for these Contractors in accordance with the requirements of their Overhead Equipment contract.

Storage
accommoda-
tion.

Four wagons have been provided at a cost of £650 for transporting the drums of cable along the public roads, and to enable the cable to be conveniently laid in the trenches.

Cable
wagons.

Mr. Merz has arranged for the provision in the Sub-stations of apparatus to measure the output of current to the trains, so as to enable an accurate record to be maintained of the quantity consumed.

Me sure-
ment of
power.

An independent telephone system has been provided for by Mr. Merz, whereby the Officer-in-charge of the Control Room at the Power Station will be directly connected to the Sub-stations for the purpose of regulating the distribution of power.

Telephone
system.

On the outlying sections where the high tension conductors will be carried overhead the power control telephone cables will be laid in the automatic signalling troughing alongside the tracks. These sections are Footscray-Albion Sub-station, Caulfield-Seaford-Springvale, Camberwell-Mitcham, Merri-Macleod, Merri-Reservoir, and Essendon-Glenroy.

In addition to the arrangements made by Mr. Merz, a scheme of telephone communication between the Sub-stations, railway stations, exchanges, and the various switching points along the lines for the regulation of the power supply, is being considered, and will be carried into effect by the Telegraph Superintendent in conjunction with the Chief Electrical Engineer.

The high and low tension cable required to admit of the undergrounding of certain of the overhead conductors connected with the Spencer Street Electric Light Station has been obtained, and the work is about to be put in hand. This alteration is necessitated by the Electrification of the Suburban lines, and the work requires to be co-ordinated with other sections of the scheme.

Spencer-st.
Electric
Light
Station.

The Power Station now under construction will, it is considered, be sufficient at the period of peak load only for the demands of the Railways and other Public Departments.

Supply of
power to
outside
bodies.

The Hawthorn Tramway Trust enquired whether the Department could provide power by September, 1915, to operate the Burwood Tramway, and was informed that no arrangements for the supply of power to tramway or other additional bodies could be made at present.

The Melbourne Harbor Trust also requested that power be made available for the proposed electric tramway between Spencer Street and Dudley Street, via the wharves. As current for lighting and power is already being supplied, and the Trust is regarded as practically a Government body, the request was acceded to.

A scheme has been adopted for the supply of power to the proposed Sandringham-Black Rock Electric Street Railway, and tenders invited for the converting apparatus. It is not likely, however, that the requisite arrangements to enable energy to be supplied for the purpose from the Newport Power Station can be completed until later in 1916.

To facilitate the electrical equipment of the rolling stock, it was arranged to supply the Contractors—the General Electric Company—with electrical energy to operate their tools, from the Spencer Street Electric Light Station, until power is available from Newport. The company is being debited with the actual cost to the Department of installing the temporary plant, including a charge for depreciation, and the energy is being metered and paid for.

SUB-STATIONS.

Progress Summary.

The Sub-stations at Prince's Bridge, Newmarket, and Middle Brighton, which are required for the operation of the Sandringham-Essendon and Flemington Racecourse Lines, have been completed so far as the buildings are concerned, but very little progress has been made with the installation of the converting and other electrical machinery which is to be provided and erected by Messrs. Siemens Brothers, while the same difficulty as in the case of the Power Station also exists in respect of the provision of switchgear for the Sub-stations.

The Sub-station buildings at Glenroy and Newport have also been erected, and satisfactory progress made with those at Albion and North Fitzroy. The two last named Sub-stations are required for the operation of the Coburg-Fawkner and St. Albans lines. *& Fawkner lines*

The construction of additional Sub-station buildings has been postponed until the position in regard to the supply of the electrical plant by Messrs. Siemens Brothers becomes more definite; but there will be no difficulty in co-ordinating these buildings with the requirements of the other sections of the scheme.

Sub-station equipment.

A contract was let to Messrs. Siemens Brothers' Dynamo Works Limited for Sub-station equipment capable of converting 60,000 kilowatts of power, the price for the definite order being £171,624, while an option was held for the supply of 15,000 kilowatts additional plant, of which 13,500 kilowatts have been ordered at an extra cost of £37,191. This apparatus will afford ample Sub-station equipment for the traffic estimated for 1917.

To supply additional power for automatic signalling the 5-kilowatt sets originally specified for lighting and switchgear operation have been replaced by thirteen 50-kilowatt sets to be installed at an extra cost, excluding switchgear, of £25,038 in the six central Sub-stations, viz:—Prince's Bridge, Newmarket, Middle Brighton, Newport, North Fitzroy and Caulfield. Similar provision for the remaining Sub-stations will be made when the time arrives.

In addition, four sets of oil-driven generators were ordered as an extra at a cost, including spare parts, of £2,026. These sets will be used to provide power for operating the Automatic Signalling Equipment until power is available from the Newport Power Station, and it is expected that they will shortly be put into commission. The option for the supply of additional auxiliary plant for the Sub-stations was also exercised to the extent of £2,636.

The above and sundry minor extras have increased the total commitments under this contract to £240,140, of which approximately £29,950 is debitable to Automatic Signalling, and £1,046 to Subsidiary Schemes.

The total capacity of the distribution system will be 73,500 kilowatts

The following is a list of the Sub-stations, with particulars of the dates by which it was originally considered that the buildings would be required for the erection of the electrical equipment, the sites selected, and the stage reached in regard to each :—

Sub-station
buildings

Sub-station.	Original date building required for equipment.	Location.	Stage of the Work.
1. Prince's Bridge	15th September, 1915.	On east side of Scotch College cricket ground to afford room for extension of car shed.	Erected by the Department and ready for the electrical equipment.
2. Middle Brighton	25th April, 1915.	On land purchased at cost of £800.	
3. Newmarket ...	25th April, 1915.	On railway land adjacent to cattle yards.	
4. Glenroy ...	1st September, 1915.	On land purchased at cost of £300.	
5. Newport ...	15th October, 1915.	On railway land.	
6. North Fitzroy ...	15th January, 1916.	On railway land.	In course of erection by contract.
7. Albion ...	15th February, 1916.	On railway land about one mile on Up side of Albion Station.	In course of erection by contract.
8. Mentone ...	15th February, 1916.	On land purchased at cost of £300.	Tenders invited, but acceptance deferred pending settlement of difficulty that has arisen in connection with the supply of the Sub-station electrical equipment.
9. Caulfield ...	15th March, 1916.	On portion of public reserve which is being resumed for the purpose.	
10. Seaford ...	15th March, 1916.	On Crown land, which is being transferred to the Department.	It is intended to invite tenders for the erection of as many of these Sub-station buildings as practicable after it is definitely known when the electrical apparatus will be available. The plans and specifications for several of the Sub-stations have been completed.
11. Springvale ...	15th May, 1916.	On railway land.	
12. East Camberwell	15th May, 1916.	On railway land.	
13. Reservoir ...	15th June, 1916.	On railway land.	
14. Macleod ...	15th June, 1916.	On land purchased at cost of £100.	
15. Mitcham ...	15th July, 1916.	On land purchased at cost of £325.	

Owing, however, to the adverse influence of the war, which has upset the contract arrangements with Messrs Siemens Bros.' Dynamo Works Limited, for the supply of plant, the Sub-station buildings are not now required as indicated above, and the dates will depend upon the future progress of the manufacture of the apparatus.

In addition to the above Sub-stations another is being erected by the Department in substitution for the existing power plant at Elwood to supply current for operating the St. Kilda-Brighton Street Railway when the Newport Power Station is completed. This railway may at a future date be taken over by the Greater Melbourne authorities, and the building is therefore being

erected separately from the existing car sheds, offices, etc., so that when the transfer takes place the Sub-station may remain under the control of the Commissioners, because on account of it being connected with the main power supply for the railways it is inadvisable to hand it over to another body. Current can be supplied for the Street Railway at a rate that will be satisfactory both to the Department and the Tramway authorities.

Two smaller Sub-stations will also be required, one at the Newport Workshops and one at the Jolimont Car Repair Shed, to distribute power for the operation of the machine tool equipment, and for lighting and other purposes, and possibly another will be necessary at a later date for the Newport Signal Shops, should it be decided to equip it with an electric drive. The Sub-station buildings at the Newport Workshops and the Jolimont Car Repair Shed are approaching completion. It will also be necessary to erect a Switch-house at the Footscray Station, to regulate the supply of power over the cross-country high-tension cable connections with the Flemington Racecourse line.

Mr. Merz's original scheme provided for twelve Sub-stations. This number was increased to fifteen, in order to afford a more favourable distribution of the Sub-station plant, which is capable of meeting the normal expansion of traffic for many years to come, as will be seen from the information on page 7, respecting the maximum train services provided for. The additional Sub-stations are Newmarket, to provide for the drop in the voltage during the heavy race services, and Reservoir and Seaford, to meet the requirements of the rapidly expanding traffic on the Preston and Frankston lines.

The Sub-stations, which it was at first contemplated to establish at North Carlton and Chelsea, are to be located instead at North Fitzroy and Mentone respectively.

The Sub-stations are substantial brick buildings, provided with direct siding access and fitted with overhead travelling cranes, and, wherever practicable, are being erected under contract. It was not possible to arrange contracts for the erection of the Sub-station buildings at Prince's Bridge, Newmarket, Middle Brighton, Glenroy and Newport, as sufficient details were not available to enable a complete specification to be prepared, while the complicated and unusual nature of the internal brickwork rendered it essential for the Department to construct them, in order to prevent delay in their electrical equipment, as the war and the difficulty which has since arisen in obtaining apparatus could not, of course, be then foreseen. Drawings and building notes have been received from Mr. Merz, supplying the information necessary for the preparation of plans and specifications for all the remaining Sub-station buildings.

The Signalling Bays at the Sub-stations, which have been either constructed or are under construction, have been completed for the accommodation of the signalling motor generators and accessories. The Bays at the remaining Sub-stations will be of the same design if it be decided to install similar electrical apparatus. Vide paragraph 5, page 28.

Sub-station
cranes.

As the overhead travelling cranes for Prince's Bridge, Middle Brighton, Newmarket and Glenroy were urgently needed, arrangements were made through Mr. Merz for their supply, but tenders are about to be invited locally for the crabs of the remaining cranes required, with the exception of the crab for the Newport Sub-station crane, which is being obtained under the contract entered into with Messrs. Herbert Morris and Co. The girders for the cranes have been already obtained. The cranes have been erected at the Prince's Bridge, Newmarket and Middle Brighton Sub-stations, the tender of Messrs. Herbert Morris & Co., at £3,101, having been accepted for them and for a manually-operated crane for the Glenroy Sub-station as well as for the Power Station overhead travelling cranes. In addition, the crab for the Newport Sub-station crane is being supplied by this firm at a cost of £521, making the total commitments £3,623.

To prevent additional expense in the future, it has been arranged with Mr. Merz that the cranes to be installed in the remaining Sub-stations shall be all of 20-tons capacity, so as to be capable of handling the larger sized machines that may ultimately be installed, and to preserve uniformity of type, while for the same reason the 10-ton crane ordered for Glenroy will be transferred to the Elwood Sub-station.

To enable appropriate records to be instituted to ensure economical operation, meters to measure the current output to the trains will be installed at each Sub-station, and Mr. Merz has made the necessary arrangements at an extra cost of £375.

Current measuring apparatus.

The Sub-station equipment Contractors are providing a portable vacuum apparatus for the extraction of moisture from the oil which is to be used in the transformers, and the question as to whether it would be advantageous for the Department to take over this plant at the close of the contracts is being kept in view.

Oil drying plant.

The suggestion was made that it would be advantageous for the Department, instead of the Contractors for the Sub-station electrical equipments, to install the air compressor piping in the respective Sub-stations, and that a considerable saving in cost would thereby be practicable. The question, however, is dependent upon the arrangements that have been made in England by Mr. Merz, from whom further information is awaited.

Air compressor piping.

Some slight alterations to the brickwork of the Sub-stations will be necessitated when the final lay-out of the air compressor piping is settled and a separate record of the cost of the work will be kept to enable debit to be raised against the Contractors in due course should that be necessary.

The distribution of the Sub-station plant arranged by Mr. Merz is based upon the estimated traffic in 1917 of 150,000,000 passenger journeys, and the schedule of train services possible under such arrangement has been determined and is shown on page 7.

Distribution of plant

The equipment will be as under :

- (a) 3,000 kilowatt units—Prince's Bridge (6), Newmarket (3), North Fitzroy (3), East Camberwell (3), Caulfield (3).
- (b) 1,500 kilowatt units—Newport (3), Middle Brighton (4), and Mentone (3).
- (c) 750 kilowatt units—Glenroy (2), Albion (3), Macleod (2), Mitcham (2), Spring Vale (2), Reservoir (2), and Seaford (3).

The buildings and machine foundations for Newport and for the 750 kilowatt unit Sub-stations have been designed so that larger-sized units may, without heavy additional expense for reconstruction, be installed later if necessitated by expansion of the traffic.

Mr. Merz reported that no financial benefit would result from the use of storage batteries in outlying Sub-stations to supply power for train operation instead of, or in conjunction with, rotary converter plant, and that as the traffic developed the advantage of the rotary converter Sub-station would increase. The use of rotary converter Sub-stations as provided for will keep the Sub-station equipment standard throughout the entire system.

Storage batteries.

Storage batteries will, however, be installed in all Sub-stations to maintain the lighting, and the operation of the automatic signals in the event of a stoppage of the Sub-station plant.

It was found necessary to take in an additional strip of the Flinders Park, between the Yarra Bank Road and the Prince's Bridge Sub-station, in order to afford a way for the high tension cables from the Newport Power Station.

Land for cableway purposes.

As noted in connection with the Car Shed arrangements, the sum of £200 was paid to the Trustees to cover the cost of altering approaches, footpaths, etc., necessitated through the transfer of park land to the Department for Electrification purposes.

Roadway.

A 15 ft. space for cable marshalling and roadway purposes will be required at the respective Sub-stations between the building and the railway, and investigation showed that this is available at all the Sub-station sites selected.

Maintenance and repair of electrical equipment.

Mr. Grove has been asked to indicate the provision contemplated for repairing the mechanical and electrical portions of the large Sub-station rotary converters and transformers, and the matter is under consideration.

Fencing.

The Sub-stations located in the more thickly populated neighbourhoods will be enclosed with a picket fence six feet high, similar to that which is being erected around the Power Station, but in isolated localities the fencing arrangements will be decided upon according to circumstances.

Flooring.

Parts of the floors of the Sub-stations will be tiled and the remainder finished with cement, and in the unloading bay the floor will be laid flush with the rail level and check rails provided along each rail of the track.

Telephones.

An automatic telephone exchange, connecting the Power Station, Sub-stations, and certain other points along the track will be provided at the Prince's Bridge Sub-station. The detail arrangements are now under consideration.

Fire protection.

The Sub-station buildings have been specially designed so as to be fire-proof, and the only protection necessary will be portable chemical extinguishers and receptacles filled with dry sand, which will be provided in due course. The provision of direct telephone communication with the Fire Brigade, to enable assistance to be immediately summoned in case of an outbreak of fire, is under consideration, in conjunction with the general telephone arrangements for the electrical system, and also the action necessary to prevent serious consequences through the indiscriminate use of water for extinguishing purposes in the event of an electrical fire occurring.

Concrete pipe bends.

The large number of concrete pipe bends required for the cable conduits of the Sub-stations are being manufactured at the Power Station site, and the cost is being allocated under the proper heading. The stoneware pipes necessary are being obtained by contract in the ordinary way.

Residences for Sub-station staff.

Consideration has been given to the question as to whether it will be necessary in any instance to erect house accommodation for the Sub-station staff, particularly at places such as Albion, Macleod, Springvale and Chelsea, and the matter will remain in abeyance pending experience of operating conditions.

Regrading Essendon-Broadmeadows section.

If the proposal to regrade the Essendon-Broadmeadows section of the North-Eastern line be adopted, it will necessitate the postponement of the equipment for electrical operation of the Essendon-Broadmeadows section, and if the regrading be not sufficiently advanced by the time the Contractors have completed the other lines, it may be advisable for the Department to erect the overhead equipment.

Switchgear.

Sufficient power for operating the train service between Melbourne and Essendon will be available from the Newmarket Sub-station, but in any case temporary provision could be made for a feeder line from the Glenroy Sub-station, which is now ready for the electrical equipment.

None of the tenders originally submitted for switchgear was considered suitable, and after Mr. Merz returned to England further tenders were invited for switchgear for both the Power Station and the Sub-stations, that of Messrs. Siemens Brothers' Dynamo Works Limited being accepted. The total amount of the commitments is approximately £181,635, of which £150,996 is debitable to Sub-stations and the Power Station, £16,027 to Automatic Signalling, £11,855 to Subsidiary Schemes, and £2,757 to the Jolimont Car Shed. These apportionments are, however, subject to revision when further details become available.

Certain alterations were found to be necessary to the switchgear brickwork of the Prince's Bridge, Newmarket and Middle Brighton Sub-stations, the cost of which is debitable to Messrs. Siemens Brothers' Dynamo Works Limited, the Contractors for the apparatus, and will be charged accordingly.

Switchgear
brickwork.

Particulars have been received of the tiling of the 20,000 volt switch panels in the Sub-stations, and arrangements made for the requisite tiles to be procured locally.

Switchgear
panels.

The allocation of the feeder panels in the various Sub-stations in connection with the automatic signalling arrangements has been agreed upon with Mr. Grove.

It will be necessary to provide trained staff at the Sub-stations to supervise the machinery, and the matter is under investigation by the Chief Electrical Engineer.

Training of
staff.

Transformer Stations belonging to private Electric Supply Companies are situated on railway land at various points within the Suburban area, and each case has been looked into with the view of ascertaining whether any should be removed consequent upon the adoption of electric traction, but so far it has not been considered necessary to take any action.

Private
Transformer
Stations.

TRACK EQUIPMENT.

Progress
summary.

The construction of the overhead equipment by means of which power will be supplied to the trains is proceeding along the Flemington Racecourse and the Sandringham-Essendon lines. The Department has erected the steel latticed masts and bridging. The Contractors are fixing in position the catenary and contact wires. A large quantity of insulators, switches and other fittings is yet required to complete the lines.

The erection of the masts will shortly be taken in hand by the Department at the Essendon end of the Sandringham-Essendon line. Contracts have either been or are about to be arranged for the manufacture of all the standard structures required for the system, as well as for the incidental materials, and when supplies of steel are received from the Contractors, tenders will be invited for the remaining structures of special design.

Sufficient overhead contact wire is now available for about 50 miles or single track, together with considerable quantities of accessories, but additional supplies of essential materials are necessary before this length of line can be completely equipped after the masts and bridges have been erected. Although the manufacture of the contact wire is only proceeding at a slow rate, no difficulty is apprehended in obtaining sufficient supplies to co-ordinate with other sections, but as in the case of previously mentioned contracts, war conditions, and the shortage of skilled labor, is a retarding factor.

In addition, the re-construction of the Flinders Street Viaduct and its equipment with the electrical overhead gear, will be completed so as to fit in with Electrification requirements.

Overhead
equipment of
permanent
way.

The tender of the British Insulated and Helsby Cables Limited was accepted for the overhead equipment of the permanent way, including the provision of the 1,500 volt contact wire and catenary suspension. The expense of erecting the wiring and also of the masts and bridging is being borne by the Department. The estimated amount of the tender was £278,286. As it was on a schedule of rates basis it is not practicable at present to make a close approximation of the total commitments under this contract.

The proportion of the contract actually debitable to this section is, however, approximately £251,254, as £27,032 included in this contract for power transmission equipment requires to be deducted. On the other hand £15,692 for conductors and accessories provided for under the Cable contract should be added.

It is provided in the contract that the Department shall reimburse the Contractors the actual expenditure incurred by them in connection with the carrying out of the work for the salaries of draughtsmen, wages of surveying staff, skilled and unskilled labor, office accommodation, storage, etc., and the necessary procedure has been arranged.

Structures
for the
overhead
equipment.

To enable a supply of steel to be available for the construction of the masts and bridging which carry the overhead transmission cables and contact wires, and thus facilitate the provision of structures by the Department, it was arranged, in July, 1914, after consultation with Mr. Grove, to invite tenders for quantities of channels and angle iron, and 1,053 tons were obtained, and this material is being utilised for masts and bridging under construction at the Newport Signal Shops, and portion was also supplied to private contractors in instances where the conditions of tender stipulated that the steel should be purchased from the Department at a price specified.

In the case of tenders subsequently accepted, the time quoted for delivery where the Department supplied the material was about one-half that required if the Contractors made their own arrangements to obtain supplies of steel channels. Further contracts were accordingly entered into by the Department for an additional 3,200 tons of channels, as well as 500 tons of angles, in order to expedite the overhead equipment of the permanent way.

Drawings have been received from Mr. Grove for the track structures required for the first group of lines to be converted, and additional drawings, as well as those showing the arrangement of the structures at special places, will be supplied from time to time. In designing the structures, the advisability has been kept in mind of utilising as far as practicable material readily obtainable within the State.

Tenders have either been, or shortly will be, invited locally for the manufacture of all the standard structures required, as well as for a quantity of the numerous special structures (masts and bridging), and the following have been accepted, viz. :—

	Masts.	Bridges.	Cantilever Arms.	Pull-off Arms.	Brackets and Attachments
Messrs. Challingsworth Ltd. ...	217	16	—	—	—
Messrs. Gray Bros. ...	1254	—	—	—	—
Messrs. Forman and Co. ...	26	—	—	—	—
Messrs. Johns and Waygood ...	51	24	—	—	—
The Engineer of Signals ...	629	517	164	301	3
The Metropolitan Ironwork Shop	—	—	—	—	2262
Messrs. Cowleys' Eureka Iron-works Ltd. ...	123	39	—	—	23
	2300	596	164	301	2288

The Engineer of Signals is constructing the major proportion of the special and urgent structures so as to expedite their availability for the first line.

Most of the contracts contain a provision that enables additional structures, up to 25 per cent. of the quantity specified, to be obtained at the option of the Commissioners at the price tendered.

Provision has also been made for the manufacture of the miscellaneous details of the overhead equipment, such as ladders, platforms, pull-off arms, etc., required for the first section.

The inspection of the structures during the process of manufacture is being carried out by the Departmental Inspector of Ironwork acting in the matter under Mr. Grove's supervision.

Various special tools are required for the erection of the overhead equipment, and as it is obligatory on the Department to arrange for their supply, they are being manufactured at Departmental workshops.

Tools.

Power for propelling the trains will be collected from the overhead contact wire by means of a pantograph collector of the slider type mounted on the roof of the motor coaches. This contact wire will be suspended from a catenary messenger wire carried, as previously explained, on latticed steel masts and bridging erected along the tracks.

Erection arrangements.

Sites for the track structures have all been definitely selected on the Sandringham-Essendon and Flemington Racecourse lines, and on the Williamstown and Williamstown Racecourse lines, Departmental Officers collaborating with Mr. Grove where necessary.

Additional land was required along part of the Flemington Racecourse line, and the Victoria Racing Club agreed to grant the Department an easement over a 10-foot strip within its boundary to afford room for the overhead structures, cables, etc.

The erection of the masts, bridging, and wires will require to be done without interfering with the traffic, and this necessitates it being carried out principally at night, and on Sundays, during the intervals between trains.

The construction of the foundations for the overhead equipment structures, and the erection of the masts and bridging are being carried out by the Department, and have been completed between Richmond and Sandringham, North Melbourne and Essendon, and North Melbourne and Williamstown, while the Spencer Street-North Melbourne section is in hand. As the overhead equipment of the tracks for electrical operation is one of the most important and difficult sections of the undertaking, an engineer has been specially appointed to ensure efficient and economical execution of the Departmental portion of the work.

The structures which are being erected to support the overhead contact wire are, wherever required, being adapted, so as to serve also as signal bridges, and the necessary arrangements have been made for the sections between Richmond and Flinders Street, and Spencer Street and North Melbourne.

The design of the track structures has been arranged so as to admit of the width between parallel lines being increased from 6 feet to 7 feet when track alterations are made in future.

The question of making the overhead structures readily adaptable in the event of duplication was discussed with Mr. Grove, when it was agreed as a general principle that where necessary the two-track structures could be strengthened to admit of extension over four tracks, either by means of bracket arms or by adding an additional mast and bridge.

The Chief Engineer of Way and Works and the General Superintendent of Transportation have been instructed to draw attention to any suggested alterations in the tracks, or other work which may affect the overhead equipment arrangements, to enable Mr. Grove to be apprised and supplied with a preliminary plan, and unnecessary work thus avoided.

Data for the various lines were prepared and forwarded to Mr. Grove to enable the overhead equipment arrangements, etc., to be formulated, and the Caulfield and Camberwell lines (reggraded sections) are the only ones for which no details have yet been supplied.

Lay out plans and cross section drawings for the overhead equipment have been received from Mr. Grove, for the Sandringham-Essendon, Flemington Racecourse, Williamstown and Williamstown Racecourse lines, while plans are in hand for the Port Melbourne, St. Kilda, and Coburg-Fawkner lines, and for the connection to the North Fitzroy Sub-station.

The overhead contact wire will be divided into sections to enable power, if necessary, to be cut off a particular section, without interrupting the train service along the whole line. These sections have been determined on the Sandringham-Essendon line, while the location of the telephones for regulating the power supply has also been referred for settlement.

Additional sidings for the storage of race trains have been provided at the Williamstown Racecourse, so as to obviate the necessity for erecting the overhead contact wire on any part of the privately owned Altona Bay line, on which, by arrangement, the Department has at present the right to place trains.

The Power House line and sidings are to be equipped with 1,500 volt overhead contact lines for the supply of power to an electric locomotive with which to perform shunting operations.

The arrangements to be made for equipping the railway pier and the new pier at Port Melbourne for electric traction have been tentatively agreed to, and the tracks which it is proposed to electrify decided on after consultation with the Melbourne Harbor Trust.

Mr. Grove has been requested to lay out the overhead equipment on the Clifton Hill-Heidelberg line on the basis of a double track throughout, and also to arrange the masts on the Coburg-Fawkner line so that they may be adapted for duplication in the future, while the masts along the ^{Melbourne} ~~Braybrook~~ ^{Clifton Hill} loop line, which will support the high tension conductors between the Power Station and the Albion Sub-station, will be constructed so as to admit of the Electrification of the line later.

All the curves on the Suburban lines will be centre pegged and pulled true prior to the erection of the overhead equipment.

To facilitate erection work the concrete foundations for the masts have so far been prepared as soon as the cross section drawings for the respective lines were received, in such a manner as to avoid the necessity of waiting for the masts to be fabricated, but alternative methods are now under consideration.

The masts are being constructed with a uniform taper extending from one end to the other, and the distance from centre of track to face of mast will be 8 ft. 0 in. where practicable.

A sample length of overhead equipment, about three-quarters of a mile long, was erected on the North-Eastern Railway between Shildon and Newport (England) section, and exhaustive tests were carried out to prove the suitability both of the overhead equipment and of the collecting gear.

Tests.

Mr. Merz reported that the overhead equipment appeared very satisfactory, and, with the exception of one or two slight modifications, was generally approved, and after the final drawings and samples had been approved by Mr. Merz, the Contractors proceeded with the manufacture of the equipment.

Samples of the masts and bridging for the overhead equipment of the tracks have been tested to destruction for experimental purposes at North Melbourne with very satisfactory results.

Tests were conducted with experimental track structures, erected at Newmarket, to determine the insulation necessary for the bases of the masts to prevent a too great lowering of the resistance between the track and the earth, which would interfere with the Automatic Signalling Circuits. As a result, it has been decided to dip the bases of the masts in a hot paint mixture before their erection, and the necessary plant has been provided.

A minimum headway of 15 ft. 6 in. is being provided at all overline road bridges throughout the Electrification area for overhead equipment purposes, but at public road crossings it is obligatory that the contact wire shall be not less than 18 ft. from the rail level; the minimum height of bridges under steam conditions was 14 ft. 6 in.

Bridges.

A number of the overline footbridges, particularly those in the vicinity of public road crossings, will therefore require to be either raised or superseded by subways, to enable the height of the contact wire to be kept as uniform as possible, and satisfactory running and maintenance conditions obtained. Particulars of the headway required at each footbridge are being supplied by Mr. Grove in conjunction with the lay-out plans of the overhead equipment, and any alterations necessary are being completed prior to the erection of the track structures. The desirability of minimising expense in the matter is being kept in view.

The footbridges on the Sandringham-Essendon line have been dealt with, and those at Greville Street, Prahran, and Glenhuntly Road, Elsternwick, replaced with subways. Plans have also been adopted for replacing several of the footbridges on the Williamstown line by subways. The work of providing the necessary clearance at all the structures on this line is in hand.

Footbridges on outlying sections of line above which high tension conductors pass will be partly enclosed with suitable material to prevent injury to pedestrians who may be carrying long articles of conducting material.

A footbridge having a 6-feet walkway will be erected across the tracks in the Flinders Street Station Yard to afford safe access to and from their work for the staff, and will be utilised also as a track structure and switching point for overhead lines to various sidings. The design of the bridge has been settled with Mr. Grove, and a tender for the erection of the portion of the bridge which crosses the Sandringham-Essendon line and the lay-by sidings connected therewith has been accepted. Action will be taken in due course as to the remaining sections.

Flinders
Street
viaduct.

The Flinders Street Viaduct is an important link in the overhead equipment arrangements, and it is expected that the alterations necessary to enable steam trains to be run to all platforms at Flinders Street will be completed by 3rd September.

It is expected that this will enable the erection of the overhead equipment for the section between Sandringham and Essendon to be finished by 1st October, 1916.

Route of
Essendon
trains.

A plan and estimate of cost are in preparation for the junction alterations that would be necessary, should it be decided to change the route of the Essendon trains between the North Melbourne Junction and Kensington, by utilising two of the tracks through the Gravitation Yards. If this be done it will prevent the Essendon trains from crossing the path of the Williamstown trains. The steps already taken for the electrical equipment of the tracks will conform to this arrangement.

New
overline
structures.

The Engineering Officers of the Department have been instructed to keep Electrification possibilities in view when designing new bridges or other overline structures

Numbering
of struc-
tures.

The structures will be numbered consecutively along each Main line, the zero point in each case to be the east side of the Swanston Street Bridge, Flinders Street Station. The intermediate structures on sidings, etc., will be distinguished by appending decimals to the Main line structure number. The numbering will be done after the erection of the structures along the respective lines has been completed.

Order of
conversion.

The order in which it is proposed (subject to revision) to equip the respective lines for electrical operation is shown on pages 8-9.

Height of
contact
wires.

The following arrangements have been agreed to respecting the Pantograph Collector and the height of the contact wire, allowance having been made for expansion and contraction due to changes of temperature:—

- (1) A well, 9 ft. 6 in. long, to be provided in the roof of each sliding door motor coach for the Pantograph, to enable a Pantograph with a maximum range of 20 ft. 6 in. to be adopted.
- (2) The height of the contact wire to be—
from rail level
 - (a) In open country, at centre of span, minimum, 15 ft 4 in.; maximum, 17 ft. 8 in., and at the structures 16 ft. 6 in.
 - (b) At level crossings, minimum 18 ft.
 - (c) At stand-by sidings, minimum 18 ft.
 - (d) At terminal sidings, minimum 18 ft.
 - (e) At terminal stations, minimum 16 ft.; certain special places, 18 ft.
 - (f) In proximity to water cranes, 18 ft. where practicable.

Tracks to be
electrified.

A sub-committee has prepared data showing the stations and sidings where the special arrangements indicated above will be necessary, while steps have been decided on to prevent the enginemen who will require to mount the locomotive tenders in order to handle the water cranes, from touching the electrically charged overhead contact wire.

A sub-committee has been appointed to define the sidings which will require to be electrified throughout the Suburban area, and final plans showing the tracks and sidings to be electrified on the Sandringham-Essendon, Williamstown, Coburg, St. Albans and the South Yarra-Caulfield lines have been supplied to Mr. Grove.

All sidings not essential for the electrical equipment of the first section have been eliminated from the plans.

To ensure the safe operation of both the railway and tramway traffic, specially designed overhead gear will be required at places where electric tramways cross the railway tracks on the level, and a general understanding as to the electrical arrangements necessary has been reached with the authorities concerned. Details of the electrical equipment at each crossing will, however, require to be settled according to circumstances. The first crossing to be dealt with is that at the Epsom Road, on the Flemington Race-course line.

Electric tramway crossings.

Generally speaking, the cost of the special equipment will be divided equally between the Railway Department and the Tramway authorities.

The adoption of electric traction will enable a number of engine sidings, coal stages, water cranes, etc., to be abolished, and when the time arrives the question of removing them will be considered.

Removal of sidings, etc.

There is no immediate intention to equip the new Shipping Shed Sidings at Montague with overhead conductors; but the footbridge which crosses these tracks has been made high enough to admit of its being done, if necessary, in future.

New shipping shed.

The question of obtaining a suitable motor vehicle to traverse the public roads with staff and appliances to effect emergency repairs so as to minimise delay to the train service, in the event of a break occurring in the overhead contact lines, will be considered after experience has been gained with the first electrically equipped line.

Breakdown vehicle.

Three 3-ton locomotive steam cranes for the expeditious and economical erection of the track structures are under construction locally, and it is expected that the first one will be put into commission during the next few weeks, the others following at short intervals. When the Electrification scheme is completed, these cranes will be required for general Departmental purposes.

Appliances for erection of overhead equipment.

For construction and heavy overhead equipment repair work, steam locomotives and suitably fitted "H" and "Q" trucks will be utilised. These vehicles are being made available by the Chief Mechanical Engineer as required.

The Contractors are required to devise protection at all overline bridges to prevent articles being thrown from the footways on to the electrical conductors below, and it is proposed to provide a protecting shield extending from each bridge over the contact wires.

Protection at overline bridges.

At bridges on lines where the high tension transmission lines will be carried overhead, the wires which now cross them will be undergrounded or protected, while at footbridges, in addition to the shield extending over the contact wires, a covering 8 feet high will be provided over the walkway to prevent anything touching the transmission lines above.

The question is under consideration whether at level crossings, where the contact wire will be at least 18 feet above the rail level, guards or load limiting devices shall be provided at both sides to lessen the risk of accident due to road vehicles containing unusually high loads.

The contract with the British Insulated and Helsby Cables Limited provides that the Department shall reimburse the cost of preparing and printing drawings for the overhead equipment, and as it is more economical and expeditious for the printing to be done by the Department, this course has been adopted where possible.

Drawings.

Store and siding accommodation have been provided at Arden Street, North Melbourne, for the use of the Contractors for the overhead equipment of the permanent way, as required by the contract. These facilities will be utilised for general Departmental purposes when the Electrification scheme is completed.

Storage accommodation.

TRACK BONDING.

Progress summary.

Generally speaking, about one half the total quantity of material required to bond all the tracks within the Electrification area has been delivered to the Department, and the work of affixing the bonds is progressing satisfactorily to co-ordinate with other sections of the scheme.

Contract arrangements.

The tender of the Allgemeine Elektricitäts Gesellschaft, of Berlin, at £5,931, was accepted for the track bonds necessary to equip the Sandringham-Broadmeadows, Williamstown and Flemington Racecourse lines, and provision made for the balance required for the remaining lines, to be obtained under options, the total cost being estimated at £20,000. The outbreak of war, however, necessitated the cancellation of this contract, after bonds to the value of £1,052 had been delivered, on which the sum of £105 4s. 1d. is still due; but payment has been deferred indefinitely. The bonds received were sufficient for only a few miles of line, and another contract was therefore entered into with the British Insulated and Helsby Cables Limited, the approximate cost of the material required to equip all the lines within the Electrification area being £22,549. The liabilities under the contract to date total £18,684, which figure is based upon a market price for copper of £67 per ton; but as the actual market price at the time of ordering was less than £67 per ton, adjustments provided for in the conditions of contract will reduce the total to approximately £17,565.

Measuring apparatus.

Arrangements were made to obtain two ducters to measure the resistance of the joints in connection with track bonding operations at a cost of £165, and they are in use.

Organization for track bonding.

Particulars were supplied by Mr. Merz of the manner in which he suggested the work of bonding the tracks should be carried out so as to afford proper electrical connection; and also as to the staff and tools required, and arrangements were made for the bonds to be affixed to the rails by the Signal Engineer's staff working in conjunction with the Way staff. The tracks on the Sandringham-Essendon, Flemington Racecourse, Williamstown and Williamstown Racecourse lines, and at South Yarra Station have either been bonded or will shortly be completed.

Thermit welding.

The question of welding the rails by means of the Thermit process instead of using track bonds was investigated, but was not recommended on account of the high cost and other difficulties.

ALTERATIONS TO WAY AND WORKS.

The alteration of overline structures and of the position of telegraph, telephone, and signalling wires, so as to afford sufficient clearance for the electrical overhead equipment, is approaching completion on the Sandringham-Essendon, Flemington Racecourse, and Williamstown lines. The lines to be next dealt with are those to Port Melbourne and St. Kilda.

Progress
summary.

Particulars are given on page 37 of the arrangements that are being made to afford the clearance necessary at overline structures for the overhead equipment. Briefly stated the additional headway required on the Sandringham-Essendon and Williamstown lines has been determined, and the bridges on the former line have either been completed or are progressing towards completion, and no delay to the erection of the electrical equipment will be occasioned thereby. In some instances it has been found desirable to substitute subways for footbridges in the vicinity of level crossings where the contact wire must be maintained at a minimum height of 18 feet. The places where the alterations involved were of an extensive nature are mentioned below.

Clearances.

The question of increasing the clearance at the Swanston Street bridge at Flinders Street, to meet electrical conditions, was specially considered on account of the difficulties, consequent upon the heavy traffic, attending the work and the cost involved. The work has been successfully completed, and a minimum clearance of 15 feet 6 inches is available above all the tracks passing underneath the bridge.

Swanston
Street
bridge.

The removal of the Suspension bridge, situated between Spencer Street and North Melbourne, which was suggested by Mr. Grove, was considered inadvisable on account of the inconvenience that would be caused to about 1,500 employes at the North Melbourne Locomotive Sheds and Truck Shops, and the bridge is therefore being retained in its present position, and raised so as to afford the requisite headway for electrical purposes.

Suspension
bridge
between
Spencer
Street and
North Mel-
bourne.

Advantage was taken of the necessity for providing additional headway for electrical purposes at the Dynon Road bridge, North Melbourne, to reconstruct it so as to dispense with the arches which restrict the loading gauge and the general view of Signals; an important consideration, as all trains from the North Eastern, Northern, North Western and Western main trunk lines pass beneath the bridge. The whole cost of the work will not therefore be debitable to the Electrification scheme.

Dynon Road
bridge,
North Mel-
bourne.

A monthly statement is supplied by the Chief Engineer of Way and Works, showing the progress made with the provision of headway for electrical purposes at the various bridges. This section of the undertaking is being carefully watched to ensure that no avoidable delay arises in the equipment of the tracks.

Progress
statement.

The Pantograph Collector to be mounted on the roofs of the motor coaches will be 6 feet 8 inches wide between the tips of the horns, and in order to allow for the super-elevation, oscillation, and the lateral movement of the coaches, the verandahs at a number of stations in the Electrification area require to be cut back so that there may be no projections beyond a vertical line extending from the outside edge of the platform copings, and all future verandahs will be constructed to this standard. The cutting back of the verandahs on the Sandringham-Essendon, Williamstown, Coburg, and St. Albans lines has been completed, and operations will shortly be commenced on the Port Melbourne and St. Kilda lines.

Clearance
for panto-
graph
collector.

Special attention will be given by the Way and Works Branch to the track throughout the Electrification area in order to minimise the oscillation of the Pantograph.

Alterations
to electric
lighting,
telegraph,
telephone,
and signal-
ing wires.

A conference of representatives of the Railway and Postal Departments and Mr. Grove agreed that as a general principle all lighting and power, telegraph, telephone and other electric wires which cross the railway overhead, within the Electrification area, should be undergrounded, but that in the case of wires at overline bridges special consideration be given to each case.

The various outside authorities concerned have accordingly been requested to underground their wires which cross the railway tracks within the Electrification area, and this work is now in progress on the Sandringham-Essendon line. The cost in most cases will require to be borne by the Railway Department.

The necessary action is also being taken in regard to all Railway, telegraph, telephone, signalling, and other wires.

Electric
tramways
crossing the
rails.

Special electrical arrangements will be required at crossings where electric tramways intersect the railway on the level, and a scheme has been prepared by Mr. Grove, the general features of which have been approved by the Tramway authorities concerned. The details will, however, require to be adjusted according to the circumstances of each particular place. One object sought to be achieved is the absolute security of both the railway and the tramway traffic, and this will be provided for, not only by means of derails in the tram tracks, but also by the installation of switches and interlocking, which will prevent current for propulsion purposes being available in the vicinity of the crossing for both trams and trains at the same time.

EQUIPMENT OF CAR SHEDS, PITS, ETC.

The erection of all the Car Repair Shed buildings is practically completed, but delay is being experienced in obtaining delivery of the requisite machine tools and the motors for operating them, for which contracts were entered into some time ago. This section of the scheme will not, however, delay the inauguration of electric traction.

Progress
summary.

The Jolimont Car Repair Shed is a brick building 357 feet wide, and varying in length from 400 feet to 600 feet, with provision for subsequent extension to a uniform length of 1,000 feet. In it will be carried out all the work in connection with the maintenance and periodical overhaul of the electrical equipment and the ordinary repair of the Suburban rolling stock. The trains, after completing a specified mileage, will be placed for examination in the Car Shed, which is designed to deal with a total equipment of 950 coaches, and as the stock in use, when all the lines are electrically operated, will probably not exceed 800, adequate margin for expansion has been afforded.

Car Repair
Shed.

The Car Shed is divided into three main sections:—

- (a) The Workshop and Lifting Bays, each 600 feet by 60 feet, will contain four tracks for the full length (three of which will have pits), with 24 short transverse tracks and pits for handling the bogies when undergoing overhaul. A gallery, 25 feet wide, will extend along the south wall where light repair work will be done, and where dining and lavatory accommodation for the staff will be provided.
- (b) The Inspection and Running Repair Bay, 400 ft. by 132 ft., will contain 9 tracks, all of which will have pits extending their full length.
- (c) The Painting or Varnishing Bay, 400 feet by 104 feet, will contain five tracks, and will be equipped with platforms level with the coach floors to facilitate repairing work, and probably with heating apparatus for keeping the inside of the building at an even temperature for drying the varnish, paint, etc., quickly. Alternative schemes are now under consideration.

The building along the northern wall of the Painting Bay contains the Upholsterers' and Carpenters' Shop, Paint and Varnish Store, and the Boiler house for the heating plant.

The Workshop and Lifting Bays and the Inspection and Running Repair Bay have been finished, while the Painting Bay is approaching final completion. The internal equipment of the Car Shed cannot, however, be completed until the machine tools and companion motors to drive them are available.

All doors in the dividing walls of the Car Shed are of fire-resisting material, and can also be simultaneously operated in the event of an outbreak of fire.

A double roof to minimise the risk of condensation has been provided over the Workshop and Lifting Bays and the Painting Bay, while the roof over the Inspection Bay will be in one span.

The offices and store situated at the west end of the Workshop Bay consist of three stories. Access to the main offices which will be located on the first floor, will be obtained from the ground floor or gallery by means of stairs or an electric lift. The building will contain provision for the storage of spare parts of the electrical equipment.

The electric lift is to be designed to handle loads of up to two tons; tenders for its supply have been invited.

Contracts have been arranged for the supply of paving blocks to floor sections of the Car Shed, and also the Fitting Shop and Unloading Bay at the Power Station. About 350,000 wooden blocks will be required altogether at a cost of £1,555, and their delivery on the site has been commenced.

An automatic telephone system will be installed throughout the shed, connected with the main Railway system.

Compressed
air plant.

An electrically operated air compressor plant, with a capacity of 300 cubic feet per minute, will be installed with service pipes distributed throughout the Shed to afford facilities for blowing out the electrical equipments, for brake testing, driving pneumatic tools, and operating the lifting gear, blowing the furnace, &c.

Tool
equipment.

Contracts have been entered into for the supply of machine tools to deal with the electrical and mechanical equipment of the coaches. The machine tools are to be motor driven, and arrangements have been made through Mr. Merz for the makers to be supplied direct with the motors ordered for the purpose under the general contract for the provision of workshop motors. entered into with Messrs. J. H. Holmes and Co., so that the tools and motors may be harmonised with one another. The arrangements for obtaining and installing the tools are in the hands of the Chief Mechanical Engineer and the Chief Electrical Engineer.

Lighting,
gas, etc

The Car Shed will be lighted by high candle power electric incandescent lamps, while fixed lights will be installed in the examining pits. Portable electric lamps will also be provided to admit of the ready inspection of the undergear of the coaches.

Gas will also be laid on for soldering and blow-pipe work.

Tanks and
impregnating
plant.

An impregnating plant is to be installed to deal with the coils of the armatures and other electrical apparatus.

Tanks, capable of holding a complete bogie, to enable the bogies and motor carcasses to be plunged into hot alkali to clean off all accumulated dirt and oil, will be erected, as well as tanks containing a cold water spray service for rinsing the bogies, &c. The tanks will be protected by means of lids; the alkali after being treated will be discharged into the river.

Fire
protection.

All doors of the Car Shed are of fire resisting material.

A 9-inch water main, connected with the Melbourne and Metropolitan Board of Works system at Spring Street, has been laid, from which pipes radiate throughout the Car Shed. An electrically operated pump will increase the pressure when required. In addition, automatic sprinklers will be installed, and a tender has recently been accepted for their provision. Millcocks and hoses have been provided in the Car Shed, and pillar millcocks and hoses at frequent intervals on the adjacent lay-by sidings, while a system of electric syrens with direct alarm connections to the Metropolitan Fire Brigade, is about to be put in. The cost of the fire protection provision is estimated at about £11,000, which, however, represents merely a fractional percentage on the value of the electric rolling stock that will be stored at times in and about the Car Shed.

Turntable.

A 70-feet turntable is being provided for reversing motor coaches, in order to place the driving compartment at the end desired.

Overhead
equipment
repair train.

Housing accommodation for the overhead equipment repair train will be arranged parallel to and north of the exterior wall of the Paint Shop, but nothing definite is proposed until the description of train has been decided upon. The matter is under consideration.

Storage for
rolling stock
material.

Sidings commanded by a Goliath crane will be laid at the east end of the Car Shed for the storage of wheels, axles, and other rolling stock material.

A Sub-station is being erected about 80 feet from the western end of the Car Shed for the transformation of current from the Newport Power Station to a voltage suitable for operating the lighting and tool installations in the Car Shed, and also to supply at least 100 kilowatts of power for lighting the Flinders Street Yard and the buildings situated therein. Provision has been made by Mr. Merz for the supply, under the existing contract with Messrs. C. A. Parsons and Co., of the two transformers required for the Sub-station at a cost of £2,614.

Car Shed
sub-station.

The installation of the power transmission cables between the Sub-station and the Car Shed distribution boards, and of the internal wiring, will be carried out by the Chief Electrical Engineer. The necessary material is being obtained under the optional provisions of the contract with the British Insulated and Helsby Cables Ltd.

The Lifting Bay is equipped with two 25-ton, and the Workshop Bay with two 15-ton electrically operated cranes. As these were required to equip the rolling stock for electric traction, Mr. Merz was asked to invite tenders in London, that of Messrs. Chambers, Scott & Co. at £4,480 being accepted. Subsequently it was agreed, on the recommendation of Mr. Merz, to grant the Contractors an additional payment of £123, which still left their price the lowest, to cover unforeseen expenses due to the war and to minimise delay in the provision of the cranes. This extra, with a further item of £110 for altering the hand operating gear and the cage floors, brought the total commitments to £4,713.

Electrically
operated
cranes.

The erection of the cranes is being carried out by the Departmental Engineers in conjunction with Mr. Grove, and one 25-ton crane as well as the two 15-ton cranes are available for hand operation, while the additional 25-ton crane is in course of erection. Temporary arrangements can be made, if necessary, for the supply of power to operate the cranes so as to enable full use to be made of them for the equipment of the coaches, and to supersede the temporary hand operated overhead crane that is now being utilised.

Various minor matters of detail in connection with the interior arrangements of the Car Shed are under consideration by the special sub-committee, presided over by Mr. Stone (Chief Electrical Engineer), but all the important questions have either been dealt with, or put in train for definite action.

Car Shed
internal
arrange-
ments.

The erection of the Car Repair Shed has necessitated the abolition of the footbridge over the railway tracks situated in line with the Jolimont Road, as a suitable new site where it would not interfere with the signalling arrangements or the future duplication of the lines is not available. Portion of the bridge has been re-erected near the Melbourne Cricket Ground, adjacent to the site occupied by the old structure, now removed. The alteration was necessary to afford sufficient headway for the overhead equipment and the width required for the additional tracks that will ultimately be laid between Richmond and Flinders Street. Having ramped approaches, it is more convenient for the public than the old bridge, which was fitted with steps.

Jolimont
Road
footbridge.

Satisfactory arrangements were made for the acquisition of the additional park land necessary to afford room for the Prince's Bridge Sub-station and the future extension of the Car Repair Shed, and to have it formally transferred to the Commissioners.

Acquisition
of park land

The sum of £200 was paid to the Trustees to cover the cost of altering approaches, footpaths, etc., rendered necessary through the surrender of park land to the Commissioners for Electrification purposes.

In connection with the re-erection of the Jolimont Road Footbridge, the Parks and Gardens Committee has also concurred in the excision of park land that will ultimately be necessary for the laying down of additional tracks between Jolimont and Richmond, subject to the Department paying the cost of altering the footpaths and the fencing, which was agreed to.

Jolimont
Road drain.

The work of diverting and undergrounding the Jolimont Road drain, which was rendered necessary by the erection of the Car Shed, to prevent flooding after heavy rain; and which was a somewhat extensive work, costing £10,204, has been completed.

Standage
sidings and
inspection
pits.

As the inspection and repair of the electrical equipment must be done in the Car Shed, the provision of deep inspection pits on the adjacent lay-by sidings, as originally contemplated, has been abandoned.

The question of excavating shallow pits on the lay-by sidings, or alternatively, raising the rails sufficiently to admit of such work as the replacement of brake blocks, etc., being dealt with, has been considered, with the result that, as a greater space will be available underneath the motors than was originally expected, the expenditure involved—£25,000—can be obviated.

Inspection
pits at out-
stations.

Pending experience under electric traction conditions, pits for examining the electrical equipment of the coaches will not be provided at outlying stations, but the existing engine pits will be allowed to remain for a time.

Accommo-
dation for
motormen.

A brick building, to afford suitable accommodation for the large staff of motormen who will be required for the operation of the electric trains, as well as for the supervising office staff, is approaching completion at Flinders-street. After consideration, it was decided, pending experience of electric operation, that the guards should join their trains at the Flinders-street Station platforms, as is the practice under existing conditions.

Training
facilities.

An important factor in ensuring the success of electric traction will be the provision of a well trained staff of motormen, guards and shunters, to operate the trains; and to enable this to be done Mr. J. Rist, who has had extensive experience as an instructor of motormen on the London Electric Railways, etc., has been engaged, and the training will be conducted in an appropriately equipped lecture theatre which has recently been completed at Flinders-street; this theatre will be equipped with the underframe of a motor coach, placed on a raised stand, to enable the motors to be rotated, and all the electrical equipment will be shown to the trainees exactly as it will appear under operating conditions. In addition, samples of the electrical parts of the rolling stock and of the brake equipment, together with illustrated diagrams, will be provided in the lecture theatre, and all the arrangements will be in accordance with the practice obtaining on the leading electric railways elsewhere.

Facilities for
yard staff
and car
cleaning.

When the scheme was formulated for the provision of accommodation for motormen, the opportunity was taken to improve the conditions under which the shunters, train examiners and car cleaners work in the Flinders-street yard, while, in addition, better facilities for car cleaning, including raised platforms, have been afforded on the lay-by sidings. Suitable accommodation for the car cleaners is in course of erection.

Rolling
stock
repairs.

The old Rolling Stock Repair Shop at Jolimont will be abolished when the time arrives for the completion of the tracks leading into the Car Sheds, and the work carried out therein will then be temporarily transferred to the Painting Bay in the Car Shed, pending its absorption into the general working of the Car Shed.

Garden
scheme.

With a view to relieving the bare aspect of the extensive brick walls of the Car Shed, Virginia creeper has been planted at suitable locations. The laying out of garden plots around the Car Shed and the Prince's Bridge Substation will be taken in hand later.

Lighting of
Flinders-st.
yard.

The question of improving the lighting of the Flinders-street Yard has been investigated, and it has been decided that the present facilities are sufficient in the areas already illuminated; but that when the existing overhead conductors are undergrounded to avoid interference with the track equipment, the possibility of extending the lighting areas should be kept in view.

ROLLING STOCK.

The Contractors, viz., the General Electric Company of America, who have not been appreciably affected by the war, are proceeding at the Jolimont Car Repair Shed with the equipment of the suburban coaches for electrical operation, and the progress of the work is being synchronised with other sections of the undertaking. No difficulty will be experienced in having available as required ample supplies of fully equipped rolling stock for running electric trains.

Progress
summary.

A contract was let to the General Electric Company of U.S.A. for the equipments for 400 motor coaches and 400 trailer coaches, the initial amount being £714,160, including £33,680 to cover the adoption of larger sized motors as provided for in the optional clauses of the contract, and £4,300 for the manufacture in England of 500 motors. An option is held for an additional 100 motor coaches and 50 trailer coaches. Extras totalling £23,994 have been incurred, £6,840 for placing the dynamotor beneath the motor coach floor, £3,940 for improved apparatus to allow for wider variation in the voltage, £3,252 for the provision of emergency couplers between the units, £9,479 for improvements in the design of the Pantograph collector, and £483 for sundry adjustments, making the total commitments under the contract £738,154.

Coach
equipments.

The equipments for 125 motor coaches (viz., 500 motors) are to be constructed at Rugby, England, and it was agreed to pay an additional amount of £43 each in respect of 100 of them, in order to secure their manufacture in England, but no extra charge is to be made in respect of the remaining 25 sets. The bulk of the control apparatus will also be made at Rugby. Reconsideration of this arrangement may be necessitated owing to the conditions arising from the war, as the Company's Rugby factory has been entirely commandeered by the Munitions Department; but it is not proposed to transfer the manufacture of any additional motors or other apparatus to America if it can possibly be avoided.

The contract with the General Electric Company covered the supply of 400 sets of driving equipments for trailer coaches, but as only 100 sets have been definitely ordered the Department is entitled to a credit in respect of 300 sets, and this amount, which will be adjusted later, will reduce the above quoted total commitments under this contract.

By providing couplers of uniform design between the train units, another dynamotor can be brought into operation for lighting and control purposes in the event of a failure occurring in the leading dynamotor on a four or a six coach train. The train can thus be driven from the leading end in the event of a breakdown of either the dynamotor or the collector on the leading motor coach, which would not be otherwise practicable. The additional cost for the equipment of the motor and trailer coaches will be £3,252.

Dynamotor
couplers.

Suitable receptacles will also be fitted at the ends of each trailer coach to contain the free end of the jumper coupling to prevent its being damaged, and also to increase the flexibility of the rolling stock, and this will involve a further extra of £784, which has not yet been included in the total commitments mentioned above, under the General Electric Company's contract.

Mr. Merz has advised that of the more important portions of the train equipments 732 traction motors, 189 dynamotors, 181 air compressors and 1,050 gear wheels, besides a large quantity of miscellaneous apparatus have been passed for shipment, of which a considerable proportion has reached Melbourne. No pantographs have so far been passed for shipment, and only seventeen sets of contactors, which are an essential part of the apparatus.

Supply of
equipment.

The equipment of the coaches for electrical operation is proceeding at the Jolimont Car Repair Shed, where temporary crane and storage facilities have been made available for the Contractors.

Tests

The first traction motor was tested under the personal supervision of Mr. Merz's partner (Mr. McLellan) with successful results, it being described as of sturdy and symmetrical design.

The first sliding door motor coach to be fitted with all the equipment, except the pantograph, has been tested at St. Kilda by means of power obtained from the Elwood Power Station, when all the circuits were operated with satisfactory results. The coach was moved in both directions by its own motors.

A trial run on a steam train was also made with a coach completely equipped with bogies and motors, also with satisfactory results.

Dynamotor.

Mr. Merz advised that the heating tests of the dynamotor had proved very satisfactory, and that its capacity could be increased by 50 per cent. for an additional expenditure of £8 each. It was, however, considered that as ample provision for present requirements had already been made, there was no necessity to incur this expense, which, based on the present rolling stock programme, would have amounted to £2,976.

Pantograph

As a result of tests on the North-Eastern Railway, England, and also in America, with sample collectors specially designed to suit Melbourne conditions, it has been finally decided by Mr. Merz that the slider type of Pantograph is to be adopted, and their manufacture is being proceeded with by the General Electric Company, and several are expected to reach Melbourne at an early date. The Pantographs will be mounted on the roofs of the motor coaches, and will have a maximum range of 20 ft. 6 in. They will be 6 ft. 8 in. wide between the tips of the horns, and to allow for super-elevation, oscillation, and the lateral movement of the coaches, the platform verandahs at a number of stations within the Electrification area will require to be cut back, and this matter is referred to on page 41.

The alteration in the design of the Pantograph has necessitated the provision of a larger air pump to operate it, which, with the reservoir, will be placed in the guard's compartment.

Although arrangements have been made for the insulation of the motormen's ladder, end steps and rail of the coaches, this is regarded as only a supplementary precaution against employees receiving electric shocks, and instructions will be issued that while the Pantograph is in contact with the overhead contact wire no employee is to go on the roof of any of the coaches.

Mirror and bell communication on electric trains

A mirror will be provided in each driving compartment to enable the motorman to see what is taking place on the platform, in the vicinity of his train. Mr. Merz has supplied a sample of the mirror in use on the London District Railway, also a drawing to illustrate the position it occupies. The mirror will be installed shortly before the coaches are put into electrical operation.

Consideration was given to the installation, for use in case of emergency, of a system of communication between the motorman and the guard by means of an electric bell or buzzer; but in view of the heavy cost that would be involved the matter is being held in abeyance, and as a mirror will be provided, as explained in the preceding paragraph, while the guard will be able to cut off the supply of power by applying the air brake, and in any case the system would not be used for starting purposes, it is not intended to do anything in the matter until experience is obtained under electrical operating conditions.

Custody of key of motorman's compartment.

All motormen as well as the guards employed in the electric service will be supplied with a special key of the motorman's compartment as part of their regular kit equipment. The keys are being manufactured by the Chief Mechanical Engineer.

The accommodation for motormen in each single-ended motor coach, and in the driving end of each trailer coach, will be about half the end of the van compartment, an elevated seat for the use of the guard being placed in the other half. A sliding door is being provided between the motorman's and the van compartment, and one end window for look-out purposes. The arrangement of the second driving compartment in two-ended motor coaches has also been settled.

Arrange-
ment of
driving end.

The wiring connections have been arranged so that in the future, if it should be decided to extend the motorman's compartment right across the end of the coaches, comparatively inexpensive alterations only will be involved.

The question of the number of trailer cars to be equipped with driving compartments has been dealt with. The original programme provided for 47 driving compartments, which, with the ten additional compartments in double-ended motors, made a total of 57. This number it is intended to increase to 66, so that all the detachable units on the Preston, Heidelberg, and St. Albans services may be double-ended, which with 34 spare sets will absorb the 100 sets definitely ordered under the contract with the General Electric Company. Suitable additional coaches for equipment as driving trailers have been selected.

Driving
compartment
in
trailer cars.

Pintsch gas fittings for 70 motor coaches were originally obtained, and when it became apparent that the 120 new sliding door motor coaches under construction would be available for traffic before they could be utilised electrically, the balance of 50 sets was arranged for, making a total of 120 sets of Pintsch gas equipment ordered, which, when the coaches are electrically operated, will be available for new country stock. Owing to the retardation of the scheme through the conditions arising from the war it is not now intended to equip more than 90 motor coaches with Pintsch gas lighting, and some saving will thus be effected, as the balance of the equipment will be available for country rolling stock.

Pintsch gas
equipment.

The degree of lighting to be provided in each compartment will be 80 candle power. Two lights will be fitted in each compartment of both sliding and swing door cars by means of a double-branch electric light suspended from the ceilings, the Pintsch gas fittings to be adapted for the purpose. A new design of opal shades will be used. Two lighting circuits will be installed to safeguard against a total failure of the light. The detailed arrangements are in the hands of the Chief Mechanical and the Chief Electrical Engineers, and the procedure to be adopted for the equipment of the coaches has been formulated.

Lighting of
coaches.

Tenders were invited for all the materials necessary and arrangements have been made for the supply of certain parts, but, owing to Messrs. Siemens Bros., whose offer was the most advantageous for the balance, having been proclaimed an enemy firm, it has been necessary to invite fresh tenders.

During the transition period, motor coaches partially equipped for electrical operation may, when attached to steam trains, be lighted by means of a suitable flexible connection from the trailer coaches, beneath the requisite number of which additional Pintsch gas reservoirs will be temporarily fixed for the purpose. This will be facilitated by the coaches being made up in units, consisting of one motor and one trailer coach permanently coupled.

In connection with the examination under operating conditions of the lighting equipment of the trains, it has been arranged that the lighting and extinguishing of the lamps shall be dealt with by Transportation Branch employes, and the replacement of the lamps and fuses by the Electrical Engineering Branch staff stationed at the Metropolitan and other stations, with the exception that on the longer lines the duty shall be performed by the

Head and
tail lights,
and
destination
indicator.

Three electric lamps, to show white, red or blank, as necessary, will be used for the head and tail lights with the addition of one oil lamp and each train will also be equipped with an indicator having five-inch letters to show the destination station. This indicator will be suitably illuminated at night and capable of adjustment to show the station required, and arrangements have been made for the provision of the necessary number. The equipment of the coaches with these fittings will be carried out by the Department.

Smoking
accommo-
dation.

Smoking accommodation will be provided in the electric trains on the basis, generally speaking, of three smoking compartments in each car, as owing to the size of the trains under electrical conditions being adapted to suit the variations in traffic, it is not possible to preserve the present system of complete smoking cars. The partition between the smoking and non-smoking portion of the sliding door coaches will be closed, and the seat on both sides of the partition will be carried right across the car. The total smoking accommodation in the electric trains will be equivalent to that now available under steam conditions.

As it is not practicable to provide spittoons in the floors of the motor coaches, and at the same time prevent the sputum from falling among the electrical gear, they will be dispensed with, and the same course will be followed in the case of trailer coaches to secure uniformity of practice.

Lubrication
of motors.

The question of the most suitable class of oil for the lubrication of the motor coach electrical equipment has been investigated, and ^{tenders} ~~contracts~~ have been placed for the quantity required.

Arrangements have also been made in regard to the supply of oil to the General Electric Company for the test runs of the coaches. A debit will in due course be raised against the company for the cost of the oil supplied.

Westing-
house brake
arrange-
ments.

Agreement has been reached with Mr. Merz respecting the braking apparatus for the motor coaches, and the equipment necessary for the 372 motor coaches to be provided for has been ordered, including the pressure regulating valve recommended by Mr. Merz, whilst brake equipment for the driving trailer and trailer coaches has also been arranged for.

In connection with the brake power to be afforded on electric trains it has been agreed—

- (a) That motor coaches have a brake force equal to 110 per cent. of the light weight of the vehicle, the air pressure to be 80 lbs. per square inch in the train pipe and about 60 lbs. per square inch in the brake cylinder, and
- (b) That trailer cars have a brake force equal to 100 per cent. of the light weight of the vehicle, the air pressure being the same as for motor coaches.

The steam service practice is to provide brake power equivalent to about 85 per cent. of the empty weight of the car, assuming an air pressure of 50 lbs. per square inch in the brake cylinder, and it will be seen that a higher braking efficiency is being provided for in the electric service.

Arrangements have been made to obtain, for trial in Melbourne, ten sets of electro-pneumatic brake control apparatus, five for motor coaches and five for trailer coaches. This apparatus will be fitted to the six coaches to be equipped with measuring appliances by the General Electric Company so that all tests, both braking and otherwise, may be made with the same train.

An offer was received from the General Electric Company to equip, for experimental purposes, a four coach electric train with their variable release air brake apparatus, which has been specially developed for electric railway operation. Pending experience with the Westinghouse brake equipment to be fitted to the electric trains, and the testing of the electro-pneumatic brake, the matter is being allowed to remain in abeyance.

Guard irons to prevent any obstacle on the track from getting under the wheels will be fitted to the driving end of all motor and driving trailer coaches, and to both ends of double-ended motor coaches, and provision will be made for their attachment, if required in future, at the trailing ends of both motor and trailer coaches.

Guard irons.

In August, 1913, it was arranged, at Mr. Merz's suggestion, to have an actual underframe (instead of a wooden one) constructed and electrically equipped in England for use as a sample, and material was diverted for the purpose, and buffers, drawhooks, and couplings sent from Melbourne. The cost of fitting up the underframe, including a sample driver's cab, and extras totalling £82, will be £362. The sample underframe after having been fitted to the bogies at the Newport Workshops, has been placed in the motormen's lecture theatre, where its electrical equipment is being completed by the General Electric Company.

Coach underframes.

Agreement has been reached with Mr. Merz in regard to the design of the underframes for the motor coaches, and 120 sliding door motor coach underframes are in various stages of construction, as well as 88 swing door motor coach underframes, of which the majority have been partially fitted with the electrical equipment at the Jolimont Car Shed by the General Electric Company.

Agreement has also been reached respecting the general design of the motor bogies, and 358 have been completed, while an additional 63 are under manufacture at the Newport Workshops.

Motor bogies.

The first bogie to be completely equipped with motors was placed underneath a car body at the Newport Workshops, and tested on a trial run with satisfactory results. It is being retained at the Jolimont Car Shed as a sample coach.

Number plates will be attached to the motor bogies to enable them to be readily identified.

Number plates.

Mr. Merz recommended that disc centre wheels be utilised for the bogies of the motor coaches, and the 372 sets required have been received.

Wheels, axles, etc.

The axles for the motor bogies are being made at Newport from imported blooms—the supply of which has been arranged for—to the drawing supplied by Mr. Merz.

Provision is made on the axle boxes for supporting the automatic trip gear, details of which, however, have not yet been settled, but the leading face of the left-hand axle box of each motor and driving trailer coach is being machined for the purpose; the trip gear will be located underneath the driving compartment.

but
to draw

Duplicate axle gauges have been supplied, and are being kept in the Rolling Stock Branch for use as standards.

Axle gauges.

The estimated weights of the coaches equipped for electric service are as follow:—

Weights of Coaches.

Motor Coaches :—				Tons.	Cwt.
Average tare	...	...	...	32	6
Passengers	...	...	...	5	0
Electrical gear	...	...	...	14	18
Total				52	4
Trailer Coaches :—				Tons.	Cwt.
Average tare	...	...	...	25	7
Total weight with passengers and electrical equipment...	...	...	...	31	9

Gear wheels.

It was arranged for the gear wheels in connection with the electrical equipment of the coaches to be pressed on to the axles by the Department, and for the Contractors to send out the gear wheels in instalments in sufficient time to enable them to be fixed when the underframes, etc., were being constructed, 80 gear wheels per month to be supplied, commencing January, 1914. Advice has lately been received that 1,050 gear wheels have been passed for shipment, most of which have reached Melbourne.

A few of the gear wheels received were not micrometrically true to gauge, and the cost of correcting the defect will be charged to the General Electric Company.

Fire extinguishers.

The hand chemical fire appliances provided in the vans at each end of the steam Suburban trains are unsuitable for dealing with fires due to electrical causes. It was therefore necessary to select another type of fire extinguisher for installation in the electric rolling stock, and for use in the Power Station, Car Repair Shed, Sub-stations, etc. Tenders were invited for 400 additional extinguishers. Experiments conducted by the Department in conjunction with the Metropolitan Fire Brigade showed that the "Electrene" type is the most suitable apparatus available; that type has been adopted.

The fire extinguishers at present in Suburban trains will be available for the equipment of country trains.

Indicating letters for coaches.

The following descriptive letters to distinguish motor and trailer coaches have been adopted, viz.:—Motors, "M"; driving trailers, "D"; trailers, "T"; and will be added to the ordinary class symbols, while the coaches are undergoing equipment with electrical apparatus at the Jolimont Car Shed.

Rolling stock equipment released.

A number of underframes and bogies will be released by the provision of new underframes and bogies for the electric stock, and investigation is being made as to their utilisation.

The new Westinghouse brake equipment to be provided on the motor coaches will release brake parts valued at £2,075, of which material to the extent of £510 will be available for other classes of new rolling stock and the balance for maintenance purposes.

Speed restrictions.

The question of the extent to which the existing speed restrictions should apply in the case of electric trains has been deferred until the signalling arrangements have been developed.

Speed recorders.

The desirability of installing speed recorders on the electric trains has been noted for consideration later. In the meantime enquiry is being made to determine what type of apparatus would be most suitable for the purpose, but it is unlikely that a decision can be reached till industrial conditions improve and more types are available to select from.

Coasting clocks.

The question of installing coasting clocks, or metering appliances, on the electric trains with a view to ensuring economy on the part of the motormen in the consumption of power is under investigation, and particulars of the current measuring appliances on the market are being collected.

Test trips of electric trains.

If the Essendon-Broadmeadows section be regraded, a modification will be required in the contract arrangements for the test trips of the electric trains, which were prescribed to be run between Sandringham and Broadmeadows, but Mr. Grove has advised that while it would be an advantage if the regrading could be completed in time for the testing, no difficulty would be experienced in making calculations to ensure that the electrical equipment fully complies with the contract conditions.

The construction and alteration programme provided for 729 cars to be in readiness by June, 1916, as under:—

Provision of rolling stock for electrical operation.

—	Motors.	Trailers.	Driving Trailers.	Total.
SWING DOOR CARS—				
To be extended ...	177	140	27	344
SLIDING DOOR CARS—				
To be altered ...	—	161	—	385
To be constructed...	195	—	29	
Total ...	372	301	56	729

and the work is in progress at the Newport Workshops; but owing to the delay which has been caused to the general scheme on account of the war, it has been necessary to extend the time for completing the coaches, which will not all now be dealt with by the date mentioned.

The bodies of the following cars have been altered:—Motors, 113; driving trailers, 18; and trailers, 215; total, 346; while 98 new sliding-door motor coaches have been completed, and 22 more are approaching completion. For the equipment of the swing-door motor coaches, 75 underframes have been completed and 13 are in hand, while 358 bogies for sliding and swing door motor coaches are finished and 63 are well forward.

In order to provide for the expanding traffic and maintain continuity of work at the Newport Workshops, the Commissioners have approved of 71 additional coaches (36 motors—18 of the swing-door and 18 of the sliding-door type—and 35 trailers) being constructed at a later stage, making a total of 800 coaches for the electric service, and the question of arranging for the electrical equipment of these additional coaches is noted for consideration in due course.

The provision necessary for the traffic during the period of transition from steam to electrical operation has been reviewed, and the necessary steps will be taken in due course.

With the view of affording sufficient suitable rolling stock under electrical operation for the Sunday country excursion services for which Suburban cars are now largely used, it is in contemplation later to design a special type of coach for this class of traffic.

The General Electric Company is proceeding with the electrical equipment of the coaches at Jolimont. Seven new sliding-door motor coaches per month are being furnished to the General Electric Company to be electrically equipped throughout and afterwards stored until required for electric service. In addition, a number of cars are being only partially equipped with the electric apparatus, so as to admit of their use on steam-hauled trains as long as possible. A number of new underframes for the swing-door type of motor coaches are being fully equipped with the electrical apparatus, and the bodies, which are being altered and kept in steam service for the time being, will be mounted on the underframes at a later stage when required for electrical operation.

In order to identify the ends of the coaches it is intended to designate as the No. 1 End the combined guards' and motormen's end of all motor coaches as well as of the driving trailer coaches, and also the smoking end of the non-driving trailers, and as No. 2 the other end. Commencing at

Hopper trucks for coal carriage.

The construction of the 4-wheeled 15-ton hopper trucks to be used for the carriage of slack coal from Wonthaggi has been commenced, and two pattern trucks completed at the Newport Workshops have been tested with satisfactory results over the 160 feet radius curves at the Power House. It is estimated that 200 hopper trucks will ultimately be required, and the construction of the first 50 is well forward.

Trucks for ashes.

When the Power Station is in full operation $3\frac{1}{2}$ "QR" truck loads of ashes will require to be removed daily, and 20 additional "QR" trucks, which will be necessary to compensate for the trucks that will be utilised for this purpose, have been arranged for.

Repair train for overhead equipment.

The question of obtaining special cars for the inspection and repair of the overhead contact lines has been reviewed, and no action will be taken in the direction of obtaining self-propelled cars for the purpose until experience has been gained with the first electrically equipped line.

For constructional and heavy overhead equipment repair work steam locomotives and suitably fitted "H" and "Q" trucks will be utilised, and altogether four trains will be required for the erection of the overhead equipment. Of these two have been completed at the Newport Workshops and the balance will be available shortly.

The question of obtaining a motor vehicle to quickly traverse the public roads with staff and appliances for the purpose of effecting emergency repairs to the overhead equipment has been noted for consideration. Action is not contemplated, however, until experience has been gained under electrical conditions.

Electric locomotives.

It may be an advantage to obtain some electric locomotives for such purposes as the operation of goods trains in the Suburban area, for switching in the Melbourne yards, and also to gain experience in view of the possibility of the electrification of some of the more important country lines being found advisable in the future, and the matter has been noted for review at a later stage.

Reconsideration of the question of obtaining an electric locomotive for use at and about the Power Station has, in view of the prevailing industrial conditions, been deferred until the end of 1916. A "T" locomotive altered to admit of its negotiating the sharp curves at the Power Station sidings has been provided, and this will meet all requirements for some time to come.

Provision has been made for the erection of electrical overhead equipment at the Power Station sidings, and along the line from Spotswood to the Power Station.

Motor parcels trains.

It may be desirable later on to obtain several motor parcels coaches to relieve the ordinary Suburban trains of parcels traffic on the busier lines, and the matter is noted for attention.

Oil tank trucks.

Two 3,300-gallon tank trucks, fitted with motor pumps, will be required for the conveyance of oil for the electrical apparatus (transformers) between the Power Station oil store and the Sub-stations, and the drawings having been approved by Mr. Merz their construction has been taken in hand. Tenders will be invited locally for the pumps.

Uniform gauge.

The electric motors and equipment are being constructed with sufficient clearance to admit of the bogie frames being closed in on each side, in the event of the Victorian Railways being converted to the 4 ft. 8 $\frac{1}{2}$ in. gauge.

Car cleaning.

Improved arrangements for cleaning the coaches, including raised platforms on each group of lay-by sidings, have been provided at Flinders Street.

In order to assist the General Electric Company with the electrical equipment of the coaches, it has been arranged for the Rolling Stock Branch to execute odd jobs for which the Department possesses superior facilities, and to debit the cost to the company. In such cases the Contractors' supervising engineer will submit a written request, and will thereupon be notified of the charges proposed, after which debit will be raised against the company by the Chief Accountant.

Arrange-
ments with
General
Electric
Company.

The question of obtaining some accumulator cars for runs outside the electrified area has been noted for consideration at a later stage.

Accumula-
tor cars.

The question of providing accommodation at outside terminals for the motormen and guards is under consideration. With the exception of one or two places the existing accommodation will probably be found to be sufficient.

Motormen's
accommo-
dation at
outside
terminals.

SUBSIDIARY SCHEMES.

The agreement with Mr. Merz provided that he should submit schemes for the supply of electrical energy to the following places, viz. :—

Places to be
equipped.

Spencer Street Lighting Station	Newport Signal Shops
Newport Rolling Stock Shops	Ironwork Shops at Spencer Street
North Melbourne Repair Shops	and for the
Worksmaster's Shop, Arden Street	Electric Lighting of Stations in the
Elwood Tramway Power Station	Suburban area,

but by mutual consent this has been modified to the extent, that whilst Mr. Merz will provide for the supply of the Workshop Motors, and of power in the Sub-stations, the Department will execute the detailed work of installation.

Departmental Officers calculated the demand for electric power at the respective Workshops, and the number and capacity of the motors for operating the machines, and this information was supplied to Mr. Merz, who provided for the supply of power.

The tender of Messrs. J. H. Holmes & Co., England, for the supply of motors on a schedule of rates basis, has been accepted, and two instalments, comprising 84 motors, have been ordered for the Newport Workshops and the Jolimont Car Repair Shed. Of these motors 10 are under construction, while the material for the balance has been marshalled; but owing to Messrs. Holmes & Co. being a controlled establishment busily engaged on munitions orders, progress has been slow. The total commitments under this contract amount to £8,642.

The motors are being obtained on a general specification in order to secure uniformity of type; and under the arrangement, not only the Newport Workshops and the Jolimont Car Shed can be equipped, but also any other Workshops which it may be decided to provide with an electric drive.

The scheme contemplates the establishment of Sub-stations at the Newport Workshops and the Newport Signal Shops to supply power to the Workshops machinery and the conversion to Sub-stations, linked up with the Newport Power Station system, of the existing Electric Light Station at Spencer Street and the Power House at Elwood; but on account of the difficulties created by the war in obtaining electrical equipment, and the financial stringency, only the works most urgently required have, so far, been taken in hand, viz., the erection of Sub-stations at the Newport Workshops and Elwood respectively, the former to meet the increasing demand for power at the Workshops, and the latter to supply the needs of the St. Kilda-Brighton Electric Street railway.

Arrange-
ments for
installing
schemes.

The following position has been reached in connection with the various schemes :—

SPENCER STREET ELECTRIC LIGHT STATION AND ELWOOD TRAMWAY POWER HOUSE.—The tender of the British Westinghouse Electric and Manufacturing Company, at £15,502, has been accepted for the supply of the rotary converters and frequency changers, necessary on account of the conversion of these places to Sub-stations deriving electrical energy from the Newport Power Station.

The design of the Elwood Sub-station has been agreed upon with Mr. Merz, and the building is in course of erection by the Department, by day labor, on portion of a reserve situated on the St. Kilda side of the present Power House. The Sub-station is being erected apart from the existing buildings, so that the Department may retain control of the power supply in the event of the St. Kilda-Brighton electric street railway being transferred.

to a central tramway authority for the Metropolis. This is advisable on account of the Sub-station being connected with the main railway power supply system, while at the same time it will be a satisfactory business proposition both to the Department and the Tramway authorities as current can be supplied for the street railway at a rate profitable to both parties. The building will be equipped with a 10-ton overhead travelling crane, and in view of the possibility of the street railway being later vested in a central authority, the range of the apparatus has been altered from 500-550 volts to 550-600 volts at an extra cost of £81, so as to harmonise with the Malvern Tramway Trust equipment.

The Chief Electrical Engineer has in preparation particulars of the alterations that will be required at the Spencer Street Electric Light Station.

NEWPORT WORKSHOPS.—Mr. Merz is to provide for everything necessary up to and including the low tension switchboard in the Workshops Sub-station, the Department to make all arrangements from that point into and about the Workshops. He has also ordered, under current contracts, the transformers and switchgear necessary for the equipment of the Sub-station.

The Sub-station building, in which ample provision has been made for increased electrical capacity, is under erection by the Department, by day labor.

The 20,000 volt cables will be laid underground from the Newport Traction Sub-station into the Workshops Sub-station, the feeder cables from which to the distribution boxes will be carried partly underground and partly overhead.

The Chief Mechanical Engineer will carry out the installation of the motors and wiring at the Workshops, and has prepared revised particulars of the number and capacity of the motors required.

NEWPORT SIGNAL SHOPS.—A small Sub-station similar to that for the Newport Workshops will be required to supply the power required, and the Chief Engineer of Way and Works will install the motors, and the Chief Electrical Engineer the cables and other electrical apparatus necessary, and execute all repairs. As the work is not at present of an urgent nature, it has been deferred, and the question of putting it in hand will be reconsidered at the end of the year.

IRONWORK SHOPS, SPENCER STREET; WORKSMAN'S SHOP, ARDEN STREET.—The Chief Engineer of Way and Works and the Chief Electrical Engineer will, when the time arrives, decide as to the motors required and their arrangement; while the installation and subsequent supervision of the motors and electrical equipment generally will be attended to by the Electrical Engineering Branch.

NORTH MELBOURNE ROLLING STOCK REPAIR SHOPS, NORTH MELBOURNE LOCOMOTIVE SHOPS AND SPEED RECORDER SHOP, AND DUDLEY STREET CAR SHED.—The Chief Mechanical Engineer will specify the motors required and erect them, but in other respects the installation of the electric drive will be carried out by the Chief Electrical Engineer, who will also arrange for the subsequent supervision of the electric plant. The work will not, however, be put in hand for some time to come.

MELBOURNE GOODS SHEDS.—The question of installing electric cranes, telfers, capstans, and other labor saving appliances at the Melbourne Goods Sheds has been gone into, and a general scheme prepared so that appropriate sections may be put in hand when the opportune time arrives. The specification for the motors and their installation and supervision will be attended to by the Chief Electrical Engineer.

ELECTRIC LIGHTING OF SUBURBAN STATIONS.—Mr. Merz was supplied with a statement of the amount of lighting required, calculated on the basis of 100 candle power of light for each 60 feet of platform, plus a 30 per cent.

allowance for approaches, offices, &c., and he concluded that the best way to provide the power necessary is to install a small converter and storage battery at each station, the current to be taken from the train contact line. The cost was estimated at £300 per station, but as this scheme is regarded as somewhat expensive, the question of devising some cheaper system is under investigation.

Experiments, to determine the most suitable arrangement of the lamps, were conducted at Kensington station.

Any scheme which it may be decided to adopt will be under the control of the Chief Electrical Engineer.

Power for
subsidiary
schemes.

Mr. Merz has made the requisite provision at the Power Station, and in connection with the transmission cables and the high tension switchgear at the Sub-stations, for the provision of power, from the main railway supply, to operate the minor subsidiary schemes and the various electrical appliances likely to be installed throughout the Electrification area.

To provide for the possibility of overhead conductors being erected on the track structures for the transmission from the Sub-stations of power for lighting and motive purposes, it has been agreed that the signal boxes and signals shall be placed so as to afford the maximum space for the wires.

The question of the price per unit at which the power for operating should be debited to the subsidiary schemes, and credited to the main Electrification scheme, is engaging attention. In his Report in 1908 Mr. Merz stated that power for the subsidiary schemes should be charged for at the supply meters at $\frac{1}{2}$ d. per unit on the low tension side.

AUTOMATIC SIGNALLING.

Before electrical operation can be commenced on any of the Suburban lines, it is necessary for the existing track circuits, which are operated by direct current, to be altered to alternating current, and this constitutes a large proportion of the work necessary for automatic signalling which is to be installed on all the lines prior to their Electrification.

Progress
summary.

One of the essential appliances required is the track feed box, of which about 200 are necessary for the Sandringham-Essendon line, and as the Contractors have, owing to the pressure of War work, fallen behind in their deliveries, the matter was taken up with Mr. Merz, who was able to make arrangements which it is expected will prevent this section interfering with the general progress of the scheme.

The procedure for carrying out the installation of automatic signalling on the sections of the Suburban lines to be equipped was discussed with Mr. Merz, when it was mutually agreed that a modification of the clause in his agreement relating to automatic signalling is desirable, to enable the work of placing in position the whole of the signalling apparatus and interconnections beyond the point at which power for their operation will be taken from the signalling feeder cables to be carried out entirely by the Department, which will also obtain any signalling apparatus not already provided for in the tenders let under Mr. Merz's supervision. Mr. Merz will, however, continue to supervise the installation of the switchgear and power signalling generators in the Sub-stations, and the laying of the signalling feeder cables.

Arrange-
ments with
Mr. Merz.

Mr. Merz will inspect before shipment materials supplied under existing or future contracts, arranged through him, or as may be desired in respect of additional equipment obtained directly by the Commissioners.

Tenders were accepted by Mr. Merz for the supply of the following apparatus necessary for the conversion of the track circuits on the respective lines:—

Supply of
automatic
signalling
equipment.

Track relays—

British Pneumatic Signal Co.	£8,094
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Track resistances—

McKenzie, Holland and Westinghouse Co.	1,548
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Track feed boxes, including signal transformers, switchgear and accessories—

A. Reyrolle and Co.	17,260
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Impedance bonds—

British Pneumatic Signal Co.	8,023
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Signal cabin transformers—

Ferranti Limited.	789
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Subsequently additional tenders were arranged locally as under:—

Track transformers—

Australian General Electric Co.	351
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Kerite insulated wire—

R. W. Cameron and Co.	4,755
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Lead-covered twin wire—

Western Electric Co.	18,600
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Electric point and lock detectors—

McKenzie and Holland Limited	3,988
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Relays for point indication—

Australian General Electric Co.	2,979
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Electric signalling machines—

R. W. Cameron and Co.	15,964
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Three-position 2-element alternating current relays—

R. W. Cameron and Co.	3,863
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Electric train stop machines—

R. W. Cameron and Co.	9,908
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Fuse blocks, porcelain base and fuse clips—

R. W. Cameron and Co.	494
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The relay boxes, 110 volt track feed boxes, lever circuit controllers, and other considerable sections of the automatic signalling equipment will be made at the Signal Shops, Newport.

In addition, options were included in many of the abovementioned contracts to enable further supplies of apparatus to be obtained when required for other lines, and in the contracts arranged locally Mr. Merz will, where necessary, and where they are manufactured abroad, arrange for the inspection of the apparatus and materials before shipment.

As a matter of convenience and economy, it was arranged that the jointing of the cables for the transmission of power to operate the signalling equipment be carried out by the Contractor for their supply (The British Insulated and Helsby Cables Ltd.).

In order to prevent delay in the equipment for automatic signalling of the Sandringham-Broadmeadows line, arrangements were made with Mr. Merz to obtain 48 transformers for the electrical operation of signals at present manually controlled from signal boxes which, under any system of automatic working, would be manned by signalmen on account of the proximity of level crossings or points, and the tender of Messrs. Ferranti Ltd. of England, at £789, was accepted for their supply. Additional switchgear will be required to work in conjunction with these transformers, and Mr. Merz has arranged for this under the optional provision in the contract with Messrs. Reyrolle & Co., and also for a number of the signalling testing instruments necessary.

Considerable quantities of the signalling equipment arranged for in the contracts referred to above have been received.

An electro-mechanical frame has been erected at the new junction, South Yarra, and similar apparatus will be installed at all new and renewal interlockings on electrified lines (with the exception of the dense traffic area between Jolimont Junction and North Melbourne Junction, where it may be advantageous to introduce all-electric or electro-pneumatic apparatus).

Lines to be
equipped.

All the two, four and six-track Suburban lines are to be equipped with track block and automatic stops, and complete or intermediate automatic signals (according to the circumstances), before they are electrified, the sections being:—

1. Flinders Street to Sandringham.
2. Flinders Street to Broadmeadows (including the Flemington Racecourse Branch).
3. Flinders Street to Williamstown.
4. Flinders Street to St. Kilda.
5. Flinders Street to Port Melbourne.
6. North Melbourne Junction to Coburg.
7. South Yarra to Caulfield.
8. Caulfield to Dandenong.
9. Caulfield to Frankston.
10. Prince's Bridge to Clifton Hill.
11. Clifton Hill to Reservoir.
12. Royal Park to North Fitzroy.
13. Westgarth to Alphington.
14. Footscray to St. Albans.
15. East Camberwell to Ringwood.
16. Richmond to East Camberwell *

* To be taken in hand after regrading.

A metallic return circuit will be provided on the single lines within the electrified area where the electric staff or tablet systems are in operation, while no alteration will be made at present in connection with the signalling arrangements on the single lines which are operated by ordinary train staff.

The provision of a cab signal system in the suburban area will not be considered until a system suitable for alternating current operation has been developed and tested.

Electric trains and steam locomotives running within the Suburban area will be equipped with tripping apparatus for operating in conjunction with the automatic stops.

Arrangements in connection with the tripping apparatus train stop arm, etc.

The tripping apparatus will be fitted to the leading left hand axle box of each motor and driving trailer car, and in a suitable place on the steam locomotives that will traverse the suburban area, and all the detailed arrangements in connection with the equipment of the rolling stock have been put into train.

The same type of trip apparatus is to be installed on both steam locomotives and electric trains, but while it is desirable for the steam locomotives to be equipped with trips concurrently with the operation of the electric trains, no diminution in the existing margin of safety will result if it be not practicable at the outset seeing that two men are available on the steam trains, which are also subject to a speed limitation of 40 miles per hour within the Suburban radius.

The type of trip to be adopted is being investigated, and a sample constructed at the Newport Workshops, with which tests will be made under operating conditions on the Williamstown Racecourse line.

The apparatus provides for power to be automatically cut off the motors simultaneously with the application of the brake through the operation of the trip.

The train stop arm when in the vertical position will project approximately four inches above the top of the running rail. The engaging surface will measure about six inches at right angles to the rail and the centre will be about 13½ inches from the gauge line. Safety appliances will, by means of a reverse governor, prevent a train from being started unless there is air in the brake system, and will also necessitate two men being at the driving end when the automatic trip valve is out of order.

Tests to determine the distance required to stop a train with emergency and service applications of the brake were conducted with a train consisting of two motor and two trailer coaches fitted with the brake equipment which will be used under electrical conditions, and with all the electrical gear except the pantograph, the cars being detached from a locomotive by means of a slip coupling and brought to a stop either by the automatic train stop or by an ordinary application with the driver's valve in the motor coach.

Braking basis and spacing of signals.

The overlap, i.e., the minimum distance between the automatic stop and a possible obstruction on the line must be arranged to suit the majority of the trains passing over the section, i.e., electric trains in the case of the suburban lines. This distance will be insufficient for steam trains if running at the same speed as electric trains, and it will therefore be necessary to impose upon them a speed restriction while they are passing through the dense traffic area in which train stops are in use so that the braking distance provided may be sufficient to ensure the stoppage of such trains within the overlap allowed.

The maximum speed on down grades within the suburban area, which is being taken as a basis, is 52 miles per hour.

Arrangements have been made:—

- (a) For Mr. Merz (through Mr. Grove) to arrange with the General Electric Company, who are the Contractors for the electrical equipment of the coaches, for the supply, erection, and connecting up on the electrical side of the reverse governor and the guard's releasing switch.
- (b) For the Department to manufacture and erect the trip, the trip valve, air piping, and hose connections between the emergency relay valve and the trip valve and the reverse governor.

Arrangements made for obtaining tripping apparatus.

Line of demarcation between the branches.

The train stop apparatus, which co-acts with the signal, and all connections thereof are to be supplied and fixed by the Way and Works Branch.

The tripping apparatus necessary to effect the automatic application of the air brake is to be supplied and fixed :—

(a) To the electric cars by the Rolling Stock and Electrical Engineering Branches ;

(b) To the locomotives by the Rolling Stock Branch.

Each Branch will be responsible for the maintenance to the proper gauge and alignment of the respective sections of the equipment under its control.

Savings due to automatic signalling.

Considerable savings will be rendered possible by the abolition of signal boxes, etc., and, although the details are not yet available, it appears from an estimate that has been prepared that they will be sufficient to meet the interest charges on all or nearly all of the capital cost of the signalling scheme, without taking into consideration the advantages derivable from the safer and more elastic system of signalling that will be afforded.

Provision of additional signalling apparatus in the Sub-stations.

Provision has been made in the contracts with Messrs. Siemens Brothers' Dynamo Works Limited for the motor generators, switch gear, and other signalling apparatus required in the Sub-stations at Princes Bridge, Newmarket, Middle Brighton, Caulfield, Newport, and North Fitzroy. The question of obtaining the signalling equipment necessary for the remaining Sub-stations at Seaford, Mentone, Springvale, North Fitzroy, Albion, Glenroy, Reservoir, Mitcham and Macleod will be reconsidered later, having been deferred on account of the rise in prices and the difficulty in obtaining apparatus.

General progress of the work.

Following is a brief summary showing generally the progress of the work :—

As a result of braking distance tests, a retardation factor was agreed upon for the electric rolling stock which gave a basis for the spacing of the signals.

The interlocking at South Yarra and certain automatic signals approaching that junction were brought into use on 3rd October, 1915, and are being temporarily operated by direct current.

The immediate installation between South Yarra and Caulfield of three-position automatic signals operated by direct current has been approved, and arrangements are in hand for the execution of the work.

Regulations governing the working of three-position signals have been compiled and the employees instructed.

Arrangements have been made to harmonise the overhead equipment and signalling arrangements by providing combined track structure and signal bridges wherever practicable.

A plan showing the proposed signalling arrangements between Middle Brighton and Sandringham has been agreed to, and preparations are in hand for the equipment of this section.

A general programme for dealing with the central area between Richmond and North Melbourne is in preparation.

The sites for signals on the St. Kilda, North Melbourne-Coburg, Royal Park-North Fitzroy, North Melbourne-Essendon, Richmond-Sandringham, Flinders-street Viaduct and North Melbourne-Williamstown lines have been tentatively planned and will be co-ordinated with the overhead equipment arrangements.

The installation of an electric interlocking machine at Brighton Beach has been approved, and tenders have been received for the apparatus.

The trunking to contain the signalling cables has been completed between Sandringham and Flinders-street, North Melbourne and Essendon, and on the Caulfield and Flemington Racecourse lines, and is in course of installation along the Williamstown line.

Designs have been prepared for electric lever locks and circuit breakers for use with mechanical levers, and for signal lamps, relay boxes, 110 volt track feed boxes, etc. Part of this apparatus will be obtained by contract, but most of the work will be done at the Newport Signal Shops.

Tenders have either been accepted, or will shortly be advertised, for the supply of transformers, electric lamps, relays, time release mechanisms, direct current battery machines, and miscellaneous apparatus.

Considerable quantities of 2,200 volt and 110 volt signalling cable have been delivered, and Mr. Merz has been requested to expedite the delivery of track feed boxes, signal cabin transformers, and the cabin switchgear necessary for the Sandringham-Essendon and Flemington Racecourse lines.

The oil driven sets for generating current to operate temporarily the signalling equipment until power is available from the main railway supply have been erected in position, and when the switchgear, for the supply of which arrangements have been made, is available, it will be practicable to put the generators into commission. Two of these sets have been erected at South Yarra and two at Middle Brighton, where they are under the control of the Engineer of Signals.

The signalling cables will be placed in wooden trunking alongside the tracks, this system having been adopted for reasons of economy, as the estimated cost of placing the cables underground was about £1,431 per mile more than if they were laid in trunking.

Accommodation for the automatic signalling fitters will be provided alongside the motormen's lecture theatre, and the building will be constructed so as to be capable of having another storey added to it if necessary later. It will also be uniform in design with the other structures in the vicinity.

£39,000 has been provided in the Loan Application Act for 1915-16, towards the cost of installing automatic and power signalling.

Provision of funds.

The various lines within the Electrification area are being inspected by a special sub-committee to determine the action necessary respecting each level crossing prior to the inauguration of electric traction. The reports submitted for the Sandringham-Essendon, Williamstown, Port Melbourne, St. Kilda, Coburg and St. Albans lines have been reviewed by the Electrification committee, and the additional interlocking and protection recommended as essential in certain cases and approved by the Commissioners will be provided prior to the commencement of electrical operation, and that required on the Sandringham-Essendon line is now in hand.

Level crossings.

A gate indicator signal interlocked with the gates at level crossings, but distinct from the signals applicable to track block working, has been devised to show the position of the gates both by day and by night, and the question of installing it for the protection of busy crossings as circumstances may require is under consideration.

STAFF ARRANGEMENTS.

Operating staff.

The crew of each train will ordinarily consist of a motorman and a guard, and, in order to be able to take charge in cases of emergency, the latter will require to be trained in portion of the motorman's duties, as will also the shunting staff who will handle the trains in the Metropolitan yards. The motormen will be under the supervision of the Chief Mechanical Engineer, and the guards under the General Superintendent of Transportation.

Training of staff.

An important factor in the successful operation of the electric train service will be the provision of an efficient well-trained operating staff, and the training facilities necessary to ensure their being available at the time required have been determined.

Mr. J. Rist, formerly of the Central London Railway, who has had wide experience as an instructor of motormen, has been engaged by the Department to train the motormen, guards and others, and a lecture theatre, in which will be installed an underframe and bogie completely fitted with the electrical gear, as well as other apparatus and diagrams, is approaching completion at Flinders Street. This lecture theatre will be used for the training of the staff by whom the electric trains will be manned, so that they may become familiar with the apparatus to be operated.

The Flemington Racecourse line will be utilised as a training track for imparting practical instruction to the staff in the operation of the electric trains under actual conditions.

Payment of motormen.

The estimates dealt with by Mr. Merz were based on a wage for motormen of 10s. 6d. per day. Since then, however, the rates for various sections of the staff have been increased, with the result that it has been necessary to fix the wages of motormen at 11s., advancing by increments to 12s. per day.

Staff instruction books.

The altered conditions consequent on the inauguration of electric traction will necessitate the revision of the Book of Rules and Regulations and of the General Appendix and the Working Time Table, and also the issue for the guidance of the staff concerned of additional suitable instruction books. A book is now in preparation embodying, under appropriate headings, directions to the train operating staff generally, while suitable technical books for the different sections of the staff employed at the Power Station, Sub-stations, Jolimont Car Repair Shed, and for the motormen and Way and Works staff will also be issued. Mr. Grove and Mr. Clapp, the Supervising Engineer for the train equipment Contractors, are kindly assisting in connection with the technical details.

An instruction book respecting the 3-position upper quadrant semaphore signals and automatic and speed signalling introduced at South Yarra in October last, has been compiled and issued for the guidance of the staff.

Uniforms.

The motormen will be supplied with uniforms in conformity with the practice of electric railways generally, and in this respect they will be placed on the same basis as the guards.

Motormen's accommodation.

A building is being erected at Flinders Street for the accommodation of the motormen in which is being provided a mess room, lockers and other facilities, and where the men will sign on and off when arriving and leaving work. The building has been designed so as to admit of an additional storey being added when the expansion of traffic or other circumstances necessitate it.

Mr. Merz's staff in Melbourne for the carrying out of the Electrification scheme consists of:—

Engineering staff.

Mr. E. P. Grove, Chief Superintending Engineer.
 Mr. A. Horton, Power House Engineer.
 Mr. H. N. May, Rolling Stock Engineer.
 Mr. T. C. Christianson, Sub-station Engineer.
 Mr. P. A. McGee, Overhead Equipment Engineer.

while the following are the Supervising Engineers in Melbourne for the Contractors:—

Mr. W. P. Ward, The British Insulated and Helsby Cables Ltd.
 Mr. F. B. Clapp, Jun., The General Electric Company.
 Mr. W. A. Reynolds, Messrs. Babcock and Wilcox.
 Mr. W. J. Greaves, Messrs. Parsons and Co. Ltd.
 Mr. W. H. Williams, Messrs. Siemens Bros.' Dynamo Works Ltd.

The question of at a later stage taking into the service of the Department some of the engineers, viz.:—Messrs. Horton (Power Station), May (Rolling Stock) and Christianson (Sub-stations), at present on Mr. Grove's staff, to supervise under the Chief Electrical Engineer the operation of various sections of the installation, has been noted for determination later.

The Clerks of Works provided by the Commissioners to assist Mr. Grove and his staff in the supervision of contract works are being returned on Departmental pay rolls, but are under the sole control of Mr. Grove and his staff. The following number have so far been provided:—

Clerks of Works.

Power Station, 2; Overhead Equipment, 1; Cable Laying, 1.

The Clerks of Works selected for the different sections of the scheme will be available for engagement in connection with the operation of the plant, the installation of which they will supervise.

Qualified electrical working staff will be required at the Newport Power Station, Car Repair Shed, Overhead Maintenance Depot, and the various Sub-stations, and as sufficient trained men may not be readily obtainable, the Chief Electrical Engineer is looking into the matter.

Provision of trained electrical staff.

Three qualified men will be required at the outset to supervise the gangs for the inspection and overhaul at the Car Repair Shed of the rolling stock, electrical and other equipment, and steps are being taken to ascertain whether men with the requisite technical knowledge are available within the Department. They will be designated Leading Hand Examiners (Electric Stock).

With the object of assisting the Department in the training of the staff for operating and maintenance, some of the Contractors for the supply of electrical equipment have offered to employ Departmental workmen in the erection of their apparatus to enable them to obtain the requisite experience. The principle has been adopted, and the Chief Electrical Engineer is ascertaining what suitable employees are available for the purpose.

ACCOUNTS AND PROVISION OF FUNDS.

Funds.

The following provision for Electrification and allied schemes was made in the several Loan Application Acts passed since the authorisation of the work:—

	1913.	1914.	1915.	1916.
Electrification ...	£300,000	£649,863	£1,289,003	£675,000
Automatic and Power Signalling	—	25,000	58,000	89,000
Subsidiary Schemes ...	—	3,000	50,500	33,000

Periodical statement of accounts.

A statement of accounts showing the extent of the contract liabilities in connection with the Electrification works is being furnished periodically by the Chief Accountant. The approximate total commitments to 31st March, 1916, were:—

Electrification ...	£2,404,446
Automatic Signalling ...	156,574
Subsidiary Schemes ...	54,901

Expenditure

The total booked expenditure actually debited on 31st March, 1916, was reported by the Chief Accountant to be:—

Electrification ...	£1,509,901
Automatic and Power Signalling...	54,241
Subsidiary Schemes ...	18,237

Arrangements with the Agent-General.

It has been arranged with the Under-Treasurer that the Agent-General shall be supplied with sufficient funds to meet all liabilities arising in London in connection with the Electrification scheme.

Apportionment of cost.

The cost of the various Electrification works undertaken by the Department is analysed by a special sub-committee of officers to ascertain the apportionment necessary as between Electrification and Ordinary Capital and Working Expenses.

A scheme has been prepared for recording on a suitable basis the cost of constructing new rolling stock and altering existing stock for electric traction.

Payment of fees to Mr. Merz.

The agreement with Mr. Merz was entered into by direction, and with the approval of, the Government, and the fees payable were expressly agreed upon between the Government and Mr. Merz and are claimed to be below those usually paid to engineers for similar large works.

The agreement provides that Mr. Merz shall be paid fees on all the work including approved extras in connection with the scheme, with the exception of the construction of new coaches and the alteration of existing coaches, the amount of Customs duties, and the alterations to bridges, verandahs, cost of the branch line to the Yarraville site, etc.

£1,200 per month is being paid to the credit of Mr. Merz in London. The additional payment of £400 per month in Melbourne was discontinued at his request as from the 1st January, 1916.

The total payments to 31st March, 1916, for fees were £73,700, and for cables, printing, etc., £3,286.

Comparison of cost.

Arrangements have been made for a special record to be kept showing the particulars essential to enable the actual cost of each section of the Electrification scheme, including rolling stock, to be compared with Mr. Merz's estimate. It has also been arranged that all costs involved in the Electrification scheme which are provided for in Mr. Merz's estimate be recorded for comparative purposes, whether debited to capital or working expenses.

Mr. Merz has supplied various details of the estimates contained in his Traction Report, and also a statement showing the commitments at the latest practicable date under the various contracts entered into through him.

A committee, representing the Rolling Stock, Way and Works, Transportation, Electrical Engineering, and Accountancy Branches, was appointed to consider what modifications are necessary in the classification of accounts to suit the Electrification scheme, particularly to enable comparisons of cost in certain respects to be made with other electric railways. A draft scheme has been prepared and is under consideration.

Classification of accounts.

Provision is made in Mr. Merz's estimate for an Antiquation Fund for the Power House plant, and it is intended when the time arrives to take the requisite steps to obtain the Legislative authority necessary. The object of the fund is to enable capital expenditure to be written off in the event of more efficient apparatus becoming available at some future date. Mr. Merz did not consider further provision necessary, because the efficiency of the Substation and other electrical equipment admits of practically no improvement.

Antiquation fund.

Certain obligations are imposed on the Commissioners under the respective contracts, and these are being arranged for in the regular course. Machinery has been devised in conjunction with Mr. Grove for giving effect to the provisions of the overhead equipment and cable contracts.

Obligations of the Commissioners.

Mr. Merz is being supplied periodically with comparative particulars of the passengers, revenue and train mileage for the Suburban system.

Statistics.

The cost of the scheme will be increased by an amount roughly estimated at £90,000, owing to the increase in Customs duties on electrical and other materials resulting from the tariff alterations, which became effective on 4th December, 1914. The extra duty will require to be reimbursed to the Contractors by the Department, and the procedure to be observed as between the Department, Mr. Grove, and the Contractors, has been defined.

Customs duties.

Arrangements have been made for a record to be kept by the Chief Accountant of the amount of the Customs duties, both ordinary and extra, paid on Electrification materials supplied under the various contracts.

Under the contract the Department is required to reimburse the overhead equipment Contractors the cost of travelling done by their workmen in connection with the overhead equipment of the permanent way, and it has been arranged for these men to be supplied with employees' duty passes.

Passes.

Shortly after the outbreak of war request was received from several of the Electrification Contractors for advances in excess of what they were actually entitled to under the contracts, which provided for a percentage payment on shipment. To prevent as far as possible delay to the Electrification work, it was agreed, on the recommendation of Mr. Merz, to make temporary advances on certain conditions.

Advances to contractors.

In addition, it was agreed that the Commissioners would pay one-half the extra freight and carry one-half the war risk in connection with Electrification shipments.

The procedure to be adopted in connection with the insurance of the equipment against fire, as provided for in the contracts, from the time of delivery on the site until accepted by the Commissioners, has been settled. A joint policy is being prepared in each case which stipulates for the Commissioners to have priority of claim over the Contractors.

Fire insurance.

Various modifications have been necessary in connection with the plant supplied under the respective contracts, giving rise to debits and credits as between the Department and the Contractors. The matter is being kept in view by the Chief Accountant so that equitable adjustments may be made at a later stage.

Contract adjustments.

Arrangements have been made as to the course to be followed in connection with the certification of the final payments under the respective contracts arranged through Mr. Merz.

The contracts entered into through Mr. Merz provide for free railway transport for Electrification materials. Some of the Contractors have interpreted this to imply that the Department is to load and unload the electrical plant on to and from the railway trucks, and as this view is contrary to the Commissioners' intention, which was simply to afford free haulage, and the amount involved is appreciable, the question has been referred to Mr. Merz for decision as provided for in the contract.

Increased
cost through
war.

A record is being prepared showing the estimated increased cost owing to the war of the Electrification works undertaken by the Department.