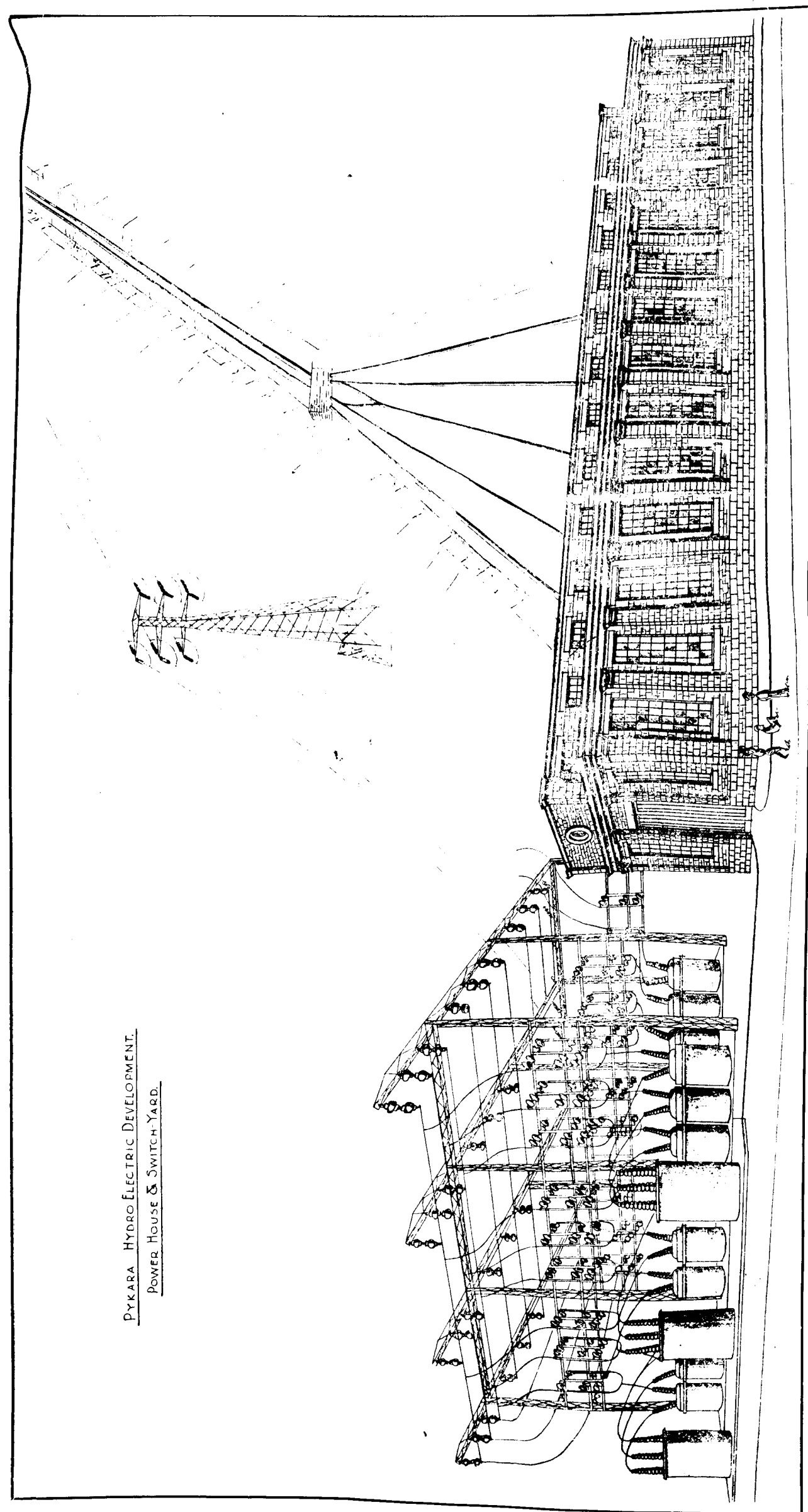




PYKARA HYDRO-ELECTRIC DEVELOPMENT.
POWER HOUSE & SWITCH-YARD.

SUPPLEMENT TO THE GENERAL REPORT

ON THE

PYKARA HYDRO-ELECTRIC DEVELOPMENT

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SUPPLEMENT TO THE GENERAL REPORT ON THE PYKARA
HYDRO-ELECTRIC DEVELOPMENT.

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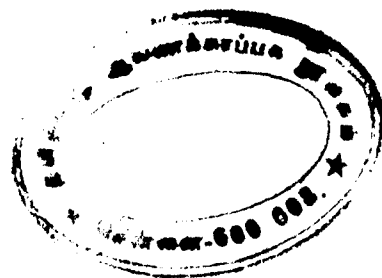
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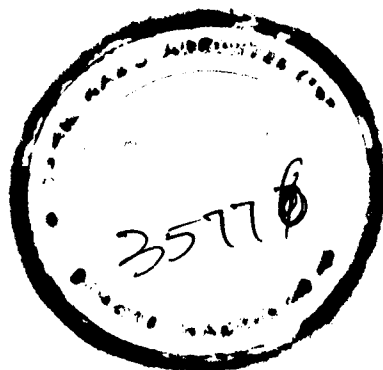
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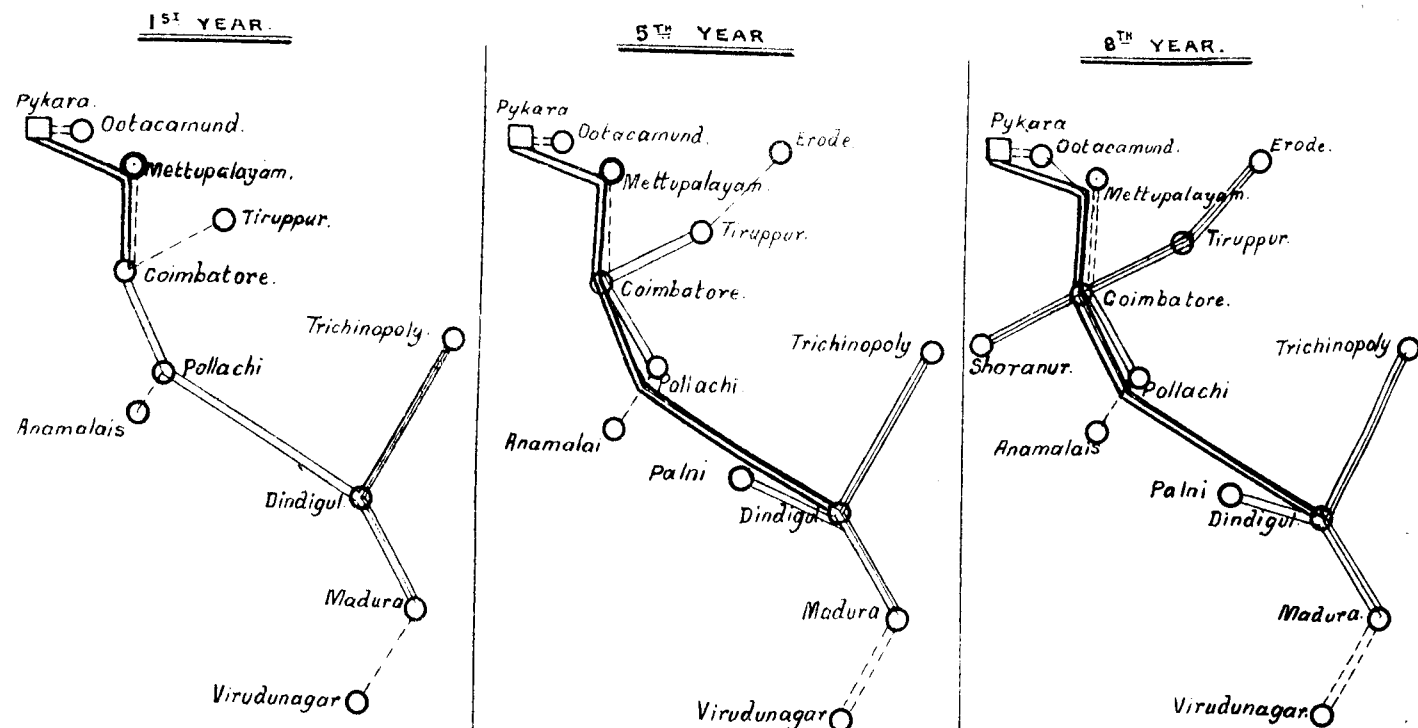
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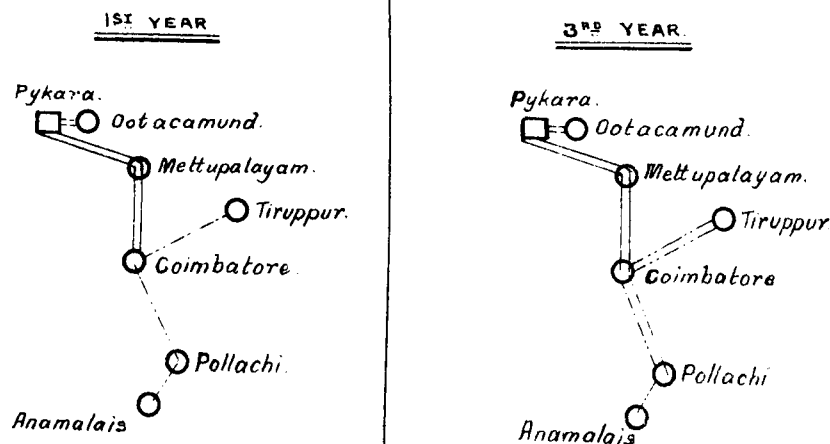
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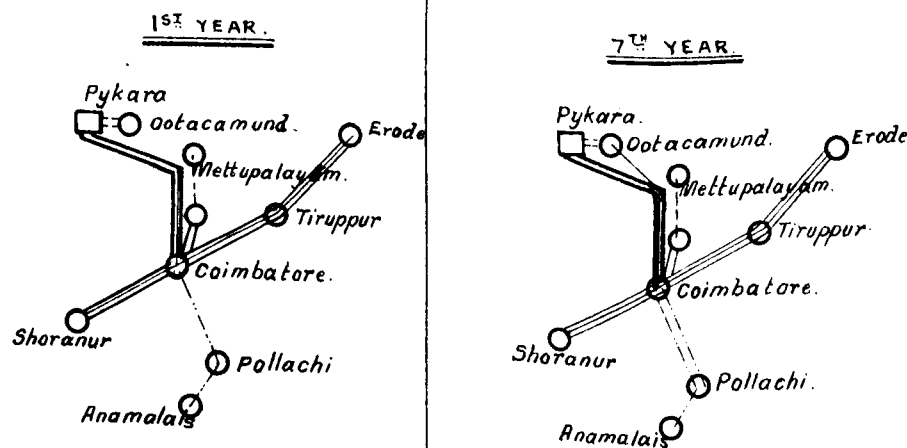
SCHEME "A".



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REFERENCE.

- 110. K.V. Line. Double circuit.
- 66 K.V. Line. " "
- 22 K.V. Line. Single " "
- 11 K.V. Line. " "
- Sections of Railway Electrified.

- Main Power House.
- Sub-station.

SUPPLEMENT TO THE GENERAL REPORT ON THE PYKARA HYDRO-ELECTRIC DEVELOPMENT.

FOREWORD.

Since the Pykara General Report was written a certain amount of progress has been made. The construction of the Glen Morgan Project has been sanctioned, and contracts awarded, the latest quotations for machinery and equipment have been received from the Power Securities Corporation and it has also been possible to carry out a preliminary survey of the Ghat section of the main transmission line. The report on the electrification of the South Indian Railway by their Consulting Engineers, Messrs. Robert White & Partners, has recently been issued and recommends the electrification of certain sections of the Railway.

With this information available the methods of developing the Pykara Catchment have been revised, and all estimates checked again.

As a result, revised estimates for Scheme* (a) have been prepared, and two more Schemes (c) and (d) have been drawn up as alternative developments.

In order that the progress of the studies of the Pykara Development may be available in a continuous form it is proposed not to change the last Edition of Parts I, II and III of the Pykara General Report, but to show the results of succeeding studies by the compilation of a supplementary report which is now submitted for the consideration of Government.

Scheme (a)—(Revision).—It should be noted that to be absolutely up to date it is necessary constantly to revise the designs and estimates of such projects as Pykara, so long as no construction work has been sanctioned.

Capital Expenditure.—For the power plant, transmission line and sub-stations, the major items in the estimates are machinery and equipment, the prices of which vary quite frequently. Firms rarely give close quotations, which are good for more than three months. Hence estimates must tend to vary. Civil Engineering works are different. Rates for labour and the material used, are not usually subject to such constant fluctuations.

It may be of interest to note that, after several months of detailed surveys, careful estimating and designing, the total cost including interest for the first stage development of scheme (a) is Rs. 240 lakhs, whilst the Introductory Report, completed in November 1927, gave a total of Rs. 239.5 lakhs.

Power Demand.—The recent examination of the load possibilities in the Nilgiris indicates that the original estimates of power demand in this district should be exceeded after the first year or so.

Additions have been made lately to the installed horse power in Coimbatore, and the load forecast has been increased accordingly.

No allowance was made in the original report for agricultural load, but recent experience in the Nilgiris and Mysore tends to show that a certain amount of this load can easily be obtained in the Coimbatore District, and near the projected 11 K. V. and 22 K. V. lines.

The following nomenclature has been adopted in this Supplement as being very convenient:—
Scheme (a) of the Pykara Hydro-Electric Development is the one based on Programme (a) of the South Indian Railway electrification.
Similarly Schemes (b) and (d) are the ones based on Programmes (b) and (d) respectively of the South Indian Railway electrification.
Scheme (c) however assumes no main line railway electrification.

Reference.	Drawn. K. R.	DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT, MADRAS.	No. <u>P. 56.</u> <u>F. 1.</u>
	Traced. <u>G. S.</u>		
Revision.	Checked. <u>M. S. Mani</u>	PYKARA H.E. DEVELOPMENT.	Scale:
	Approved. <u>G. S.</u>	POWER SYSTEM LAYOUT- SCHEMES "A, C & D".	Date: 7-12-28.

In view of the above, a very modest demand of 150 K. W. has been assumed as approximating the requirements of the agriculturists at the outset, increasing slowly in succeeding years.

The figures for Madura and the other districts remain the same, as the necessary staff was not available to carry out a load survey. It is reasonable to suppose, however, that the capacity of the mechanical horse power installed in these districts has also increased in the last two years.

Power Rates.—The average rates for power have been decreased in the later years in order that the consumer may receive power at all times just above cost. These rates, however, could easily be increased without affecting the progress of electrical development to any marked extent. The revenue in later years could hence be safely increased if it was considered that the return on the investment in the tenth year was not sufficiently attractive.

Operating Expenses and Depreciation.—The revision has resulted in the operating expenses being slightly increased during the first few years of operation, while the depreciation fund has also been increased to allow for the larger capital expenditure.

Financial Results.—There is not a very marked difference in the financial results.

Attention is again directed to the instructions of Government to allow six per cent for interest during construction, which is not only higher than that which is actually charged to projects, but renders the schemes, as submitted, less attractive.

In order to give an idea of the results under actual conditions, financial statements have been prepared with $5\frac{3}{8}$ per cent rate of interest which was the rate fixed by the local Government for 1927-28 for Irrigation and other Capital Outlay.

Statements with 6 per cent interest rate as required by rules have also been prepared.

It may be mentioned that the South Indian Railway allow only 4.75 per cent on construction capital in all electrification projects which are being submitted at present to the Railway Board.

Estimates.—The revised estimates together with the new financial statements for Scheme (a) are given in Section 1. The capital cost in the tenth year is no Rs. 320.75 lakhs against the previous figure of Rs. 296.44 lakhs. This will compare with Rs. 335.38 lakhs given in Messrs. Merz & Partners' recent report of this scheme. The financial return is now 8.75 per cent in the tenth year against the previous figure of 9.43 per cent.

If Messrs. Merz & Partners' figures for capital expenditure, depreciation and operating expenses are substituted, the equivalent return is 7.54 per cent.

The initial capital commitments are as follows :—

	Gross outlay. RS.	Credits. RS.	Net outlay. RS.
First year of construction ...	21,35,000	11,52,780*	9,82,220
Second year of construction ...	55,38,000	...	55,38,000
Third year of construction ...	1,08,50,000	...	1,08,50,000
Fourth year of construction ...	36,36,300	1,77,000†	34,59,300
	2,21,59,300	13,29,780	2,08,29,520

This scheme is now recommended for sanction by Government. It has been examined carefully by this Department, and Messrs. Merz & Partners, Consulting Engineers to the Railway Board, have also studied it and given their general approval. The railway demand on which it is based has every chance of materializing since Messrs. Robert White & Partners definitely recommend

* Expenditure incurred on the Glen Morgan Project.

† Credits for construction plant and building materials.

programme (a) of electrification in their Report. The returns that can be expected from the scheme are attractive and Government can embark on the scheme with confidence.

It is, however, important that no more delay must take place if the Pykara development is to be a commercial success.

A further postponement will only tend to increase the cost of construction, make the power market less favourable for development, and electrification in general more difficult and costly to bring about.

The load of the most immediate importance is that of the Mills in Coimbatore, and the owners have been led to believe for some time that a start was to be made to bring cheap electric power to the District. One group of mills has had a reserve of Rs. 5,00,000 put aside for past few years for electrification, while another has stated in its prospectus that the power installation is being laid out to take Pykara power. Unless some definite action is taken in the near future, the reserve of Rs. 5,00,000 will obviously be spent on an independent power-plant for the factory. Other mills, who wish to modernize their installations, will undoubtedly follow suit.

It would therefore appear that unless Government are prepared to sanction the construction of the scheme now, the idea of any hydro-electric development in this area should be definitely dropped for some time.

As the construction of the Glen Morgan Project is under way, certain plant, temporary buildings, and the nucleus of an experienced construction staff are available. It will thus be most convenient, and result in an appreciable economy, if the work can proceed uninterruptedly by the sanction of the construction of a scheme for the Pykara Project.

In view, however, of the important part which the Railway demand plays in the development, it has been considered prudent to examine the effect on the scheme of certain possible contingencies.

Messrs. Merz and Partners in their recent report on the Pykara scheme to the Railway Board, while giving general approval to it and recommending certain additions to the sub-station equipment do not give any indication as to the attitude which they will adopt towards the proposals of Messrs. Robert White and Partners to electrify certain sections of the South Indian Railway. It is understood that these are being examined, but a decision on the matter by the Railway Board cannot be expected for some months to come.

At the same time, for reasons mentioned already it will not be advisable to further postpone Pykara development. In the circumstances it was decided to anticipate all decisions possible for the Railway Board to come to and to provide for them in the designs. The decisions can be—

- (1) to electrify what has been recommended by the Consulting Engineers to the South Indian Railway, viz., the Trichinopoly-Madura section, Dindigul-Podanur and Erode-Podanur-Shoranur-Mettupalayam sections, or
- (2) to electrify only the Erode-Podanur-Shoranur-Mettupalayam sections, or
- (3) not to electrify any main line at all.

Scheme (a) provides for the first contingency. Modifications of scheme (a) have been worked out as scheme (d) for the second contingency, and as scheme (c) for the third. These are so designed that the transition from scheme (a) to either of them will be easy and can be effected, when the Railway Board decision is known, without loss of time or material. The hydraulic works, however, have been kept the same as in scheme (a) as it is not considered good policy to reduce the capacity merely to take care of immediate needs.

Scheme (b) involving Railway electrification programme (b) may be taken as superseded by scheme (d).

Scheme (c).—Briefly, this scheme contemplates, what may be considered, minimum programme of development, without limiting the complete utilization of the Pykara catchment whenever the load demand may justify further extensions. No main line railway electrification is assumed.

It allows for the distribution of power in the Nilgiris, and the Coimbatore area, including also Mettupalayam, Pollachi, Tiruppur, and a small block of railway load, which may be either the electrification of the Nilgiris Railway or the Podanur shops with the pumping and lighting load at all stations near the projected lines, or both. A certain amount of agricultural load is also expected. The details of the scheme are given in Section 2.

The design of the hydraulic works, except for details, is the same as for previous schemes.

However the design of the works from the forebay down has been modified to meet the requirements of the scheme as now presented.

The penstocks, for instance, are smaller, but additional ones may be added later to suit the load demand. Similarly the size and number of the generating units have been reduced, but the possibility of increasing the capacity of the power house in general has been taken into account. For the present provision has been made for 2—5,000 K.W. units with a third unit to be added in the third year of operation. The three units may be installed in the first year, if desired, without affecting the financial results to any marked degree.

The voltage of the transmission lines to Coimbatore has been fixed at 66,000 volts, but the clearances on all the towers and sub-station structures will permit an increase to 110 K.V. whenever required. This naturally involves a more expensive transmission line than is necessary for the actual requirements of the Scheme, and a certain amount of non-productive investment is involved, but is unavoidable.

The general design and lay-out of the present scheme follows very closely those already described as (a) and (b), and Parts I, II, and III of the General Report should be referred to for further technical details.

The results show that the Pykara Catchment may be developed independent of any main line electrification and yet be classed as a productive work.

The initial net capital commitments are only Rs. 1,08,60,060, which would be spent approximately as follows:—

	Gross outlay. RS.	Credits. RS.	Net outlay. RS.
First year of construction ...	19,50,000	11,52,780 *	7,97,220
Second year of construction ...	27,80,000	...	27,80,000
Third year of construction ...	60,50,000	...	60,50,000
Fourth year of construction ...	13,94,840	1,62,000 †	12,32,840
	<u>1,21,74,840</u>	<u>13,14,780</u>	<u>1,08,60,060</u>

The work is expected to be completed in two and a half years, from the completion of the Glen Morgan Project, provided that the Scheme is sanctioned by April 1929.

With this capital expenditure in mind, a brief visit to the Nilgiris and Coimbatore should convince any business man that, irrespective of financial statements and load forecasts, it would be well nigh impossible for such a modest hydro-electric development to prove a "white elephant" to the Government, always provided that reasonable efficiency and energy were shown in the construction and operation of the property.

In passing, it might be stated that if the capacity of the hydraulic works were reduced, a power house was erected at the end of the steepest part of the penstock profiles giving a head of about 2,000 feet, and the transmission line structures were designed for 66 K.V. only, the estimates could have been decreased by about 30 lakhs. Such a design cannot be recommended as it limits the capacity of the ultimate development of the catchment to a point much below its potential possibilities.

Scheme (d).—Another modification of scheme (a) called scheme (d) is outlined showing how the electrification of Shoranur-Erode-Podanur-Mettupalayam section

* Expenditure incurred on the Glen Morgan Project.

† Credits for construction plant and building materials.

of the South Indian Railway may be allowed for. The designs have been so drawn up that this scheme could easily be evolved out of schemes (a) and (c). The details are given in section 3.

The hydraulic works are just the same as for scheme (c) as also the penstock. The power house units are, however, bigger and correspond to those in scheme (a). Three 7,500 K.W. units are provided for the present.

The voltage of the transmissions line to Coimbatore would be 110 K.V., and the distribution of power will be as in scheme (c), but will include in addition supply to Erode and Shoranur. Eventually Cochin and Calicut may come in and the load demand would then possibly warrant the installation of two additional generating sets.

The initial net capital expenditure for this Scheme will be Rs. 1,65,17,130 and it would be spent as follows:—

	Gross RS.	Credits. RS.	Net outlay. RS.
First year of construction ...	20,90,000	11,52,780*	9,37,220
Second year of construction ...	37,82,000	...	37,82,000
Third year of construction ...	97,50,000	...	97,50,000
Fourth year of construction ...	22,24,910	1,77,000 †	20,47,910
	<u>1,78,46,910</u>	<u>13,29,780</u>	<u>1,65,17,130</u>

A net return of 6.46 per cent is expected at the end of the tenth year of operation.

Either of the schemes (c) or (d) have the following advantages:—

(a) The system will be a very compact one, ensuring a very reliable electric power service. The stability of the system is improved and the regulation problem is simplified.

(b) It will be easier to train an operating staff and there will be less liability of mistakes during the first few years of operation than would be the case on a more complicated system. The confidence of the public can therefore be more easily secured.

(c) Efforts can then be concentrated on a development east and west which is more natural than towards south which is best taken up by another project, probably in the neighbourhood of the Palnis.

Two or three projects in this region should be investigated. If it is found that a feasible water-power development is possible in the Palni Hills or Periyar, the Madura and Trichinopoly districts may be electrified independently of Pykara. At a later stage a tie line would be constructed between the two systems and a most flexible and reliable transmission system would result. Practically every town would have an alternative power supply.

Future developments.—From a perusal of the report of the Consulting Engineers to the South Indian Railway already referred to, it is noted that a study of the electrification of the Erode-Jalarpet section of the railway would probably show attractive results. It would therefore not be unreasonable to assume that the electrification of this section might be undertaken at some future date. With the electrification of this section assured, the minimum amount of load necessary at Madras in order to economically justify the extension of the transmission lines to that port, could be reduced and no difficulty should be experienced in obtaining the required amount. In fact as soon as the main Pykara Scheme is actually under construction an attempt will be made to secure the guarantee of sufficient load in Madras to warrant the construction of the transmission line.

This step would involve the installation of at least one large generating unit in the main Pykara power house and a possible increase in the main voltage to 132 K.V. In order to ensure a continuity of supply, it may be necessary to make

* Expenditure incurred on the Glen Morgan Project.

† Credit for construction plant and building materials.

arrangements to rent or acquire a certain proportion of the existing steam plant at Madras as a standby and emergency station.

Further studies may warrant the construction of "development" stations. Such stations would consist, where feasible, of a small hydro-electric development of special design and economically constructed, to develop the local load and create a demand for power until such time as the main transmission system would be extended to the particular district. Once the main transmission lines had arrived, the smaller station would either be reconstructed with one large generating unit and used as a standby and emergency plant, also for voltage regulation, or the plant and machinery could be dismantled and used elsewhere. Mettur may possibly develop into such a station and investigations are now in progress to find out if another could be established nearer to Madras, in the Javadi Hills.

The Pykara transmission system would then extend from Calicut and Cochin on the West Coast to Madras on the east, with emergency plants for most sections.

To Summarise—1. Government are recommended to approve of the construction of scheme (a) in the immediate future for the reasons mentioned on page 3. By this step they will not have committed themselves to this scheme only, but will be free to modify it to suit other conditions as they may arise. The initial capital expenditure * is Rs. 219.82 lakhs. The return † is 8.75 per cent.

2. The hydraulic works being the same for all schemes, construction work can proceed forthwith and nearly a year will elapse before it will be necessary to order the machinery.

During this period the Railway Board and their Consulting Engineers should be able to decide upon the details of the future electrification programme, if any, of the South Indian Railway.

3. If the Railway Board adopt the recommendations of the Consulting Engineers to the South Indian Railway and electrify programme (a), further work on scheme (a) can be undertaken and there will have been no loss of time.

4. If the Railway Board decide not to electrify any section, scheme (c) can be taken up without difficulty, but once this scheme is constructed it does not appear to be possible to take on any railway load except at an enhanced rate for power. The additional load would necessitate an increase in the line voltage and a consequent extra investment in new equipment.

The initial capital expenditure * is Rs. 120.13 lakhs and the return † 6.33 per cent.

5. If the Railway Board wish to electrify the Erode-Podanur-Shoranur-Mettupalaiyam line, scheme (d) will be taken up and the machinery corresponding will be ordered. There will be no hitch whatever in taking this step from the original sanction for scheme (a). The initial capital expenditure * for scheme (d) is Rs. 176.70 lakhs and the return † is 6.46 per cent.

6. With the restricted schemes (c) and (d), the Madura and Trichinopoly districts are not so easily developed from Pykara and in order that these fairly important industrial areas may soon be electrified it is recommended that investigation for a suitable project in the Palni Hills or Periyar be ordered immediately.

If this leads to a feasible development, Madura and Trichinopoly districts can have power independently of Pykara. Two power systems will then be in operation and before long a tie between them can be effected. The return on the investment should be attractive and a most reliable and stable transmission system will be in operation.

7. The above recommendations should enable an immediate advance to be made and yet offer full facilities for modification to suit all possible contingencies that may arise.

* Inclusive of expenditure on Glen Morgan Project.
† Return in the tenth year of operation on the capital invested including arrears of simple interest—vide paragraph 360 of the Madras Public Works Department Code.

8. A comparative statement of Capital Expenditure, gross Revenue and Net return for the three schemes (a), (c) and (d) is given in Table No. 1 for easy reference. Plan No. P 56 F. 1 shows the system lay-out for the different schemes with the sections of railways electrified.

TABLE No. 1.—Comparative statement giving capital expenditure, gross revenue and net financial return.

	Scheme (a).	Scheme (c).	Scheme (d).
<i>Capital Expenditure—</i>			
First year	Rs. 2,19,82,300	1,20,12,840	1,76,69,910
Tenth year	„ 3,20,75,200	1,32,97,350	1,93,37,450
<i>Gross Revenue—</i>			
First year	Rs. 8,85,888	3,38,160	7,85,830
Tenth year	„ 40,40,490	14,92,260	20,43,660
Net financial return at the end of ten years.	8.75%	6.33%	6.46%

9. If the cost of construction is met by a series of loans, and it is assumed that the inclusive cost of the necessary capital averages 5½ per cent per annum, also that the interest payments are met when due, the annual budget would have to provide for the following approximate charges:—

	Scheme (a).	Scheme (c).	Scheme (d).
	RS.	RS.	RS.
First year of construction ...	78,610	72,970	77,540
Second do. ...	3,04,520	2,12,580	2,54,250
Third do. ...	8,34,360	4,96,110	7,01,280
Fourth (part only) ...	5,95,530	1,63,600	2,39,820
First year of operation ...	7,89,172	5,71,010	4,78,770
Second do. ...	5,84,522	4,79,030	3,31,850
Third do. ...	3,96,302	3,24,000	2,25,010
Fourth do. ...	2,53,500	2,21,050	40,850
Fifth do. ...	1,28,010	1,27,350	Surplus.
Sixth do. ...	Surplus.	15,700	Do.
Seventh do. ...	Do.	Surplus.	Do.
Eighth do. ...	Do.	Do.	Do.
Ninth do. ...	Do.	Do.	Do.
Tenth do. ...	Do.	Do.	Do.

Considering the productive and permanent nature of the works, and the economical benefit which would accrue to the districts served by hydro-electric power, it would appear that the Government by sanctioning the construction of the Pykara Project would not be placing any great burden on the finances of the Presidency. In fact it might be possible to start the construction of another project at the same time.

10. As mentioned in Part III of the General Report, the question of the Railway Board contributing a proportion of the capital cost of the project has been seriously considered in the past.

From an engineering point of view such dual interests may probably lead to complications and delays in the work, and further, Government may have to divide the profits of the enterprise.

It will be far better to treat the Railway Board as a privileged consumer, provided that they render the construction of schemes (a) or (d) possible by agreeing to one of the electrification programmes at an early date. If, on the other hand, Government are obliged to proceed with scheme (c) and the railways decide to electrify after the scheme has been constructed, the ordinary commercial tariff, corresponding to their demand for power, should apply.

December 1928.

H. G. HOWARD.

SECTION 1—SCHEME (a)—REVISION.

Scheme (a) of the Pykara Development is based on the assumption that Programme (a) of the South Indian Railway electrification will be taken up namely,

First year—Electrification of the Trichinopoly-Madura Section and Railway shops at Trichinopoly.

Fifth year—Electrification of Dindigul-Podanur Section.

Eighth year—Electrification of the Erode-Podanur, Shoranur-Mettupalaiyam and the Nilgiri Section.

The revision of the scheme consists principally in bringing up to date the power demand forecast and the estimates of capital expenditure and revenue given in Part II. The outlines and designs of the scheme remain the same as before. As mentioned in the Foreword the latest quotations for machinery and equipment received from the Power Securities Corporation, the actual contract rates for hydraulic works in the Glen Morgan Project construction and the results of the transmission line survey recently completed made such a revision necessary.

Drawing No. $\frac{P. 56}{F. 1}$ shows the lay-out of scheme as it progresses.

Power Demand and Revenue.—Additions have recently been made to the installed horse power at Coimbatore and the total is now 7,240 against 6,200 given in previous reports based on 1927 figures. The load and revenue forecast has been modified accordingly and is given in Table No. 2. For convenience an abstract is given in Table No. 3 below.

TABLE No. 3.

A.—Demand at the distributing end, revenue estimate, and return per unit.
Scheme (a).

Year of operation.	Demand K. W.	Distributed K.W.H.	Estimated revenue from bulk supply.	Average return per K.W.H. sol
First	6,160	23,006,600	RS. 8,85,888	ANNA. 0.615
Second	8,820	29,240,400	11,46,628	0.628
Third	11,960	37,112,000	14,98,118	0.648
Fourth	13,300	43,879,400	17,91,060	0.653
Fifth	15,740	57,544,000	22,44,010	0.623
Sixth	16,580	63,107,650	24,86,030	0.631
Seventh	17,690	70,382,100	27,81,680	0.634
Eighth	22,220	94,622,300	35,35,240	0.598
Ninth	23,340	100,843,900	37,54,350	0.596
Tenth	24,770	109,793,780	40,40,490	0.590

B.—Power house load details.

Scheme (a).

Year of operation.	Demand K.W.	Generated K.W.H.	Average load K.W.	Load factor.
First	7,040	25,563,000	2,930	PER CENT.
Second	10,090	32,489,000	3,710	40
Third	13,700	41,236,000	4,710	37
Fourth	15,200	48,755,000	5,530	34
Fifth	17,990	63,938,000	7,300	36
Sixth	18,940	70,120,000	8,000	40
Seventh	20,220	78,202,000	8,930	42
Eighth	25,380	105,136,000	12,000	44
Ninth	26,640	112,049,000	12,800	47
Tenth	28,280	121,993,000	13,940	48

TABLE No. 2.
SUMMARY OF POWER DEMAND.
Scheme (a).

	First year.				Second year.				Third year.						
	Demand at S.S. K.W.	L.F. at S.S.	Consumption, K.W.H.	Average rate.	Revenue.	Demand at S.S. K.W.	L.F. at S.S.	Consumption, K.W.H.	Average rate.	Revenue.	Demand at S.S. K.W.	L.F. at S.S.	Consumption, K.W.H.	Average rate.	Revenue.
1. Coimbatore	2,193	21	4,040,000	0.78	RS. 1,84,400	3,290	21	6,060,000	0.68	2,57,500	4,387	22	8,538,000	0.68	RS. 3,64,200
2. Tiruppur	233	18	372,000	0.93	21,620	349	18.5	562,000	0.93	32,670	510	18.5	820,000	0.93	47,660
3. Pollachi	160	18	252,000	0.93	14,780	245	18	387,000	0.93	22,500	316	18	499,000	0.93	29,000
4. Anamalais	140	15	186,000	0.93	10,800	215	15	287,000	0.93	16,680	290	15.5	395,000	0.93	22,960
5. Railways	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6. Agricultural	...	...	...	...	...	150	15	200,000	1.3	16,250	175	15	230,000	1.3	18,700
7. Nilgiris...	370	23	752,000	1.4	65,800	415	25	902,400	1.2	67,700	455	26	1,038,000	1.2	77,800
8. Total, Coimbatore division	3,096	...	5,602,000	...	2,97,380	4,684	...	8,398,400	...	4,13,300	6,138	...	11,550,000	...	5,60,320
9. Demand on S.S. diversity factor	2,893	...	...	...	...	3,970	...	...	...	...	5,330	...	...	...	...
10. Dindigul and Palni	160	18.5	228,000	0.93	13,250	320	16.5	456,000	0.93	26,510	390	16.5	567,000	0.93	32,960
11. Trichinopoly	215	21	391,600	0.93	22,770	430	21	784,000	0.83	40,670	540	21.5	1,012,000	0.83	52,490
12. Madura	1,120	20	1,945,000	0.73	88,740	2,580	21	4,762,000	0.68	2,02,400	4,760	22	9,143,000	0.68	3,88,600
13. Total, Industrial	1,495	20	2,564,600	0.778	1,24,760	3,330	...	6,002,000	0.52	2,69,580	5,690	54	10,722,000	...	4,74,050
14. Railways	2,510	51	11,350,000	0.50	3,54,688	2,540	51	11,350,000	0.50	3,54,688	2,540	51	11,350,000	0.50	3,54,688
15. Workshops	530	75	3,490,000	0.50	1,09,060	530	75	3,490,000	0.50	1,09,060	530	75	3,490,000	0.50	1,09,060
16. Total, Madura division	4,565	...	17,404,600	...	5,88,508	6,400	...	20,842,000	...	7,33,328	8,760	...	25,562,000	...	9,37,798
17. Demand on S.S. diversity factor	3,910	...	...	...	...	5,560	...	...	...	...	7,610	...	...	...	...
18. Total, system load	6,650	...	23,006,600	0.615	8,85,888	9,530	...	29,240,400	0.628	11,46,628	12,940	...	37,112,000	0.648	14,98,118
19. Demand on P.H. diversity factor	6,160	...	...	...	...	8,820	...	...	...	...	11,960	...	...	...	...
Power House.															
20. Average load, K.W.	...	...	2,930	...	...	...	...	3,710	...	...	...	...	4,710	...	...
21. Average load factor, per cent	...	...	40	...	...	...	...	37	...	...	...	...	34	...	...
22. Total generation, K.W.H.	...	...	25,563,000	...	...	...	...	32,489,000	...	...	...	...	41,236,000	...	...
23. Peak load, K.W.	...	...	7,040	...	...	...	...	10,090	...	...	...	...	13,700	...	...
24. Estimated Revenue, Rs.	...	...	885,888	...	...	...	...	11,46,628	...	...	...	...	14,98,118	...	...

Overall average load efficiency generator bus to H.T. substations 90 per cent.
" peak
Diversity factor generator to H.T. substations 1.24.

TABLE No. 2—cont.
SUMMARY OF POWER DEMAND.
Scheme (a).

	Fourth year.				Fifth year.				Sixth year.						
	Demand at S.S. K.W.	L.F. at S.S.	Consump- tion, K.W.H.	Average rate.	Revenue.	Demand at S.S. K.W.	L.F. at S.S.	Consump- tion, K.W.H.	Average rate.	Revenue.	Demand at S.S. K.W.	L.F. at S.S.	Consump- tion, K.W.H.	Average rate.	Revenue.
1. Coimbatore	4,700	25	10,282,000	0.88	4,36,800	5,140	27.5	12,338,000	0.88	5,21,400	5,400	30	14,189,000	0.88	6,03,000
2. Tiruppur	585	20	1,024,500	0.93	59,550	668	21	1,230,000	0.93	71,500	750	22.5	1,478,000	0.83	76,680
3. Erode	195	20	341,500	0.93	19,850	222	21	410,000	0.93	23,830	250	22.5	492,670	0.93	28,640
4. Pollachi	355	20	623,800	0.93	36,260	405	21	746,000	0.93	43,360	430	22.5	847,600	0.93	41,270
5. Anamalais	820	17.5	493,800	0.93	28,700	340	20	196,000	0.93	34,640	370	21	680,600	0.93	39,570
6. Railways, Podanur-Dindigul	...	...	...	...	...	1,835	51	9,200,000	0.47	2,40,880	1,835	51	8,200,000	0.47	2,40,880
7. Agricultural	193	16	270,000	1.30	21,900	200	17.5	310,000	1.20	23,250	200	20	350,000	1.00	21,880
8. Nilgiris	505	27	1,195,000	1.20	89,600	550	28	1,349,000	1.20	94,900	575	30	1,511,000	1.20	1,13,300
9. Total	6,853	...	14,280,600	...	6,92,080	9,360	...	25,179,000	...	10,56,780	9,810	...	27,748,870	...	11,73,220
10. Demand on S.S. Diversity factor 1.15.	5,970	...	...	...	...	8,140	...	...	...	...	8,530	...	...	...	...
11. Dindigul	430	18	680,400	0.93	39,560	445	20	780,000	0.93	45,340	455	22.5	898,080	0.83	46,680
12. Trichinopoly	615	22.5	1,214,400	0.83	62,980	665	25	1,460,000	0.83	75,750	685	27.5	1,675,800	0.83	86,960
13. Madura	5,220	25	11,429,000	0.68	4,85,700	5,720	27.5	13,800,000	0.68	5,86,500	6,260	30	16,458,000	0.68	6,99,500
14. Total Industrial	6,265	24	13,323,800	0.707	5,88,240	6,830	27	16,040,000	0.706	7,07,590	7,410	29	19,033,780	0.70	8,37,150
15. Railways	2,800	51	12,436,000	0.50	3,90,160	2,800	51	12,456,000	0.47	3,66,860	2,800	51	12,485,000	0.47	3,66,860
16. Workshops	584	75	3,840,000	0.50	1,20,000	584	75	3,840,000	0.47	1,12,800	584	75	3,840,000	0.47	1,12,800
17. Total Madura Division	9,649	...	29,648,800	...	10,98,400	10,214	...	32,365,000	...	11,87,250	10,784	...	35,358,780	...	13,12,510
18. Demand on S.S. Diversity factor 1.15.	8,400	...	...	...	...	8,880	...	...	...	...	9,380	...	...	...	...
19. Total system load	14,370	...	48,879,400	0.653	17,91,060	17,020	...	57,544,000	0.623	22,44,010	17,910	...	63,107,650	0.631	24,86,030
20. Demand on P.H. Diversity factor 1.08.	13,300	...	...	...	...	15,740	...	...	...	...	16,580	...	...	...	...
Power House.															
21. Average load K.W.	...	...	5,530	...	...	...	...	7,300	...	...	...	...	8,000	...	...
22. Average load factor per cent	...	...	36	...	...	...	...	40	...	...	...	...	42	...	...
23. Total generation K.W.H.	...	...	48,755,000	...	...	...	...	63,938,000	...	...	...	...	70,120,000	...	...
24. Peak load generation K.W.	...	...	15,200	...	...	...	...	17,980	...	...	...	...	18,940	...	...
25. Estimated Revenue Rs.	...	...	17,91,060	...	...	...	...	22,44,010	...	...	...	...	24,86,030	...	...

Power House.

TABLE No. 2—cont.
SUMMARY OF POWER DEMAND.
Scheme (a).

	Seventh year.					Eighth year.					Ninth year.					Tenth Year.				
	Demand at age S.S. K.W.	L.F. at S.S.	Consumption, K.W.H.	Average rate.	Revenue.	Demand at age S.S. K.W.	L.F. at S.S.	Consumption, K.W.H.	Average rate.	Revenue.	Demand at age S.S. K.W.	L.F. at S.S.	Consumption, K.W.H.	Average rate.	Revenue.	Demand at age S.S. K.W.	L.F. at S.S.	Consumption, K.W.H.	Average rate.	Revenue.
1. Coimbatore	5,750	32.5	16,318,000	0.68	6,93,000	6,110	35	18,766,000	0.98	7,97,500	6,700	36	21,112,000	0.98	8,97,800	7,230	37.5	23,751,000	0.66	9,79,500
2. Tiruppur	806	24	1,685,000	0.83	87,940	803	25	1,954,000	0.83	1,01,400	945	26.5	2,194,000	0.83	1,13,900	1,024	27.5	2,469,000	0.73	1,12,550
3. Erode	269	24	565,000	0.93	32,840	267	25	651,000	0.93	37,840	315	26.5	731,000	0.93	43,480	341	27.5	823,000	0.93	47,840
4. Pollachi	440	24	967,200	0.83	50,180	485	25	1,000,000	0.83	65,040	515	26	1,173,000	0.83	68,850	525	27.5	1,285,400	0.83	65,800
5. Anamalais	400	22	770,900	0.93	44,810	420	23	846,100	0.93	40,180	440	24	925,100	0.93	53,700	460	25	1,005,100	0.83	52,130
6. Railways— (a) Podanur-Dindigul (b) Erode-Shoranur (c) Mettupalayam-Ookkamund.	1,835	51	8,200,000	0.47	2,40,880	2,018	51	9,020,000	0.45	2,53,680	2,018	51	9,020,000	0.45	2,53,680	2,018	51	9,020,000	0.45	2,53,680
7. Shoranur	...	...	...	...	...	3,446	51	15,400,000	0.45	4,33,130	3,446	51	15,400,000	0.45	4,33,130	3,446	51	15,400,000	0.45	4,33,130
8. Agricultural	212	21	390,000	0.93	22,670	223	22	430,000	0.93	3,780	190	12.8	135,000	0.93	3,780	270	13.4	201,000	0.93	56,240
9. Nilgiris	610	31	1,057,000	1.20	1,24,300	650	33	1,878,000	1.20	1,40,860	715	33	2,065,000	1.20	1,54,940	787	33	2,272,880	1.20	1,70,430
10. Total	10,342	...	30,563,100	...	12,97,220	15,502	...	52,070,100	...	19,53,650	16,350	...	55,230,900	...	21,01,650	17,151	...	58,984,880	...	22,13,610
11. Demand on S.S. Diversity factor 1.15.	8,960	...	...	...	...	13,470	...	...	...	...	14,220	...	...	...	...	14,920	...	...	...	...
12. Dindigul	465	25	1,012,300	0.83	52,480	480	27	1,138,000	0.83	59,030	495	29	1,257,000	0.83	65,540	526	30	1,377,800	0.83	71,500
13. Trichinopoly	735	30	1,927,300	0.83	96,970	775	32	2,168,300	0.83	1,13,000	820	34	2,442,000	0.72	1,09,500	875	35	2,683,100	0.71	1,10,100
14. Madura	6,750	32	18,936,000	0.68	8,04,600	7,150	34	21,261,000	0.68	9,04,600	7,600	36	23,960,000	0.65	9,73,000	8,100	38	26,948,000	0.64	10,78,600
15. Total Industrial	7,950	31	21,865,000	0.70	9,37,060	8,405	33	24,598,000	0.701	10,76,630	8,915	35	27,659,000	0.685	11,48,740	9,500	37	31,008,900	0.685	13,68,600
16. Railways	3,073	51	13,730,000	0.47	4,03,300	3,073	51	13,730,000	0.45	3,86,100	3,073	51	13,730,000	0.45	3,86,100	3,400	51	15,200,000	0.45	4,20,500
17. Workshops	613	75	4,224,000	0.47	1,24,100	643	75	4,224,000	0.45	1,18,800	613	75	4,224,000	0.45	1,18,800	708	75	4,680,000	0.45	1,37,000
18. Total Madura Division	11,066	...	39,819,000	...	14,84,460	12,121	...	42,552,200	...	15,81,560	12,631	...	45,613,000	...	16,53,700	13,608	...	50,858,900	...	18,26,880
19. Demand on S.S. Diversity factor 1.15.	10,140	...	...	...	...	10,530	...	...	...	...	10,980	...	...	...	...	11,830	...	...	...	...
20. Total system load	19,109	...	70,382,100	0.634	27,81,680	24,000	...	94,622,300	0.698	35,35,240	25,210	...	100,848,300	0.596	37,54,350	26,750	...	109,768,780	0.590	40,40,490
21. Demand on P.H. Diversity factor 1.08.	17,680	...	...	...	...	22,220	...	...	...	...	23,340	...	...	...	...	24,770	...	...	...	...
Power House.																				
22. Average load K.W.	...	...	8,920	...	...	...	...	12,000	...	...	...	...	...	...	...	...	...	13,940	...	...
23. Average load factor per cent	...	...	44	...	...	...	...	47	...	...	...	...	...	...	...	...	...	48	...	...
24. Total generation K.W.H.	...	...	8,202,000	...	...	...	...	105,136,000	...	...	...	...	112,049,000	...	...	...	...	121,903,000	...	...
25. Peak load K.W.	...	...	20,220	...	...	...	...	25,880	...	...	...	...	26,640	...	...	...	...	28,280	...	...
26. Estimated Revenue, Rs.	...	...	27,81,680	...	...	...	...	35,35,240	...	...	...	...	37,54,350	...	...	...	...	40,40,490	...	...

Power House.

It will be noticed that in the revenue estimates the average rates for the larger blocks of power have again been decreased. Recent experience has led to the belief that, if the rates are made a little more attractive than before, it would facilitate and speed up the electrification of the districts under review.

As noted before, a small allowance has been added for agricultural load, but the figures given are merely nominal and should easily be exceeded, provided that proper attention is devoted to load building of this class.

The load prospects in the Nilgiris at present are very favourable, and it is expected to commence distributing power to Ootacamund, Coonoor, and certain Tea Estates by July 1929 from the Glen Morgan Project. For this reason the demand allowed for the main scheme, corresponds to the third year's figures of the original load forecast.

The demand figures for Madura and Trichinopoly districts remain as before.

The Railway demand and the expected revenue are actual figures taken from the latest report of the Consulting Engineers to the South Indian Railways, but do not include the lighting and pumping installations at the more important stations, nor the electrification of the Erode shops.

A small demand for power can be expected in the neighbourhood of Shoranur and Palghat, and has been included in the forecast.

Plan No. ^{P. 22-A}_{F. I.} gives the demand on the Power Station and the installed capacity.

The rates for power which have been assumed are, except for slight modifications, similar to those given in the General Report and are repeated for reference:—

Industrial, 11,000 volt.

Demand—	Maximum demand rate per K.V.A. per annum.		Unit rate per K.W.H.	
	RS.	ANNA.		
75- 99 K.W.	60	plus	0.70	
100- 499 "	60	"	0.60	
500- 999 "	60	"	0.50	
1,000-2,999 "	60	"	0.40	
3,000-4,999 "	60	"	0.35	
5,000 K.W. and above	60	"	0.30	

Railways, 66 K.V.

Combined Demand—				
Up to 4,000 K.V.A.	75	plus	0.25	
4,000 to 8,000 "	75	"	0.20	
Above 8,000 "	75	"	0.175	

It is assumed that all extensions to the distribution system will be constructed by the licensee or customer, or financed independently.

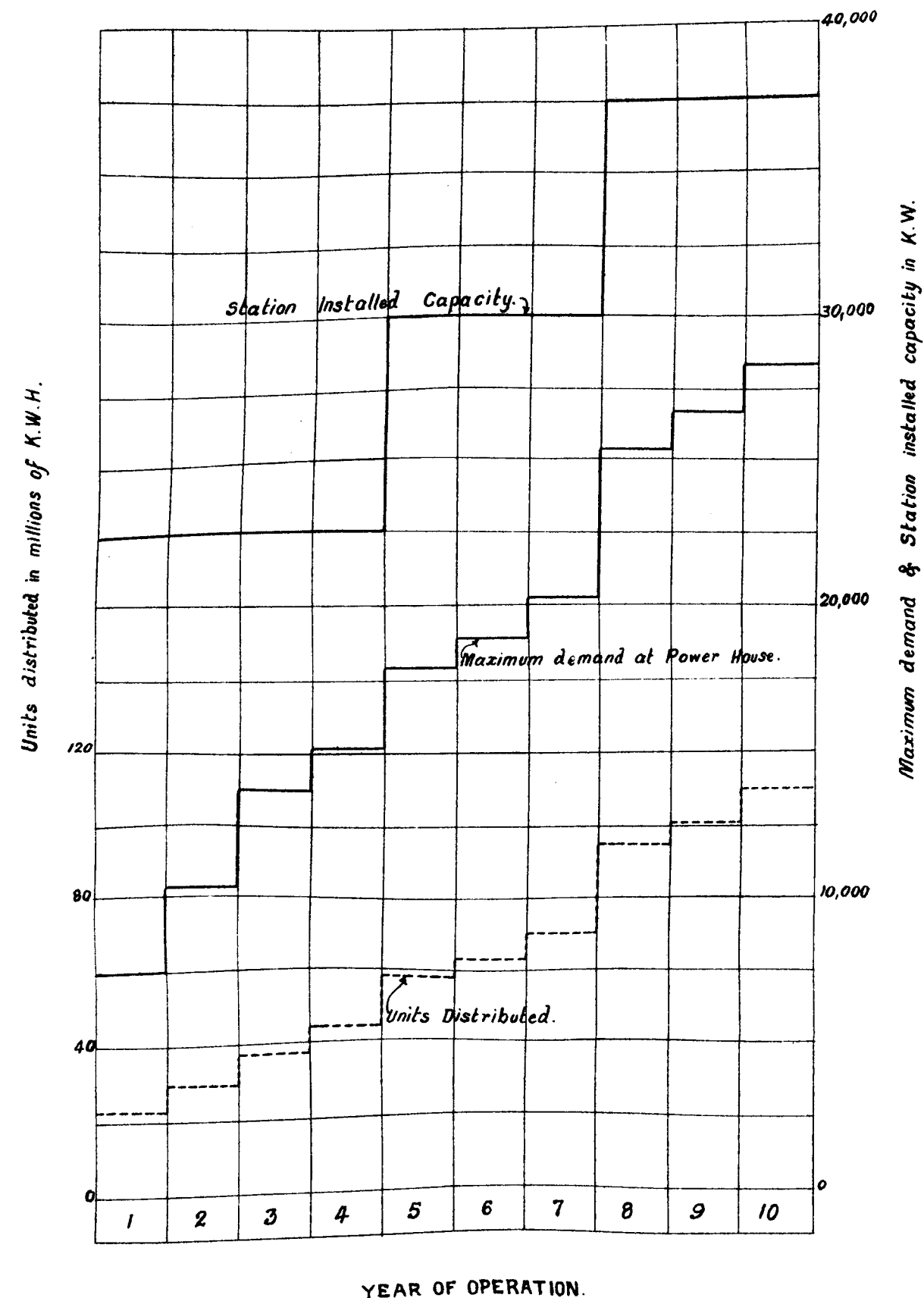
It will be necessary to establish a Mill Conversion Fund. This has already been discussed in Part III, vide page 9.

The approximate capital cost of conversion for this scheme is given below:—

	RS.
Last year of construction	5.00 lakhs.
First year of operation	2.50 "
Second year of operation	1.04 "
Total	8.54 "

This expenditure will be recovered by annual or monthly instalments extending over an agreed period of years.

Hydrology.—The section on the hydrology of the Pykara and other catchments in Part I of the report has been checked, but the results of this year's



R. S. S.
Chief Engineer.

Reference.	Drawn: K.R.	DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT, MADRAS.	No. ^{P. 22 A} _{F. I.}
	Traced: K.R.		
Revision of No. ^{P. 22} _{F. I.}	Checked <i>M. S. Mani</i>	PYKARA H.E. DEVELOPMENT.	Scale:
Dated. 28-4-26	Approved <i>S. S.</i>	POWER DEMAND & STATION INSTALLED CAPACITY. SCHEME "A."	Date: 12-12-26

rainfalls and gaugings, as recorded to date do not indicate any need to modify the theories already advanced and the conclusions arrived at on this subject.

Hydraulic Works.—Except for a few details, it has not been found necessary to modify the designs of the diversion dam, flume, and the upper and lower bunds.

The design of the lower bund was studied again carefully.

The cost of the core-wall is a high proportion of the cost of the finished dam, and a study was made to ascertain if this wall could be avoided altogether or alternatively, redesigned to cost less.

The material to be used in the construction of the dam is good. The upstream part will contain a percentage of clay, and will be nearly impervious. A suitable cut off trench might have reduced the percolation through the foundations, and a stable structure undoubtedly would have resulted.

However the most important factor is seepage, and no earth dam can be considered entirely impervious. At full head an appreciable loss of water could occur through such a dam, although, probably not sufficient to endanger the structure.

The loss of water in high head developments means an appreciable loss of power.

It is quite reasonable to assume, for a well constructed earthen dam of this height and without a core-wall, a loss of 2 cusecs continuously at a full head and yet the stability of the structure would not be endangered provided that it were properly drained.

But a continuous loss of 2 cusecs, with a head of 3,050 feet at the power house, means a loss of over 500-horse power, which is a formidable item. It has also to be borne in mind that the forebay is one of the most important parts of the hydraulic lay-out, and any accident to either bund would completely dislocate the power service.

It was finally concluded that a core-wall was essential for the following reasons :—

The seepage could be reduced to a minimum, leaks prevented, and a better bond made with the natural ground at the flanks.

The outlet works would be carried through the dam with greater safety.

Animals would be prevented from burrowing through the structure.

It would ensure a safe stable structure.

The design of the core-wall was again studied, and it was proposed to use sheet steel piling in order to reduce the cost. Experience has shown however that, apart from the question of durability, such piling is liable to pull apart and become bent in the process of driving. Such a defect might result in leaks and even piping. It was therefore decided to adhere to the original idea of a concrete core-wall.

The capacity of the flume remains the same, although it is more than is actually needed to meet the requirements of the first few years.

The arrangements provided for taking care of both negative and positive surges in the penstocks have been modified, in order to allow a lower draw down in the forebay. With the new elevations 58.8 millions can now be utilized instead of 53.5 millions as originally allowed.

The design for the surge tank is only tentative. The final design will be undertaken when the actual velocities in the penstock have been settled and the characteristics and governing of the impulse wheels are known.

The pipe line and valves are similar to those proposed for the other schemes.

The estimate for the hydraulic works are given in Table No. 4.

Penstocks.—The estimates for penstocks have been raised slightly as a result of recent quotations. The designs remain as before. It may be of interest to add that these designs were submitted some time ago to Messrs. Balfour, Beatty & Co., London, for comments; certain Swiss hydraulic Engineers and high pressure penstock builders were also consulted. They have recently expressed agreement with the design both from an hydraulic point of view and economical cost.

TABLE No. 4.—Estimate for hydraulic works.

Year of operation.	Scheme (a).			
	1st	3rd	After 10th.	
	RS.	RS.	RS.	RS.
Land and preliminary work ...				
Dams and reservoirs—				
Glenmorgan ...	3,00,000			
Makurti ...				
Porthimund ...	3,04,000			
Sandy nalla ...		10,80,000		
Pykara ...			8,90,000	
Main diversion dam				20,00,000*
Flume ...				29,50,000*
Glenmorgan flume	1,10,000			
Auxiliary flume	1,30,000			
Forebay—	41,000			
Upper band ...	36,000			
Lower band ...				
Spillway ...	76,000			
Headworks ...	3,60,000			
Auxiliary forebay ...	20,000			
Permanent buildings and services	2,58,000			
Do. roads and bridges	19,000			
Do. water-supply	3,40,000	6,000	6,000	
Do. tools and equipment	3,92,000	1,23,000	76,000	
Do. light, power and telephone lines	22,000			
Contingencies 5 per cent	38,000			
	68,000	80,000	24,000	
	1,27,000	62,000	49,800	
Sub-total	26,65,000	13,01,000	10,45,800	
Temporary construction plant and tools	3,20,000	70,000	62,000	
Auxiliary power installation	2,58,000			
Lines and transformers	55,000	25,000	22,000	
Camps	2,36,000	57,000	52,000	
General expenses	7,99,000	3,20,000	2,80,000	
Total	43,83,000	17,73,000	14,62,800	
Deduct—Salvage—Auxiliary plant and construction equipment	-1,77,000			
Net cost	41,58,000	17,73,000	14,62,800	49,50,000

* Tentative estimates.

Power House Building.—This will be a steel structure with masonry walls; steel window frames and doors will be used. The type of building on which the estimates are based is shown on the front page of this report.

For other details, Part II of the General Report may be referred to.

Power House Plant.—The estimates have been checked and revised with the prices available from the latest quotations. There is a small increase in cost.

It was found necessary to proceed to the second and third stages of development in the 5th and 8th years of operation as against the 6th and 10th years in the last report.

The revised Power House and Penstock estimates are given in Table No. 5.

Transmission Lines.—Similarly, the estimates for the lines were checked and revised and the results are given in Tables Nos. 6 and 7. There is a small increase in the estimate due to revised costs based on up-to-date quotations. The weights of some of the towers have been increased to be more in accordance with the requirements of Messrs. Merz and Partners, who also questioned the spacing of the towers.

The usual curves for determining the most economical span were constructed from the revised costs, the results being slightly higher than those arrived at in the General Report.

It is, however, proposed to adhere to the original figures. These spacings respond very closely to similar and well designed lines elsewhere and which have been constructed within the last few years.

The mechanical characteristics of the lines are shown in Table No. 9 on pages 19 and 20.

TABLE No. 5.—Estimate for penstocks and power house.

Stage of development.	Scheme (a).		
	I.	II.	III.
Year of operation.	First	Fifth	Eighth
Installed capacity K. W.	22,500	30,000	37,500
	RS.	RS.	RS.
Penstocks ...	24,13,000		
Incline Railways ...	1,60,000		
Buildings ...	3,00,000		
Tail race ...	28,000	1,00,000	1,00,000
Valves and manifold	1,00,000		
Turbines and governors	2,82,000	95,330	95,330
Generators and exciters	5,40,800	1,80,670	1,80,670
L.T. gear and control gear	2,10,500	59,740	59,740
Auxiliaries and feeders	1,26,800	20,800	20,800
Cranes, piping, repair shop, etc.	1,41,000	30,000	30,000
H.T. gear	3,74,900	57,800	57,800
Transformers	2,02,700	67,800	67,800
Outdoor structure	83,000	12,000	12,000
Sub-total	49,62,700	6,24,140	6,24,140
Contingencies 5 per cent	2,48,100	31,210	31,210
Construction plants and tools	2,00,000	50,000	50,000
Temporary camp	1,00,000	25,000	25,000
Sub-total	55,10,800	7,30,350	7,30,350
Engineering and general expenses...	11,84,000	1,60,000	1,60,000
Total	66,94,800	8,90,350	8,90,350

TABLE No. 6.—Average cost per mile of transmission lines.

Section.	Length.	Present voltage.	Span.	Conductor.	Cost of line per mile.
	MILES.	K.V.	FT.	A.C.S.R.	RS.
1. Pykara-Mettupalaiyam	33	110	1,050	37/102	44,400
2. Mettupalaiyam-Coimbatore	22	110	1,050	37/102	41,200
3. Coimbatore-Dindigul	95	110	1,050	6/188	33,700
				+ 7/062	
4. Do.	95	66	1,050	do.	81,900
				do.	
5. Coimbatore-Erode	59	66	750	7/144	25,000
Trichinopoly-Dindigul-Madura	96				
6. Coimbatore-Shoranur	59				
Coimbatore-Pollachi and	24	66	750	7/118	23,100
Dindigul-Palni	32				
7. 11 K.V. Branch lines—Double Circuit.	...	11	...	...	8,700
8. 11 K.V. Branch lines—Single Circuit	...	11	...	...	7,400

TABLE No. 7.— Estimate for transmission lines.

Scheme (a).

Stage.	I.	II.	III.	IV.	Total.
Year of operation.	1st	4th	5th	8th	
Section.	MILES.	RS.	RS.	RS.	RS.
Pykara-Mettupalaiyam ...	33	14,65,200	...	...	14,65,200
Mettupalaiyam-Coimbatore ...	22	9,06,400	...	...	9,06,400
Coimbatore-Dindigul ...	95	30,30,500	1,71,000	...	32,01,500
Trichinopoly-Dindigul-Madura	96	24,00,000	...	...	24,00,000
Pykara-Ootacamund ...	13	1,13,100	...	...	1,13,100
Coimbatore-Mettupalaiyam ...	22	1,02,800	...	28,800	1,01,400
Do. Tiruppur ...	29	5,07,500	2,17,500	...	7,25,000
Do. Pollachi ...	24	...	5,54,400	...	5,54,400
Do. Shoranur ...	59	...	...	13,62,900	13,62,900
Tiruppur-Erode ...	30	...	5,25,000	2,25,000	7,50,000
Pollachi-Anamalais ...	8	59,200	...	...	59,200
Dindigul-Palni ...	33	...	7,82,300	...	7,82,300
Madura-Virudhunagar ...	27	1,99,800	35,100	...	2,24,900
Total ...	...	88,44,500	14,67,900	7,97,400	16,16,500
					1,27,26,800

TABLE No. 8.—Electrical characteristics of transmission lines.

(a) Characteristics of various points on the system on zero load (with all transformers except spares in circuit).

Scheme (a).

Station.	Line Voltage.	Line Current.	P.F.	K.V.A.	K.W.
Pykara ...	103,000	41.2	0.0698 lead	7,348	513
Coimbatore ...	107,900	35.0	0.0436 lead	6,543	285
Dindigul, H.T. ...	110,000	2.6	0.1108 lead	495	55
Dindigul, L.T. ...	66,000	...	...	...	...
Trichinopoly ...	66,333	...	...	...	...
Madura ...	66,150	...	...	...	...

TABLE No. 8—cont.

ELECTRICAL CHARACTERISTICS OF TRANSMISSION LINES.

(b) Characteristics of single circuit from Pykara to Coimbatore for various loads at P.F.=0.9 lag.

Effect of transformers at Coimbatore (except spares) included.

Scheme (a).

Kilowatts.	Line volts.		Line amperes.		K.V.A.		Power factor.		Per cent.	
	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Regulation.	Line drop.
0*	307	109,500	5.25	2.09	...	3.06	0.7760 lead.	0.84	...	...
1,000	1,009	109,200	5.25	14.20	1,111	2,386	0.8665 "	0.84	99.15	-0.72
2,500	2,527	110,400	13.12	16.00	2,778	3,059	0.8261 "	1.60	98.93	0.36
5,000	5,077	112,000	26.25	26.22	5,556	5,086	0.9468 "	3.19	98.54	1.21
10,000	10,180	115,500	52.50	52.50	11,111	10,500	0.9684 lag.	6.45	98.22	5.00
15,000	15,520	119,300	78.75	80.70	16,887	16,670	0.9811 "	9.85	96.65	8.45

(c) Characteristics of single circuit from Coimbatore to Dindigul for various loads at P.F.=0.9 lag.

Effect of transformers at Dindigul (except spares) taken into account.

Scheme (a).

Kilowatts.	Line-volts.		Line amperes.		K.V.A.		Power factor.		Per cent.	
	Dindigul.	Coimbatore.	Dindigul.	Coimbatore.	Dindigul.	Coimbatore.	Dindigul.	Coimbatore.	Regulation.	Line drop.
0*	106	1,07,900	5.25	23.21	...	4,339	0.0.44	0.22.4 lead.	1.22	-2.09
1,000	1,031	1,07,700	5.25	24.9	1,111	3,646	0.22.4 "	0.55.3 "	94.26	-0.55
2,500	2,573	1,09,400	13.12	24.4	2,778	4,626	0.55.3 "	0.89.7 "	97.14	2.18
5,000	5,162	1,12,400	26.25	29.6	5,556	5,762	0.89.7 "	0.95.0 lag.	95.97	8.0
10,000	10,580	1,18,800	52.50	51.2	11,111	10,540	0.95.0 "	0.96.7 "	94.99	8.0
15,000	16,210	1,25,400	78.75	77.2	16,667	16,770	0.96.7 "	0.96.7 "	92.51	14.0

* Note.—In zero load calculations, the power house transformers (except spares) are also included.

TABLE No. 8—cont.

ELECTRICAL CHARACTERISTICS OF TRANSMISSION LINES—cont.

(d) Characteristics of single circuit from Dindigul to Trichinopoly for various loads at P.F.=0.9 lag.
Effect of transformers not included (except for column 12).

Scheme (a).

Kilowatts.		Line volts.		Line amperes.		K. V. A.		Power factor.		Per cent regulation.		Per cent.	
Trichinopoly.	Dindigul.	Trichino- poly.	Dindigul.	Trichino- poly.	Dindigul.	Trichino- poly.	Dindigul.	Trichino- poly.	Dindigul.	Railway load @ 66 K.V.	Commercial load @ 11 K.V.	Efficiency.	Line drop.
										(11)	(12)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
0	...	66,000	65,630	...	9.8	...	1,115	...	...	...	3.03	...	-0.57
1,000	1,040	"	66,590	8.75	10.5	1,111	1,211	0.9 lag.	.8530 lead.	1.46	7.51	96.14	0.90
2,500	2,612	"	67,970	21.88	22.2	2,778	2,813	"	.9997 lag.	3.57	15.13	95.68	2.98
5,000	5,326	"	70,310	43.75	45.5	5,556	5,542	"	.9613 "	7.13		93.89	6.53

(e) Characteristics of single circuit from Dindigul to Madura for various loads at P.F.=0.9 lag.
Effect of transformers not included (except for column 12).

Scheme (a).

Kilowatts.		Line volts.		Line amperes.		K. V. A.		Power factor.		Per cent regulation.		Per cent.	
Madura.	Dindigul.	Madura.	Dindigul.	Madura.	Dindigul.	Madura.	Dindigul.	Madura.	Dindigul.	Railway load @ 66 K. V.	Commercial load @ 11 K. V.	Efficiency.	Line drop.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
0	...	66,000	65,800	...	8.4	...	729	...	...	...	...	...	-0.3
1,000	1,007	"	66,500	8.75	9.00	1,111	1,036	0.9 lag.	0.9711 lead.	1.06	1.72	99.38	0.76
2,500	2,545	"	67,500	21.88	22.20	2,778	2,593	"	0.9813 lag.	2.58	4.29	98.22	2.27
5,000	5,160	"	68,900	43.75	45.80	5,556	5,468	"	0.9438 "	4.71	8.12	96.90	4.41
10,000	10,690	"	71,900	87.50	94.00	11,111	11,690	"	0.9143 "	9.26	16.21	93.50	8.95

TABLE No. 9.

MECHANICAL CHARACTERISTICS OF TRANSMISSION LINES.

A.—Conductors, Ground Wires and Insulators.

Section.	Mileage.	Eventual voltage.	Present voltage.	Normal span.	Clearances.			Conductors.				
					Vertical.	Horizontal.	Offset.	Size.	Ultimate strength.	Maximum tension.	Maximum sag.	Factor of safety.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Pykara-Mettupalaiyam-Coimbatore.	55	132	110	1,050	12	18	*	A.C.S.R. 37/102	15,238	6,100	22.3	2.5
Coimbatore-Dindigul	95	110	66	1,050	9.5	17	...	(6/186 + 7/062)	7,387	3,694	21.8	2.0
Trichinopoly-Dindigul-Madura.	96	66	66	750	8	14	...	7/144	4,886	2,443	12.0	2.0
Coimbatore-Erode	59	66	66	750	8	14	...	7/144	4,886	2,443	12.0	2.0
Shoranur-Coimbatore	"	"	"	"	"	"	...	7/118	8,409	1,705	"	"

Section.	Insulators.				Ground wire.					Towers.
	Type.	Number on strain.	Number on suspension.	Maximum strength.	Size.	Ultimate strength.	Maximum tension.	Maximum sag.	Factor of safety.	
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(23)
Pykara-Mettupalaiyam-Coimbatore.	Disc.	8	7	LB. 16,000	INCH. 3	11,500	4,600	19.2	2.5	A & B.
Coimbatore-Dindigul	Do.	5	4	12,000	5/16	8,100	4,050	13.5	2.0	C & D.
Trichinopoly-Dindigul-Madura.	Do.	5	4	12,000	5/16	8,100	4,050	7.0	2.0	E & F.
Shoranur-Coimbatore-Erode.	Do.	5	4	12,000	5/16	8,100	4,050	7.0	2.0	E & F.

* Offset is 3 feet in the Pykara-Mettupalaiyam Section.

B.—Tower Details.

Type of tower.	A	B	C	D	E	F
1. Height of tower ... Ft.	75	75	69	69	54	54
2. Weight of each tower (approximate) ... Lb.	7,000	11,000	6,000	7,500	2,750	4,250
3. Factor of safety ... "	2.5	2.5	2.5	2.5	2.5	2.5
4. Conductor (six) ... "	37/102	37/102	{ 6/186 + 7/062 }	{ 6/186 + 7/062 }	7/144	7/144
5. Ground cable (one) ... "	3/8	3/8	5/16	5/16	5/16	5/16
6. Number of conductors assumed broken on one side ...	Two	Three	Two	Three	One	Three
7. Total number of conductors and ground cable assumed broken ...	Two	Seven	Two	Three	One	Three
8. Maximum horizontal angle ... °	5°	40°	5°	30°	5°	30°
9. Do. vertical angle ... °	20°	40°	20°	30°	20°	30°
10. Ultimate strength of conductor and ground cable—						
Conductor ... Lb.	15,238	15,238	7,387	7,387	4,886	4,886
Ground cable ... "	11,500	11,500	8,100	8,100	8,100	8,100
11. Maximum working tension—						
Conductor ... "	* 6,100	6,100	* 3,700	3,700	* 2,450	2,450
Ground cable ... "	4,600	4,600	4,050	4,050	4,050	4,050

* Note.—When conductor is broken tension will be reduced by 25 per cent for tangent towers.

TABLE NO. 9—*cont.*MECHANICAL CHARACTERISTICS OF TRANSMISSION LINES—*cont.*

C.—Tower loadings.

Structures must be able to withstand the following stresses without distortion or injury :—

Case.	Type of towers.					
	A	B	C	D	E	F
Case A.—Individual cable supports—	LB.	LB.	LB.	LB.	LB.	LB.
Simultaneous stresses on any one insulator support—						
(1) A longitudinal stress of	6,100	9,000	3,700	6,000	2,500	4,000
(2) A stress up or down of	6,100	6,100	3,700	3,700	2,500	2,500
On the ground cable support—						
(1) A longitudinal stress of	8,000	8,000	6,000	6,000	4,000	4,000
(2) A stress up or down of	6,100	6,100	3,700	3,700	2,500	2,500
Case B.—Combination loads—						
Simultaneously the stresses equivalent to—						
(1) (a) Number of conductors broken.	Two on one side.	Six conductors and the ground cable.	Two on one side.	Three on one side.	One top ...	Three on one side.
(b) At a vertical angle of	20°	40°	20°	30°	20°	30°
or (c) At a horizontal angle of	5°	40°	5°	30°	5°	30°
(d) With wind pressure on cables per square foot on 2/3rds projected area.	18 lb.	18 lb.	15 lb.	15 lb.	15 lb.	15 lb.
(2) Wind pressure on tower per square foot.	25 lb. on twice the projected area of one face.	25 lb. on twice the projected area of one face.	25 lb. on one and a half times the projected area of one face.	25 lb. on one and a half times the projected area of one face.	25 lb. on one and a half times the projected area of one face.	25 lb. on one and a half times the projected area of one face.
(3) Dead load of structure.	...	...	...	...	...	...
Case C.—Combination load— Similar to case B but with conductors broken as shown.	One top conductor and ground cable.	Three conductors on one side only.	One top conductor and ground cable.	Two top conductors and ground cable.	Ground cable.	Two top conductors and ground cable.
Case D.—Combination load— Similar to case B but with conductors broken as shown.	...	Four top conductors and ground cable.	...	...	...	...
Case E.—Integral load— Tower to be able to withstand a load concentrated at the centre of the structure at the elevation of the middle crossarm, equivalent to a combination of the stresses enumerated in case shown whichever is the most severe.	B or C	B or C or D	B or C	B or C	B or C	B or C

Sub-stations.—In their comments on the Pykara General Report, Messrs. Merz & Partners recommended the installation of additional high tension oil circuit breakers. Modern practice tends to the simplification of the control equipment of a high tension transformer installation, and the lay-out shown in the General Report is considered suitable for the purpose in view.

Messrs. Merz & Partners also remark that the arrangements for voltage regulation are hardly adequate, but do not advance any reasons for the conclusions arrived at, nor the methods which they would recommend. They are probably referring to a later period when the lines become more heavily loaded, rather than to the first few years when the load is light.

This subject was analysed very carefully when the General Report was prepared, and has been studied again. Voltages for the more important sections of the transmission lines, taken independently, and for certain assumed load conditions are shown on Table No. 8.

For load regulation the transformers in the railway sub-stations were included in previous calculations as more nearly representing normal operating conditions.

In the present studies the effect of these transformers has been neglected, in order that the results may be considered more conservative.

It should also be noted that the exciter voltage regulating system will be capable of adjustment to give a higher voltage on the station bus at peak loads, and a lower at light loads.

The general conclusions arrived at are not different from those previously submitted.

Provided that synchronous motor-generators sets are installed in the railway sub-stations and the power factor is kept around unity, the voltage at peak and average loads should not vary beyond the agreed tolerance of 5 per cent for the first few years.

As an additional aid to good regulation, tap changing under load was advocated in the General Report for the 110/66 K. V. transformers.

At zero or very light loads, sections of the main transmission lines would be cut out. This may be considered as the general practice adopted on similar systems elsewhere.

Similarly it is very unlikely that an experienced operating engineer would attempt to start up Pykara with the whole transmission system connected, even if it was equipped with costly static reactors or rotating reactive machinery.

If the station lost its load or became automatically disconnected from the system, contingencies which would only occur at rare intervals, the network could be gradually energized by sections.

If proper operating regulations are drawn up and the staff suitably trained the consequent interruptions to service, even at the farthest end of the system, should be of comparatively short duration.

When the future load conditions can be definitely determined, further studies of the currents and voltages at different points of the system will be made and the comments on regulation by Messrs. Merz & Partners carefully kept in mind.

Short circuit analyses are also to be prepared, and the specifications for transformers and circuit breakers will be based on these final results.

However, in order to provide for any additional equipment, which might be considered necessary at the last moment contingent allowances have been included in the sub-station estimates for the first and fourth years. The revised estimate is given in Table No. 10.

TABLE No. 10.—Sub-station Estimate.
Scheme (a).

Station.	Years of operation.										Total.
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
1. Coimbatore	RS. 7,65,000	RS. 1,61,000	RS. ...	RS. 2,43,000 (-67,800)	RS. 10,090	RS. ...	RS. ...	RS. 2,19,000	RS. ...	RS. ...	RS. 13,98,000 (-87,600)
2. Dindigul	4,21,000	...	...	5,19,000 (-2,500)	1,77,000	...	...	...	...	...	11,17,000 (-2,500)
3. Madurai	3,51,000	...	69,000	...	62,000 (-5,000)	...	...	...	...	...	4,82,000 (-5,000)
4. Trichinopoly	2,86,000	44,000	...	...	46,000 (-5,000)	...	...	...	...	...	3,26,000 (-5,000)
5. Pollachi	1,77,000	...	40,000	...	10,000	...	...	...	...	...	2,27,000
6. Tiruppur	47,000	...	...	1,95,000	...	...	...	17,000 (-10,500)	...	...	2,59,000 (-10,500)
7. Erode	...	...	...	48,000	...	...	...	1,28,000	...	...	1,76,000
8. Palni	...	...	...	...	80,000	...	...	...	...	...	80,000
9. Shoranur	...	...	...	...	...	...	...	80,000	...	...	80,000
10. Anamalais	45,000	...	...	...	...	...	...	...	...	...	45,000
11. Virudhunagar	45,000	...	...	...	...	...	...	...	...	...	45,000
Overall contingent allowances	2,00,000*	...	...	6,00,000*	...	...	...	...	...	...	8,00,000
Total	22,87,000	2,05,000	1,09,000	16,05,000 (-70,100)	3,86,000 (-10,000)	...	...	4,44,000 (-10,500)	...	...	50,35,000 (-90,600)
											49,44,400

* Contingent allowance to meet any suggestions that may be made by the Consulting Engineers to the Railway Board.

FINANCIAL.

Capital Expenditure—The estimated amounts of capital needed annually for the works both during the construction and the operation periods are given in Table No. 11.

Simple interest on the capital outlay during the construction period has been allowed to accumulate and is shown in the financial tables Nos. 13 and 14 as arrears of interest for the construction period. These arrears will gradually be wiped out by revenue receipts in the subsequent years of operation. No provision for the abatement of land revenue for the right of way acquired for transmission lines is considered necessary since the land where arable could always be rented for cultivation.

TABLE No. 11.—Annual Capital Expenditure.

Scheme (a).					
Year and Period.	Hydraulic Works.	Power plant and Penstocks.	Transmission Lines.	Sub-stations.	Total.
	RS.	RS.	RS.	RS.	RS.
<i>Construction period—</i>					
First... { First ...	7,30,000	...	65,000	...	7,90,000
Second ... { Second ...	9,30,000	3,00,000	65,000	50,000	13,45,000
Second { First ...	6,90,000	7,00,000	93,000	50,000	15,38,000
Third { Second ...	6,50,000	25,00,000	7,00,000	1,50,000	40,00,000
Fourth { First ...	6,00,000	20,00,000	16,00,000	6,50,000	48,50,000
Second ... { Second ...	4,00,000	9,00,000	38,00,000	9,00,000	60,00,000
Fourth. First ...	3,33,000	2,94,800	25,21,500	4,87,000	36,36,800
Sub-total ...	43,33,000	66,94,800	88,44,500	22,87,000	2,21,59,300
<i>Deduct salvage auxiliary plant and construction equipment ...</i>					
	—1,77,000	...	...	...	—1,77,000
Sub-total ...	41,56,000	66,94,800	88,44,500	22,87,000	2,19,82,300
<i>Operation period—</i>					
First ...	...	...	...	2,05,000	2,05,000
Second ...	17,73,000	...	...	1,09,000	18,82,000
Third ...	...	...	14,67,900	15,34,900	30,02,800
Fourth ...	...	8,90,350	7,97,400	3,75,000	20,62,750
Fifth ...	...	...	...	...	...
Sixth ...	...	...	...	...	...
Seventh ...	...	8,90,350	16,16,500	4,33,500	29,40,350
Eighth ...	...	...	...	...	...
Ninth ...	...	...	...	...	...
Tenth ...	...	...	...	...	...
Sub-total ...	59,29,000	84,75,500	1,27,26,300	49,44,400	3,20,75,200
Future development including Moyar.	...	...	...	...	3,79,24,800
Total ...	...	...	...	...	7,00,00,000

NOTE.—Accumulated simple interest on capital outlay during initial construction period is at 5½ per cent Rs. 18,13,420, and at 6 per cent Rs. 20,24,290.

Operation and Maintenance.—The operation and maintenance expenses have been allowed as shown below:—

Year of operation.	Amount. RS.	Year of Operation.	Amount. RS.
First	4,88,000	Sixth	5,60,000
Second	4,88,000	Seventh	5,60,000
Third	5,20,000	Eighth	6,13,000
Fourth	5,34,000	Ninth	6,20,000
Fifth	5,50,000	Tenth	6,37,000

Depreciation.—The method of calculating the depreciation figures and the assumed "lives" of the machinery and equipment are the same as given in the General Report. The amounts set aside are as follows:—

Year of operation.	Interest at 5½ per cent. RS.	Interest at 6 per cent. RS.	Year of operation.	Interest at 5½ per cent. RS.	Interest at 6 per cent. RS.
Sixth	3,94,300	3,58,170	Ninth	4,30,470	3,90,380
Seventh	3,94,300	3,58,170	Tenth	4,30,470	3,90,380
Eighth	4,30,470	3,90,380	Twentieth.	6,80,000	6,00,000

Financial Statements.—Financial statements have been prepared for two rates of interest, one at 5½ per cent representing the prevailing rate, and the other at 6 per cent representing the rate prescribed by Government—vide Tables Nos. 13 and 14.

It will be seen that the initial capital expenditure is Rs. 219.82 lakhs rising to Rs. 320.75 lakhs in the tenth year.

With 6 per cent rate, the net return on the actual capital outlay in the tenth year is 9.38 per cent and the return at the end of ten years on the "sum at charge" (which includes arrears of interest) is 8.75 per cent.

The corresponding results with 5½ per cent rate are, of course more favourable.

A summary of the results for the tenth and twentieth years of operation is given in Table No. 12 below:

Plan No. ^{P. 23 B}_{F. 1.} has been plotted to show the capital expenditure and the revenue, and the cost and revenue received per unit.

TABLE No. 12.—Summary of financial results.

Scheme (a).

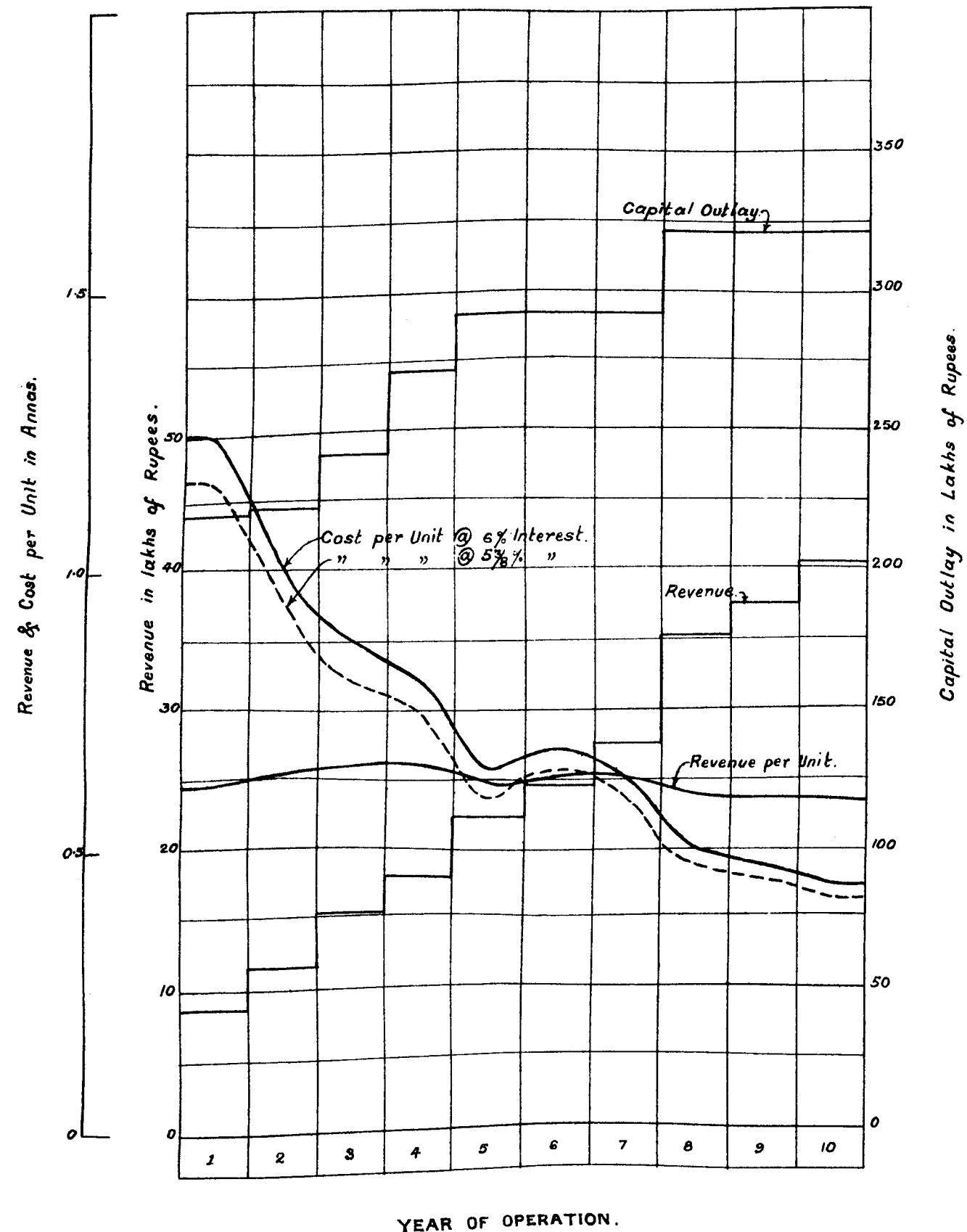
	5½ per cent interest rate.	6 per cent interest rate.	From Messrs. Merz & Partners' figures. At 6 per cent interest rate.
Tenth year of operation—			
1. Capital outlay	Lakhs of Rs. 320.75	320.75	335.38
2. Arrears of simple interest	5.65	23.58	36.00
3. Sum at charge	326.40	344.33	371.38
4. Net revenue	29.73	30.13	27.98
5. Interest on sum at charge	17.54	20.66	22.28
6. Net surplus	12.19	9.47	5.70
7. Return on sum at charge	Per cent 9.11	8.75	7.54
Twentieth year of operation—			
1. Capital outlay	Lakhs of Rs. 700.00	700.00	...
2. Arrears of simple interest	Nil.	Nil.	...
3. Sum at charge	700.00	700.00	...
4. Net revenue	81.50	82.30	...
5. Interest on sum at charge	37.63	42.00	...
6. Net surplus	43.87	40.30	...
7. Return on sum at charge	Per cent 11.64	11.76	...
8. Accumulated surplus	Lakhs of Rs. 310.00*	250.00*	...

Item No. 3 = 1+2.

" 4 = Gross revenue less operating expenses and depreciation.

" 7 = $\frac{\text{Item (4)}}{\text{Item (3)}} \times 100$.

* Tentative estimates only.



K. S. Srinivasan
Chief Engineer.

Reference.	Drawn: K.R. Traced: A.A.	DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT, MADRAS.	No. ^{P. 23 B.} _{F. 1.}
Revision: of No. ^{P. 23} _{F. 1.}	Checked: <i>M. S. Mani</i> Approved: <i>G. S.</i>	PYKARA H.E. DEVELOPMENT.	Scale:
Dated: 28-4-26		FINANCIAL RESULTS - SCHEME. "A".	Date: 12-12-28.



TABLE No. 13.—Giving capital outlay, operating expenses, revenue, surplus, etc.

Interest charged at 5½ per cent.

Scheme (a).

Construction period	Capital outlay up to the year.	Capital outlay during the year.	Simple interest at 5½ per cent on capital outlay up to the year plus half the outlay during the year.	Operation and maintenance.	Depreciation and renewals.	Total expenses (5) + (6).	Gross revenue.	Net revenue (8) - (7).	Return on capital outlay $\frac{9}{2} \times 100$	Surplus after deducting interest charges (9) - (4).	Accumulated surplus.	Average cost per K. W. H. at 11,000 volts.
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	PER CENT	RS.	RS.	ANN.
First	...	...	...	...	...	...	...	...	...	...	...	...
Second	2,19,52,360	2,05,000	11,87,060	4,88,000	...	4,88,000	8,85,888	3,97,888	1.81	-7,89,172	-18,13,420*	1.16
Third	2,21,87,300	18,82,000	12,43,150	4,88,000	...	4,88,000	11,46,828	6,53,628	2.87	-5,84,522	-31,87,114	0.94
Fourth	2,40,69,300	30,02,800	13,74,420	5,20,000	...	5,20,000	14,98,118	9,78,118	4.06	-3,96,302	-35,83,416	0.82
Fifth	2,70,72,110	20,62,750	15,10,560	5,34,000	...	5,34,000	17,91,060	12,57,060	4.64	-2,53,500	-38,36,916	0.75
Sixth	2,51,34,850	...	15,66,000	5,50,000	...	5,50,000	22,44,010	16,94,010	5.82	-1,28,010	-37,08,906	0.59
Seventh	2,91,34,850	29,40,350	15,66,000	5,61,000	3,94,300	9,54,300	24,86,030	15,31,730	5.26	-8,4270	-37,43,176	0.64
Eighth	2,91,34,850	...	16,45,10	5,60,000	3,94,300	9,54,300	27,81,680	18,27,380	6.27	+1,23,70	-35,60,806	0.59
Ninth	3,20,75,200	...	17,24,040	6,13,000	4,30,470	10,43,470	35,35,240	24,91,770	7.77	+7,67,730	-27,93,076	0.47
Tenth	3,20,75,200	...	17,24,040	6,20,000	4,30,470	10,50,470	37,54,850	27,03,880	8.43	+9,79,840	-18,13,236	0.41
† Twentieth	7,00,09,000	...	37,62,500	11,00,000	6,80,000	17,80,000	40,40,400	29,72,520	9.27	+12,48,480	-5,64,756	0.25
							29,30,000	81,50,000	11.64	+43,87,500	...	

Tenth year.—
Capital outlay ... 3,20,75,200
Arrears of simple interest ... 6,64,756
Sum at charge ... 3,26,39,956
Net revenue ... 29,72,520
Return on sum at charge ... 9.11 per cent.

* Accumulated simple interest at 5½ per cent on the capital outlay during the initial construction period.

† Assumes development including Moyar at 50 per cent load factor distributing 353,000,000 units. Average receipts per unit at 0.45 anna allowing 23.6 per cent reduction on the 1911 year average.

TABLE No. 14.—Giving capital outlay, operating expenses revenue, surplus, etc.
Interest charged at 6 per cent.
Scheme (a).

Year of operation.	Capital outlay up to the year. (2)	Capital outlay during the year. (3)	Simple interest at 6 per cent. on the capital outlay up to the year plus half the outlay during the year. (4)	Operation and maintenance. (5)	Depreciation and renewals. (6)	Total expenses (5) + (6). (7)	Gross revenue. (8)	Net revenue (8) - (7). (9)	Return on capital outlay $\frac{(9)}{(2)} \times 100$. (10)	Surplus after deducting interest charges (10) - (4). (11)	Accumulated surplus. (12)	Average cost per K.W.H. at 11,000 volts. (13)
Construction period ...	Rs. 2,19,82,800	Rs. ...	Rs. ...	Rs. ...	Rs. ...	Rs. ...	Rs. ...	Rs. ...	PER CENT. ...	Rs. ...	Rs. -20,21,250*	ANNA. ...
First ...	2,19,82,800	2,05,000	13,25,090	4,83,000	...	4,88,000	8,35,888	3,97,838	1.81	-9,27,202	-29,51,492	1.25
Second ...	2,21,87,300	18,82,000	13,87,700	4,83,000	...	4,88,000	11,48,628	6,58,628	2.97	-7,29,072	-36,80,564	1.02
Third ...	2,40,69,300	30,02,800	15,34,740	5,20,000	...	5,20,000	14,98,118	9,78,118	4.06	-5,53,122	-42,33,686	0.89
Fourth ...	2,70,72,100	20,82,750	18,86,210	5,34,000	...	5,34,000	17,91,060	12,57,060	4.64	-4,29,150	-46,62,836	0.81
Fifth ...	2,91,34,850	...	17,48,020	5,60,000	...	5,60,000	22,44,010	16,94,010	5.83	-54,080	-47,19,916	0.64
Sixth ...	2,91,34,850	...	17,48,020	5,60,000	3,58,170	9,18,170	24,86,030	15,67,860	5.37	-1,80,230	-49,00,146	0.68
Seventh ...	2,91,34,850	29,40,350	18,36,300	5,60,000	3,58,170	9,18,170	27,81,380	18,63,510	6.39	+27,210	-48,72,936	0.63
Eighth ...	3,20,75,200	...	19,24,510	6,13,000	3,90,380	10,03,380	35,35,240	25,31,560	7.88	+6,07,350	-42,65,586	0.50
Ninth ...	3,20,75,200	...	19,24,510	6,20,000	3,90,380	10,10,380	37,54,750	27,43,970	8.53	+8,14,160	-34,46,126	0.47
Tenth ...	3,20,75,200	...	19,24,510	6,37,500	3,90,380	10,27,880	40,40,490	30,12,610	9.38	+10,88,100	-23,58,026	0.43
†Twentieth ...	7,00,00,000	...	42,00,000	11,00,000	6,00,000	17,00,000	99,30,000	82,30,000	11.76	+40,30,000	...	0.27

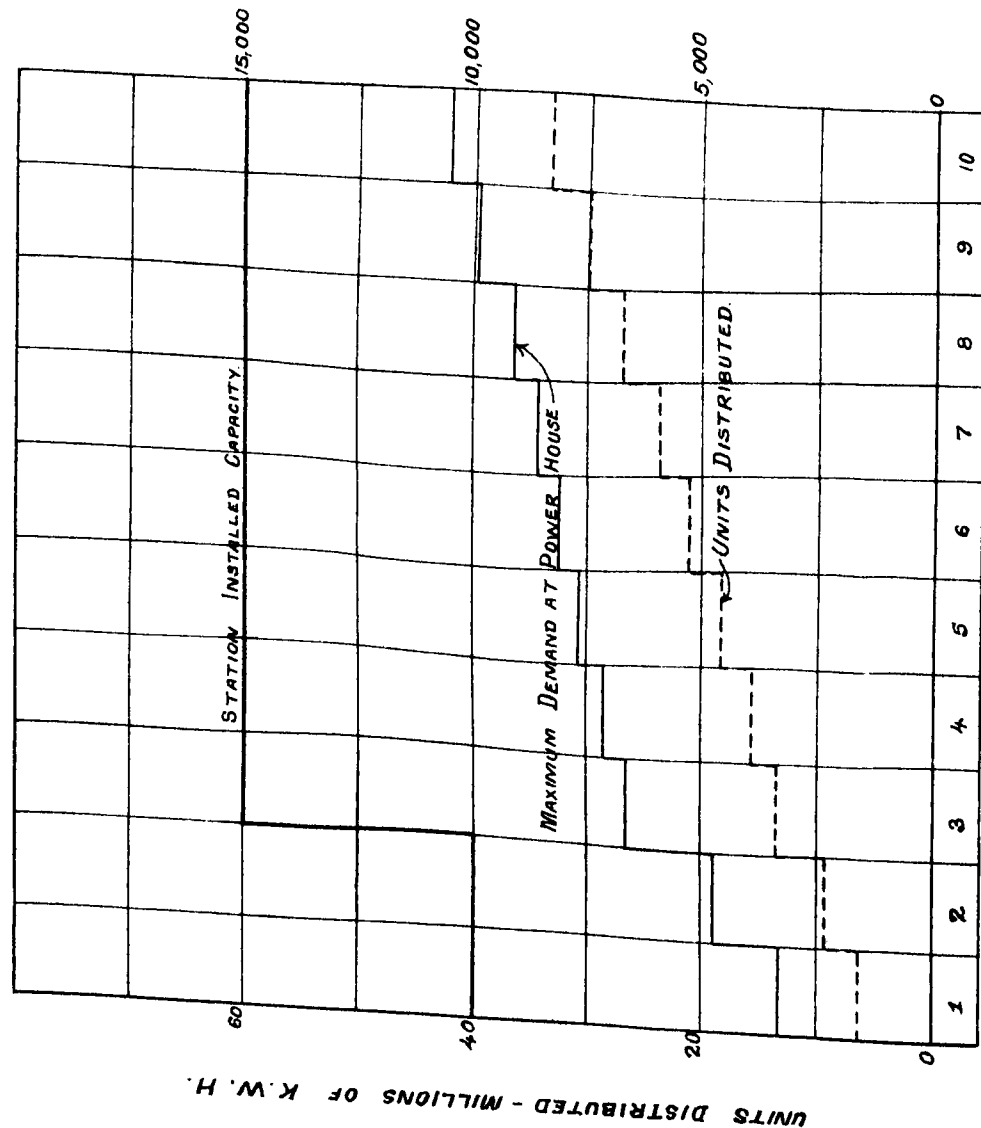
Tenth year—

Capital outlay	Rs. 3,20,75,200
Arrears of simple interest	23,58,026
Sum at charge	3,44,33,226
Net revenue	30,12,610
Return on sum at charge	8.75 per cent.

* Accumulated simple interest at 6 per cent on the capital outlay during the initial construction period.

† Assumes development including M. year at 50 per cent load factor, distributing 353,000,000 units. Average receipt per unit at 0.45 anna allowing 23.6 per cent reduction on the tenth year average.

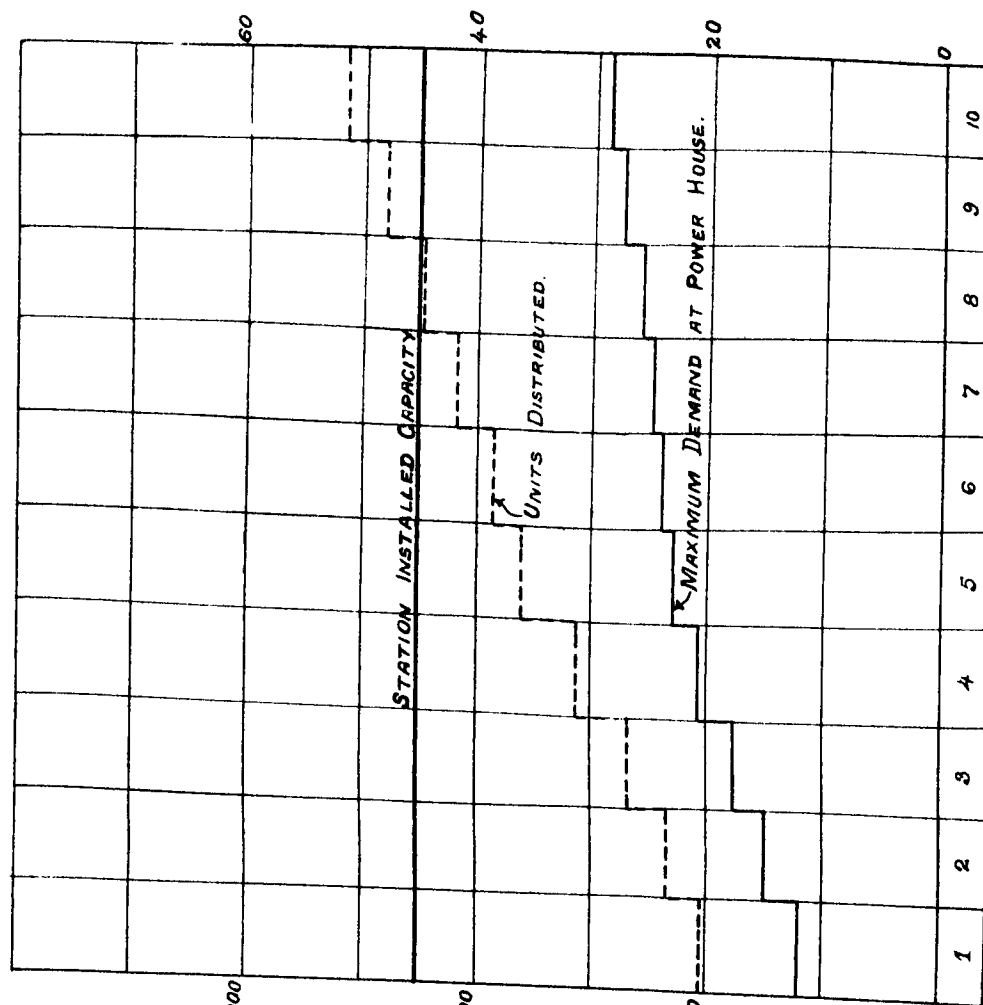
SCHEME "C".



YEAR OF OPERATION.

MAXIMUM DEMAND & STATION INSTALLED CAPACITY-K.W.

SCHEME "D".



YEAR OF OPERATION.

UNITS DISTRIBUTED - MILLIONS OF K.W.H.

Reference.	Drawn. K.R.		DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT MADRAS.	No P 61. F. 1.
	Traced. A.A.			
Revision.	Checked. <i>M. S. M. S.</i>		PYKARA H.E. DEVELOPMENT.	Scale:-
	Approved. <i>G. S.</i>		POWER DEMAND & STATION INSTALLED CAPACITY.	Date: 11-12-28.

Retained
Chief Engineer.

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27

SECTION 2—SCHEME (c).

This scheme assumes no main line railway electrification, and is designed for supply of power to the Nilgiris and Coimbatore districts. It is, however, conceived in such a manner that any possible railway electrification demand can be taken up later by suitable modifications, without in any way impairing the full utilization of the catchment.

The Power system is shown in Plan No. ^{P. 66.}_{F. 1.}

Power Demand.—The demand from the Nilgiris and Coimbatore districts are the same as those assumed for Scheme (a). A summary of the power demand and revenue is given in Table No. 15 of which, for convenience, an abstract is given in Tables Nos. 16 and 17.

TABLE No. 16.—Demand at the distributing end, revenue estimate, and return per unit.

Scheme (c).

Year of operation.	Demand, K.W.	Distributed, K.W.H.	Estimated revenue.	Average return per K.W.H. sold.
			RS.	ANNA.
First ...	3,040	6,534,000	3,38,160	0.828
Second ...	4,400	9,330,400	4,54,080	0.779
Third ...	6,120	13,550,000	6,41,570	0.758
Fourth ...	6,570	15,889,000	7,54,060	0.759
Fifth ...	7,130	18,389,000	8,73,300	0.760
Sixth ...	7,500	21,056,200	9,84,950	0.748
Seventh ...	7,950	23,798,100	11,04,750	0.743
Eighth ...	8,410	26,934,100	12,55,220	0.745
Ninth ...	9,090	29,944,900	13,89,600	0.743
Tenth ...	9,720	33,290,900	14,92,260	0.717

TABLE No. 17.—Power house load details.

Year of operation.	Demand, K.W.	Generation, K.W.H.	Average load, K.W.	Load factor.
				PER CENT.
First ...	3,290	6,879,000	790	24
Second ...	4,760	9,822,000	1,120	24
Third ...	6,620	14,270,000	1,630	25
Fourth ...	7,100	16,730,000	1,910	27
Fifth ...	7,710	19,360,000	2,210	29
Sixth ...	8,110	22,160,000	2,530	31
Seventh ...	8,600	25,050,000	2,860	33
Eighth ...	9,090	28,356,000	3,240	36
Ninth ...	9,830	31,520,000	3,600	37
Tenth ...	10,510	35,040,000	4,000	38

A small railway load of 400 K.W. in the first year rising to 900 K.W. from the fifth year can be expected from the electrification of a section of the Nilgiris Railways or the Podanur workshops, and has been taken into account. There should be little difficulty experienced in lighting all the railway stations and electrifying the pumping installations near the projected transmission lines. This would bring in a load of about 100,000 units per annum, but has not been included in the estimate as being a little uncertain.

The agricultural load assumed is the same as for Scheme (a).

Plan No. ^{P. 61.}_{F. 1.} is plotted to show graphically the power demand and station installed capacity.

4-A

TABLE No. 15.—SUMMARY OF POWER DEMAND.

Scheme (c).

District.	First year.					Second year.					Third year.				
	Demand at S.S. K.W.	L.F. at S.S. PER CENT.	Consumption K.W.H.	Average rate ANNA.	Revenue Rs.	Demand at S.S. K.W.	L.F. at S.S. PER CENT.	Consumption K.W.H.	Average rate ANNA.	Revenue Rs.	Demand at S.S. K.W.	L.F. at S.S. PER CENT.	Consumption K.W.H.	Average rate ANNA.	Revenue Rs.
1. Coimbatore	2,198	21	4,040,000	78	1,84,400	3,290	21	6,060,000	68	2,57,500	4,387	22	8,528,000	68	3,04,200
2. Tirunelveli	983	18	872,000	93	21,580	849	18.5	3,621,000	93	22,670	510	18.5	829,000	93	47,680
3. Tiruppur	180	18	342,000	93	14,760	245	18	3,87,000	98	22,500	310	19	490,000	93	29,000
4. Arani	120	15	180,000	93	10,800	215	15	287,000	93	19,680	370	15.5	546,000	93	22,800
5. Rameswaram	430	28.6	932,000	70	40,780	420	28.6	932,000	70	41,780	400	25	2,040,000	65	81,250
6. Rameswaram	370	...	752,000	...	65,800	150	15	2,00,000	130	16,250	175	15	280,000	13	18,700
7. Rameswaram	3,499	...	6,584,000	0.988	3,38,100	5,064	...	9,330,400	0.772	4,54,000	7,033	...	13,750,000	0.755	6,41,570
8. Total	3,040	...	...	...	...	4,450	...	...	...	...	6,120	...	...	...	...
9. Demand on P.H. Diversity factor 1.15.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Power House.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10. Average load K.W.	...	...	780	...	...	...	...	1,120	...	...	...	...	1,830	...	...
11. Average load factor per cent	...	...	24	...	...	...	...	24	...	...	...	...	25	...	...
12. Total generated K.W.H.	...	...	6,870,000	...	...	...	...	9,822,000	...	...	...	...	14,270,000	...	...
13. Peak load K.W.	...	...	3,280	...	...	...	...	4,760	...	...	...	...	6,520	...	...
14. Estimated revenue	...	...	3,88,160	...	...	...	...	4,54,080	...	...	...	...	6,41,570	...	...

TABLE No 15.—SUMMARY OF POWER DEMAND—cont.

Scheme (c)—cont.

District.	Fourth year.				Fifth year.				Sixth year.						
	Demand at S.S. K.W.	L.F. at S.S. PER CENT.	Consumption K.W.H.	Average rate. ANNA.	Revenue. RS.	Demand at S.S. K.W.	L.F. at S.S. PER CENT.	Consumption K.W.H.	Average rate. ANNA.	Revenue. RS.	Demand at S.S. K.W.	L.F. at S.S. PER CENT.	Consumption K.W.H.	Average rate. ANNA.	Revenue RS.
1. Coimbatore	4,710	25	10,222,000	68	4,36,800	5,140	27.5	12,338,000	68	5,24,400	5,400	30	14,189,000	68	6,08,000
2. Tiruppur	585	20	1,024,500	93	59,500	668	21	1,230,000	93	71,500	750	22.5	1,478,000	93	76,680
3. Pollachi	355	20	623,800	93	33,260	405	21	748,000	93	43,360	430	24.5	847,600	93	49,270
4. Anamalais	320	17.5	493,500	93	28,700	340	20	596,000	93	34,640	370	21	680,600	93	39,570
5. Railways	900	25	2,000,000	65	81,250	900	25	2,000,000	65	81,250	900	25	2,000,000	65	81,250
6. Agricultural	193	16	270,000	130	21,900	200	17.5	310,000	120	23,250	200	20	350,000	100	21,380
7. Nilgiris	505	27	1,195,000	120	89,600	580	28	1,349,000	120	94,900	575	30	1,511,000	120	1,13,300
8. Total	7,558	...	15,889,100	0.769	7,54,060	8,203	...	18,389,000	0.780	8,73,300	8,625	...	21,056,200	0.748	9,84,950
9. Demand on P.H. Diversity Factor, 1.15.	6,570	...	...	...	...	7,110	...	...	...	...	7,500	...	...	...	...
Power House.															
10. Average load K.W.	...	...	1,910	...	...	...	...	2,210	...	...	...	...	2,530	...	...
11. Average load factor per cent	...	...	27	...	...	...	...	29	...	...	...	...	31	...	...
12. Total generated, K.W.H.	...	...	16,730,000	...	...	...	...	19,360,000	...	...	...	...	22,160,000	...	...
13. Peak load, K.W.	...	...	7,100	...	...	...	...	7,710	...	...	...	...	8,110	...	...
14. Estimated revenue	...	...	7,54,060	...	...	...	...	8,73,300	...	...	...	...	9,84,950	...	...

TABLE No. 15.—SUMMARY OF POWER DEMAND—cont.

Scheme (c).

District.	Seventh year.						Eighth year.						Ninth year.						Tenth year.						
	De- mand at S.S. K.W.	L.F. at S.S. S.S.	Consump- tion, K.W.H.	Aver- age rate.	Revenue, RS.	De- mand at S.S. K.W.	L.F. at S.S. S.S.	Consump- tion, K.W.H.	Aver- age rate.	Revenue, RS.	De- mand at S.S. K.W.	L.F. at S.S. S.S.	Consump- tion, K.W.H.	Aver- age rate.	Revenue, RS.	De- mand at S.S. K.W.	L.F. at S.S. S.S.	Consump- tion, K.W.H.	Aver- age rate.	Revenue, RS.	De- mand at S.S. K.W.	L.F. at S.S. S.S.	Consump- tion, K.W.H.	Aver- age rate.	Revenue, RS.
1. Coimbatore	5,750	32.5	16,318,000	0.8	6,93,600	6,110	35	18,766,000	0.8	7,97,500	6,700	36	21,112,000	0.8	8,97,300	7,250	37.5	22,751,000	0.8	9,75,500	7,250	37.5	22,751,000	0.8	9,75,500
2. Tiruppur	806	24	1,695,000	0.8	87,000	803	25	1,554,000	0.8	1,01,400	945	26.5	2,194,000	0.8	1,13,000	1,024	27.5	2,469,000	0.8	1,12,050	1,024	27.5	2,469,000	0.8	1,12,050
3. Pollachi	400	24	1,067,000	0.8	50,180	485	25	1,066,000	0.8	55,000	515	26	1,173,000	0.8	69,800	555	27.5	1,258,000	0.8	62,800	555	27.5	1,258,000	0.8	62,800
4. Annamalais	400	24	1,067,000	0.8	41,810	420	23	846,000	0.8	40,180	440	24	925,000	0.8	53,750	400	25	1,003,000	0.8	52,130	400	25	1,003,000	0.8	52,130
5. Railways	190	25	2,000,000	0.65	81,250	190	23	2,000,000	0.65	81,250	900	25	2,000,000	0.65	81,250	900	25	2,000,000	0.65	81,250	900	25	2,000,000	0.65	81,250
6. Agricultural	212	21	300,000	0.93	22,670	223	22	420,000	0.93	25,000	298	23	475,000	0.93	27,000	270	24	525,000	0.93	28,500	270	24	525,000	0.93	28,500
7. Nilgiris	610	31	1,657,000	1.20	1,21,300	650	33	1,878,000	1.20	1,40,850	715	33	2,065,000	1.20	1,51,900	757	33	2,272,000	1.20	1,70,130	757	33	2,272,000	1.20	1,70,130
8. Total	9,138	...	23,780,000	0.743	11,04,750	9,681	...	26,094,000	0.745	12,55,220	10,451	...	29,541,000	0.743	13,80,000	11,176	...	33,290,000	0.747	14,52,260	11,176	...	33,290,000	0.747	14,52,260
9. Demand on P.H. Diversity Factor, 115.	7,450	...	...	...	...	8,410	...	...	...	...	9,000	...	...	...	...	9,720	...	...	...	...	...	...	...	...	...
Power House.																									
10. Average load, K.W.	...	...	2,800	...	...	...	...	3,240	...	...	...	...	3,600	...	...	...	...	3,900	...	...	...	...	...	...	...
11. Average load factor per cent	...	...	33	...	...	...	...	36	...	...	...	...	37	...	...	...	...	38	...	...	...	...	...	...	...
12. Total generated, K.W.H.	...	...	25,050,000	...	...	...	...	28,350,000	...	...	...	...	31,520,000	...	...	...	...	34,700,000	...	...	...	...	...	...	...
13. Peak load, K.W.	...	...	8,600	...	...	...	...	9,600	...	...	...	...	10,800	...	...	...	...	12,000	...	...	...	...	...	...	...
14. Estimated revenue, Rs.	...	...	1,01,760	...	...	...	...	1,10,000	...	...	...	...	1,20,000	...	...	...	...	1,30,000	...	...	...	...	...	...	...

Overall peak load efficiency generator bus to H. T. sub-stations ... 92.5 per cent.
Average load efficiency generator bus to H. T. sub-stations ... 95 do.

Overall peak load efficiency generator bus to H. T. sub-stations ... 92.5 per cent.
Average load efficiency generator bus to H. T. sub-stations ... 95 do.

Power Rates.—The rates for power are also identical with those for scheme (a). A Mill Conversion Fund on the lines recommended on page 9 of Part III of the General Report will be necessary for this scheme also. The approximate capital cost of conversion is given below:—

	RS.
Last year of construction	2.30 lakhs.
First year of operation	1.10 "
Second year of operation	0.77 "
Total	4.17 "

The expenditure will be recovered by instalments extending over an agreed period of years.

Hydrology and Hydraulic Works.—The section on the hydrology of the Pykara and other catchments in Part I of the report has been checked, and the results of this year's rainfalls and gaugings as recorded to date do not indicate any need to modify the theories already advanced and conclusions arrived at on this subject.

The original working table of the Glen Morgan Reservoir was based on a 90 per cent year for the Pykara River. Table No. 18 has been prepared based on the minimum year, and is given below.

It will be seen that a maximum continuous draw off for the minimum year is 29.5 cusecs corresponding to 5,900 K.W.

The power requirements up to the tenth year for scheme (c) are only 4,000 K.W. so that the forebay should always be full. A second reservoir in addition to Glen Morgan will not be required.

The remarks under Hydraulic Works under scheme (a) on page 13 will apply to this scheme as well. The estimate for Hydraulic Works is given in Table No. 19.

TABLE No. 18.—Working table for the Glen Morgan Reservoir.

(Pykara minimum and Glen Morgan minimum year.)

	Million cubic feet.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1. Pykara flow in minimum year.	71	71	9	97	186	292	212	611	89	195	1,266	283
2. Forebay opening balance and supply from the Pykara river during the month.	12.8	120.8	55.6	97	206.2	350.8	370.8	669.8	147.8	253.8	1,324.8	341.8
3. Replenishment from Glen Morgan Reservoir.	Nil.	Nil.	23.9	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
4. Evaporation	0.9	0.8	0.4	0.4	1.3	1.4	0.6	0.6	0.6	1.0	1.0	1.0
5. Draw off for power 29.5 cusecs.	7.1	74.0	79.1	76.4	79.1	76.4	79.1	79.1	76.4	79.1	76.4	79.1
6. Forebay balance.	4.8	46.0	Nil.	20.2	58.8	58.8	58.8	58.8	58.8	58.8	58.8	58.8
(Surplus in all the months)												
Glen Morgan Reservoir.												
1. Glen Morgan flow in minimum year.	Nil.	1.6	Nil.	3.3	3.0	11.4	12.3	8.2	6.8	11.6	6.1	1.6
2. Draw off for water-supply.	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3. Evaporation	0.8	0.8	0.4	0.3	0.4	0.3	0.4	0.5	0.5	0.8	0.8	0.8
4. Draw off for power into Forebay.	Nil.	Nil.	23.9	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.
5. Accumulation or deficiency during the month.	1.1	0.5	24.6	2.7	2.3	10.8	11.6	7.4	6.0	10.5	5.0	0.5
6. Storage at the end of the month.	24.9	25.4	0.8	3.5	5.8	16.6	26.0	26.0	26.0	26.0	26.0	26.0
(Surplus in all the months)												

Effective capacity to F.R.L. of Forebay Reservoir = 58.8 mill. c.ft.
Do. Glen Morgan = 26.0 " "

TABLE No. 19.—Estimate for hydraulic works.

Scheme (c).

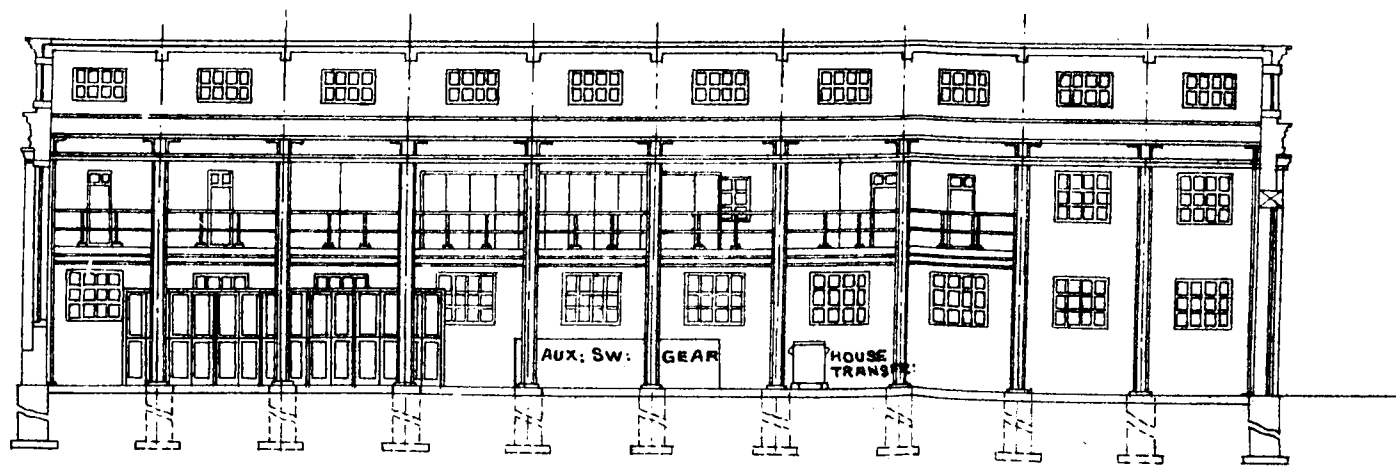
Year of operation.					1st.	After 10th, when needed.			
Stage.					I.	II.	III.	IV.	
					RS.	RS.	RS.	RS.	
Land and Preliminary work					3,00,000	...	...	...	
Dams and Reservoirs—									
Glen Morgan					3,04,000	...	...	...	
M. korti					...	10,80,000	...	...	
Porthimund					...	...	8,90,000	...	
Sandy Nalla					...	...	...	...	20,07,000
Pykara					...	...	...	...	29,50,000
Main Diversion Dam					1,19,000	...	...	...	
Flume					1,30,000	...	...	...	
Glen Morgan Flume					41,000	...	...	...	
Auxiliary Flume					34,000	...	...	...	
Forebay—									
Upper Band					76,000	...	...	...	
Lower Band					3,64,000	...	...	...	
Spillway					20,000	...	...	...	
Headworks					2,88,000	...	...	...	
Auxiliary Forebay					12,000	...	...	...	
Permanent Buildings and Services					3,40,000	6,000	8,000	...	
" Roads and Bridges					3,92,000	1,23,000	76,000	...	
" Water Supply					22,000	...	...	...	
" Tools and Equipment					35,000	...	...	...	
" Light, Power and Telephone Lines					65,000	30,000	24,000	...	
Contingencies, 5 per cent					1,27,000	62,000	49,800	...	
Sub-total					26,65,000	13,01,000	10,45,800	...	
Temporary Construction—Plant and tools					2,80,000	70,000	63,000	...	
Auxiliary Power installation					2,58,000	...	...	...	
Lines and Transformers					55,000	25,000	22,000	...	
Camps					2,20,000	57,000	52,000	...	
General Expenses					7,49,000	3,20,000	2,80,000	...	
Deduct—Salvage—Auxiliary Plant and Construction Equipment.					42,37,000	17,73,000	14,62,800	...	
Net cost					40,75,000	17,73,000	14,62,800	49,50,000	

Penstocks.—Owing to the high cost of the penstocks and the large proportion which it forms of the total investment, it has been considered necessary to design them for the actual load demand estimated for the first ten years. No difficulty will be experienced in adding to the number of penstocks, whenever necessary. After studying the subject in the usual manner, and taking into account the average probable load factor of the plant, cost of storage, and annual fixed and operating charges, penstocks allowing a comparatively high velocity of water were again decided upon. Two penstocks have been provided, each of capacity 40 cusecs, with diameters varying from 30" at the top to 21" at the Power House giving velocities of 8 feet per second in the larger section and 17 feet per second in the smaller. These figures correspond to a normal load of 10,000 h.p. per line. The penstocks will serve for the initial stages of either of the schemes (c) or (d); in the former case four (one spare) 5,000 K.W. units could ultimately be connected up, and in the latter case three (one spare)—7,500 K.W. units.

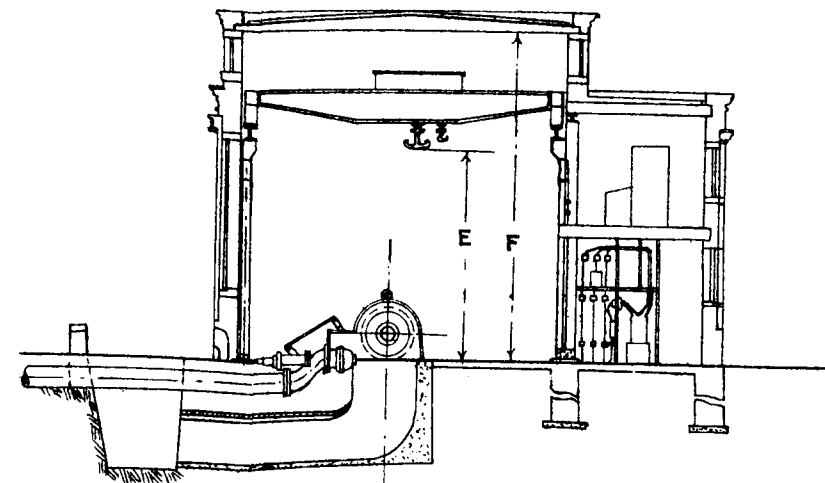
Power House Building.—This will be a steel structure with masonry walls; steel window frames and doors will be used. The type of building on which the estimates are based is shown on the front page of this report, and a preliminary design is given in plan No. $\frac{P. 53}{F. 2}$.

Other details are as given in Part II of the General Report.

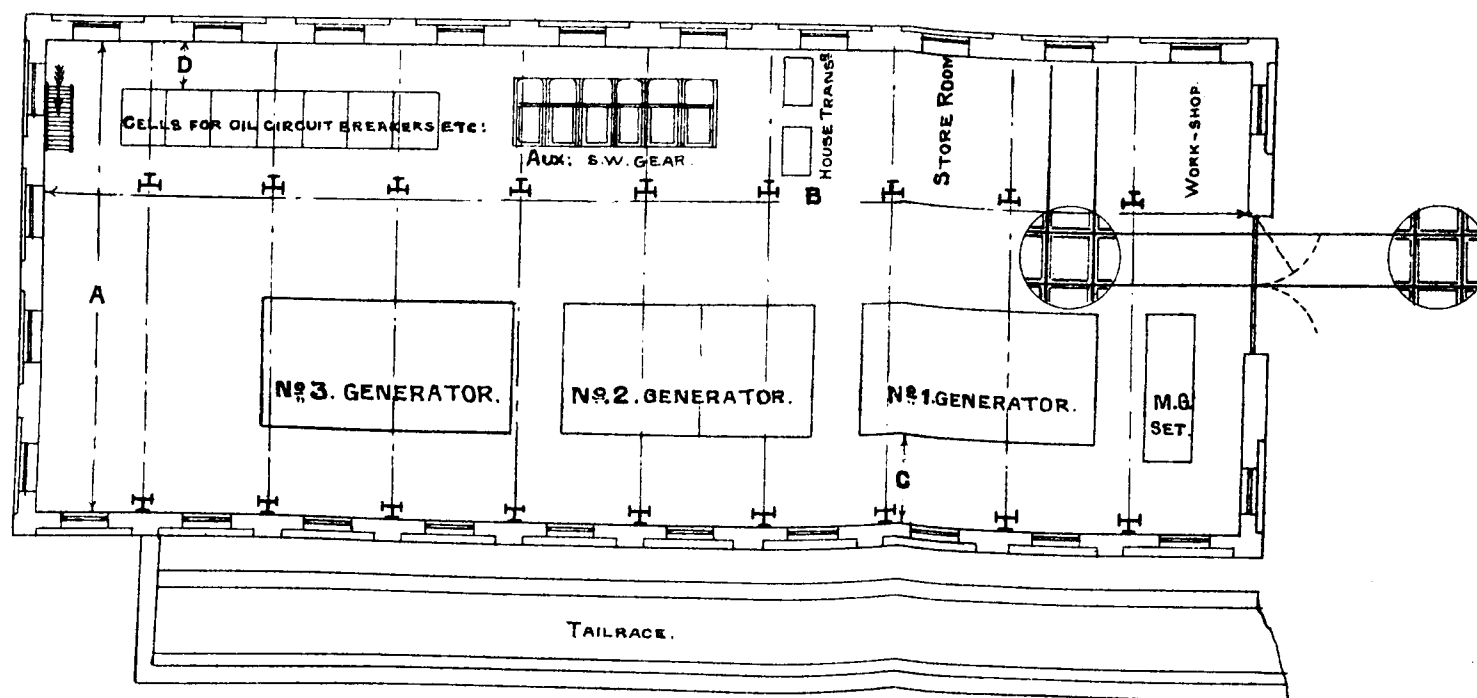
Power House Plant.—In order to reduce the number of high tension circuit breakers, the lay-out of the power plant has been modified from the original design and is shown in plan No. $\frac{P. 52}{F. 1}$. A smaller capacity is contemplated. The



SECTIONAL ELEVATION.

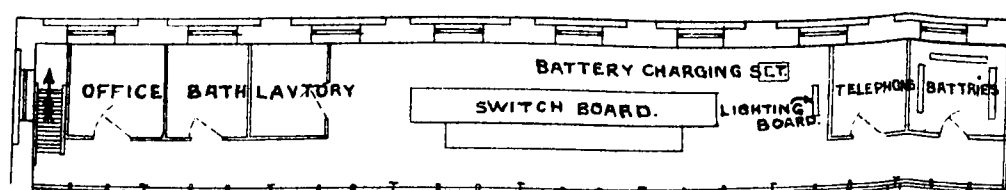


END ELEVATION.



PLAN.

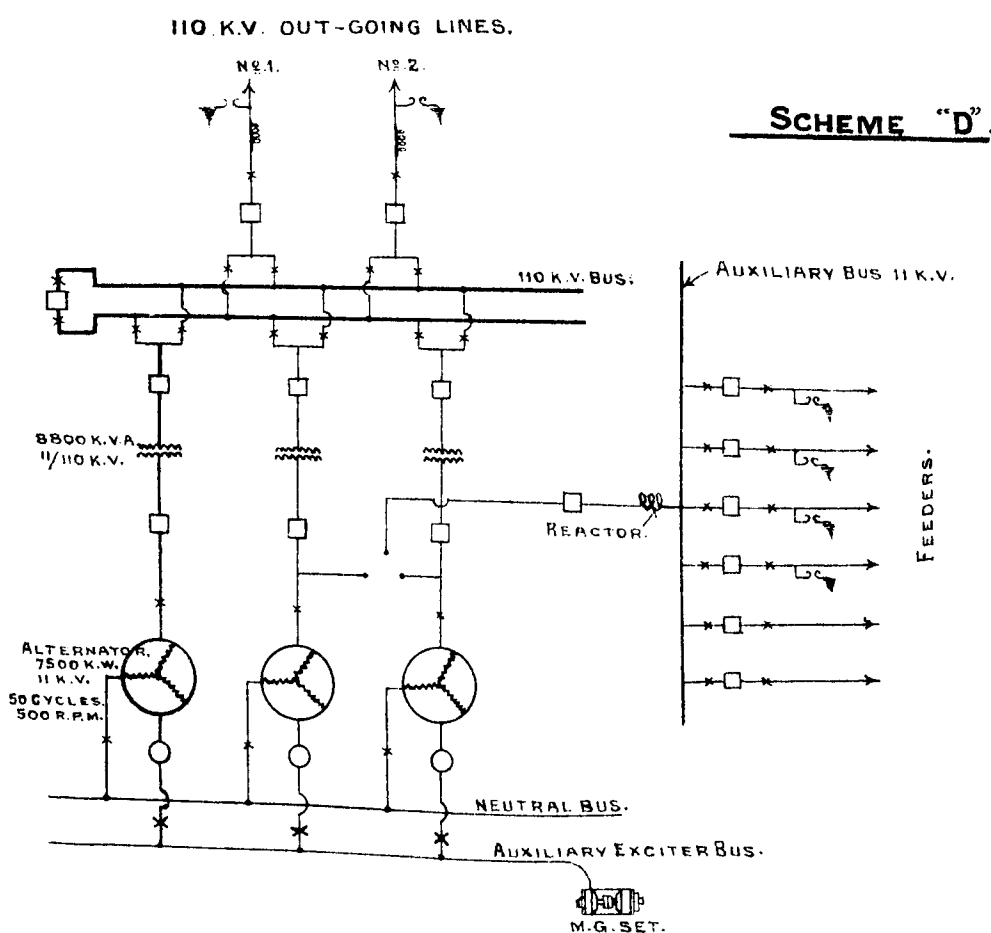
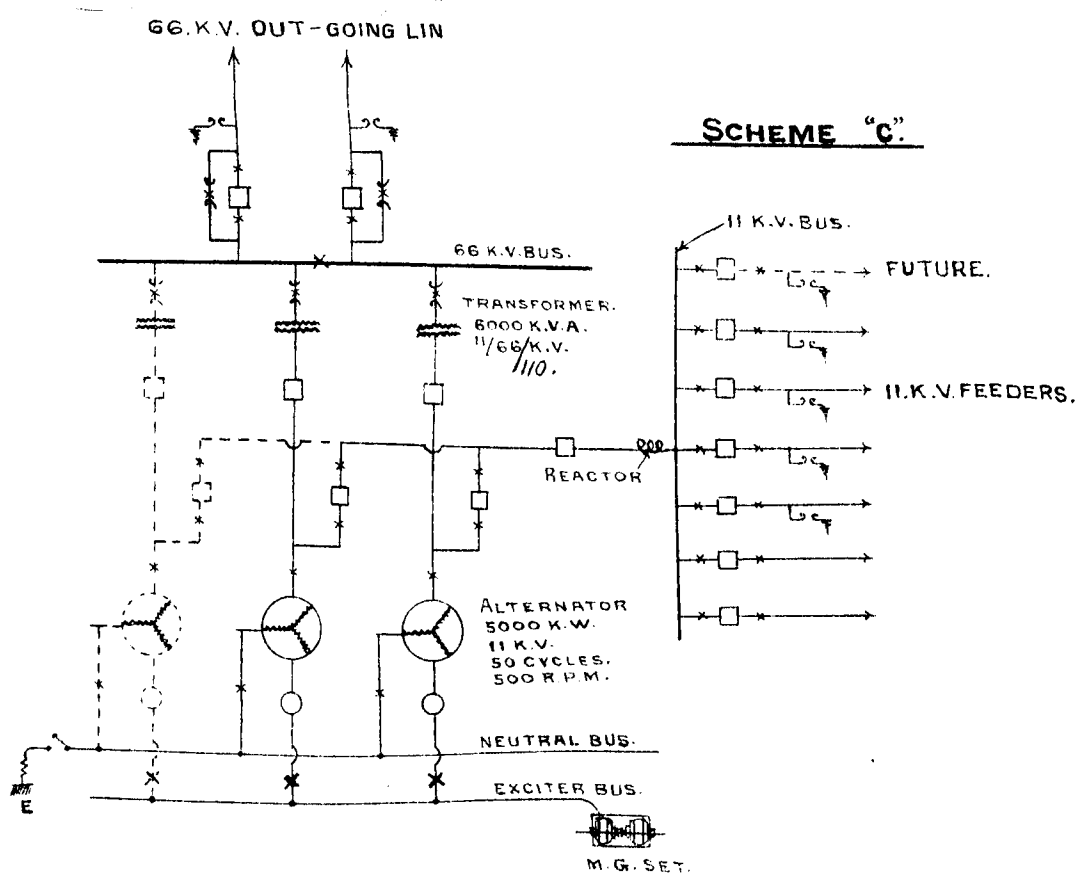
TYPICAL DIMENSIONS	A	B	C	D	E	F
SCHEME 'C'	50'	126'	9'-6"	5'-0"	28'-6"	34'-0"
" 'D'	52'	"	"	"		



SECTIONAL PLAN OF GALLERY.

H. Howard
Chief Engineer.

References.	Drawn, V. K. G. M.	DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT MADRAS.	No. P. 53. F. 2.
	Traced, A. A.		
Revisions	Checked, <i>M. M. M.</i>	PYKARA H.E. DEVELOPMENT.	Scale:- 1"=20'±
	Approved <i>S. S.</i>	POWER HOUSE-SCHEMES C&D	Date:- 28-11-28.



K. S. S. S.
CHIEF ENGINEER

REFERENCES.	DRAWN BY. K.R.	DEPARTMENT OF	N ^o P.52.
	TRACED BY. P. PARAMASIVAN.	HYDRO-ELECTRIC DEVELOPMENT, MADRAS	F. 1.
REVISIONS.	CHECKED BY. M. M. M.	PYKARA H. E. DEVELOPMENT.	SCALE.
	APPROVED BY. <i>93</i>	POWER HOUSE LAYOUT—SCHEMES C&D	DATE 26-11-28.

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short circuit K.V.A. will thus be less, which will permit the rupturing capacity of the low tension breakers to be decreased, and the cost reduced. Switching operations and synchronizing are better carried out on the low tension side than on the high tension side as in the larger schemes. For reasons of economy 66 K.V. air break gang disconnecting switches are advocated for the transformers. Only one high tension bus will be installed; this however may be sectionalized. The low tension voltage will, as before, be 11,000, but the high tension voltage will only be 66 K.V. this being high enough for the load to be transmitted, and will involve much less costly high tension equipment. Clearances will be such that the high tension voltage could be raised to 110 K.V. at any time by merely increasing the insulation. The transformers in the first installation are to be wound for 110/66/11 K.V., as it will probably be found that, when others are needed, the load demand will warrant increase to 110 K.V. Except where noted otherwise the power plant and equipment are the same as for scheme (a).

Table No. 20 shows the equipment during the different stages of development of this scheme.

TABLE No. 20.—Penstocks and power house equipment.

Scheme (c).

Stage.		I.	II.
Year.		2.	3.
Installed Capacity	K.W.	10,000	15,000
1. Penstocks—			
Number	...	2	...
Head Gross	Feet.	3,090	...
Diameter	Inches.	21 to 30	...
Length	Feet.	9,300	...
2. Turbines—			
Number	...	2	1
Size	H.P.	7,500	7,500
Speed	R.P.M.	500	500
3. Alternators—			
Number	...	2	1
Size	K.W.	5,000	5,000
Voltage	K.V.	11	11
Frequency	Cycles per second.	50	50
4. Transformers—			
Number	...	2	1
Size	K.V.A.	6,000	6,000
Voltage ratio	K.V.	11/66/110	11/66/110

Generators.—It is proposed to install two units of 5,000 K.W. (6,000 K.V.A.) at the outset, followed by a third in the third year of operation and a fourth, later when needed. One unit will always be spare. The characteristics of the generators will be similar to those of the 7,500 K.W. units in scheme (a). The results of recent enquiries seem to indicate that horizontal units at 500 R.P.M. will be the most suitable for the purpose in view.

Turbines.—Single impulse overhung wheels with a speed of 500 R.P.M. will probably be specified; in other respects they will be as already described. The main reason for specifying 500 R.P.M. is the higher efficiency possible—some 2 per cent extra—over machines designed for 750 R.P.M.; this is an important item with high head storage plants. The question of the increased cost of the unit and the transportation of the heavier pieces have, however, to be taken into account before arriving at a final decision.

Transformers.—Will be 3 phase, 6,000 K.V.A. outdoor units cooled by the forced circulation of oil.

The outdoor transformer yard is shown in Plan No. $\frac{P. 51.}{F. 2.}$

Auxiliaries.—The auxiliary equipment and feeders are to be substantially as described in Part II of the General Report.

Estimates.—The estimate for the power house and penstocks is given in Table No. 21.

TABLE No. 21.—Power House Estimate.

Scheme (c).

Stage of Development.	I.	II.
Year of operation.	1st	3rd
Installed Capacity K. W.	10,000.	15,000.
	RS.	RS.
Penstocks	15,70,000	...
Incline railways	1,60,000	...
Buildings and tail race	2,60,000	80,000
Turbines and governors	1,60,300	80,800
Generators and exciters	2,78,300	1,39,800
L. T. and control gear	1,35,400	43,800
Auxiliaries and feeders	1,44,600	21,300
Crane, piping, repair shop, etc.	90,000	20,000
H. T. gear	1,55,000	12,770
Transformers	1,28,900	64,100
Outdoor structure	60,000	20,000
Sub-total ...	31,40,500	4,82,570
Contingencies 5 per cent	1,57,000	24,130
Construction plant and tools	1,90,000	50,000
Temporary camps	1,17,000	25,000
Sub-total ...	36,04,500	5,81,700
General Expenses	8,24,000	1,30,500
Total ...	44,28,500	7,12,200

Transmission Lines.—The general design of the transmission lines between Pykara and Coimbatore has been modified for scheme (c). The design submitted for other schemes was found to be too costly and would have involved too much idle investment, in view of the limited load requirements in this scheme.

The size of the conductor has been reduced to 6/208+7/069 A.C.S.R. and the weight of the steel towers decreased accordingly.

The voltage has been fixed at 66 K.V., but the clearances on all structures will permit an increase to 110 K.V. when necessary; the insulation of the equipment would, then, have to be increased.

The mechanical characteristics of this line are shown in Table No. 22.

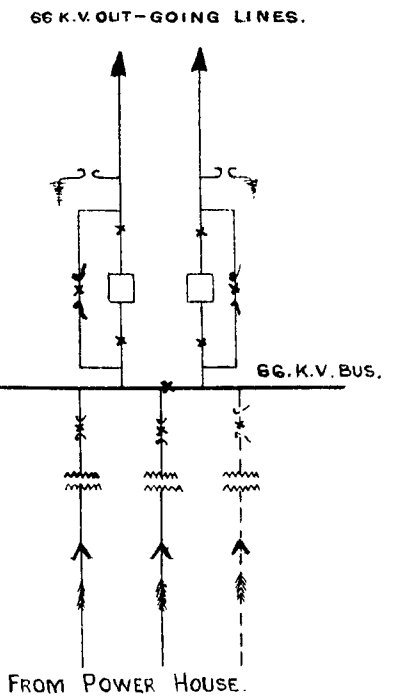
The designs of the 11 K.V. and 22 K.V. branch and distribution lines are the same as described in Part II of the General Report.

In Plan No. $\frac{P. 57}{F. 1}$ is shown the proposed transmission system.

NOTE.-

ALL SPACINGS ARE FOR 110 K.V.

SINGLE LINE DIAGRAM OF CONNECTIONS.



OUT-GOING LINE.

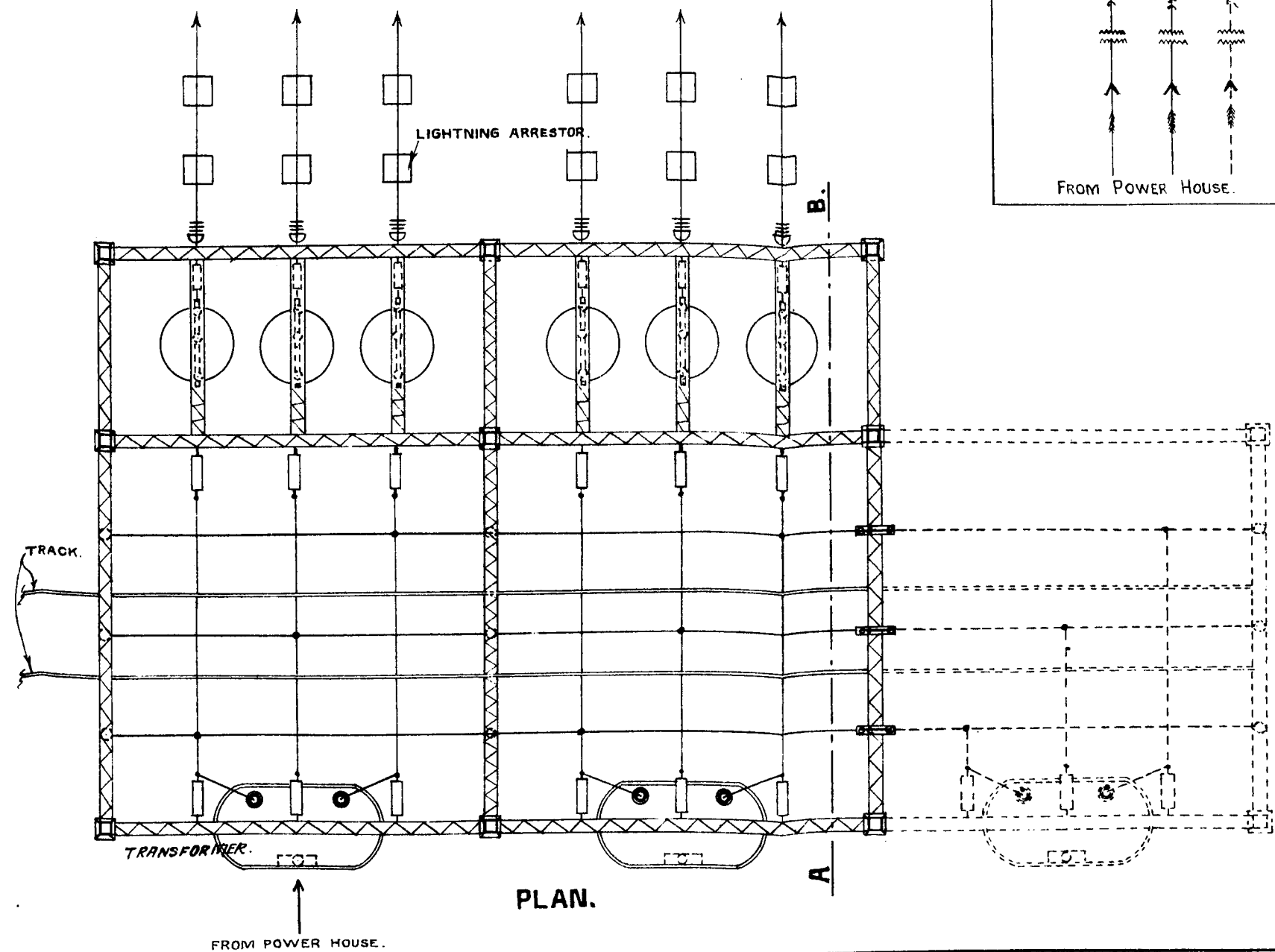
OUT-GOING LINE

No 1

No 2

LIGHTNING ARRESTOR.

SECTION ON AB.



PLAN.

FROM POWER HOUSE.

Chief Engineer.

Reference.	Drawn. <i>K.R.</i>	DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT, MADRAS.	No. <u>P. 54.</u> F. 2.
	Traced. <i>P.P.</i>		
Revision.	Checked <i>M.S. Man</i>	PYKARA H.E. DEVELOPMENT.	Scale:- 1" = 10'.
	Approved. <i>G.S.</i>		
		OUT DOOR TRANSFORMER YARD - SCHEME "C".	Date:- 8-11-28

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1929.

TABLE No. 22.—Mechanical characteristics of transmission lines.

Scheme (c).

Pykara-Mettupalaiyam-Coimbatore Section.

Mileage	...	...	...	...	55 miles.	
Voltage	{	Eventual	...	...	110 K. V.	
		Present	...	...	66 K. V.	
Span	{	Normal	...	...	1,050 feet.	
Clearances.	{	Vertical	...	...	9.5 feet.	
		Horizontal	...	...	17 "	
		Offset	...	...	3 "	In the Pykara-Mettupalaiyam Section only.
Conductor (six).	{	Size	...	...	6/208 + 7/069. A.C.S.R.	
		Ultimate strength	...	...	9,134 lb.	
		Maximum tension	...	...	3,654 "	
		Do. sag	...	...	29.2 feet.	
		Factor of safety	...	...	2.5	
* Insulators...	{	Type	...	...	Disc.	
		Number on strain	...	...	5	
		Do. suspension	...	...	4	
		Maximum strength	...	...	12,000 lb.	
Ground wire (one).	{	Size	...	...	$\frac{3}{8}$ inch.	
		Ultimate strength	...	...	11,500 lb.	
		Maximum tension	...	...	4,600 lb.	
		Do. sag	...	...	19.2 feet.	
		Factor of safety	...	...	2.5.	
Type of tower	...	...	...	...	A	B
Height of tower	...	...	...	...	76 feet.	76 feet.
Weight of each tower (approximate)	...	...	...	...	6,000. lb.	10,000. lb.
Factor of safety	...	...	...	...	2.5.	2.5.
Number of conductors assumed broken on one side	...	...	...	...	Two.	Three.
Total number of conductors and ground cable assumed broken...	...	...	...	...	Two.	Seven.
Maximum horizontal angle	...	...	...	...	5°.	40°.
Maximum vertical angle	...	...	...	...	20°.	40°.

TABLE No. 23.—Characteristics of single circuit from Pykara to Coimbatore.

For various loads at 0.9 P.F.

Scheme (c).

Effect of Transformers at Coimbatore (except spares) included.

Kilowatts.		Line volts.		Line amperes.		K.V.A.		Power factor.		Per cent.		Per cent line loss.
Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Regulation.	Efficiency.	—
0*	...	66,000	66,500	0	1.73	0	200	...	0.735	0	...	...
1,000	1,010	66,000	66,330	9.72	10.2	1,111	1,183	0.9	0.8528	1.4	99.13	0.5
2,500	2,523	66,000	67,630	24.3	21.6	2,778	2,530	Lag. 0.9	0.9972	3.45	99.06	2.47
5,000	5,140	66,000	70,010	48.6	44.7	5,556	5,420	Lag. 0.9	0.9483	7.0	97.27	6.06
10,000	10,640	66,000	74,910	97.2	92.5	11,111	11,900	Lag. 0.9	0.8870	14.6	93.97	13.5

* Power house transformers are included in zero load calculations.

TABLE No. 24.—Characteristics of single circuit 66 K.V. from Pykara to Coimbatore. For various loads at 0.9 P.F.

Constant sending end, and receiving end voltages.

Scheme (c).

Effect of transformers at Coimbatore (except spares) included.

Sending end voltage 70,000.
Receiver do. 66,000.

Kilowatts.		Amperes.			K.V.A.		Power Factor.			K. V. A. of condenser.	Per cent Efficiency Line and Transformer (excluding condenser losses).
Load.	Generator.	Load.	Generator.	Condenser.	Load.	Generator.	Load.	Generator.	Receiver.		
Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.		
0*	...	0	37.90	—36	0	4,300	...	...	...	—4,100 (reactive)	...
1,000	1,064	9.72	24.5	—29.75	1,111	2,970	0.9 lag	0.8584 lag.	0.2588 lag.	—3,400 (reactive)	94.0
2,500	2,560	24.3	28.5	—17.8	2,778	3,454	0.9 lag	0.7431 lag.	0.6157 lag.	—2,034 (reactive)	97.5
5,000	5,140	48.6	44.7	0	5,556	5,419	0.9 lag	0.9483 lag.	0.9 lag.	0 (reactive)	97.3
10,000	10,530	97.2	87.0	41.9	11,111	10,540	0.9 lag	0.9986 lag.	1.0 lag.	+4,800	95.0

* Power house transformers are also included in zero load calculations.

TABLE No. 25.—Characteristics for various points on the System on Zero Load.

With all transformers except spares in Circuit.

Scheme (c).

Station.	Line Voltage.	Line Current.	P.F.	K.V.A.	K.W.
Pykara	...	...	...	...	...
Coimbatore	66,500	1.73	0.735 lag.	200	147
	66,000	0	...	...	...

TABLE No. 26.—Regulation of the 22 K.V. lines.

Scheme (c).

Year of operation.	Coimbatore-Tiruppur Section.			Coimbatore-Pollachi Section.			Pollachi-Anamalai Section.	
	Load in K.W. 0.9 lag.	One line.	Two lines.	Load in K.W. 0.9 lag.	One line.	Two lines.	Load in K.W. 0.9 lag.	One line.
First	...	...	...	...	...	...	...	...
Second	233	PER CENT. 1.9	PER CENT. 0.95	300	PER CENT. 2.0	PER CENT. 1.0	140	PER CENT. 0.8
Third	349	2.9	1.45	460	3.1	1.55	215	0.5
Fourth	510	4.2	2.1	606	4.1	2.05	190	0.65
Fifth	585	4.8	2.4	875	4.55	2.08	320	0.72
Sixth	668	5.5	2.75	745	5.04	2.52	340	0.77
Seventh	750	6.1	3.05	800	5.4	2.7	370	0.83
Eighth	806	6.6	3.3	860	5.8	2.9	400	0.90
Ninth	893	7.8	3.65	905	6.1	3.05	420	0.94
Tenth	945	7.7	3.85	955	6.45	3.23	440	0.99
	1,024	8.4	4.2	985	6.65	3.33	460	1.03

NOTE:-

INSTALLATION.

— BEFORE 1st YEAR OF OPERATION.
 - - - - - AFTER 1st YEAR OF OPERATION.

TRANSFORMERS.

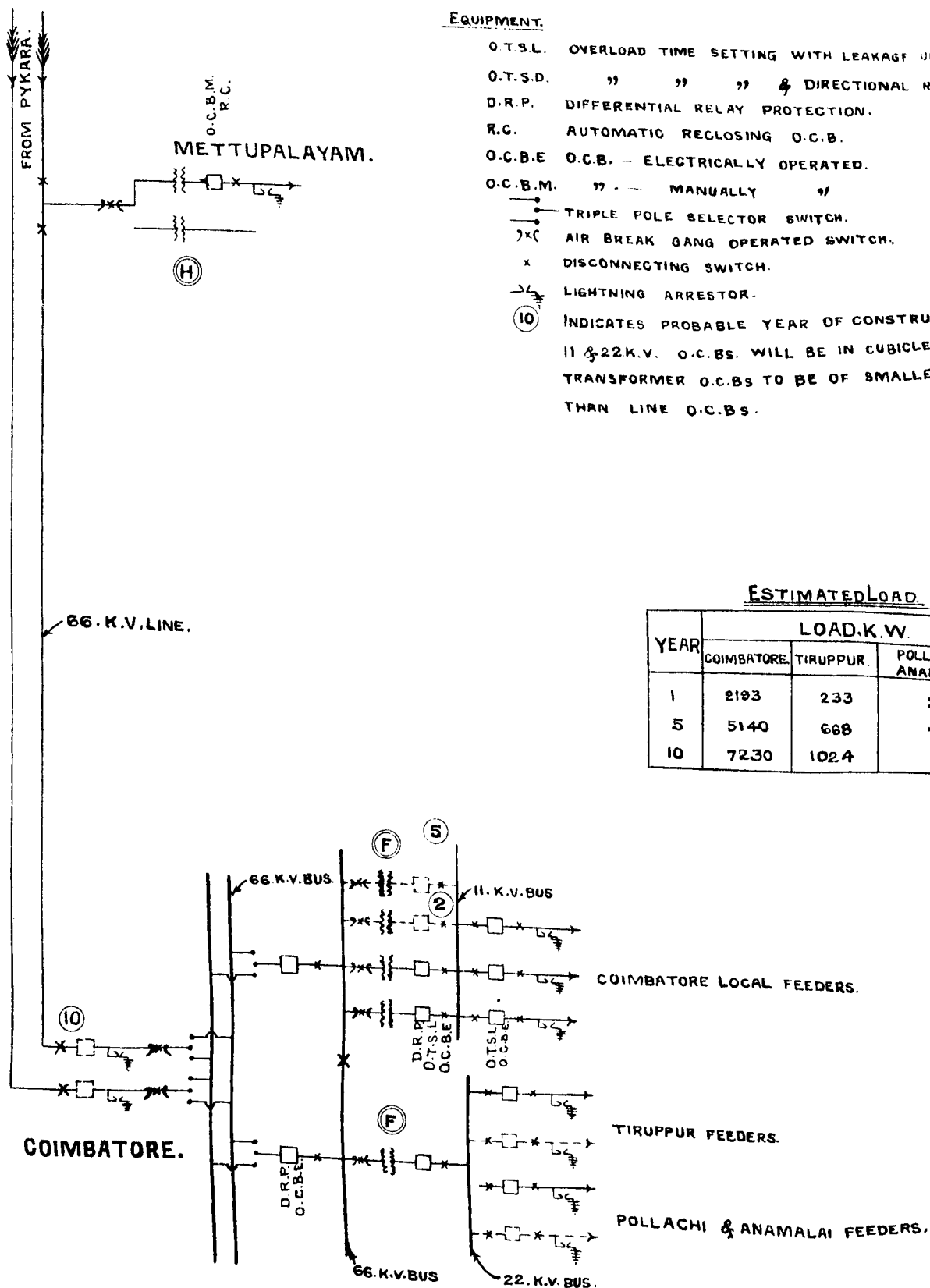
(H) 100 K.V.A. 66/22/11 K.V.
 (F) 2500. " " "

EQUIPMENT.

O.T.S.L. OVERLOAD TIME SETTING WITH LEAKAGE UNIT
 O.T.S.D. " " " & DIRECTIONAL RELAY.
 D.R.P. DIFFERENTIAL RELAY PROTECTION.
 R.C. AUTOMATIC RECLOSING O.C.B.
 O.C.B.E O.C.B. — ELECTRICALLY OPERATED.
 O.C.B.M. " — MANUALLY "
 — TRIPLE POLE SELECTOR SWITCH.
 (X) AIR BREAK GANG OPERATED SWITCH.
 x DISCONNECTING SWITCH.
 — LIGHTNING ARRESTOR.
 (10) INDICATES PROBABLE YEAR OF CONSTRUCTION.
 11 & 22 K.V. O.C.B.S. WILL BE IN CUBICLES.
 TRANSFORMER O.C.B.S TO BE OF SMALLER CAPACITY
 THAN LINE O.C.B.S.

ESTIMATED LOAD.

YEAR	LOAD K.W.		
	COIMBATORE	TIRUPPUR.	POLLACHI & ANAMALAI.
1	2193	233	300
5	5140	668	745
10	7230	1024	985.



H. S. Howard
 CHIEF ENGINEER.

Reference	Drawn. K.R.	DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT MADRAS.	No. P. 57. F.1.
	Traced. A.A.		
Revision.	Checked. <i>mmani</i>	PYKARA H.E. DEVELOPMENT.	Scale:-
	Approved. <i>SS</i>		
Reg. No. 384 / 3		POWER SYSTEM LAY-OUT. SCHEME "C."	Date:- 21-11-28.

37

Regulation.—The question of the regulation of the lines has again been studied carefully. Table No. 23 gives the electrical characteristics of a single circuit between Pykara and Coimbatore for various loads. Assuming an allowable tolerance of ± 5 per cent in the voltage at the receiver end, it will be seen that each line has a maximum capacity of around 7,500 K.W. In order to take care of the maximum demand on one circuit it would be necessary to change the transformer taps at the power-house some time between the fifth and tenth years.

Table No. 24 shows the amount of lagging or leading K.V.A., needed to keep the voltages constant at the power-house and receiver ends, while Table No. 25 gives the line conditions at zero load.

The estimates have allowed for the installation of a 5,000 K.V.A. synchronous condenser in the fifth year, but from the results shown in the above tables it would appear that such an expenditure would probably not be necessary.

Table No. 26 gives the regulation figures for the 11 K.V. and 22 K.V. branch lines, and indicates the necessity of doubling up these circuits after a certain time.

The estimates for the transmission lines are given in Tables Nos. 27 and 28.

TABLE No. 27.—Average cost per mile of transmission lines

Scheme (c).

Section.	Length mile.	Voltage K.V.	Span feet.	Conductor A.C.S.R.	Cost of line per mile.
Pykara-Mettupalaiyam ...	33	66	1,050	6/208 + 7/069	RS. 38,400
Mettupalaiyam-Coimbatore ...	22	66	1,050	6/208 + 7/069	35,400
11 K.V. Branch line single ...	...	...	...	...	7,400
Do. double ...	...	...	...	...	8,700
22 K.V. Branch line single ...	...	...	...	...	8,500
Do. double ...	...	...	...	...	10,000

TABLE No. 28.—Transmission line estimate.

Scheme (c).

Section.	Miles.	Cost.	
		First year.	Third year.
Pykara-Mettupalaiyam ...	33	RS. 12,67,200	...
Mettupalaiyam-Coimbatore ...	22	7,78,800	...
Pykara-Ootacamund ...	13	1,13,100	...
Coimbatore-Pollachi ...	24	2,04,000	36,000
Do. Tiruppur ...	29	2,46,500	43,500
Pollachi-Anamalais ...	8	68,000	...
Contingent allowance for 22 K.V. connection to Nilgiri Railway sub-station ...	...	50,000	...
		27,27,600	79,500

Sub-stations.—The general design of the Coimbatore sub-station for this scheme is shown on Plan No. $\frac{P. 59}{F. 2}$. It is somewhat simpler than those submitted for the larger schemes.

Three three-phase 2,500 K.V.A. 66/22/11 K.V. transformers are to be installed at first, and two others added before tenth year; there will always be one spare unit. If ever the voltage is raised to 110 K. V., the load will undoubtedly have developed sufficiently to warrant certain branch lines at 66 K.V., hence the original transformers and switchgear could be used on the 66 K.V. system, and 110 K.V. equipment purchased for the sub-station. Plan No. $\frac{P. 57}{F. 1}$ shows the proposed lay-out of the power system.

The estimate provides for a small synchronous condenser installation about the 5th year, but it is very doubtful if it will be needed. Table No. 29 gives the sub-station estimate.

TABLE No. 29.—Sub-station estimate.

Scheme (c).

Sub-station.	Year of operation.					
	First.	Second.	Third.	Fifth.	Tenth.	Total.
	RS.	RS.	RS.	RS.	RS.	RS.
Coimbatore	4,81,740	55,040	44,000	55,040	43,400 — (4,670)	6,82,220 — (4,670)
Tiruppur	1,00,000 *	...	...	...	...	1,00,000
Pollachi	80,000 *	...	...	...	...	80,000
Anamalais	80,000 *	...	...	...	...	80,000
Mettupalaiyam	57,000	...	...	...	...	57,000
Contingent cost for line regulation.	...	...	...	3,00,000	...	3,00,000
Total	7,81,740	55,040	44,000	3,55,040	43,400 (— 4,670)	12,78,220 (— 4,670)

* Contingent costs.

FINANCIAL.

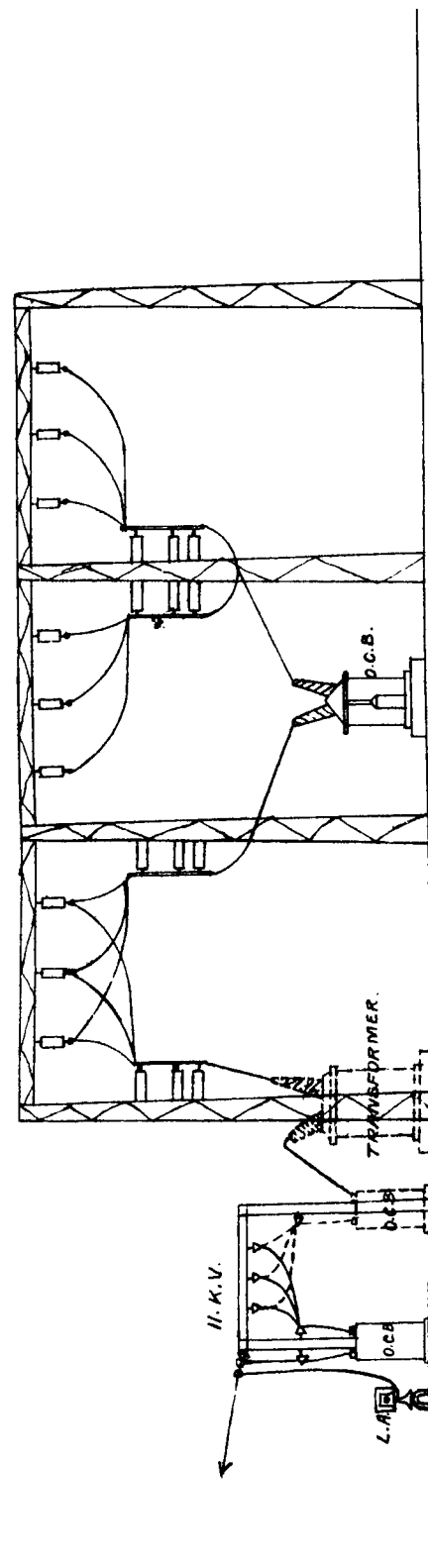
Capital Expenditure.—The estimated amounts of capital needed annually for the works, both during the construction and the operation periods, are given in Table No. 30.

Simple interest on the capital outlay during the construction period has been allowed to accumulate and is shown in the financial Tables Nos. 32 and 33 as arrears of interest for the construction period. These arrears will gradually be wiped out by revenue receipts in the subsequent years of operation.

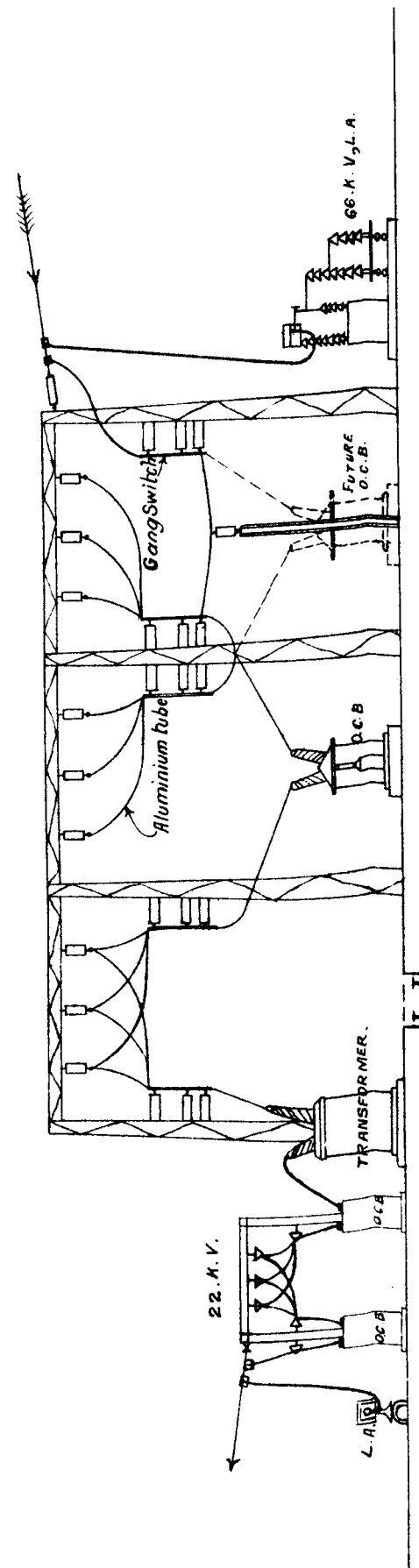
No provision for the abatement of land revenue for the right of way acquired for transmission lines is considered necessary since the land where arable could always be rented for cultivation.

Operation and Maintenance.—The operation and maintenance expenses have been allowed as follows:—

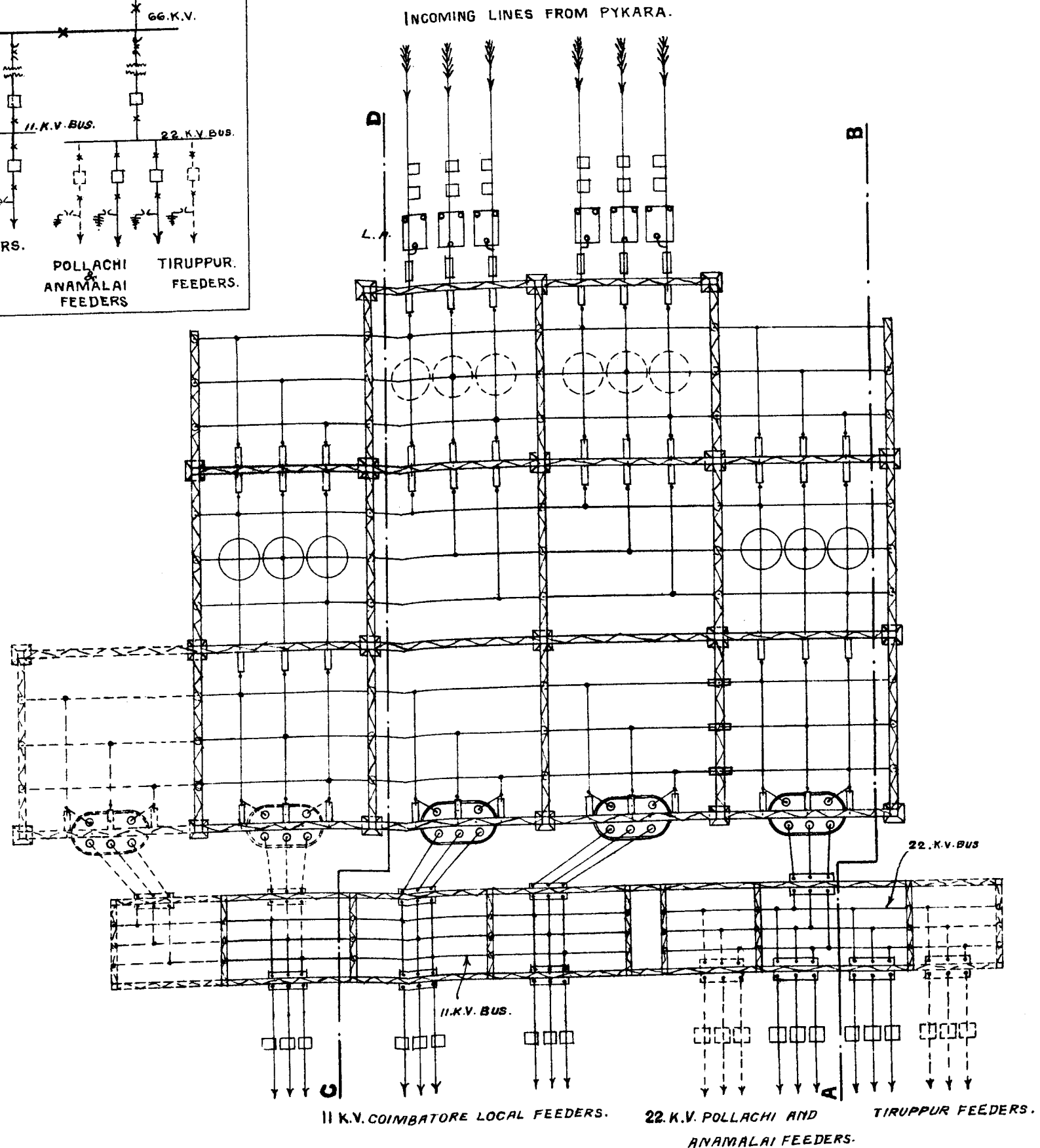
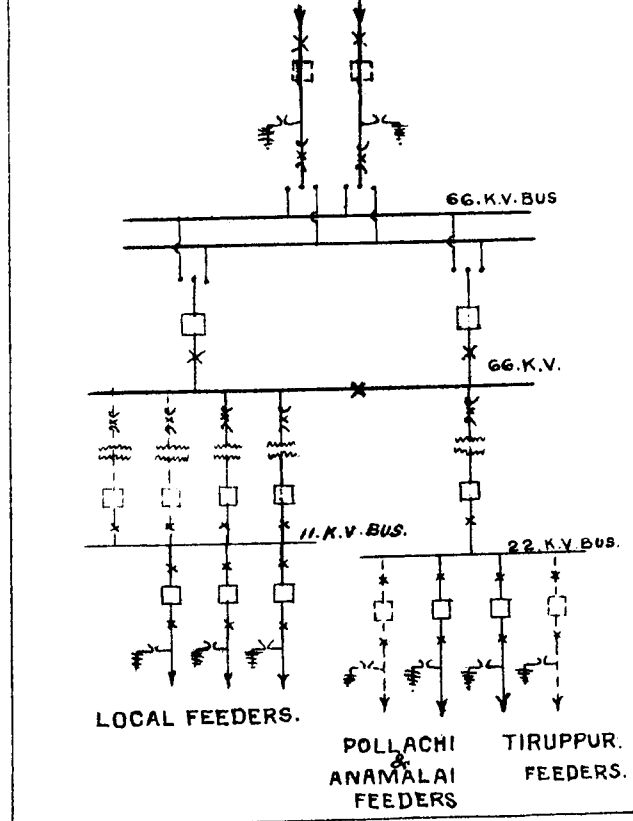
Year of operation.			Amount	Year of operation.			Amount
			RS.				RS.
First	...	...	2,62,000	Sixth	...	...	2,88,000
Second	...	...	2,62,000	Seventh	...	...	2,88,000
Third	...	...	2,72,000	Eighth	...	...	3,02,000
Fourth	...	...	2,72,000	Ninth	...	...	3,02,000
Fifth	...	...	2,88,000	Tenth	...	...	3,02,000



SECTION ON C.D.



SECTION ON A.B.



PLAN.

H. S. Nair
Chief Engineer.

Reference.	DRAWN. <i>K.R.</i>	DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT MADRAS	No. P. 59. F. 2.
	TRACED. <i>at</i>		
Revision	CHECKED <i>M. S. Nair</i>	PYKARA H. E. DEVELOPMENT.	Scale: 1" = 20'
	APPROVED <i>S.S.</i>		
		COIMBATORE SUB-STATION PROGRAMME	Date: 4-12-28.

Vanduyke & Co.

TABLE No. 30.—Annual capital expenditure.

Scheme (c).

Year and period.					Hydraulic works.	Power House and Penstocks	Transmission Lines.	Sub-station.	Total.
Construction period.					RS.	RS.	RS.	RS.	RS.
First	{	First half	...	...	7,00,000	...	65,000	...	7,65,000
		Second half	...	...	9,00,000	2,00,000	65,000	20,000	11,85,000
Second	{	First half	...	...	6,90,000	4,50,000	70,000	20,000	12,30,000
		Second half	...	...	6,10,000	7,00,000	2,00,000	40,000	15,50,000
Third	{	First half	...	...	6,00,000	16,50,000	5,00,000	2,00,000	29,50,000
		Second half	...	...	4,00,000	12,00,000	12,00,000	3,00,000	31,00,000
Fourth	{	First quarter	...	...	3,37,000	2,28,500	6,27,600	2,01,740	13,94,840
Sub-total					42,37,000	44,28,500	27,27,600	7,81,740	1,21,74,840
Deduct—Salvage construction plant and equipment					-1,62,000	...	...	...	-1,62,000
Sub-total					...	...	...	...	1,20,12,840
Operation period.									
First	...	...	...	...	...	...	...	55,040	55,040
Second	...	...	...	...	...	7,12,270	79,500	44,000	8,35,700
Third	...	...	...	...	...	...	...	...	...
Fourth	...	...	...	...	...	...	...	3,55,040	3,55,040
Fifth	...	...	...	...	...	...	...	...	...
Sixth	...	...	...	...	...	...	...	...	...
Seventh	...	...	...	...	...	...	...	...	...
Eighth	...	...	...	...	...	...	...	38,730	38,730
Ninth	...	...	...	...	...	...	...	...	...
Tenth	...	...	...	...	...	...	...	...	...
Total					40,75,000	51,40,700	28,07,100	12,74,550	1,32,97,350

Accumulated simple interest at 5½ per cent on the capital outlay during the initial construction period is Rs. 9,45,260.

Accumulated simple interest at 6 per cent on the capital outlay during the initial construction period is Rs. 10,55,170.

Depreciation.—The method of calculating the depreciation figures and the assumed lives of the machinery and equipment are the same as given in the General Report. The amounts set aside are as follows :—

Year of operation.	At 5½ per cent simple interest.	At 6 per cent simple interest.
	RS.	RS.
Sixth year	1,61,830	1,47,020
Seventh „	1,61,830	1,47,020
Eighth „	1,61,830	1,47,020
Ninth „	1,62,730	1,47,810
Tenth „	1,62,730	1,47,810

Financial Statements.—Financial statements have been prepared for two rates of interest, one at 5½ per cent representing the prevailing rate, and the other at 6 per cent representing the rate prescribed by Government—vide Tables Nos. 32 and 33.

It will be seen that the initial capital expenditure is Rs. 120·13 lakhs rising to Rs. 132·97 lakhs in the tenth year.

With the 6 per cent rate, the net return on the actual capital outlay in the tenth year is 7·83 per cent and the return at the end of ten years on the “sum at charge” (in which is included the arrears of interest) is 6·33 per cent.

The corresponding results with 5½ per cent rate are, of course, more favourable.

A summary of the results for the tenth year of operation is given in Table 31.

TABLE No. 31.—Summary of financial results.

Scheme (c).			
		5½ per cent interest rate.	6 per cent interest rate.
		LAKHS OF RS.	LAKHS OF RS.
Tenth year of operation—			
1. Capital outlay	...	132.97	132.97
2. Arrears of simple interest	...	23.00	31.49
3. Sum at charge	...	155.97	164.46
4. Net revenue	...	10.28	10.42
5. Interest on sum at charge	...	8.38	9.87
6. Net surplus	...	1.90	0.55
		PER CENT.	PER CENT.
7. Return on sum at charge	...	6.59	6.23

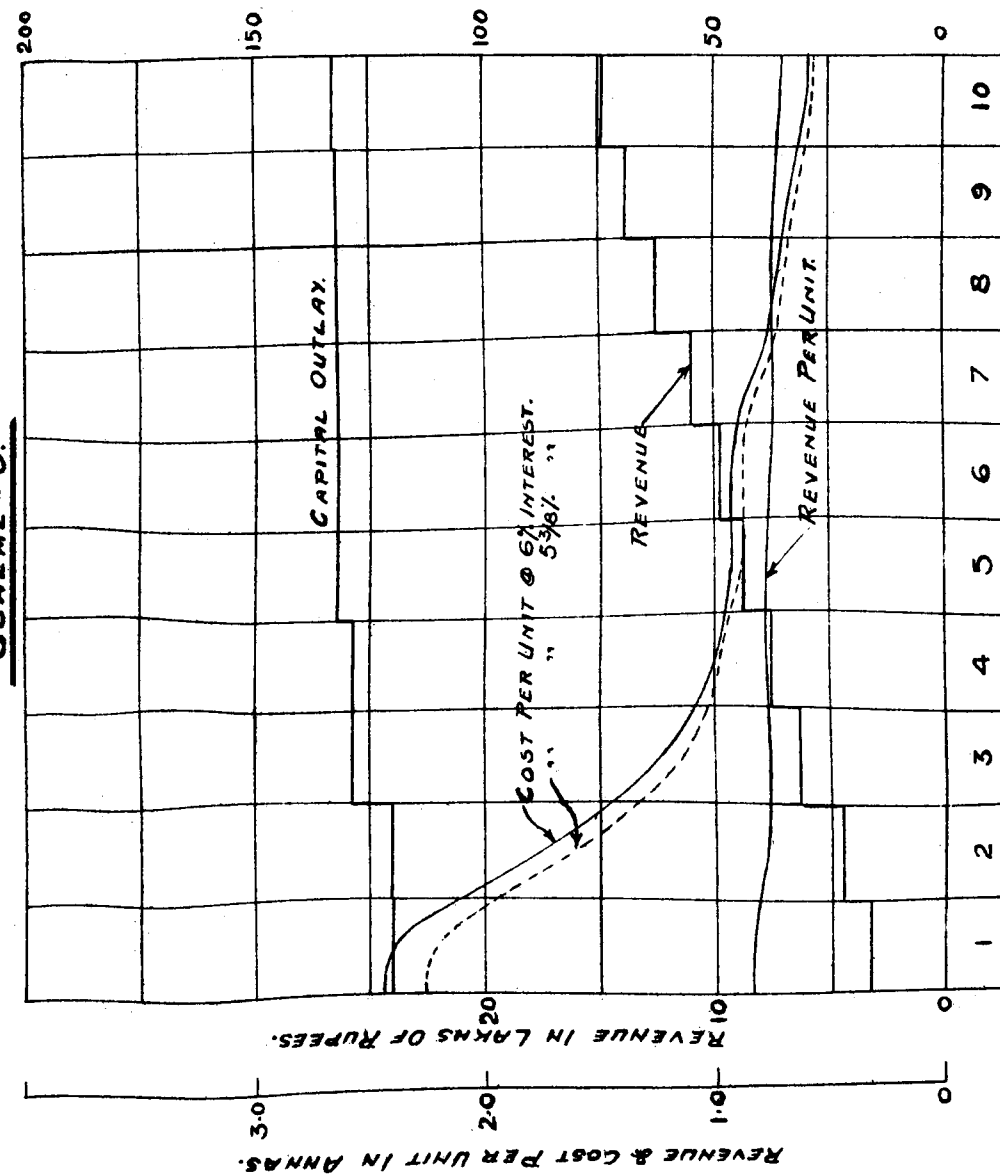
Item 3 = 1 + 2.

" 4 = Gross revenue less operating expenses and depreciation.

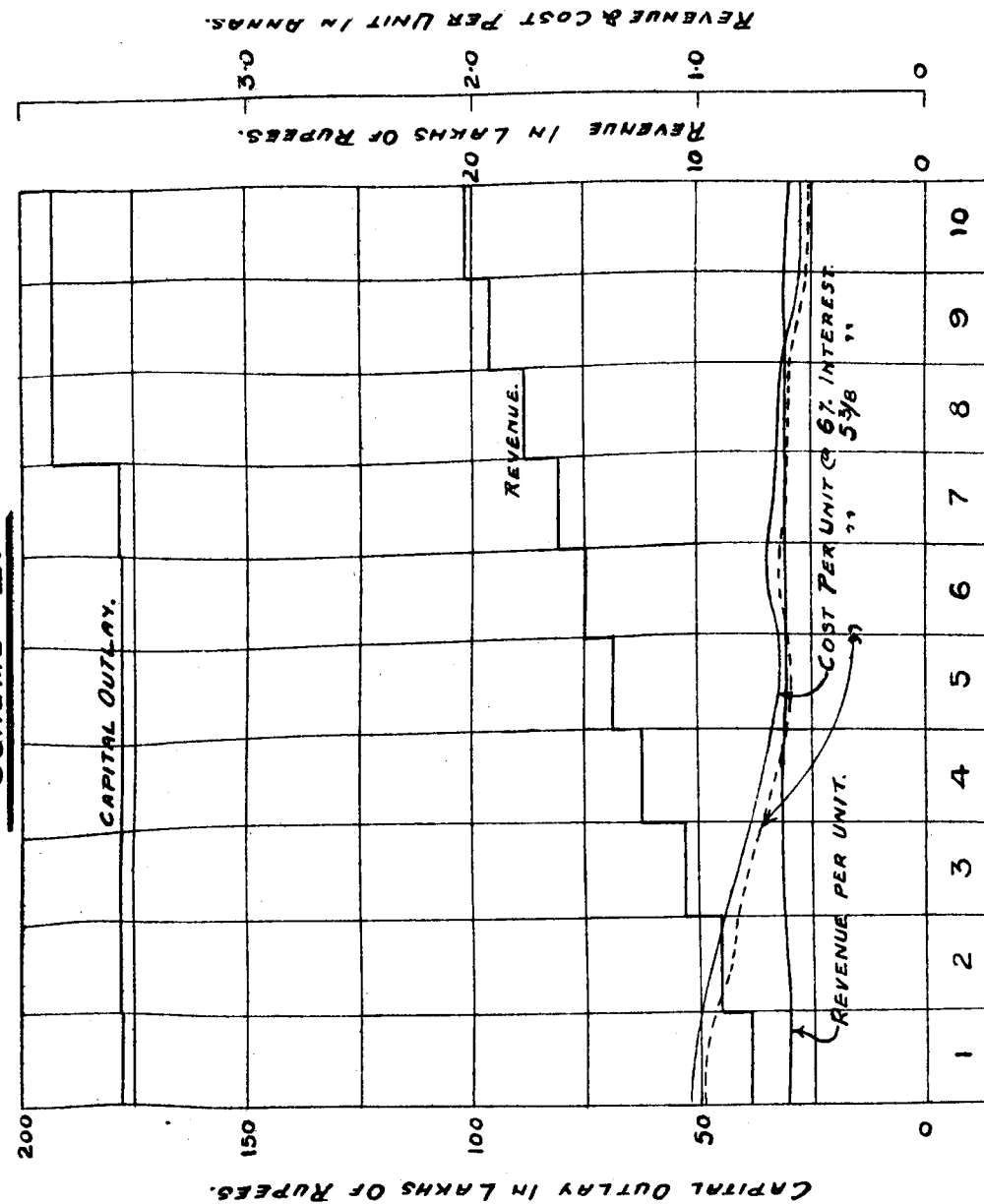
" 7 = $\frac{\text{Item (4)}}{\text{Item (3)}} \times 100$.

Plan No. $\frac{P. 62}{F. 1}$ has been plotted to show the relationship between capital expenditure and the revenue, and between the cost and the revenue received per unit.

SCHEME - C.



SCHEME - D.



YEAR OF OPERATION.

YEAR OF OPERATION.

Reference.

Drawn. K. R.

DEPARTMENT
OF

HYDRO ELECTRIC DEVELOPMENT MADRAS.

No. P 62.
F. 1.

Revision.

Traced. K. R.

PYKARA H.E. DEVELOPMENT.

Scale:

Date: 7-12-28.

Approved G.S.

FINANCIAL RESULTS - SCHEMES C & D.

K. R. Srinivasan
CHIEF ENGINEER.

TABLE No. 32—Giving capital outlay, operating expenses, revenue, surplus, etc
Interest charged at $5\frac{1}{2}$ per cent.
Scheme (c).

Year of operation	Capital outlay up to the year	Capital outlay during the year.	Interest at $5\frac{1}{2}$ per cent on the capital outlay up to the year plus half the outlay during the year.	Operation and maintenance.	Depreciation and renewals.	Total expenses, (5) + (6).	Gross revenue.	Net revenue, (8) - (7).	Per cent return on capital outlay, $\frac{\#}{\#} \times 100$.	Surplus after deducting interest charges, (9) - (4).	Accumulated surplus.	Average cost per K.W.H. distributed.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Construction period	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	PER CENT.	RS.	RS.	ANNA.
First	1,20,12,840	...	...	...	...	...	...	...	...	...	-9,45,260 *	...
Second	1,20,12,840	55,040	6,47,170	2,62,000	...	2,62,000	3,38,160	76,160	0.63	-5,71,010	-15,16,270	2.23
Third	1,20,67,880	8,35,700	6,71,110	2,62,000	...	2,62,000	4,54,080	1,92,480	1.59	-4,73,030	-19,95,300	1.60
Fourth	1,29,03,580	3,55,040	6,99,570	2,72,000	...	2,72,000	6,41,570	3,69,570	2.86	-3,24,000	-23,19,300	1.14
Fifth	1,29,03,580	...	7,03,110	2,72,000	...	2,72,000	7,54,060	4,82,060	3.74	-2,21,050	-25,40,350	0.98
Sixth	1,32,68,620	...	7,12,650	2,88,000	...	2,88,000	8,73,300	5,85,300	4.42	-1,27,350	-26,67,700	0.87
Seventh	1,32,58,620	...	7,12,650	2,88,000	1,61,830	4,49,830	9,84,850	5,35,120	4.04	-1,77,530	-28,45,230	0.88
Eighth	1,32,58,620	...	7,12,650	3,02,000	1,61,830	4,63,830	11,04,750	6,54,920	4.91	+ 57,30	-29,02,860	0.78
Ninth	1,32,58,620	38,790	7,13,690	3,02,000	1,62,730	4,64,730	12,55,220	7,91,390	5.97	+ 78,740	-28,24,220	0.70
Tenth	1,32,97,350	...	7,14,730	3,02,000	1,62,730	4,64,730	13,89,600	9,24,870	6.98	+ 2,11,180	-26,13,040	0.63
							14,92,260	10,27,530	7.55	+ 3,12,800	-23,00,240	0.57

Tenth year—	RS.
Capital outlay	1,32,97,350
Arrears of simple interest	23,00,240
Sum at charge	1,55,97,590
Net revenue	10,27,530
Return on sum at charge...	6.59 per cent.

* Accumulated simple interest at $5\frac{1}{2}$ per cent on the capital outlay during the initial construction period.

TABLE No. 33.—Giving capital outlay, operating expenses, revenue, surplus, etc.
Interest charged at 6 per cent.

Scheme (c).

Year of operation.	Capital outlay up to the year.	Capital outlay during the year.	Interest at 6 per cent on the capital outlay up to the year plus half the outlay during the year.	Operation and maintenance.	Depreciation and renewals.	Total expenses (5) + (6).	Gross revenue.	Net revenue (8) - (7).	Per cent return on capital outlay $\frac{9}{10} \times 100$.	Surplus after deducting interest charges (9) - (4).	Accumulated surplus.	Average cost per K.W.H. distributed.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Construction period	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	PER CENT.	RS.	RS.	ANNA.
First	1,20,12,840	55,040	7,22,420	2,62,000	...	2,62,000	3,38,160	76,160	0.63	-6,43,260	-10,55,170	241
Second	1,20,12,840	8,35,710	7,49,140	2,62,000	...	2,62,000	4,54,080	1,92,080	1.59	-5,57,060	-17,01,430	173
Third	1,20,03,880	...	7,74,210	2,62,000	...	2,72,000	6,41,570	3,69,570	2.86	-4,04,640	-22,58,490	124
Fourth	1,20,03,500	...	7,84,860	2,72,000	...	2,72,000	7,51,060	4,82,060	3.74	-3,02,800	-26,63,130	106
Fifth	1,20,03,500	...	7,84,860	2,72,000	...	2,72,000	7,51,060	4,82,060	4.42	-2,10,220	-29,65,930	94
Sixth	1,32,58,620	...	7,95,520	2,88,000	1,47,020	2,88,000	9,73,300	5,85,300	4.15	-2,45,590	-31,76,150	0.83
Seventh	1,32,58,620	...	7,95,520	2,88,000	1,47,020	4,35,020	11,04,750	6,69,750	5.06	-1,25,790	-34,21,740	0.83
Eighth	1,32,58,620	...	7,95,520	2,88,000	1,47,020	4,35,020	12,55,220	8,16,200	6.08	+10,586	-35,36,850	0.74
Ninth	1,32,58,620	...	7,95,520	3,02,000	1,47,810	4,49,810	13,59,600	9,38,790	7.09	+1,43,110	-33,93,740	0.67
Tenth	1,32,58,620	...	7,97,840	3,02,000	1,47,810	4,49,810	14,92,260	10,42,450	7.83	+2,44,610	-31,49,130	0.60

Tenth year—	RS.
Capital outlay	1,32,97,350
Arrears of simple interest	31,49,130
Sum at charge	1,64,46,480
Net revenue	10,42,450
Return on sum at charge	6.33 per cent.

* Accumulated simple interest at 6 per cent on the capital outlay during the initial construction period.

SECTION 3—SCHEME (d).

This scheme supersedes programme (b) of the General Report. It includes only such sections of the railway as are most likely to be electrified in the immediate future, and does not contemplate supply of power to the Madura and Trichinopoly districts. The supply area covered is that of scheme (c), namely, the Nilgiris and Coimbatore districts, with the addition of the railway load for the electrification of the Erode—Coimbatore—Shoranur—Mettupalayam and Nilgiri sections. Plan No. ^{P. 56}_{F. 1} shows the system lay-out compared with those for schemes (a) and (c). The scheme is put forward for the contingency of the Railway Board deciding to electrify the Erode—Shoranur—Mettupalayam and Nilgiri sections of the South Indian Railway.

Power Demand and Revenue.—These are the same as for scheme (c) except for inclusion of the railway electrification demand which is taken from the latest report of the Consulting Engineers to the South Indian Railway. A small demand for power can be expected in the neighbourhood of Shoranur and Palghat, and has been allowed for in the forecast. Full details regarding power demand and revenue are given in Table No. 34 of which, for convenience an abstract is given in Tables Nos. 35 and 36 below.

Plan No. ^{P. 61}_{F. 1} gives the power demand and station installed capacity.

TABLE No. 35.—Demand at the distributing end, revenue estimate, and return per unit.

Scheme (d).				
Year of operation	Demand. K.W.	Distributed. K.W.H.	Estimated Revenue.	Average return per K.W.H. sold.
First	5,440	20,526,000	RS. 7,85,830	ANNA. 0.612
Second	6,780	23,450,000	9,09,220	0.620
Third	8,060	26,758,000	10,65,410	0.637
Fourth	9,380	31,231,600	12,50,610	0.641
Fifth	10,320	36,020,000	13,82,640	0.615
Sixth	10,710	38,625,000	15,01,190	0.622
Seventh	11,100	41,725,000	16,27,220	0.624
Eighth	11,630	44,986,000	17,87,310	0.635
Ninth	12,280	48,111,900	19,33,380	0.643
Tenth	12,900	51,588,500	20,43,660	0.630

TABLE No. 36.—Power house load details.

Year of operation.	Demand. K.W.	Generation. K.W.H.	Average load. K.W.	Load factor.
First	6,040	22,200,000	2,530	PER CENT. 42
Second	7,530	25,350,000	2,890	38
Third	8,960	28,940,000	3,300	37
Fourth	10,420	33,810,000	3,860	37
Fifth	11,470	38,940,000	4,450	39
Sixth	11,900	41,770,000	4,770	40
Seventh	12,390	45,110,000	5,150	42
Eighth	12,920	48,640,000	5,550	43
Ninth	13,640	52,010,000	5,940	44
Tenth	14,330	55,780,000	6,370	44

A load of about 1,000,000 K.W.H. per annum can be expected for lighting the railway stations in the area of supply and for electrifying the Erode shops, but this has not been included in these estimates.

TABLE No. 34.

SUMMARY OF POWER DEMAND.

Scheme (d).

Serial number and district.	First year.				Second year.				Third year.						
	Demand at S.S. K.W.	L.F. at S.S.	Consumption K.W.H.	Average rate.	Revenue.	Demand at S.S. K.W.	L.F. at S.S.	Consumption K.W.H.	Average rate.	Revenue.	Demand at S.S. K.W.	L.F. at S.S.	Consumption K.W.H.	Average rate.	Revenue.
	RS.	PER CENT.	ANNA.	ANNA.	RS.	PER CENT.	ANNA.	ANNA.	ANNA.	RS.	PER CENT.	ANNA.	ANNA.	ANNA.	RS.
1. Coimbatore	2,198	21	4,040,000	0.73	1,84,400	3,390	21	6,060,000	0.68	2,57,500	4,387	22	8,568,000	0.68	3,64,200
2. Tiruppur	233	18	372,000	0.93	21,620	349	18.5	562,000	0.93	32,670	510	18.5	820,000	0.93	47,680
3. Erode	77	18	124,000	0.93	7,200	116	18.5	187,000	0.93	10,890	170	18.5	273,000	0.93	15,390
4. Pollachi	160	18	252,000	0.93	14,760	245	18	387,000	0.93	22,500	316	18	499,000	0.93	28,000
5. Anamalais	140	15	186,000	0.93	10,800	215	15	287,000	0.93	16,680	290	15.5	395,000	0.93	22,960
6. Railways Erode-Shoranur	3,520	48	14,800,000	0.52	4,81,250	3,520	48	14,800,000	0.52	4,81,250	3,520	48	14,800,000	0.52	4,81,250
7. Shoranur	...	...	...	...	...	63	12.4	65,000	0.93	3,780	120	12.8	135,000	0.93	7,850
8. Agricultural	...	...	...	...	...	150	15	200,000	1.30	16,250	175	15	230,000	1.30	18,700
9. Total Coimbatore	6,323	...	19,774,000	...	7,20,030	7,945	...	22,548,000	...	8,41,520	9,488	...	25,720,000	...	9,87,610
10. Demand at S.S. Diversity factor 1.15.	5,500	...	...	...	...	6,910	...	...	...	...	8,250	...	...	...	...
11. Nilgiris	370	...	752,000	...	65,800	415	...	902,400	...	67,700	455	...	1,038,000	...	77,800
12. Total	5,870	...	20,526,000	0.612	7,85,830	7,325	...	23,450,400	0.620	9,08,220	8,705	...	26,758,000	0.637	10,65,410
13. Demand on P.H. Diversity factor 1.08.	5,440	...	...	...	...	6,780	...	...	...	...	8,060	...	...	...	...
Power-house.															
14. Average load K.W.	...	...	2,530	...	...	...	...	2,890	...	...	...	...	3,300	...	...
15. Do. factor per cent	...	...	42	...	...	...	...	38	...	...	...	...	37	...	...
16. Total generated K.W.H.	...	...	22,200,000	...	...	...	...	25,350,000	...	...	...	...	29,940,000	...	...
17. Peak load K.W.	...	...	6,040	...	...	...	...	7,530	...	...	...	...	8,960	...	...
18. Estimated revenue	Rs.	...	7,85,830	...	...	...	...	9,08,220	...	...	...	...	10,65,410	...	...

TABLE No. 34—cont.

SUMMARY OF POWER DEMAND.

Scheme (d).

Serial number and district	Fourth year.				Fifth year.				Sixth year.						
	Demand at S.S. K.W.	L.F. at S.S.	Consumption K.W.H.	Average rate.	Revenue.	Demand at S.S. K.W.	L.F. at S.S.	Consumption K.W.H.	Average rate.	Revenue.	Demand at S.S. K.W.	L.F. at S.S.	Consumption K.W.H.	Average rate.	Revenue.
	PER CENT.	ANNA.	ANNA.	ANNA.	RS.	PER CENT.	ANNA.	ANNA.	ANNA.	RS.	PER CENT.	ANNA.	ANNA.	ANNA.	RS.
1. Coimbatore	4,700	25	10,282,000	0.68	4,31,800	5,140	27.5	12,338,000	0.68	5,24,400	5,400	30	14,189,000	0.68	6,03,000
2. Tiruppur	585	20	1,024,500	0.93	69,550	668	21	1,230,000	0.93	71,500	750	22.5	1,478,000	0.93	76,680
3. Erode	195	20	341,500	0.93	19,850	222	21	410,000	0.93	23,830	250	22.5	492,670	0.93	28,640
4. Pollachi	355	20	628,800	0.93	36,260	405	21	746,000	0.93	43,380	430	22.5	847,600	0.93	49,270
5. Anamalais	320	17.5	493,800	0.93	28,700	340	20	595,000	0.93	34,640	370	21	680,600	0.93	39,570
6. Railways Erode-Shoranur	3,520	48	14,800,000	0.52	4,81,250	4,050	48	16,800,000	0.47	4,94,000	4,000	48	16,800,000	0.47	4,94,000
7. Shoranur	170	13.4	201,000	0.93	11,700	185	15	241,000	0.93	14,010	200	16	277,000	0.93	15,100
8. Agricultural	193	16	270,000	1.30	21,900	200	17.5	310,000	1.20	23,250	200	20	350,000	1.00	21,880
9. Total Coimbatore Division	10,038	...	28,086,800	...	1,09,600	11,160	...	32,671,000	...	12,28,930	11,600	...	35,114,870	...	13,29,140
10. Demand on S.S. Diversity factor 1.15.	8,720	...	...	...	...	9,700	...	...	...	...	10,090	...	...	...	...
11. Nilgiris	505	27	1,195,000	1.20	88,600	550	28	1,342,000	1.20	94,900	575	80	1,511,000	1.20	1,13,300
12. Mettupalayam-Ootacamund Railway	800	25	2,000,000	0.52	65,000	900	25	2,000,000	0.47	58,750	900	25	2,000,000	0.47	58,750
13. Total	10,125	...	31,231,600	0.641	12,55,610	11,150	...	36,020,000	0.615	13,82,840	11,565	...	38,625,870	0.622	15,01,190
14. Demand on P.H. Diversity factor, 1.08.	9,330	...	...	...	...	10,320	...	...	...	...	10,710	...	...	...	...
Power-house.															
15. Average load, K.W.	...	...	3,880	...	...	...	...	4,450	...	...	...	...	4,770	...	...
16. Average factor, per cent.	...	...	37	...	...	...	...	39	...	...	...	...	40	...	...
17. Total generated, K.W.H.	...	...	33,910,000	...	...	...	...	38,940,000	...	...	...	...	41,770,000	...	...
18. Peak load, K.W.	...	...	10,420	...	...	...	...	11,470	...	...	...	...	11,900	...	...
19. Estimated Revenue, ...	Rs.	...	12,50,610	...	...	...	...	13,82,840	...	...	...	...	15,01,190	...	...

TABLE No. 34—cont.
SUMMARY OF POWER DEMAND.
Scheme (d).

Serial number and district. (1)	Seventh year.					Eighth year.					Ninth year.					Tenth year.				
	De- mand at S.S. K.W.	L.F. at S.S.	Consump- tion K.W.H.	Aver- age rate.	Revenue. RS.	De- mand at S.S. K.W.	L.F. at S.S.	Consump- tion K.W.H.	Aver- age rate.	Revenue. RS.	De- mand at S.S. K.W.	L.F. at S.S.	Consump- tion K.W.H.	Aver- age rate.	Revenue. RS.	De- mand at S.S. K.W.	L.F. at S.S.	Consump- tion K.W.H.	Aver- age rate.	Revenue. RS.
1. Coimbatore	5,750	32.5	16,318,000	0.68	6,97,600	6,110	35	18,768,000	0.68	7,97,500	6,700	35	21,112,000	0.68	8,97,300	7,230	37.5	23,751,000	0.68	9,79,500
2. Tiruppur	800	24	1,695,000	0.83	87,940	883	25	1,754,000	0.83	1,01,400	945	25.5	2,134,000	0.83	1,13,000	1,024	27.5	2,469,000	0.73	1,12,650
3. Erode	209	24	565,000	0.83	32,810	297	25	651,000	0.83	37,840	315	26.5	731,000	0.83	42,490	341	27.5	823,000	0.73	47,840
4. Pollachi	460	24	967,500	0.83	50,180	485	25	1,060,000	0.83	55,040	515	26	1,173,000	0.83	60,850	525	27.5	1,238,400	0.83	65,800
5. Annamalai	400	22	770,500	0.83	44,810	420	23	846,000	0.83	48,180	440	24	1,025,000	0.83	53,760	460	25	1,065,000	0.83	52,130
6. Railways Erode-Srirangar	4,000	48	16,400,000	0.47	4,94,000	4,000	48	16,800,000	0.47	4,94,000	4,000	48	16,800,000	0.47	4,94,000	4,000	48	16,800,000	0.47	4,94,000
7. Railways Srirangar	250	16	512,000	0.83	22,670	253	17	531,000	0.83	23,400	256	18	549,000	0.83	24,440	259	20	568,000	0.83	25,710
8. Agricultural	212	21	360,000	0.83	14,44,170	225	22	450,000	0.83	15,50,360	236	23	475,000	0.83	16,12,340	245	24	496,500	0.83	16,70,130
9. Total Coimbatore Division	12,117	...	37,818,100	...	...	11,010	...	40,858,100	...	...	11,650	...	43,796,100	...	...	12,240	...	47,068,500	...	...
10. Demand on S.S. Diversity factor, 1.15.	10,530	...	...	...	...	9,500	...	...	...	...	8,650	...	...	...	...	7,800	...	...	...	...
11. Nilgiris	610	31	1,457,000	1.2	1,24,300	650	3	1,878,000	1.20	1,40,850	715	33	2,65,800	1.20	1,54,940	787	33	2,272,000	1.20	1,70,430
12. Mettupalayam-Ooty. Railway	900	28.5	2,250,000	0.47	58,750	900	28.5	2,250,000	0.47	68,100	900	28.5	2,250,000	0.47	68,100	900	28.5	2,250,000	0.47	68,100
13. Total	19,040	...	41,725,100	0.624	16,27,220	12,509	...	44,986,100	0.635	17,87,310	13,265	...	48,111,900	0.643	19,33,380	13,927	...	51,558,500	0.630	20,43,690
14. Demand on P.H. Diversity factor, 1.08.	11,150	...	...	...	...	11,630	...	...	...	...	12,280	...	...	...	...	12,900	...	...	...	...
Power-house.																				
15. Average load, K.W.	...	...	5,150	...	...	...	...	5,550	...	...	...	...	5,940	...	...	...	...	6,370	...	...
16. Average factor, per cent.	...	...	43.49	...	...	...	...	48.640,000	...	...	...	...	52,010,000	...	...	...	...	55,780,000	...	...
17. Total generated, K.W.H.	...	...	43,110,000	...	...	...	...	48,640,000	...	...	...	...	52,010,000	...	...	...	...	55,780,000	...	...
18. Peak load, K.W.	...	...	16,27,320	...	...	...	...	17,87,310	...	...	...	...	19,33,380	...	...	...	...	20,43,690	...	...
19. Estimated Revenue	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Overall peak load efficiency generator bus to H.T. Sub-stations ... 90 per cent.
Average Do. ... 92.5 "
Diversity factor generator to H.T. sub-stations ... 1.24 "

A Mill Conversion Fund on the lines recommended on page 9 of Part III of the General Report will be necessary for this scheme as well. The approximate capital cost of conversion is given below :—

Last year of construction	...	...	...	RS. 2.9 lakhs.
First year of operation	...	...	...	1.4 "
Second year of operation	...	...	...	0.85 "
Total	...	...	...	5.15 "

Hydrology and Hydraulic Works.—The general remarks under this head in sections dealing with Schemes (a) and (c) are also applicable to this scheme.

The continuous power demand however rises to 6,370 K.W. by the tenth year, and if a maximum draw-off of 25 cusecs corresponding to 5,000 K.W. is allowable from the hydraulic works as for scheme (c), then more storage must be provided in the eighth year. For this purpose in this scheme it would be more economical to construct the Porthimund Dam for the second stage, on account of its lower first cost, rather than Makurti Dam which was suggested instead in scheme (a). The estimated rate of development is slower for scheme (d) and the smaller Porthimund Dam should do.

It should be noted that the Hydraulic Works in the first stage of development are identical for all the schemes (a), (c) and (d).

The estimate for hydraulic works for scheme (d) is given in Table No. 37.

TABLE No. 37.—Estimates for hydraulic works.

Scheme (d).

	Year of operation.			
	1st.	8th.	After 10th.	
	RS.	RS.	RS.	RS.
Land and Preliminary Work	3,00,000	...	...	...
Dams and Reservoirs—				
Glen Morgan	3,04,000	...	10,80,000	...
Makurti	...	8,90,000	...	...
Porthimund	...	...	...	20,00,000*
Sandy Nalla	...	...	...	29,50,000*
Pykara	...	...	...	...
Main Diversion Dam	1,10,000	...	...	...
Flume	1,30,000	...	...	...
Glen Morgan Flume	41,000	...	...	...
Auxiliary Flume	38,000	...	...	...
Forebay—				
Upper Bund	76,000	...	...	...
Lower Bund	3,40,000	...	...	...
Spillway	20,000	...	...	...
Headworks	2,88,000	...	...	...
Auxiliary Forebay	19,000	...	...	...
Permanent Buildings and Services	3,40,000	6,000	6,000	...
Do. Roads and Bridges	3,92,000	76,000	1,23,000	...
Do. Water-supply	22,000	...	...	...
Do. Tools and Equipment	35,000	...	...	...
Do. Light, Power and Telephone Lines	65,000	24,000	30,000	...
Contingencies 5 per cent	1,27,000	49,000	32,000	...
Sub-total	28,65,000	10,45,800	13,01,000	...
Temporary Construction plant and tools	3,20,000	63,000	70,000	...
Auxiliary Power Installation	2,58,000	...	...	...
Lines and Transformers	55,000	22,000	25,000	...
Camps	2,86,000	52,000	57,000	...
General Expenses	7,9,000	2,80,000	3,20,000	...
Sub-total	43,33,000	14,62,800	17,73,000	...
Deduct—Salvage—Auxiliary plant and Construction Equipment	1,77,000	...	...	...
Net cost	41,56,000	14,62,800	17,73,000	49,50,000

* Tentative estimates.

Penstocks.—The penstocks are the same as those for scheme (c) and the discussion relating thereto on page 32 is equally applicable. Two penstocks are provided, each of capacity 40 cusecs, with diameters varying from 30" at the top to 21" at the power-house. Three (one spare) 7,500 K.W. units would be connected up to the two penstocks.

Power-house building.—This will be a steel structure with masonry walls; steel window frames and doors will be used. The type of building on which the estimates are based is shown on the front page of this report and a drawing of the power-house is given in Plan No. $\frac{P. 53}{F. 2}$.

For other details, Part II of the General Report may be referred to.

Power-house plant.—The lay-out of the power plant and switching station is exactly the same as for scheme (a) and is shown in Plans Nos. $\frac{P. 52}{F. 1}$ and $\frac{P. 55}{F. 2}$. The power-house equipment is given in Table No. 38.

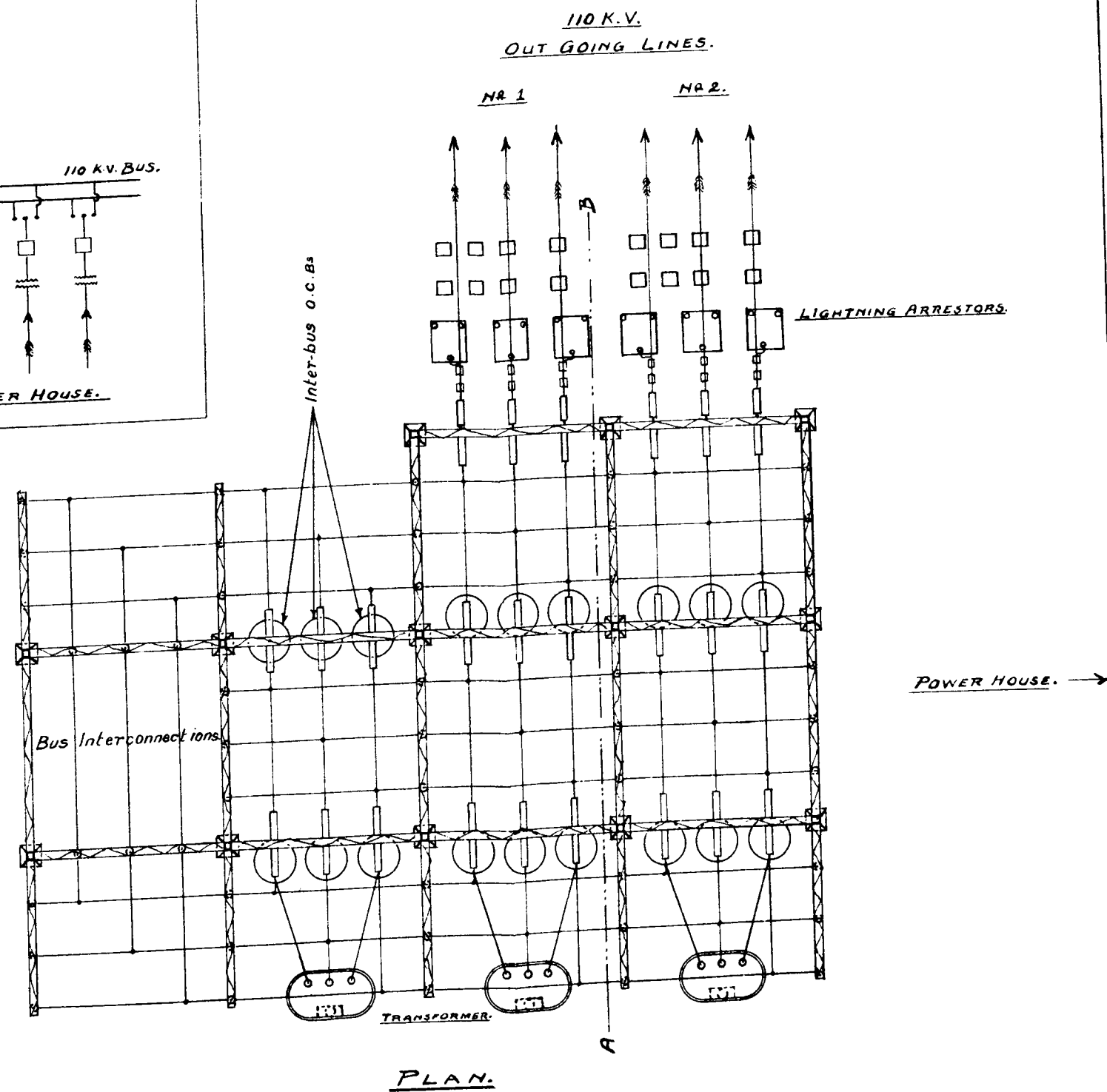
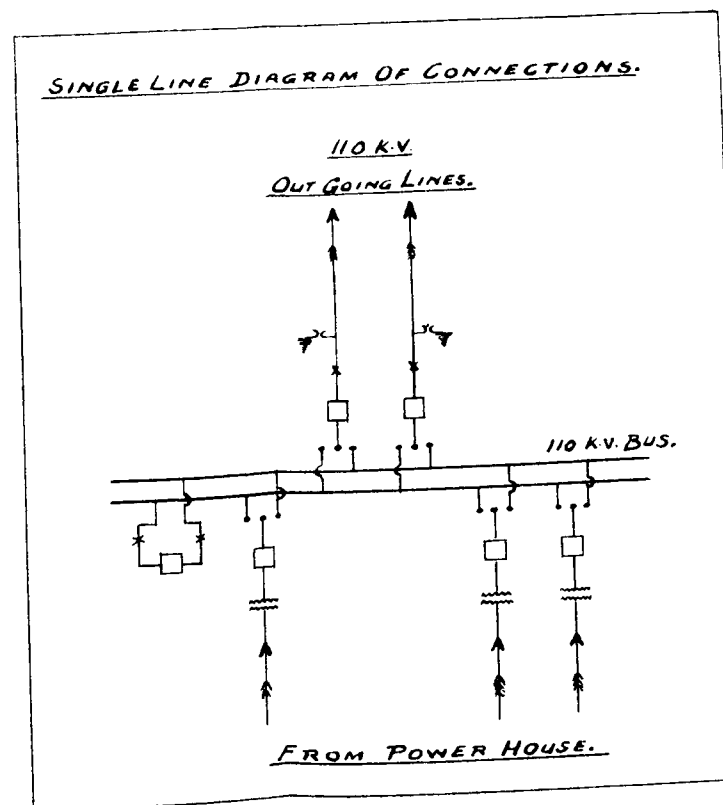
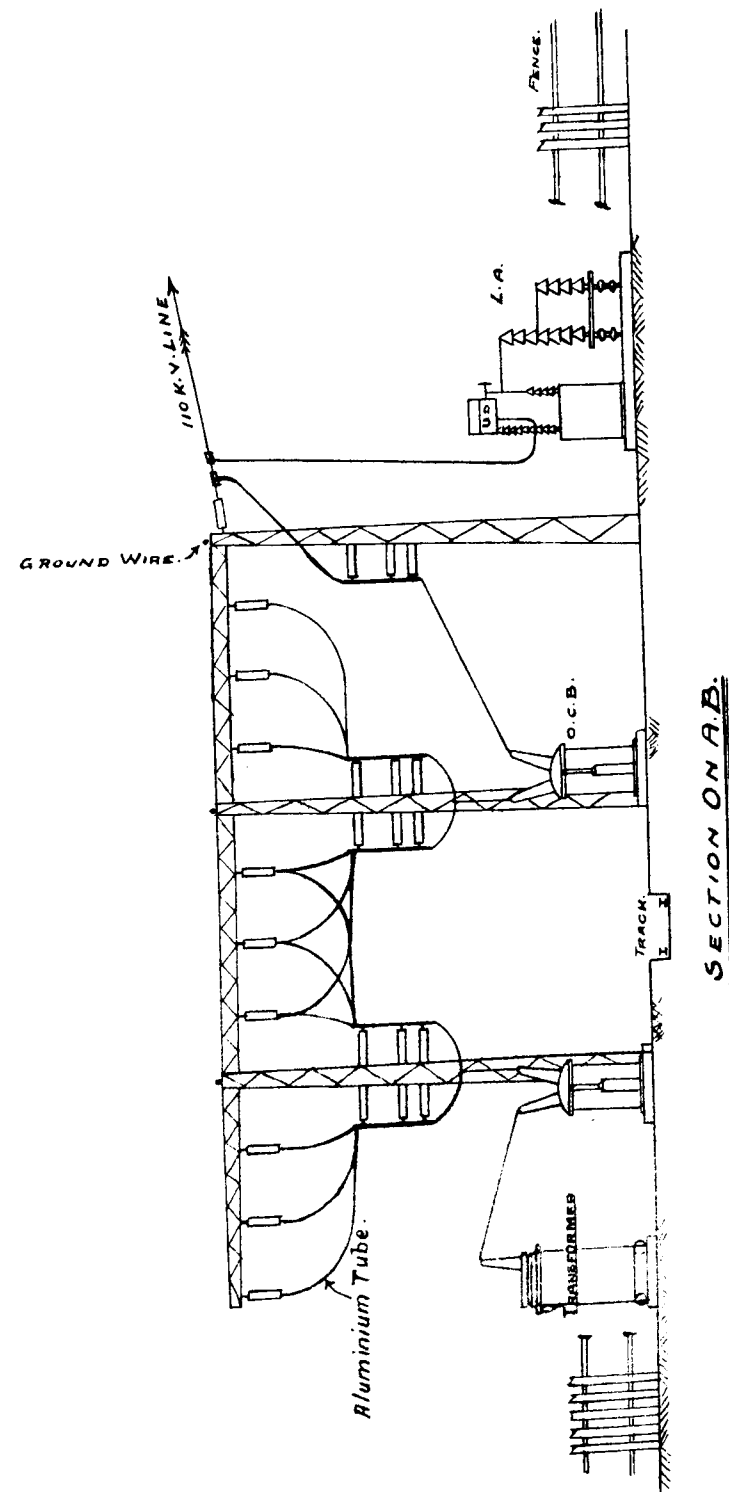
TABLE No. 38.—Penstocks and power-house equipment.

Scheme (d).						
Installed capacity					K.W.	22,500
1. Penstocks—						
Number	...	...	...	...		2
Head gross	...	...	...	...	Feet	3,090
Diameter	...	...	...	...	Inches.	21 to 30
Length	...	...	...	...	Feet	9,300
2. Turbines—						
Number	...	...	...	...		3
Size	...	...	...	...	H.P.	11,000
Speed	...	...	...	...	R.P.M.	500
3. Alternators—						
Number	...	...	...	...		3
Size	...	...	...	...	K.W.	7,500
Voltage	...	...	...	...	K.V.	11
Frequency	...	...	...	...	Cycles per second	50
4. Transformers—						
Number	...	...	...	...		3
Size	...	...	...	...	K.V.A.	8,800
Voltage	...	...	...	...	K.V.	11/110

Three 7,500 K.W. units are to be installed. This will involve considerable excess generating capacity during the first few years of operation, but the additional expenditure for the third unit is not a very heavy item of expense, and is considered justified in that it renders the power-house lay-out more attractive from the point of view of reliability of service. In view of the probable gradual extension of the transmission system it will not be feasible to reduce the size of the units.

Should, however, scheme (c) be initially taken up and it becomes necessary at a later stage to evolve scheme (d) out of it to cope with the railway demand, a fourth—5,000 K.W. unit similar to those in scheme (c) may be added—making 4 (one spare) 5,000 K.W. units in all as against 3 (one spare) 7,500 K.W. proposed above.

The estimate for power-house plant and penstocks is given in Table No. 39.



H. S. Howard
Chief Engineer.

Reference.	Drawn K. R.	DEPARTMENT OF HYDRO-ELECTRIC DEVELOPMENT, MADRAS.	No. P.55 F.2.
	Traced K. R.		
Revisions	Checked <i>msman</i>	PYKARA H. E. DEVELOPMENT.	SCALE: - 1"=20'
	Approved <i>JS</i>		
		OUTDOOR TRANSFORMER YARD- SCHEME "D"	DATE: -7-12-28
		Pykara Survey Office, Madras. 1929.	

PYKARA **POWER SYSTEM LAY-OUT.** **SCHEME "D" 1ST TEN YEARS.**

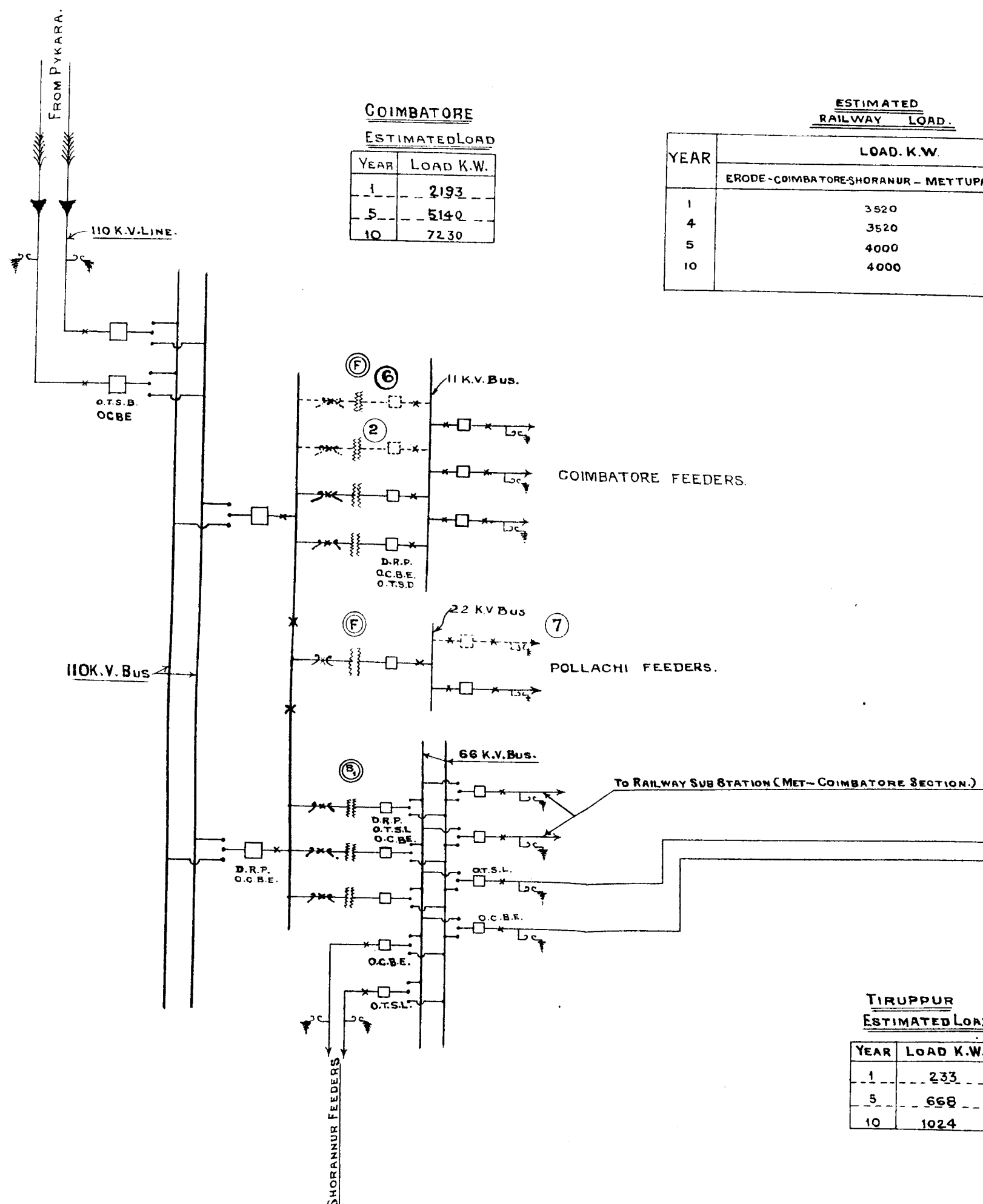
NOTE.
INSTALLATION.
 — BEFORE 1ST YEAR OF OPERATION.
 - - - - - AFTER " " " "

TRANSFORMERS:-
 (F) 2500 K.V.A. 110/22/11 K.V.
 (B) 3000 K.V.A. 110/66 K.V.
 (E) 500 K.V.A. 66/22/11 K.V.

EQUIPMENT.
 O.T.S.B. BALANCED POWER PROTECTION WITH INDEPENDENT O.T.S. UNITS.
 O.T.S.L. OVER LOAD TIME SETTING WITH LEAKAGE UNIT.
 O.T.S. " " " RELAY.
 O.T.S.D. " " " & DIRECTIONAL RELAY.
 D.R.P. DIFFERENTIAL RELAY PROTECTION.
 R.C. AUTOMATIC RECLOSING O.C.B.
 O.C.B.E. O.C.B. ELECTRICALLY OPERATED.
 O.C.B.M. O.C.B. MANUALLY OPERATED.
 — TRIPLE POLE SELECTOR SWITCH.
 — TRANSFORMER.
 — AIR BREAK GANG OPERATED SWITCH.
 x DISCONNECTING SWITCH.
 — LIGHTNING ARRESTOR.
 (2) INDICATES PROBABLE YEAR OF CONSTRUCTION.
 M & 22 K.V. O.C.B.'S WILL BE IN CUBICLES.
 RAILWAYS TO SUPPLY O.C.B.'S & L.A.'S FOR THEIR FEEDERS.

COIMBATORE ESTIMATED LOAD	
YEAR	LOAD K.W.
1	2193
5	5140
10	7230

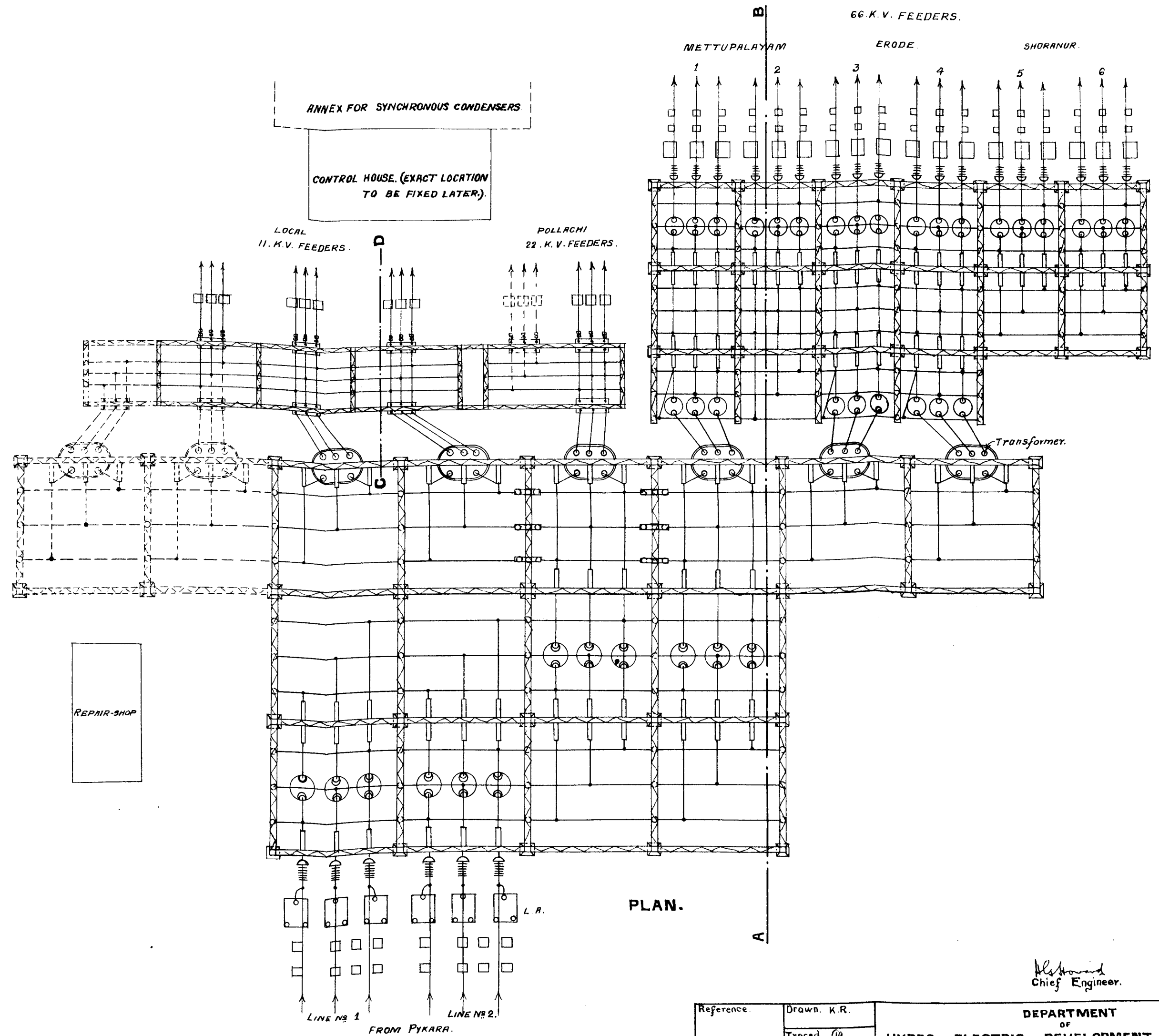
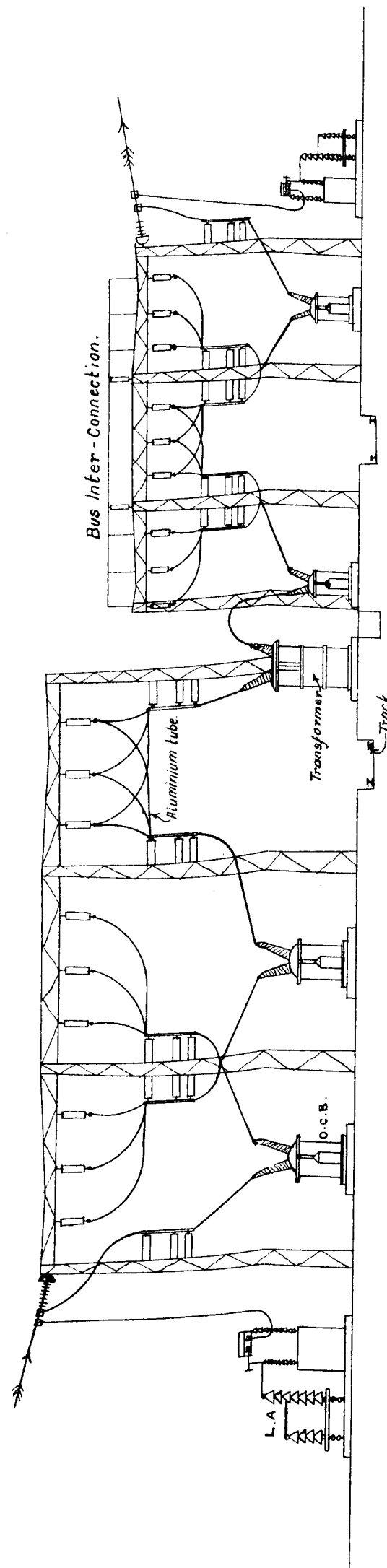
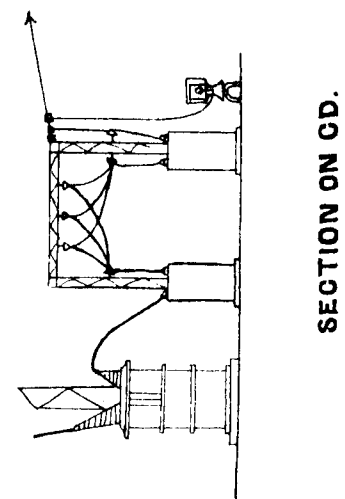
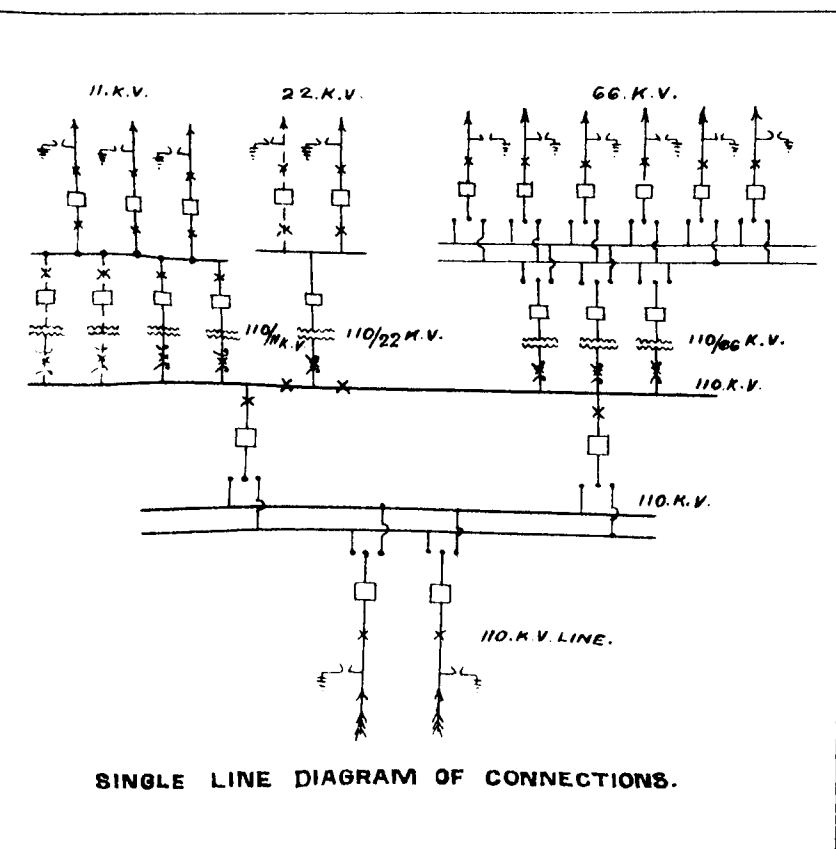
YEAR	ESTIMATED RAILWAY LOAD.	
	ERODE-COIMBATORE SHORANUR - METTUPALAYAM	NILGIRIS.
1	3520	-
4	3520	900
5	4000	900
10	4000	900



TIRUPPUR ESTIMATED LOAD.	
YEAR	LOAD K.W.
1	233
5	668
10	1024

ERODE ESTIMATED LOAD	
YEAR	LOAD K.W.
1	72
5	222
10	341

CHIEF ENGINEER			
REFERENCES.	DRAWN BY. K.R.	DEPARTMENT OF HYDRO-ELECTRIC DEVELOPMENT, MADRAS.	No. P.58 F.2.
	TRACED BY. P. PARAMASIVAN		
REVISIONS.	CHECKED BY. msm	PYKARA H. E. DEVELOPMENT.	SCALE.
	APPROVED BY. G.S.	POWER SYSTEM LAY-OUT- SCHEME "D"	
			DATE. / 26/1/28



Chief Engineer.

Reference.	Drawn. K.R.	DEPARTMENT OF HYDRO ELECTRIC DEVELOPMENT MADRAS.	N ^o P60. F.3.
	Traced <i>Ag</i>		
Revision.	Checked <i>M. Mani</i>	PYKARA H.E. DEVELOPMENT.	Scale: 1" = 20'
	Approved <i>S.S.</i>		
		COIMBATORE SUB-STATION. SCHEME. "D".	Date: 6-12-'28

Vandyke, Survey Office, Madras.
1929

Penstocks.—The penstocks are the same as those for scheme (c) and the discussion relating thereto on page 32 is equally applicable. Two penstocks are provided, each of capacity 40 cusecs, with diameters varying from 30" at the top to 21" at the power-house. Three (one spare) 7,500 K.W. units would be connected up to the two penstocks.

Power-house building.—This will be a steel structure with masonry walls; steel window frames and doors will be used. The type of building on which the estimates are based is shown on the front page of this report and a drawing of the power-house is given in Plan No. $\frac{P. 53}{F. 2}$.

For other details, Part II of the General Report may be referred to.

Power-house plant.—The lay-out of the power plant and switching station is exactly the same as for scheme (a) and is shown in Plans Nos. $\frac{P. 52}{F. 1}$ and $\frac{P. 55}{F. 2}$. The power-house equipment is given in Table No. 38.

TABLE No. 38.—Penstocks and power-house equipment.

Installed capacity		Scheme (d).				K.W.	22,500
1. Penstocks—							
Number	...	...	...	...	...		2
Head gross	...	...	...	...	...	Feet	3,090
Diameter	...	...	...	...	...	Inches.	21 to 30
Length	...	...	...	...	...	Feet	9,300
2. Turbines—							
Number	...	...	...	...	...		3
Size	...	...	...	...	...	H.P.	11,000
Speed	...	...	...	...	...	R.P.M.	500
3. Alternators—							
Number	...	...	...	...	...		3
Size	...	...	...	...	...	K.W.	7,500
Voltage	...	...	...	...	...	K.V.	11
Frequency	...	...	...	...	...	Cycles per second	50
4. Transformers—							
Number	...	...	...	...	...		3
Size	...	...	...	...	...	K.V.A.	8,800
Voltage	...	...	...	...	...	K.V.	11/110

Three 7,500 K.W. units are to be installed. This will involve considerable excess generating capacity during the first few years of operation, but the additional expenditure for the third unit is not a very heavy item of expense, and is considered justified in that it renders the power-house lay-out more attractive from the point of view of reliability of service. In view of the probable gradual extension of the transmission system it will not be feasible to reduce the size of the units.

Should, however, scheme (c) be initially taken up and it becomes necessary at a later stage to evolve scheme (d) out of it to cope with the railway demand, a fourth—5,000 K.W. unit similar to those in scheme (c) may be added—making 4 (one spare) 5,000 K.W. units in all as against 3 (one spare) 7,500 K.W. proposed above.

The estimate for power-house plant and penstocks is given in Table No. 39.

TABLE No. 39.—Estimate for penstocks and power house.

Scheme (d).		I.	
Stage of development.		1st.	
Year of operation.		22,500 K.W.	
Installed capacity.		RS.	
Penstocks	...	16,70,000	...
Incline Railways	...	1,60,000	...
Building and Tail race	...	3,60,000	...
Turbines and Governors	...	2,82,000	...
Governors and Exciters	...	5,40,800	...
L. T. Switch gear and control gear	...	2,10,500	...
Auxiliaries and feeders	...	1,26,800	...
Crane, piping repair shop, etc.	...	1,41,000	...
H. T. Gear	...	3,74,900	...
Transformers	...	2,02,700	...
Outdoor Structure	...	83,000	...
Sub-total		41,51,700	...
Contingencies 5 per cent	...	2,07,600	...
Construction plant and tools	...	2,10,000	...
Temporary camps	...	1,32,000	...
Sub-total		47,01,300	...
Engineering and general expenses	...	10,70,000	...
Total		57,71,300	...

Transmission lines.—The design of the transmission and distribution lines are the same as for Scheme (a), and the proposed lay-out is shown on Plan No. $\frac{P. 58}{F. 2}$. The mechanical characteristics of the transmission line are shown in Table No. 40 and the estimate is given in Table No. 43.

TABLE No. 43.—Estimate for transmission lines.

Scheme (d).		Year of operation.	
Section.	Miles.	1st	7th
		RS.	RS.
Pykara-Mettupalayam	33	14,65,200	...
Mettupalayam-Coimbatore	22	9,06,400	...
Coimbatore-Shoranur	59	13,62,900	...
Coimbatore-Erode	59	14,75,000	...
Coimbatore-Railway Sub-station	10	2,31,000	...
Coimbatore-Pollachi	24	2,04,000	36,000
Pollachi-Anamalais	8	68,000	...
Railway Sub-station-Mettupalayam	12	88,800	...
Pykara-Ootacamund	13	1,13,100	...
Total		59,14,400	36,000

TABLE No. 40.—Mechanical Characteristics of Transmission Lines.

A.—CONDUCTORS, GROUND WIRES AND INSULATORS.

Scheme (d).

Section.	Mileage.	Eventual voltage.	Present voltage.	Normal span.	Clearances.			Conductors.				
					Vertical.	Horizontal.	Offset.*	Size.	Ultimate strength.	Maximum tension.	Maximum sag.	Factor of safety.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
		K. V.	K. V.	FT.	FT.	FT.	FT.	A.C.S.R.	LB.	LB.	FT.	
Pykara-Mettupalayam-Coimbatore.	55	132	110	1,050	12	18	...	37/102	15,238	6,100	22.3	2.5
Shoranur-Coimbatore ...	59	...	66	750	8.0	14	...	7/118	3,409	1,705	12.0	2
Coimbatore-Erode ...	59	...	66	750	8.0	14	...	7/144	4,886	2,450	12.0	2

Section.	Mileage.	Insulators.			Ground Wire.					Towers.	
		Type.	Number on strain.	Number on suspension.	Maximum strength.	Size.	Ultimate strength.	Maximum tension.	Maximum sag.	Factor of safety.	Type of towers.
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	
					LB.	INCH.	LB.	LB.	FT.		
Pykara-Mettupalayam-Coimbatore.	55	Disc.	8	7	16,000	3/8	11,500	4,600	19.2	2.5	A & B.
Shoranur-Coimbatore ...	59	Do.	5	4	12,600	5/16	8,100	4,050	7.0	2.0	C & D.
Coimbatore-Erode ...	59	Do.	5	4	12,000	5/16	8,100	4,050	7.0	2.0	C & D.

* Offset is 3 feet in the Pykara-Mettupalayam section.

B.—TOWER DETAILS.

Type of Towers.	A	B	C	D
1. Height of tower ... Ft.	75	75	54	54
2. Weight of each tower Lb.	7,000	11,000	2,750	4,250
3. Factor of safety ...	2.5	2.5	2.5	2.5
4. Conductor (six) ...	37/102	37/102	7/144	7/144
5. Ground cable (one) ...	3/8	3/8	5/16	5/16
6. Number of conductors assumed broken on one side.	Two	Three	One	Three
7. Total number of conductors and ground cable assumed broken	Two	Seven	One	Three
8. Maximum horizontal angle ...	5°	40°	5°	30°
9. Do. vertical do. ...	20°	40°	20°	30°
10. Ultimate strength of conductor and ground cable—				
Conductor ... Lb.	15,238	15,238	4,886	4,886
Ground cable ...	11,500	11,500	8,100	8,100
11. Maximum working tension—				
Conductor ... Lb.	6,100	6,100	2,450	2,450
Ground cable ...	4,600	4,600	4,050	4,050

Regulation.—Table No. 41 gives the electrical characteristics of a single circuit between Pykara and Coimbatore for various loads. If the usual tolerance of ± 5 per cent in the voltage is allowed, it is obvious that no recourse need be had to the use of the synchronous condensers, or reactors. It may also be pointed out that the transformers at Coimbatore would be equipped with tap changing devices, and that the taps of the Pykara transformers would be changed when the load demand became high enough. Under normal load conditions there would be little variation in the voltage. A power factor of 0.9 has been assumed at the receiving end, but it is highly probable that it will be nearer 0.95. The tariffs will be based on a K.V.A. demand, so it is expected that most of the larger motors on the system will be of the synchronous induction type. The conditions at zero load are given in Table No. 42. Regulation of the 22 K.V. branch lines is given in Table No. 26.

As soon as one of the schemes is officially approved, a very carefully worked out diagram using both analytical and graphical methods, will be prepared, showing the electrical characteristics of the system at all the important points, for various load conditions. The specifications for electrical equipment will be based on it.

TABLE No. 41.—Characteristics of single circuit from Pykara to Coimbatore for various loads at 0.9 P.F. effect of transformers at Coimbatore (except Spares) included.

Scheme (d).

Kilowatts.		Line volts.		Line Amperes.		K.V.A.		Power Factor.		Per cent.		
Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Coimbatore.	Pykara.	Regulation.	Line efficiency.	Line drop.
0*	206	110,000	109,700	...	6.3	0	1,200	0.9 Lag	0.17 Lead	...	...	...
1,000	1,510	"	109,200	5.8	14.6	1,111	2,648	0.9 Lag	0.8827 Lead	0.6	99.2	0.82
2,500	2,520	"	110,800	14.6	18.0	2,778	3,058	0.9 Lag	0.8241 Lead	1.55	99.1	0.27
5,000	5,075	"	112,000	29.1	26.2	5,558	5,085	0.9 Lag	0.9981 Lead	3.15	98.54	1.82
10,000	10,220	"	115,700	58.2	52.7	11,111	10,550	0.9 Lag	0.9881 Lag	6.50	97.83	5.27
15,000	15,100	"	119,500	87.3	80.8	16,667	16,610	0.9 Lag	0.9272 Lag	10.0	97.40	8.64

* Zero load figures include power house transformers and have been calculated separately by drawing the transformer and the line vectors separately.

TABLE No. 42.—Characteristics for various points on the system on zero load with all transformers except spares in circuit.

Scheme (d).

Station.	Line Voltage.	Line Current.	P.F.	K.V.A.	K.W.
Pykara	106,400	17.8	0.06 Lead.	3,280	200
Coimbatore	66,000	19.6	0.007 Lead.	2,600	20
Tiruppur	66,100	5.0	...	600	...
Erode	66,350	0	...	...	...
Shoranur	66,340	0	...	...	...

Sub-stations.—The designs of the sub-stations are similar to those submitted for Scheme (a).

Plan No. $\frac{P. 60}{F. 3}$ gives the lay-out of the Coimbatore sub-station, and Plan No. $\frac{P. 58}{F. 2}$ shows the proposed power system.

The estimate for the sub-stations is given in Table No. 44.

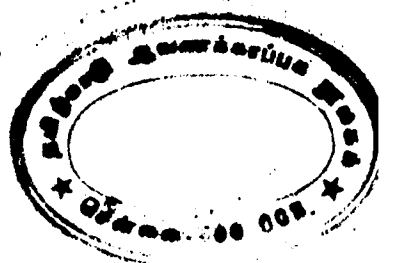


TABLE No. 44.—Estimate for sub-stations.

Scheme (d).

Station.	Year of operation.					Total.
	First.	Second.	Fourth.	Sixth.	Seventh.	
	RS.	RS.	RS.	RS.	RS.	RS.
Coimbatore	11,17,830	54,050	...	54,050	21,600	12,47,530
Tiruppur	2,05,250	...	39,040	...	...	2,44,290
Pollachi	80,000	...	...	...	...	80,000
Anamalais	60,000	...	...	...	...	60,000
Erode	1,60,130	...	...	...	...	1,60,130
Shoranur*	80,000	...	...	...	...	80,000
Railway Sub-station 10 miles from Coimbatore.*	80,000	...	...	...	...	80,000
Mettupalayam	45,000	...	...	...	...	45,000
Total ...	18,28,210	54,050	39,040	54,050	21,600	19,96,950

* Special development stations tapped off railway feeders.

FINANCIAL.

Capital expenditure.—The estimated amounts of capital needed annually for the works, both during the construction and the operation periods, are given in Table No. 45.

TABLE No. 45.—Annual capital expenditure.

Scheme (d).

Year and period.		Hydraulic works.	Power-house and penstocks.	Transmission lines.	Sub-stations.	Total.
Construction period.		RS.	RS.	RS.	RS.	RS.
First	1st half	7,30,000	...	65,000	...	7,95,000
	2nd "	9,30,000	2,50,000	65,000	50,000	12,95,000
Second	1st "	6,90,000	7,00,000	92,000	50,000	15,82,000
	2nd "	6,50,000	9,00,000	6,00,000	1,00,000	22,50,000
Third	1st "	6,00,000	23,00,000	12,00,000	5,00,000	46,00,000
	2nd "	4,00,000	13,50,000	27,00,000	7,00,000	51,50,000
Fourth—1st quarter		3,83,000	2,71,300	11,92,400	4,28,210	22,24,910
Sub-total ...		43,33,000	57,71,300	59,14,400	18,28,210	1,78,46,910
Deduct Salvage—Auxiliary Plant and Construction Equipment.		..	..	..	..	— 1,77,000
Sub-total ...		..	..	..	..	1,76,69,910
Operation period.						
First year		...	...	...	54,050	54,050
Second "		...	...	...	...	...
Third "		...	...	...	39,040	39,040
Fourth "		...	...	...	...	...
Fifth "		...	...	...	54,050	54,050
Sixth "		...	...	38,000	21,600	57,600
Seventh year		14,62,800	...	...	...	14,62,800
Eighth "		...	...	...	...	...
Ninth "		...	...	...	...	...
Tenth "		...	...	...	...	...
Total ...		56,18,800	57,71,300	59,50,400	19,96,950	1,93,37,450

Accumulated simple interest on capital outlay during construction period at 5½ per cent = Rs. 12,72,890.
Do. do. at 6 per cent = Rs. 14,20,900.

Simple interest on the capital outlay during the construction period has been allowed to accumulate and is shown in the Financial Tables Nos. 47 and 48 as

arrears of interest for the construction period. These arrears will gradually be wiped out by revenue receipts in the subsequent years of operation.

No provision for the abatement of land revenue for the right of way acquired for transmission lines is considered necessary since the land where arable could always be rented for cultivation.

Operation and Maintenance.—The operation and maintenance expenses have been allowed as follows :—

Year of operation.	RS.	Year of operation.	RS.
First	3,08,400	Sixth	3,73,300
Second	3,08,400	Seventh	3,73,300
Third	3,36,700	Eighth	4,02,600
Fourth	3,36,700	Ninth	4,02,600
Fifth	3,72,300	Tenth	4,02,600

Depreciation.—The method of calculating the depreciation figures and the assumed "lives" of the machinery and equipment remain the same as given in the General Report. The amounts set aside are as follows :—

Year of operation.	Interest at 5½ per cent.	Interest at 6 per cent.
	RS.	RS.
Sixth	2,31,400	2,09,880
Seventh	2,32,230	2,10,510
Eighth	2,32,270	2,10,540
Ninth	2,32,270	2,10,540
Tenth	2,32,270	2,10,540

Financial Statements.—The results have been worked out for the rates of interest—5½ per cent representing the prevailing rate and 6 per cent representing the rate prescribed by Government—vide Tables Nos. 47 and 48.

It will be seen that the initial capital expenditure is Rs. 176·70 lakhs rising to Rs. 193·37 lakhs in the tenth year.

With the 6 per cent rate the net return on the actual capital outlay in the tenth year is 7·39 per cent and the return at the end of ten years on the "sum at charge" (in which is included the arrears of interest) is 6·46 per cent.

The results with 5½ per cent rate are, of course, more favourable.

A summary of the results for the tenth year of operation is given in Table No. 46.

Plan No. $\frac{P. 62}{F. 1}$ shows in graphical form the capital expenditure revenue and the cost and return per unit.

TABLE No. 46.—Summary of financial results.

Scheme (d).

Tenth year of operation.

	5½ per cent interest rate.	6 per cent interest rate.
	LAKHS OF RS.	LAKHS OF RS.
1. Capital outlay	193·37	193·37
2. Arrears of simple interest	16·11	27·95
3. Sum at charge	209·48	221·32
4. Net revenue	14·09	14·31
5. Interest on sum at charge	11·26	13·28
6. Net surplus	2·83	1·03
7. Return on sum at charge per cent	6·72	6·46

Item 3 = 1 + 2.

" 4 = Gross revenue less operating expenses and depreciation.

" 7 = $\frac{\text{Item (4)}}{\text{Item (3)}} \times 100$.

TABLE No. 47.—Capital outlay, operating expenses, revenue, surplus, etc.

Interest charged at 5½ per cent.

Scheme (d).

Year of operation.	(1)	Capital outlay to end of year.	(2)	Capital outlay during the year.	(3)	Interest at 5½ per cent on capital outlay to end of year plus half the outlay during the year.	(4)	Operation and maintenance.	(5)	Depreciation and renewals.	(6)	Total expenses.	(5) + (6)	(7)	Gross revenue.	(8)	Net revenue.	(9)	Per cent return on capital outlay.	(9) × 100.	(10)	Surplus after deducting interest charges.	(9) - (4).	(11)	Accumulated surplus.	(12)	Average cost per K.W.H. distributed.	(13)
Construction period																												
First	...	1,76,69,910	...	1,76,69,910	...	9,51,200	...	3,08,400	...	...	...	3,08,400	...	...	7,55,880	...	4,77,480	...	2.70	...	...	-4,73,770	...	...	-17,40,000	...	...	...
Second	...	1,77,23,960	...	54,050	...	9,52,670	...	3,08,400	...	...	...	3,08,400	...	...	9,09,220	...	6,00,820	...	3.39	...	...	-3,51,850	...	...	-20,98,510	...	0.860	...
Third	...	1,77,23,960	...	39,040	...	9,53,720	...	3,36,700	...	...	...	3,36,700	...	...	10,65,410	...	7,28,710	...	4.11	...	...	-2,25,010	...	...	-23,23,520	...	0.771	...
Fourth	...	1,77,63,000	...	...	...	9,54,760	...	3,36,700	...	...	...	3,36,700	...	...	12,50,610	...	9,13,910	...	5.15	...	...	-40,850	...	...	-23,64,370	...	0.661	...
Fifth	...	1,77,63,000	...	54,050	...	9,56,220	...	3,73,800	...	...	...	3,73,800	...	...	13,82,640	...	10,06,340	...	5.68	...	...	+53,120	...	...	-23,11,250	...	0.590	...
Sixth	...	1,78,17,050	...	57,600	...	9,59,220	...	3,73,800	...	2,31,400	...	6,04,700	...	...	15,01,190	...	8,96,490	...	5.63	...	...	-62,730	...	...	-23,73,980	...	0.648	...
Seventh	...	1,78,74,650	...	14,62,800	...	10,00,080	...	3,73,800	...	2,32,230	...	6,05,530	...	...	16,27,220	...	10,21,690	...	5.72	...	...	+21,610	...	...	-23,52,370	...	0.614	...
Eighth	...	1,83,37,450	...	...	...	10,39,360	...	4,02,600	...	2,32,270	...	6,34,870	...	...	17,87,310	...	11,52,440	...	5.96	...	...	+1,13,050	...	...	-22,39,320	...	0.595	...
Ninth	...	1,83,37,450	...	...	...	10,39,390	...	4,02,600	...	2,32,270	...	6,34,870	...	...	19,33,360	...	12,98,510	...	6.72	...	...	+2,59,120	...	...	-19,80,200	...	0.557	...
Tenth	...	1,93,37,450	...	...	...	10,39,390	...	4,02,600	...	2,32,270	...	6,34,870	...	...	20,43,660	...	14,08,790	...	7.28	...	...	+3,69,400	...	...	-16,10,800	...	0.519	...

RS.

Tenth year—

Capital outlay ... 1,93,37,450

Arrears of simple interest ... 16,10,800

Sum at charge ... 2,09,48,250

Net revenue ... 14,08,790

Return on sum at charge ... 672 per cent.

• Accumulated simple interest at 5½ per cent on the capital outlay during the initial construction period

TABLE No. 48.—Giving capital outlay, operating expenses, gross revenue, surplus, etc.

Interest charged at 6 per cent.

Scheme (d).

Year of operation.	(1)	Capital outlay up to the year.	(2)	Capital outlay during the year.	(3)	Interest at 6 per cent on capital outlay to end of year plus half the outlay during the year.	(4)	Operation and maintenance.	(5)	Depreciation and renewals.	(6)	Total expenses.	(5) + (6)	(7)	Gross revenue.	(8)	Net revenue.	(9)	Per cent return on capital outlay.	(9) × 100.	(10)	Surplus after deducting interest charges.	(9) - (4).	(11)	Accumulated surplus.	(12)	Average cost per K.W.H. distributed.	(13)
Construction Period																												
First	...	1,76,69,910	...	1,76,69,910	...	10,61,810	...	3,08,400	...	...	...	3,08,400	...	...	7,85,930	...	4,77,430	...	2.70	...	...	-5,84,380	...	...	-14,20,900*	...	...	...
Second	...	1,77,23,960	...	54,050	...	10,63,440	...	3,08,400	...	...	...	3,08,400	...	...	9,09,220	...	6,00,820	...	3.39	...	...	-4,62,620	...	...	-20,06,280	...	1.07	...
Third	...	1,77,23,960	...	39,040	...	10,64,810	...	3,36,700	...	...	...	3,36,700	...	...	10,65,410	...	7,28,710	...	4.11	...	...	-3,83,900	...	...	-24,87,900	...	0.94	...
Fourth	...	1,77,63,000	...	...	...	10,66,780	...	3,36,700	...	...	...	3,36,700	...	...	12,50,610	...	9,13,910	...	5.15	...	...	-1,51,870	...	...	-28,66,670	...	0.84	...
Fifth	...	1,77,63,000	...	54,050	...	10,67,400	...	3,73,800	...	...	...	3,73,800	...	...	13,82,640	...	10,09,340	...	5.68	...	...	-58,060	...	...	-30,13,780	...	0.72	...
Sixth	...	1,78,17,050	...	57,600	...	11,16,360	...	3,73,800	...	2,09,880	...	5,83,180	...	...	15,01,190	...	9,18,010	...	5.15	...	...	-1,52,740	...	...	-31,66,470	...	0.65	...
Seventh	...	1,78,74,650	...	14,62,800	...	11,60,250	...	4,02,600	...	2,10,510	...	6,13,140	...	...	16,27,220	...	10,49,410	...	5.84	...	...	-72,950	...	...	-32,39,420	...	0.63	...
Eighth	...	1,93,37,450	...	...	...	11,60,250	...	4,02,600	...	2,10,540	...	6,13,140	...	...	17,87,310	...	11,74,170	...	6.07	...	...	+13,320	...	...	-32,25,500	...	0.59	...
Ninth	...	1,93,37,450	...	...	...	11,60,350	...	4,02,600	...	2,10,540	...	6,13,140	...	...	19,33,380	...	13,20,240	...	6.83	...	...	+1,59,990	...	...	-30,65,510	...	0.53	...
Tenth	...	1,93,37,450	...	...	...	11,60,350	...	4,02,600	...	2,10,540	...	6,13,140	...	...	20,43,660	...	14,30,520	...	7.39	...	...	+2,70,270	...	...	-27,95,240	...	0.55	...

RS.

Tenth year—

Capital outlay ... 1,93,37,450

Arrears of simple interest ... 27,95,240

Sum at charge ... 2,21,32,690

Net revenue ... 14,30,520

Return on sum at charge ... 6.46 per cent.

• Accumulated simple interest at 6 per cent on the capital outlay during the initial construction period.

SECTION 4.

GLEN MORGAN PROJECT AND PYKARA CONSTRUCTION PROGRAMME.

Glen Morgan Project.—This project is a combination of certain hydraulic works, included in all the main Pykara schemes, and the auxiliary power installation, from which it was proposed to receive a power supply at the works during construction.

The construction of this project is now under way as an independent work but, in the event of the main scheme being sanctioned, it would be necessary to merge the two installations.

Such being the case it has been decided to show each scheme complete in itself, and to deduct the expenditure sanctioned for the Glen Morgan Project.

In the financial statements the total expenditure must, however, be included.

Once, therefore, the construction of the main scheme is sanctioned, the Glen Morgan Installation should cease to be a separate entity and the expenditure on works should be allotted to the various capital accounts of the main scheme. The revenue from the sale of power may be credited to capital expenditure, to a special account under "General Expenses."

Such a procedure will simplify the accounting, and be conducive to economy, since no separate establishment need be maintained and the construction organization can operate and maintain the plant and lines, also collect the bills for power.

The main function of the plant is then to deliver power for construction purposes, and sell the surplus output to the neighbouring towns and tea estates.

The load demand will then probably justify the installation of a third generating unit in the power house.

Pykara Construction Programme.—If as recommended in the Foreword, scheme (a) is sanctioned immediately, construction of the hydraulic works can easily be started as the Glen Morgan organization is available.

The hydraulic works are identical for the three schemes (a), (c) and (d) and work on them can be carried on for a year before it will be necessary to place orders for machinery and equipment. This year should certainly see a decision taken by the Railway Board on the particular sections of the South Indian Railway to be electrified and Government will, in consequence, have decided on the particular scheme to be finally adopted.

If scheme (a) is sanctioned, construction work will proceed apace and there will have been no delay.

If no main line electrification is possible, scheme (c) will be proceeded with.

If the Railway Board wish to take up the Erode-Shoranur-Mettupalaiyam line electrification and in consequence scheme (d) is taken up, the ordering of machinery and equipment to suit will be done immediately.

The adoption of the restricted scheme (c) or scheme (d) would leave the Trichinopoly-Madura areas without supply. If the investigations recommended in the Foreword for a suitable scheme in the Palnis or Periyar lead to a development, an independent power system in the south is possible. This would permit a simultaneous and natural development of large areas without the risks involved in a system dependent on a single power house. The Pykara and Palni System can later be tied together and will stabilize and render absolutely sound the power supply in the areas covered by both.

By sanctioning scheme (a) Government will not have bound themselves to it as the plans may be curtailed later to scheme (c) or (d) to suit railway requirements without waste of time or material.

