1947

NEW ZEALAND

# STATE HYDRO-ELECTRIC DEPARTMENT

## STATEMENT BY THE HON. R. SEMPLE, MINISTER IN CHARGE OF THE STATE HYDRO-ELECTRIC DEPARTMENT

MR. SPEAKER,—

The past year has been one of great difficulty in the field of electricity supply. With increasing difficulty in obtaining any alternative means of supplying light, heat, and power, and in accord with the Government's general policy of encouraging local manufacture wherever possible, the demand for electricity supply has continued to grow. Unfortunately, however, consequent on the war and the subsequent disorganization throughout the world, there are serious delays in obtaining the necessary plant for additional generating-stations, and even in obtaining the necessary skilled staff, labour, and materials to carry on local construction work at the rate necessary to catch up on our delayed programme. The problem is not special to New Zealand; shortage of electricity and delays in providing additional generating-plant are occurring in Great Britain, in Australia, in Canada, in Switzerland, and in practically all countries where electricity is used.

Superimposed on this general delay, which, under normal conditions, would tax our existing power resources to the limit, we have during each of the past two summers experienced abnormally dry periods with an absence of the prevailing westerly depressions which bring rain to all the rivers and lake basins with a westerly aspect. In particular this has reduced the available power from Lake Taupo, Mangahao, and from the lakes and rivers rising in the Southern Alps. This superimposed condition will, no doubt, be overcome when more normal weather conditions return; the Government is doing its utmost, by the provision of additional power plants, to catch up with the more general deficiency. The Government has been subjected to a certain amount of criticism because it has not rushed in and purchased steam generating-plant for standby in a hydro-electric system to obviate the present shortage. I have indicated on previous occasions that there may be a place on the system for a percentage of steam generating-plant, but that plant, when received, must be purchased with a proper understanding of the purpose for which it is to be used and of the possibilities of its economic use.

The operating-cost of any fuel-driven plant in New Zealand is very much greater than for main hydro generating-plant, so that there can be no question of using fuel-driven plant other than for standby purposes. The difficulties and delays in obtaining plant at the present time are so great that, as a first consideration, we must concentrate on obtaining additional main plant; to do anything else can only result in delay in completing our main system. The only justification for departing from that general policy would be if fuel-driven generating-plant were readily available much more quickly and at a substantially lower capital cost. It would be better, so long as good water-power sites are available, to push ahead with water-power plants in different parts of the country, even in excess of our immediate requirements, to act as standby, and later to form part of the main system and be a standby against transmission failures. A certain amount of steam generating-plant might be advisable adjacent to our main

load centres as a replacement for existing plant which is reaching the stage of obsolescence or in case it is not possible to meet reasonable power demands by the early construction of hydro-electric stations.

Our present power needs are so great that there can be no doubt that any generating-plant added to the system must be capable of continuous operation over long periods. The size of the plant needed, combined with the necessity for long periods of running, precludes the consideration of Diesel-electric plant except for installation in connection with some particular factory.

The present high cost of fuel-driven plant, which is greater than the cost of hydro-electric plant, and the long delay in securing delivery make the present time most inopportune for purchasing this type of plant. Coal is already in short supply, so that it is not possible to obtain further large quantities of coal for the generation of electric power. The available coal could be much more effectively used than by converting the energy in the coal to electric power.

Oil fuel has to be imported and is very high in price, and the use of oil fuel to the extent required would be a very expensive procedure indeed.

Only by the continuance of the present hydro-electric policy can the necessity for increasing the charges for bulk supply be avoided, but this would involve some control over the rate of growth of load, combined with the speeding-up of work on hydro-electric schemes to the utmost possible extent.

By these means the power position can be stabilized and eventually overcome without loading the country with excessive capital expenditure which must be carried on thereafter. The price of power from a hydro-electric station is fixed by the capital cost, but a fuel station involves about the same capital cost plus an excessive cost for fuel, be it oil or coal.

There is one possibility which must not be overlooked, and that is the use of natural steam for power-generation. It is proposed to investigate this matter without delay and to put down trial bores in suitable locations. Natural steam would provide power comparable to water-power, in that it would be supplied by Nature.

Under present world conditions it is very desirable that the electric supply of this country should be independent of imported fuel, and to this end we should develop the natural resources with which the country has been generously endowed.

## FINANCIAL RESULTS

In my 1946 statement a brief summary was given of the financial results for the year ended 31st March, 1946. The audited accounts and balance-sheet for that year will be published in this year's parliamentary paper B–1 [Pt. IV].

The following is a summary of the results (unaudited) for the year ended 31st March, 1947 :—

NORTH ISLAND SCHEME

Capital outlay at end of year, £23,487,394

| | £ | £ |
|---|---|---|
| Revenue .. .. .. .. | 2,023,237 | |
| Operating-costs .. .. .. .. | 1,150,144 | |
| Gross profit .. .. .. .. .. | | 873,093 |
| The capital charges are— | | |
| Interest .. .. .. .. .. | 541,047 | |
| Depreciation .. .. .. .. | 275,376 | |
| Total .. .. .. .. .. | | 816,423 |
| Leaving a balance of .. .. .. | | £56,670 |

Income-tax, social security, and national security taxes amount to £132,624, resulting in a net deficiency of £75,954, with the result that we are again unable to meet any of the statutory requirement for loan-redemption purposes, which is £315,876 this year.

Arrears of Loans Redemption Fund now amount to £692,408.

SOUTH ISLAND SCHEME

Capital outlay at end of year, £10,485,932

| | £ | £ |
|---|---|---|
| Revenue .. .. .. .. | 1,086,339 | |
| Operating-costs .. .. .. .. | 380,240 | |
| Gross profit .. .. .. .. .. | | 706,099 |
| The capital charges are— | | |
| Interest .. .. .. .. .. | 342,755 | |
| Depreciation .. .. .. .. | 78,372 | |
| Total .. .. .. .. .. | | 421,127 |
| Leaving a balance of .. .. .. | | £284,972 |

The balance has been used to pay income-tax, &c. (£111,230), and loans redemption of £173,742, being the current year's charge of £145,386 plus £28,356 of arrears.

Arrears of loans redemption are now £148,267.

## NEW WORKS

During the period of the war the construction of hydro-electric works presented many difficulties, but the end of the war did not bring the expected relief.

The delivery of plant and materials is getting worse, so that it is almost impossible to work out time schedules that can be adhered to. Nevertheless, and despite the many handicaps, good progress has been made.

At Arapuni the long-awaited 21,600 kW. generating-unit ordered in 1939 went into service towards the end of 1946 and so permitted overhaul work to commence on the older machines.

Under very trying conditions the first of the three 30,000 kW. generating-units at Karapiro went into operation in April, 1947, and is giving good service.

The second machine has been delayed due to the non-arrival of the final parts of the turbine, but it is anticipated that this unit will commence operation in August of this year.

The upset caused by the shortage of electric power in Great Britain has seriously delayed the delivery of vital parts of the third turbine which will delay the completion of this unit till the end of 1947.

There has been a similar hold up of turbine parts ordered in March, 1943, for delivery in 1944 at Kaitawa, the 32,000 kW. upper station at Waikaremoana. They are now expected to be ready for shipment shortly. The new machines may be ready for service in September of this year.

At Maraetai, the new 180,000 kW. station on the Waikato, much preliminary work has been done and the construction of the diversion tunnel is now well under way. Men have been transferred from Karapiro to the new village at Mangakino, which is unlike any other construction village and represents a serious attempt to better the living-conditions of the men who are constructing these essential works.

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Large quantities of machinery for the undertaking have already arrived, and all the plant should be available by the end of 1948.

No effort is being spared to push on with Maraetai with the utmost speed, and at the same time the investigation work on the next Waikato project continues at Whakamaru.

While all this work is proceeding on new generating-stations the network of transmission-lines is in process of extension, together with the construction of several major substations.

In the South Island, work on the construction of a dam across the outlet of Lake Pukaki is being pushed on at great speed, and it is hoped to complete this work early in 1948 in time to store water to help with the winter load of that and the succeeding years. The fifth 15,000 kW. generating-unit for Waitaki Power-station is due for delivery about the end of 1947, but the industrial conditions in Great Britain may again cause delay. No time will be lost in erecting the machine as soon as it is available.

The work at Pukaki has affected some of the work at Tekapo, where a 25,000 kW. station is under construction.

The ruling feature, however, is the progress made on the tunnel at Tekapo, and this has been speeded up very considerably during the last six months.

Investigation work on the new 300,000 kW. station on the Clutha River has proceeded during the year and soon it should be possible to go ahead with the actual work on this major project.

It has been decided to build a dam at Cobb, in the Nelson-Marlborough district, and to extend the Cobb Station by a further 20,000 kW. In the meantime, pending the completion of the main dam, a temporary dam is to be built to provide storage designed to overcome the effect of the more usual of the recurring dry periods.

Investigation work on the Lake Rotoroa scheme has been commenced.

General extensions of the system have been planned, and these include the linking of the Nelson-Marlborough system with the main South Island system, together with the supply to the Buller district.

### APPENDIX

Further information relating to the past year's working is included in the attached report by the General Manager.

The annual report of the Rural Electrical Reticulation Council is also appended.

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# APPENDICES

## APPENDIX A.—ANNUAL REPORT OF THE GENERAL MANAGER FOR THE YEAR ENDED 31ST MARCH, 1947

The General Manager to the Honourable Minister in Charge.

Wellington, 20th June, 1947.

Sir,—

I have the honour to present herewith, pursuant to section 15 of the State Supply of Electrical Energy Act, 1917, the annual report of all operations of the State Hydro-electric Department for the year ended 31st March, 1947.

In the interests of paper economy, the report is again condensed and various statistical data have been omitted.

## ELECTRICITY CONTROL

The level at Taupo fell steadily until the middle of July, despite reasonably good rains in March and April. At Lake Waikaremoana storage had fallen steadily throughout the summer, and by April the lake was at an unprecedented low level, 11 ft. below full. The emergency restrictions which were commenced in March, 1946, in the North Island had to be continued until August, when storage at Lake Taupo recovered rapidly following good rains in that and the preceding month. The siphons installed at Lake Waikaremoana commenced operating in March, 1946, and enabled the Waikaremoana stations to increase output by drawing further upon lake storage. At the end of March, 1947, the lake was 19·7 ft. below overflow level.

By November, Lake Taupo was again full, and, anticipating an average rainfall during the intervening period and with the knowledge that Karapiro should commence to operate about April, 1947, the Supply Authorities were advised that, for the first quarter of 1947, their allocations of power would be 3 per cent. higher than for the corresponding period of 1946. Despite repeated appeals to restrict load to within the allocations, however, the actual consumption of electricity from January to March, 1947, was up 7·6 per cent., instead of the 3-per-cent. increase allowed. In this same period, extremely dry weather conditions were again experienced at Taupo and rainfall was only 40 per cent. of the average. During January and February and continuing into March, Taupo was falling at the average rate of 3 in. a week, and heavy demands had to be made upon storage at Waikaremoana to make good the deficiency at Taupo. By the middle of March almost four-fifths of the storage at Taupo had been depleted, and at Waikaremoana only about 3 ft. of storage remained which could be drawn upon by the siphons.

With the possibility of continuing dry weather at Taupo, it was essential to retain the remaining storage until rains set in, and no alternative remained but to restrict consumption of electricity in the meantime. The provisions of the Electricity Control Order were therefore amended on 20th March, 1947, and full powers vested in the various North Island Supply Authorities to restrict load to within their allocations by such means as they thought fit, with certain provisoes relating to the maintenance of a sufficient supply of electricity for farming and certain other essential purposes. At the same time all Authorities were required to reduce their demand for electricity to 20 per cent. below their previous allocation.

Although in the South Island, up to the end of March, the position was not so difficult as in the North, the same adverse weather conditions had prevailed and the river flows were abnormally low. The indications were that, should these conditions continue into the winter, fairly severe rationing of electricity-supplies would also be necessary in this Island.

If average rainfall had been experienced during the summer and autumn of 1947, there would not have been any necessity for the emergency power rationing, but the conditions over both Islands were very unusual.

The stage has been reached where the load demand has overtaken the dry-season capacity of the hydro-electric stations, because the recent war has delayed the construction of various stations. The immediate post-war position is very disturbing, and it becomes nearly impossible to forecast the time required for any particular work. Under these conditions it seems necessary to exercise a measure of control over the rate of growth of load and to speed up the rate of construction of the hydro-electric stations. It is far beyond the ability of fuel stations to overtake the shortage; and the information available indicates that a steam station could not be built in less than four and a half years, even if the manufacturers were able to adhere closely to their estimated delivery times.

The magnitude of the shortage also precludes the consideration of Diesel-electric plant.

The whole subject of electric supply must now be reviewed in the light of present conditions, but I am certain that the electrical needs of New Zealand can best be met by the concentration of effort upon the major hydro-electric schemes. Any other method of dealing with the problem could result only in delays to the main projects and consequent further deterioration of the power position.

## NORTH ISLAND ELECTRIC-POWER SYSTEM

### A. SYSTEM OPERATION AND LOAD DESPATCH

#### 1. Load

The maximum half-hourly load on the system was 314,800 kW. This occurred on Monday, 18th November, 1946, between 17.00 and 17.30 hours. Last year the half-hourly peak was 306,400 kW., on Thursday, 24th May, 1945, between 17.30 and 18.00 hours.

The highest Saturday peak was 281,300 kW. between 17.30 and 18.00 hours on both 8th June and the 29th June, 1946. Last year the half-hourly peak was 273,700 kW. between 17.30 and 18.00 hours on 21st July.

The highest Sunday peak was 267,900 kW. between 11.30 and 12.00 hours on 29th September, compared with 239,200 kW. on 6th May last year.

The greatest weekly generation was 35,630,000 units on the week ending 1st September, 1947, and week ending 17th November, 1947 (last year 34,169,000 units), an increase of 4·3 per cent. The maximum units on any one day was 5,567,000 (last year, 5,232,000). This occurred on Monday, 21st October, 1946, and represented an increase of 6·3 per cent. The highest Saturday output was 4,819,000 units on 9th November, 1946 (last year, 4,643,000), an increase of 3·8 per cent.

The highest Sunday output was 4,474,000 units on 29th September, 1946 (last year, 4,173,000), an increase of 7·2 per cent.

The total system units generated by all plants in the North Island for the financial year ending 31st March, 1947, was 1,718,000,000 compared with 1,636,000,000 last year, an increase of 5 per cent. The system units generated by Government-owned plants only plus units purchased from Supply Authorities were 1,656,300,000 units for the year ending 31st March, 1947, compared with 1,576,000,000 units last year, an increase of 5·1 per cent.

On Thursday, 29th August, 1946, the rationing schedules were lifted and Supply Authorities were allowed to revert to the allocation operating in January, 1946. This caused the units to rise to the peak for the year, and the output was maintained at a high value until March, 1947. After repeated warnings to the Supply Authorities had been given without appreciable effect, great trouble was experienced and load had to be shed without other than a general warning. Following this a new Control Order was gazetted which had the effect of stabilizing the position, and heavy rationing was put into operation. In this common effort most Supply Authorities and their consumers combined most effectively to make the rationing scheme successful and the draw upon storage was lessened sufficiently for the purpose.

The introduction of heavy rationing introduced many operating difficulties which were successfully overcome, and at the present time approximately half of the rationing in the North Island has been relaxed.

Generation details by Government plants plus units purchased for resale (compared with 1945–46) are as follows:—

| Station. | Year ended 31st March, 1947. | | | Year ended 31st March, 1946. | | |
|---|---|---|---|---|---|---|
| | Maximum Kilowatts. | Units generated. | Annual Load Factor. | Maximum Kilowatts. | Units generated. | Annual Load Factor. |
| | | | Per Cent. | | | Per Cent. |
| Arapuni .. .. | 150,000 | 786,185,000 | 59·8 | 130,000 | 897,224,300 | 78·7 |
| Horahora .. .. | 12,500 | 88,235,950 | 80·6 | 12,300 | 94,847,530 | 88·0 |
| King's Wharf .. | 33,009 | 47,582,495 | 16·4 | 28,899 | 47,023,796 | 18·5 |
| Mangahao .. .. | 21,000 | 113,582,000 | 61·7 | 20,900 | 124,823,000 | 68·1 |
| Penrose .. .. | .. | 9,089,920 | .. | .. | 2,775,150 | .. |
| Piripaua .. .. | 44,000 | 182,872,510 | 47·4 | 44,000 | 126,295,040 | 32·7 |
| Tuai .. .. | 63,900 | 290,697,366 | 51·9 | 62,700 | 192,129,700 | 34·9 |
| | .. | 1,518,245,241 | .. | .. | 1,485,118,516 | .. |
| Auxiliary and standby stations— | | | | | | |
| Evans Bay .. .. | | 86,618,160 | | | 47,338,100 | |
| Hawke's Bay .. .. | | 1,262,189 | | | 1,004,814 | |
| Kourarau .. .. | | 2,973,397 | | | 2,846,829 | |
| New Plymouth .. .. | | 16,156,070 | | | 15,674,460 | |
| Onehunga .. .. | | 2,941,330 | | | 441,568 | |
| Opunake .. .. | | 1,633,599 | | | 1,648,838 | |
| Palmerston North .. .. | | 5,407,422 | | | 2,510,965 | |
| Poverty Bay .. .. | | 1,796,220 | | | 787,950 | |
| South Taranaki .. .. | | 1,112,024 | | | 230,816 | |
| Taumarunui .. .. | | 3,230,100 | | | 3,473,330 | |
| Tauranga .. .. | | 7,244,415 | | | 8,839,844 | |
| Wilson's .. .. .. | | 2,926,200 | | | 2,824,200 | |
| Other miscellaneous purchases | | 4,767,658 | | | 3,265,621 | |
| Total units generated and purchased | | 1,656,314,025 | | | 1,576,005,851 | |

## 2. Reliability of Supply

There were 261 faults, 20 of which caused no interruption to supply. Several faults were cumulative, affecting more than one district. Some of these were due to the system being overloaded. Lightning was responsible for 49 troubles, 11 of which occurred within three days.

A detailed analysis of interruptions is shown on the following table. These do not include pre-arranged shutdowns due to load rationing:—

| Description. | Year ended 31st March, 1946: Number. | Year ended 31st March, 1947. | | Distributing Authorities affected. |
|---|---|---|---|---|
| | | Number. | Duration. | |
| | | | h. m. | |
| 1. 110 kV. lines: Defects .. .. | 1 | 6 | 0 39 | 3 |
| 2. 110 kV. lines: External causes .. | 2 | 6 | 1 27 | 13 |
| 3. 33 kV., 50 kV., or 66 kV. lines: Defects | 9 | 11 | 14 18 | 10 |
| 4. 33 kV., 50 kV., or 66 kV. lines: External causes | 9 | 13 | 3 47 | 6 |
| 5. 6·6 kV. or 11 kV. lines: Defects .. | 5 | 3 | 52 48 | 2 |
| 6. 6·6 kV. or 11 kV. lines: External causes | 4 | 2 | 1 34 | 3 |
| 7. Lightning .. .. .. .. | 30 | 49 | 34 32 | 25 |
| 8. Storms: Nature of trouble not found .. | 5 | 2 | 0 07 | 2 |
| 9. 110 kV. apparatus .. .. .. | .. | 2 | 2 28 | 2 |
| 10. 33 kV., 50 kV., or 66 kV. apparatus .. | 11 | 9 | 1 49 | 9 |
| 11. 5 kV., 6·6 kV., 11 kV., or 22 kV. apparatus | 9 | 30 | 27 52 | 14 |
| 12. Generators or synchronous condensers .. | 1 | 1 | .. .. | .. |
| 13. Relays .. .. .. .. | 4 | 5 | 0 34 | 5 |
| 14. Control circuits and batteries .. | 5 | 10 | 4 56 | 12 |
| 15. Operation: Mistakes .. .. | 7 | 6 | 0 51 | 9 |
| 16. Operation: Accidents .. .. | 7 | 7 | 2 34 | 14 |
| 17. Faults and overloads on consumers' system | .. | .. | .. | .. |
| 18. Other causes .. .. .. | 38 | 82 | 7 46 | 30 |
| 19. Cause unknown .. .. .. | 11 | 17 | 3 57 | 25 |
| Totals .. .. | 158 | 261 | 161 59 | 184 |

## B. OPERATION AND MAINTENANCE

### 1. Power-stations

*Kings' Wharf.*—The continued poor hydraulic conditions placed a heavy demand on this station. No. 14 turbine was overhauled and a number of replacement parts ordered. This is the first overhaul since installation in 1931 and the machine was found to be generally in good order. No. 11 turbo-alternator experienced bearing trouble, necessitating special attention. No. 10 turbine shed a number of rotor blades, necessitating the removal of the blades and reducing the number of effective wheels by one. The turbine was serviced and has run satisfactorily since. No. 7 generator was prepared for service. A new air-cooler was installed under No. 12 generator. All boilers were inspected and passed by the Marine Department. A number of worn concrete ash-hoppers were shrouded with steel plate. Dr. V. Armstrong, Fuel Technologist, Department of Scientific and Industrial Research, carried out tests on the large boilers, analysed gases, graded the grit content, and made fuel-economy recommendations. Coal consumed was 51,331 tons, deliveries amounting to 49,895 tons, and 164 tons were sold under orders from the Mining Controller. Of the coal received, 25,268 tons came from the South Island and 24,627 tons from the North Island. The stock in hand at 31st March, 1947, was 1,369 tons.

*Arapuni and Horahora.*—The running-times of the Arapuni and Horahora generators, together with particulars of outages and shutdowns, were as follows :—

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In demand (Hours). | |
| *Arapuni Power-station* | | | | | | | |
| 1 .. .. | 7,952 | 90·78 | 808 | 9·22 | .. | .. | 100 |
| 2 .. .. | 7,983 | 91·13 | 770 | 8·79 | .. | 7 (*a*) | 99·92 |
| 3 .. .. | 8,108 | 92·56 | 652 | 7·44 | .. | .. | 100 |
| 4 .. .. | 6,215 | 70·95 | 522 | 5·96 | 1,834 (*b*) | 189 (*c*) | 76·91 |
| 5 (*d*) .. .. | 3,545 | 85·77 | 382 | 9·24 | 206 (*e*) | .. | 95·01 |
| 6 .. .. | 7,639 | 87·20 | 878 | 10·02 | 243 (*f*) | .. | 97·22 |
| 7 .. .. | 7,640 | 87·21 | 1,053 | 12·02 | 67 (*g*) | .. | 99·23 |
| 8 .. .. | 7,877 | 89·92 | 883 | 10·08 | .. | .. | 100 |
| *Horahora Power-station* | | | | | | | |
| 1 .. .. | 7,695 | 87·84 | 1,065 | 12·16 | .. | .. | 100 |
| 2 .. .. | 8,104 | 92·51 | 656 | 7·49 | .. | .. | 100 |
| 3 .. .. | 8,099 | 92·45 | 649 | 7·41 | 12 (*h*) | .. | 99·86 |
| 4 .. .. | 8,198 | 93·58 | 562 | 6·42 | .. | .. | 100 |
| 5 .. .. | 8,254 | 94·22 | 506 | 5·78 | .. | .. | 100 |
| 6 .. .. | 8,254 | 94·22 | 504 | 5·76 | 2 (*i*) | .. | 99·98 |
| 7 .. .. | 8,645 | 98·69 | 115 | 1·31 | .. | .. | 100 |
| 8 .. .. | 8,618 | 98·38 | 142 | 1·62 | .. | .. | 100 |

NOTES.—(*a*) Shutdown on 11th April, 1946, as water entered the lubricating-oil system due to blocked ejectors. (*b*) Shutdown on 14th January, 1947, to fit a new stator winding and change the turbine runner; work still in progress at end of year. (*c*) Breakdown of stator winding on 4th March, 1946; repairs completed on 8th April, 1946. (*d*) In service from 10th October, 1946, only. (*e*) Shutdown 16th to 24th October to change a faulty half coil. (*f*) Shutdown 30th October to 9th November to install the governor. (*g*) Shutdown 6th to 11th December to install permanent group C.T.s. (*h*) Shutdown on 7th April, 1946, for governor adjustments. (*i*) Shutdown on 3rd April, 1946, for belt repairs.

Horahora continued to run on maximum output until 4th April, 1947, when it was permanently shutdown. A considerable quantity of equipment was salvaged before the station was submerged by the newly formed Karapiro Lake. The 110 kV. O.C.B.s at Arapuni were modernized by fitting new double-break contacts, &c.

*Huntly Steam Plant.*—This standby station was run over the evening peak-load period five days a week from 25th June to 11th November.

*Waikaremoana.*—Three siphons were used extensively during the year, especially during the latter part when the necessity arose to store water at Taupo; the result was a record low level in Lake Waikaremoana.

The output of a single siphon varied from approximately 280 cusecs at high lake-level to 200 cusecs at low level.

The lake level on 25th March, 1947, was 1,995·3 ft., as compared with the overflow level of 2,015 ft.

Repairs through slips and extensions due to lower lake-levels were made to the siphons during the year.

The rainfall at Onepoto for the year was 81·95 in., as against 50·46 in. the previous year.

Removal of slip material adjacent to No. 3 pipe-line was continued, the spoil being carted elsewhere for levelling. The formation of a road on the upper part of the old slip area was commenced.

Repairs were done to a number of pedestals in penstocks 1 and 2, further replacements being deferred until the summer months.

Painting was commenced on Nos. 1 and 2 pipe-lines.

All machines gave satisfactory service, the usual maintenance and routine tests being carried out. A complete overhaul of No. 3 machine was postponed owing to the power situation.

Special drop tests were made on No. 5 headgate during February.

Balancing tests were carried out on No. 5 unit.

Generator-running times were as follows for the year:—

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In Demand (Hours). | |
| *Tuai* | | | | | | | |
| 1 .. .. | 7,061 | 80·6 | 1,532 | 17·5 | 159 | 8 | 98·1 |
| 2 .. .. | 6,870 | 78·4 | 1,632 | 18·6 | 258 | .. | 97·1 |
| 3 .. .. | 7,408 | 84·6 | 1,166 | 13·3 | 186 | .. | 97·9 |
| *Piripaua* | | | | | | | |
| 4 .. .. | 6,039 | 68·9 | 2,437 | 27·8 | 280 | 4 | 96·8 |
| 5 .. .. | 5,734 | 65·5 | 2,632 | 30·1 | 392 | 1 | 95·5 |

*Mangahao Power-station.*—Rainfall at No. 1 dam was again well above the average, but fell off during the last three months, when 14·95 in. were registered, compared with 38·62 in. in the previous year. A major slip on "S" bend on road above No. 2 dam necessitated assistance from Public Works Department. A crib wall was built at a washout near No. 1 dam. Several minor slips were also cleared and roads continuously maintained.

The rainfall for the year was: No. 1 dam, 188·74 in.; No. 2 dam, 121·13 in.; No. 3 dam, 90·24 in.; Power-house, 55·98 in. The average yearly rainfall at No. 1 dam for the previous ten years was 148·72 in.

An augmented maintenance programme was put in hand to overtake arrears which had occurred during the war years.

Regular and frequent inspections of the turbines and generators were made and numerous changes of cast-steel buckets were found necessary owing to continued deterioration. One cast-steel bucket on No. 2 turbine broke while in service, but no damage was caused. A field coil on rotor of No. 2 generator broke down and was replaced with a spare.

Maximum load on generators for year, 21,000 kW; load factor, 62.

Extensive repairs to the concrete apron of the tail-race outside the power-station were carried out.

The generator-running times were as follows:—

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In Demand (Hours). | |
| 1 .. .. | 8,236 | 94·0 | 471 | 5·4 | 53 | .. | 99·4 |
| 2 .. .. | 8,273 | 94·4 | 429 | 4·9 | 25 | 33 | 99·3 |
| 3 .. .. | 8,298 | 94·7 | 417 | 4·6 | 40 | 5 | 99·5 |
| 4 .. .. | 8,315 | 94·9 | 414 | 4·7 | 31 | .. | 99·6 |
| 5 .. .. | 8,157 | 93·1 | 421 | 4·8 | 93 | 89 | 97·9 |

## 2. Substations

At most substations the operators were required to work a large amount of overtime on load-restriction switching. Where possible, automatic devices were installed to overcome this. Some unusual operating-conditions occurred causing outages when excess current was exported northward through Bunnythorpe from Waikaremoana.

Regular inspection of, and minor maintenance to, all apparatus was carried out, and, in addition, progress was made with the systematic periodical overhaul of transformers and bushings.

A critical examination of substation earthing-systems, where these have been exposed, has shown that, in general, the bolted connections are unsatisfactory, and as occasion offers the systems are being redesigned.

Maintenance to buildings has been done as found necessary.

### (*a*) *110 kV.*

*Penrose.*—The jumpers on lines 3 and 4 were removed, and No. 3 now functions as a separate line. The installation of distance impedance relay protection on all incoming transmission-lines was completed. The new control-room was brought into full use. Following recommendations by the Fire Inspector, additional fire-fighting equipment has been installed.

*Roskill.*—A complete new 110 v. control battery was installed. The installation of non-bouncing contacts in transfer switches and new selector-switch arm assemblies was completed. Lightning caused breakdown between turns on two adjacent transformer units, and these units also flashed over externally, the fault being cleared by relays with very little and easily repaired damage.

*Henderson.*—The shop work for the modernization of the 110 kV. control-board is well under way. The dust-proofing of the switch-room was completed. Lightning caused a flashover across contacts on the 110 kV. off-load tapping-switches in two adjacent units in the 30,000 kV. bank, the fault being cleared by the simultaneous opening of a line O.C.B. The relays gave the alarm, but did not trip due to a fault in the tripping circuits.

*Hamilton.*—An outage of a 110/50 kV. transformer bank was caused on 1st May, 1946, by a breakdown of the pyrotenax cable in the relay circuit, and two outages of another 110/50 kV. bank were caused on 4th January, 1947, and 6th January, 1947, by water in a junction-box of the pyrotenax cable.

*Ongarue.*—A 110 kV. fuse at Ongarue gave trouble on 4th September, 1946, following which all three fuses were removed.

*Waihou* was changed over to 110 kV. supply on 6th March, 1947.

*Masterton.*—New metering C.T.s were fitted.

*Mangamaire.*—Three 11 kV. 100/5 C.T.s were removed from the condenser and reinsulated. The condenser was dried out and tested.

30/5 current-transformers on the north and south feeders were replaced by 100/5 and 50/5 C.T.s respectively.

Due to the condenser-pit flooding, the C.T.s had to be dried out and the cable-box remade.

*Waipawa.*—New meterings C.T.s were fitted, changing the ratio to 150/5.

During September two 110 kV. O.C.B.s were taken out of service and the oil drained from each tank. O.C.B.s were out of service until March.

*Napier.*—All trip contacts in Buchholz relays were adjusted to prevent operation during minor earthquakes.

A fault developed in the T.C.O.L. coupling relay and the equipment was adjusted.

(*b*) *50 kV.*

*Wairoa.*—Installation tests on all equipment were carried out prior to service at the new substation. The station was livened up on the 3rd July at 8 p.m. and the automatic earthing-switch tested. Load was then shared between the old and new stations. A transfer of total load was completed on the 15th December.

The local supply was transferred from the Power Board to the substation service transformer.

A breakdown in the cables leading to No. 2 incoming 11 kV. O.C.B. caused power failures on the 25th December and on the 3rd January.

A thermostat in one transformer tap changer operated to shut down the station. The changer was overheated, the cause being due to failure of the transformer switches to close properly and bypass the transformer resistance.

*Gisborne.*—The auto transformer supplying power to the top-position indicator burnt out.

During a shutdown, No. 1 incoming switch cables were reconnected to the outdoor 11 kV. bus.

Alterations were made to the metering circuit to provide for metering from either incoming switch.

The voltage regulator was made ready for transfer to Auckland.

*Takapuna.*—An 11 kV. switch failed to clear a fault and led to a minor fire. The O.C.B. itself was not severely damaged and no major damage resulted from the fire.

*Maungatapere.*—A booster and associated equipment was transferred from Maungatapere to Nelson district.

*Hamilton.*—No. 3 substation was cut out for dismantling on 26th March, 1947, and Rotoiti Substation on 31st March, 1947. A 50 kV. automatic earthing-switch was installed at Karapiro in May to protect the transformer bank. At Aongatete the outdoor import and export metering on the McLarens Falls 50 kV. line was moved into the substation building.

(*c*) *General*

Some thirty thousand insulators were tested (buzz stick) in the Auckland area, no defects being found.

3. Transmission and Distribution

(*a*) *110 kV. Lines*

*Arapuni–Penrose.*—In April, 1946, No. 5 line at Karapiro was changed over to two new steel towers built on concrete piers for the lake crossing. This completed the lake crossings on lines 3, 4, and 5. Five line outages were caused by lightning and one each by a tree, a haystacker, an overhead ropeway, and a youth climbing a tower.

*Woodville–Greytown.*—A line gang stationed at Mangamaire and later moved to Woodville overhauled the Woodville–Mangamaire and the Mangamaire–Mount Bruce sections of the line.

Telephone- and main-line insulator units on the Masterton–Mount Bruce section that had been damaged by rifle-fire were changed.

Tower earth tests were taken.

*Woodville–Napier (East and West).*—The maintenance gang commenced the overhaul of the west line, working from Woodville Substation northwards.

Poles on the west line are being tested.

During August an outage on the east line was caused by the linemen burning gorse under the line.

The cable was pitted for approximately 12 ft. on the yellow and red phases. A general inspection for wear was carried out of U bolts, pins, hanger brackets, and hooks.

*Napier–Tuai (East and West).*—Patrols and general maintenance of this line have been satisfactory.

As on the Woodville–Napier lines, inspections for wear of U bolts, &c., were carried out.

Earth testing of towers was commenced.

### (*b*) *50 kV. Lines*

*Henderson–Takapuna.*—Hay being blown into the line or carried by a bird resulted in a flashover, and the subsequent reclosing for test burnt the remaining two phases through, and set fire to a stack of baled hay, destroying 1,000 bales.

*Takapuna–Belmont.*—Defence purposes no longer called for a deviation of this line and the affected portion was rebuilt on the original route. Shags flying into this line resulted in tripping on at least two occasions.

*Maungatapere–Kaitaia.*—During a shutdown of this line a 6 ft. length of wire was found hanging across one phase.

*Tuai–Gisborne.*—This line is in the process of being overhauled and refitted. Lightning flashovers were found to have occurred during the previous summer at eight poles and also at the Ruakituri switch structure.

An outage occurred on the 15th July when the copper braid on the air-break switch at Ruakituri burnt through. The switch had recently been hit by lightning, and it was surmised that the braid was in the path of the lightning, which weakened it, the ultimate failure being due to fusing.

A double interruption on 13th August, 1946, to the Gisborne supply was due to a broken insulator on the east line and to an insulator becoming unhooked.

Heavy rain and flooding caused slips which necessitated a deviation of line.

Damaged cable on the east line was cut and replaced.

*Tuai–Wairoa.*—A piece of cable apparently damaged by lightning was replaced.

*Ngongotaha–Edgecumbe.*—The 7/13 steel conductors in the sulphur area at Tikitere were replaced by copper conductors owing to corrosion. Aluminium wire has been ordered for this section of the line.

### (*c*) *11 kV. Lines*

The Horahora–Leamington double-circuit line was connected to Karapiro station and supply to the Cambridge area was changed over from Horahora to Karapiro on 29th March, 1947. The old section from Horahora was dismantled with the exception of the portion from pole 5 to pole 152 which still supplies some Power Board consumers via an extension connected to a Matamata feeder. The Taumarunui–Manunui line was taken over by the King-country Electric-power Board on 1st November, 1946.

## 4. Communications

The Takapuna–Belmont supervisory system continued to give satisfactory service and, apart from routine maintenance, no major faults developed. A new 50 v. battery was installed for supply, independent of the station battery.

*Penrose–Roskill Supervisory.*—This equipment has been wired up for testing only. Bad factory workmanship, both in wiring and relay adjustment, has impeded the progress of this installation. Telephone cabinets have been installed in the apparatus-room, and partially equipped cables were run and the twenty-line cordless switchboard fitted to the control desk. Some modification has been required to provide for a fifty-line cord switchboard at a later date. Some preliminary investigation has been carried out on the major job of noise correction on the North Auckland line, and trial transposition fitted with good results. At Henderson and Takapuna a 50 kV. line contact with the telephone circuit resulted in the shattering of surge tubes and a shower of sparks which could have caused a major fire; however, the hazard has now been removed by the fitting of temporary baffles to prevent a recurrence.

The Bombay–Kerepeehi and Waikino–Aongatete 50 kV. telephone-lines were retransposed and overhauled.

Telephone-line insulators were tested on the Napier–Waipawa line and faulty insulators replaced.

Protective equipment was inspected at all stations and gas tubes installed.

A new sub-cycle ringer was installed at Tuai Power-station.

A temporary telephone-line was run from Kaitawa to the lake.

Generally the standard of the communication system has improved over last year owing to the work done by the telephone gang on the lines in Taranaki and the regular testing. The system was very much disorganized by the storm of February, 1947. The supervisory control between Khandallah and Central Park Substations needed a fair amount of checking and adjustment.

### 5. Test Department

With the transfer of the test laboratory at Auckland to more spacious accommodation and the arrival throughout the year of new testing-equipment, work there has been carried out under better conditions.

Routine tests were carried out and the faulty operation of equipment was investigated as opportunity offered, but unfortunately the time available for these purposes was limited owing to the large amount of more urgent work required on the testing of new equipment, particularly at Karapiro prior to the power-station going into service, and at Arapuni where a new 24,000 kVA. generator and associated equipment were put into service. In addition, installation tests were carried out on two new 50/11 kV. substations at Maraetai and Waiuku; a new 110/50 kV. and 50/11 kV. substation at Waihou; new 11 kV. switchgear at Aongatete, Huntly, Matamata, Ngongotaha, Waihou, and Waikino; and new transmission-lines.

The pneumatic spring closing device for the Khandallah 11 kV. switchgear was developed in the test department at Palmerston North, and the workshop there was fully employed making up switch panels.

### 6. Plant and Motor-vehicles

*Plant.*—Fifteen tractors are in use and a further 21 are on order. Four tractors are less than five years old, 8 from five to ten years old, and 3 are over ten years old. These tractors are used on transmission-line construction and maintenance and have been maintained in reasonably good mechanical condition.

The workshops have operated for long hours and the workshop plant is becoming worn out. However, the release of surplus military stocks has eased the shortage of circular saws, guillotines, drilling-machines, bench grinders, and small tools.

*Vehicles.*—Districts generally are operating on a minimum or less than requirements. All but a few vehicles are in a well-worn condition and require a good deal of attention, but the demand for vehicles is so urgent that they can be released for essential repairs only. The shortage of spare parts also makes the position acute.

Of the 229 vehicles, only 2 are less than five years old, 151 are from five to ten years, 65 are from ten to fifteen years; and 11 are more than fifteen years old.

One hundred and two new vehicles are on order. The position has deteriorated and will become untenable unless the new vehicles arrive early in the new year.

## C. CONSTRUCTION

### 1. Power-stations

*Arapuni.*—No. 5 M.V. 24,000 kVA. generator was completed and was first put on commercial load on 10th October, 1946. This completes the ultimate development of the station with eight generating-units installed.

*Karapiro.*—Satisfactory progress was made on construction, and final arrangements were in hand at the end of the year for filling the lake and putting the first 30,000 kW. generator into service early in April. Work is proceeding on the erection of the second generating-unit.

*Maraetai.*—Road access was completed, and work is in hand on metalling and sealing. A temporary bridge, later to be submerged, was built over the Waikato River.

Work has proceeded on camps, service buildings, and the planning and erection of construction plant, including the installation of a sawmill to mill pines now growing on land that will later be submerged.

Substantial progress has been made in the Town of Mangakino which will provide housing for the workers on Maraetai, Whakamaru, and Waipapa.

Work is well under way driving a tunnel to divert the river while the dam is being built. A Bailey bridge has been erected to give access across the river.

A large quantity of generator and transformer equipment has arrived at Auckland for this station.

*Whakamaru.*—Investigations were continued throughout the year, test bores being drilled, shafts excavated, and surveys and geophysical tests made in order to determine the nature of the foundations for the dam and other structures.

*Kaitawa* (Waikaremoana Upper Development).—The tunnel was completed to the prescribed point and a shaft formed to the surface. The work of removing rock and rubble to allow the entry of lake waters is now in hand. Steel lining for one pressure tunnel is complete, and it is hoped that one penstock and one generating-set will be complete by the time the intake is ready.

Early in the year under review three 4 ft. diameter siphons were installed to draw water from Waikaremoana for the main and lower stations. By this temporary expedient Waikaremoana has been able to supply in advance nearly 200,000,000 units of power to the system.

The third main transformer was received, and all three have now been dried out and placed on pads outside. The installation of control panels, relays, &c., and switchgear is progressing steadily.

Tests were carried out on two main transformers and the spare, also on No. 7 stator winding. New relays for No. 7 unit were tested and the brake magnet for the overhead crane rewound.

*Tuai* (Waikaremoana Main Development).—Work in the main outdoor station has now been completed and all construction materials have been moved from the site.

The bulk of the alterations to the control-room have been completed.

*Mangahao.*—A set of line-protection relays was put into service. No. 5 machine was fitted with a set of new manganese-bronze turbine buckets, and a contract was placed for three further sets of similar buckets to complete the renewals for all five machines. A contract has been let for six 110 kV. oil circuit-breakers to replace those now having an inadequate rupturing-capacity.

## 2. Substations

### (a) 220 kV.

*Bunnythorpe.*—By moving some 64,000 cubic yards to various fillings the site has been levelled. Fifty-five chains of formation on the railway siding and 44 chains of road-formation have been completed. Test bores were put down on the site of the main building. A contract has been let for the construction of ten houses and two single men's quarters in the new village area. A 50 ft. by 20 ft. steel Task Force hut has been erected for a works office and store.

The following equipment has been received, inspected, and stored either on site or indoors at a rented store at Kakariki: approximately 300 tons reinforcing-steel, one 80 ton electric overhead-travelling crane, twelve of the fifteen 110 kV. oil circuit-breakers, and substantial quantities of parts and insulators for the 220 kV. and 110 kV. airbreak switchgear.

Contracts have been let for the following major items, for which deliveries have not yet commenced: two 30,000 kVA. synchronous condensers, two 50,000 kVA. banks of 220 kV./110 kV. transformers, four 220 kV. oil circuit-breakers, and two 250 kVA. local-service transformers.

*Haywards* (Projected).—Contour plans of the site were prepared, some test bores were made, and instructions were given for the Proclamation of that part of the site, on which the substation proper will be erected.

*Otahuhu.*—The Proclamation for the taking of 24 acres was gazetted in August, 1946. Subsurface explorations by means of test bores have been carried out and the materials analysed by the Soil Survey Division of the Department of Scientific and Industrial Research. These investigations have disclosed that special foundations will be needed to accommodate the heavy loads of the synchronous-condenser building. A temporary water-supply has been arranged by way of a main from the Otahuhu Borough Council and 400/230 v. light and power reticulation completed. Heavy equipment continues to arrive and is being transported and stored at Auckland. As found necessary, attention is being give to the cleaning and painting of transformers, &c., as a preservation measure.

### (b) 110 kV.

*Penrose.*—The major work centred around the changeover to the new control-room, and this has been completed, all operating-equipment having been transferred. New 110 kV. P.T.s were installed, replacing older-type equipment. Push-button control for removing the interlock on condenser O.C.B. 102 was installed; this allows a quicker start up, avoiding the former time delay required for the machine to come to rest.

*Roskill.*—Cabling was run to six outdoor light-standards.

*Henderson.*—The 30,000 kVA. 110/50 kV. transformer-bank installation was completed. Buchholz and restricted earth leakage protection was fitted to two transformer banks. The modernization of the 11 kV. control-board was completed. Six outdoor light-standards were constructed and installed, together with utility power outlets in the transformer enclosure.

*Bombay.*—A 50 kV. O.C.B. for the Waiuku line was installed in May, and distance relays were put into service on the 110 kV. lines in August.

*Hamilton.*—The District Office staff moved into the new administrative building in December. A new carpenters' shop and a temporary store were completed. Tenders are being called for a new switchroom at No. 2 substation. New 11 kV. switchgear has been ordered.

*Ongarue.*—Tenders are being called for a 5,000 kVA. 110/11 kV. T.C.O.L. transformer bank.

*Waihou.*—The two 2,250 kVA. 50/11 kV. transformer banks and the old 11 kV. switchgear were replaced by a 5,000 kVA. bank and new 11 kV. switchgear on 6th December, 1946; and a 30,000 kVA. 110/50 kV. transformer bank and 110 kV. switchgear were put into service on 6th March, 1947. A second 5,000 kVA. 50/11 kV. bank is being installed.

*Greytown.*—The erection of the switch-room was commenced and completed by the contractor, enabling a start on the installation of the 11 kV. switchgear, which is proceeding.

Most outdoor structures have been completed.

Four new 110 kV. transformers were received and unpacked at Waingawa Substation, and three have been dried out and are in readiness for removal to Greytown for installation.

One 110 kV. G. II O.C.B. (ex-Penrose) was received and assembled.

*Masterton.*—11 kV. cables for the new transformer bank were run and the cable boxes completed.

The control-panel for the second T.C.O.L. regulator recently received from Invercargill was mounted in position.

A new cottage is under construction.

*Mangamaire.*—Installation of 11 kV. switchgear in the new switch-room is well under way.

Induction regulators were transferred from Mangahao. Two new electric hoists were received.

*Woodville.*—Two new houses are on order from the Housing Department. Five O.C.B.s have been ordered for this station. Four are to be transferred from other districts and one purchased new. An additional point of supply is to be created here for the Tararua Electric-power Board by the transfer of a transformer from Mangamaire.

*Dannevirke.*—The Housing Department have in hand the building of a new house at this station.

*Waipawa.*—New cables were run for the Power Board supply from Nos. 3 and 4 feeders. All feeders are now in operation. A sewerage system has been installed and a cabinet constructed to house the pump and switch for the septic tanks. A house is under construction.

*Fernhill.*—The substation site has been chosen and an estimate prepared of the cost of survey, purchase of land, &c.

On order are two 10,000 kVA. transformer banks, 11 kV. and 110 kV. switchgear, and control-boards.

*Napier.*—A new D.C. alarm panel was installed. Five 110 kV. O.C.B.s have been ordered.

*Bunnythorpe.*—New protection has been installed and the old panels dismantled, thus completing the Bunnythorpe–Woodville–Khandallah loop.

*Longburn* (Projected).—Instructions have been given for the land transfer survey preparatory to Proclamation. Contracts have been let for 2/110 kV. O.C.B.s. and two banks of 10,000 kVA. transformers for delivery in 1950.

*Marton.*—The new switch-room has been completed and the erection of the new six-panel 11 kV. switchgear is well in hand.

*Wanganui.*—One 110 kV. oil circuit-breaker ex Arapuni was substituted for the old breaker which was sent to Stratford Substation.

*Waverley* (Projected).—Contour plans of the site were prepared and instructions given for the land transfer survey preparatory to Proclamation.

*Hawera.*—A 7,500 kVA. bank of transformers (ex Bunnythorpe) and a 110 kV. lightning-arrester were put into service.

*Stratford.*—A 110 kV. lightning-arrester was installed and a very considerable amount of work was done in the running of control and indicating cables from the structure to the switch-room. A further 110 kV. O.C.B. was installed and associated airbreak switches and connections were completed.

*New Plymouth* (Projected).—A site has been selected on the outskirts of the borough, land transfer plans prepared, and instructions given for its Proclamation.

*Khandallah.*—The erection of the 20,000 kVA. synchronous condenser commenced last year has proceeded slowly. A prototype of the pneumatic spring closing-gear for the 11 kV. switchgear was designed and successfully tested. One 110 kV. oil circuit-breaker of greater rupturing-capacity was installed in Khandallah–Mangahao lines.

*Central Park.*—The second 30,000 kVA. transformer bank and the T.C.O.L. gear for this bank was put into service in December, 1946. The Wellington City Corporation installed its supervisory control gear for the operation of the 11 kV. switchgear. The substation is now complete, except for the erection of the operator's residence and the finishing of the erection of T.C.O.L. gear on the first bank.

*Melling.*—A 110 kV. lightning-arrester was erected and the second 20,000 kVA. transformer bank put into service in February, 1947.

*Upper Hutt.*—The switch-room building was completed, and the erection is proceeding of the 11 kV. switchgear which has been cleaned and repainted.

*Pahautanui.*—Considerable progress has been made with the erection of the new switch-room building.

(*c*) *50 kV.*

*Takapuna.*—A new 50 kV. control-broad was manufactured and installed.

*Belmont.*—An 18 inch standard panel was supplied and fitted for the Waitemata Electric-power Board metering. Preparatory work for a control-board was carried out.

*Edgecumbe.*—The 1,500 kVA., 50/11 kV. transformer bank and booster transformer were replaced on 28 July, 1946, by a 3,000 kVA. transformer bank and booster transformer. Tenders are being called for 110 kV. and 50 kV. outdoor switchgear and steelwork.

*Hangatiki.*—The installation of a 1,500 kVA. 50/11 kV. bank of transformers from Edgecumbe and two new 1,500 kVA. regulating transformers is in progress.

*Huntly.*—Five new 11 kV. feeder O.C.B.s were put into service in place of the existing switchgear on 12th May, 1946, and an additional feeder O.C.B. was connected up in December. The old switchgear has been transferred to Ohai.

*Lichfield.*—The installation of a second 1,000 kVA. three-phase transformer is in hand.

*Maraetai.*—A 2,250 kVA. 50/11 kV. substation was put into service on 31st May, 1946, to supply the village and construction works.

*Ngongotaha.*—The new 11 kV. switchgear in the new switch-room was put into service on 14th April, 1946. The 11 kV. and 6·6 kV. switchgear in the old switch-room and the old 50 kV. structure have been dismantled.

*Waiuku.*—A 5,000 kVA. 50/11 kV. transformer bank and temporary switchgear were put into service as a second supply point for the Franklin Electric-power Board on 6th June, 1946. A concrete switch-room has been built by the Department and the installation of 11 kV. switchgear has commenced.

*Wairoa.*—The installation of switchgear and metering equipment was completed and the total load transferred from the old substation on the 15th December. Construction of switch-room, houses, &c., was completed during the year 1942–43.

(*d*) *33 kV.*

*Stratford.*—It has been decided that the 33 kV. supply shall be given from 110 kV./33 kV. transformers instead of from 50 kV./33 kV. transformers as at present. This has been made possible by the allocation from other Districts of a 10,000 kVA. transformer bank, a 33 kV. steel structure, and most of the associated switchgear.

*(e) General*

At the Kotemaori Patrol-station the Housing Department have a house under construction.

An 11 kV. switch cubicle and metering equipment were installed on the Manunui 11 kV. line at Taumarunui as the first supply point for the King-country Electric-power Board. The Board started taking supply from the Department at midnight on 31st October, 1946.

3. Transmission and Distribution

*(a) 220 kV. Lines*

*Whakamaru–Otahuhu* (120¼ miles).—Tower-sites have been located, pegged, and cross-sectioned for the whole of the east line and for all but 10½ miles of the west line. Construction camps are being erected at Gordonton and Waerenga.

*Whakamaru–Bunnythorpe* (139 miles).—One hundred and twenty-two miles of the east line and 135 miles of the west line have been surveyed, and tower-sites located for 57½ miles of the west line. A good deal of work has been done on the location of access roads, including bridging, and on bush-felling.

Some 34 miles of roads and tracks have been formed and partly metalled to give access to the difficult country east of Waiouru. Huts have been acquired for construction camps, and camps are in process of erection at Bunnythorpe, Tihoi, and Turangi.

Orders for steel towers, insulators and hardware, and conductors sufficient for one line have been placed. Erection plant and motor-vehicles are slowly coming to hand.

*Bunnythorpe–Haywards.*—Detailed location over 53 miles has been made and 9 miles of both east and west lines have been surveyed.

*(b) 110 kV. Lines*

*Otahuhu–Penrose and Bombay–Otahuhu Deviation.*—Route plans and profile tracings prepared.

*Henderson–Maungatapere.*—Traversing and profiling completed. Seventy-seven miles have been plotted and 37 miles repegged. Route plans are in hand. Building-material for construction camps has been secured from War Assets Realization Board.

*Hamilton–Waihou.*—The line was completed in July, and was put into service on 6th March, 1947.

*Hamilton–Karapiro.*—The east circuit was put into service to supply Karapiro from Hamilton on 29th March, 1947.

*Tuai–Bunnythorpe.*—The arrival of consignments of tower steel saw the commencement of tower erection, and this, together with the construction and maintenance of access roads, &c., comprised the major part of the line-construction.

Unavoidable delays in the delivery of tower steel, line equipment, and the shortage of man-power contributed largely to the lack of better progress.

The following are comparative totals :—

| | 1945–46. | 1946–47. |
|---|---|---|
| Roads formed | 34 miles 49 chains. | 38 miles 23 chains. |
| Roads metalled | 15 miles 38 chains. | 10 miles 53 chains. |
| Culverts installed | 140 | 276 |
| Scrub cleared (2 chains wide) | 11 miles 18 chains. | 4 miles 72 chains. |
| Sites benched | .. | 217 |
| Holes dug | 76 sites. | 397 sites. |
| Foundations to site | 9 sets. | 570 sets. |
| Towers to site | .. | 485 |
| Stubs set | 4 sets. | 465 sets. |
| First section erected | .. | 391 |
| Towers erected | .. | 342 |
| Drums of cable received | .. | 307 |
| Towers despatched (ex Bay View) | .. | 529 |

It is anticipated that this line will be in operation by July, 1948.

*Tuai–Kaitawa.*—The construction of this line was completed towards the latter part of the year with the wiring of the last span. Completion of it had been held up pending erection of the Kaitawa structure and the cessation of blasting-operations in the vicinity.

*Lines Radiating from Bunnythorpe Substation.*—The surveys of the deviations to four radiating lines necessary to bring them into the new Bunnythorpe Substation were made.

### (*c*) *50 kV. Lines*

*Maungatapere–Dargaville.*—A preliminary reconnaissance has been carried out.

*Arapuni–Maraetai.*—The line was put into service on 31st May, 1946.

*Maraetai–Whakamaru.*—The line was completed and was put into service at 11 kV. in October, 1946.

*Whakamaru–Taupo.*—A reconnaissance was made of a route for a proposed line to Huka Falls.

*Bombay–Waiuku.*—The line was livened in May, and was put into service on 6th June, 1946.

*Tuai–Gisborne.*—A survey was made to deviate a section of the line at Waerenga-o-kuri which was subsiding through heavy rains and flooding. The fitting and erection of poles was commenced.

*Tuai–Wairoa.*—Six poles and 270 chains of 19/·064 copper cable were used in a deviation to the new Wairoa Substation.

### (*d*) *General*

*Mangaparo 230-volt Reticulation.*—Service lines were erected, and supply to eight domestic consumers was commenced on 1st May, 1946.

*Maraetai Reticulation.*—Four and three-quarter miles of 11 kV. lines were erected to supply the construction works, village, and sawmill. Service lines have been run to 180 houses.

At Mareretu a survey was made of a dam-site for a permanent water-supply. Surveys are being undertaken by the Public Works Department for extending the town water-supply to the substation at Kaikohe.

## 4. Communications

*Arapuni–Hamilton Telephone-line.*—The Karapiro–Hamilton section was completed in October and two circuits were put into service, one of them being connected to the Arapuni–Karapiro section of the old line. The Karapiro–Hamilton section of the old line has been dismantled.

On the Arapuni–Karapiro section all poles have been erected for the new line and wiring is in progress, about 3½ miles being completed.

*Maraetai–Arapuni Telephone-line.*—Pole-erection and wiring is proceeding. Wiring was completed to Arohena and the Arohena Camp was connected to the Arapuni Exchange.

*Channel Carrier System.*—In conjunction with the major overhaul of the telephone-line from Khandallah to Arapuni via Stratford preparatory to carrier-current working, new transposition designs have been worked out and put into service and new panels with carrier filters have been put into all huts as far north as Pohokura. The terminal

equipments have been installed at Khandallah and Bunnythorpe Substations. A contract has been let for carrier-current protective relaying and communication equipment for use over the Tuai–Bunnythorpe 110 kV. line, and delivery of material is now overdue.

A major deviation was made to the Bunnythorpe–Woodville telephone-line to allow it to clear the New Bunnythorpe site, and surveys made to bring all the other telephone-lines into the site when required.

## SOUTH ISLAND SYSTEM

### A. SYSTEM OPERATION AND LOAD DESPATCH

#### 1. Load

The maximum half-hourly demand on the Department's generating-stations was 128,745 kW. at 17.30 hours on 1st July, as compared with 121,460 kW. the previous year, an increase of almost 6 per cent., as against an increase of 3 per cent. for the previous year.

The combined system maximum demand, which includes the Dunedin City Corporation plants and other auxiliaries, was 153,914 kW. at 12.00 hours on 1st October, representing an increase of 7·8 per cent. compared with the previous year's figures of 142,734 kW. and 5·98 per cent. respectively.

Generation details of complete interconnected system (compared with 1945–46) are as follows :—

| Station. | Year ended 31st March, 1947. | | | Year ended 31st March, 1946. | | |
|---|---|---|---|---|---|---|
| | Maximum Kilowatts. | Units generated. | Annual Load Factor. | Maximum Kilowatts. | Units generated. | Annual Load Factor. |
| | | | Per Cent. | | | Per Cent. |
| Arnold .. .. | 3,200 | 22,511,800 | 80·3 | 3,250 | 23,093,200 | 81·0 |
| Dobson (oil) .. | .. | 3,268,240 | .. | .. | 377,400 | .. |
| Coleridge .. .. | 38,980 | 142,279,330 | 41·8 | 41,800 | 133,015,560 | 36·3 |
| Highbank .. .. | 28,500 | 109,113,090 | 43·7 | 26,000 | 37,281,630 | 16·4 |
| Monowai .. .. | 6,600 | 28,689,050 | 49·6 | 6,600 | 24,599,300 | 42·3 |
| Waitaki .. .. | 67,980 | 342,237,950 | 57·5 | 68,000 | 358,588,820 | 60·2 |
| Departmental totals | .. | 648,099,460 | .. | .. | 576,955,910 | .. |
| Dunedin City (all stations) | .. | 93,900,243 | .. | .. | 101,108,211 | .. |
| Invercargill City .. | .. | 1,576,090 | .. | .. | 35,900 | .. |
| Kanieri Electric Co. .. | .. | 5,398,140 | .. | .. | 5,348,440 | .. |
| Westland Power, Ltd. | .. | 2,023,200 | .. | .. | 1,371,040 | .. |
| Others .. .. | .. | 2,324.005 | .. | .. | 89,422 | .. |
| Grand total .. | .. | 753,321,138 | .. | .. | 684,908,923 | .. |

### 2. Reliability of Supply

There has been a total of 236 faults, of which 229 caused interruptions to supply. Included in this total are 24 secondary interruptions caused by faults in consumers' systems. A detailed analysis of interruptions is shown on the following table. These do not include prearranged shutdowns :—

| Description. | Year ending 31st March, 1947. | | |
|---|---|---|---|
| | Number. | Duration. | Distributing Authorities affected. |
| | | h. m. | |
| 1. 110 kV. lines : Defects | 2 | 7 52 | 10 |
| 2. 110 kV. lines : External causes | 3 | 1 58½ | 7 |
| 3. 66 kV. lines : Defects | 8 | 2 15 | 1 |
| 4. 66 kV. lines : External causes | 1 | 0 08 | .. |
| 5. 11 kV. lines : Defects | 69 | 52 22½ | 3 |
| 6. 11 kV. lines : External causes | 41 | 19 36½ | 2 |
| 7. Lightning | 30 | 62 42 | 7 |
| 8. Storms : Nature of trouble unknown | 8 | 10 01 | 3 |
| 9. 110 kV. equipment | 2 | 2 02 | 1 |
| 10. 66 kV. equipment | 3 | 4 57 | 3 |
| 11. 33 kV., 11 kV., or 6·6 kV. equipment | 4 | 3 44½ | .. |
| 12. Generators | .. | .. | .. |
| 13. Turbines | 1 | 0 01 | 2 |
| 14. Diesel-oil engines | .. | .. | .. |
| 15. Relays | .. | .. | .. |
| 16. Control circuits and batteries | 1 | 23 35 | .. |
| 17. Operation : Mistakes | 1 | 0 06 | 9 |
| 18. Operation : Accidents | 6 | 0 56½ | 9 |
| 19. Faults and overloads on consumers' system | 24 | 29 12 | 4 |
| 20. Other causes | 8 | 4 44½ | 8 |
| 21. Cause unknown | 24 | 14 58½ | 5 |
| Totals | 236 | 241 12½ | 74 |

## B. OPERATION AND MAINTENANCE

### 1. Power-stations

All the generating-plant at the main stations was run satisfactorily and there were no major breakdowns. The loading of each station required constant and careful consideration in anticipation of high peak loads expected during the winter of 1947. The storage of water soon became a matter of major, and then of vital, importance. The increase in the number of units purchased from 216,481 in 1946 to 5,869,146 in 1947 gives ample evidence that steps were taken early to counteract any shortage of water. Of the 5,869,146 units purchased, 4,617,752 were generated by auxiliary stations operated by steam power.

*Coleridge.*—The lake-level, which stood at 1,673·2 ft. at 1st April, 1946, declined to 1,665·67 ft. at 23rd July. Wet weather then set in and recovery was rapid. The lake was again full at the beginning of March. The continued lack of north-west rain and heavy demands on the station due to Highbank being shut down and Waitaki and Arnold outputs reduced resulted, however, in a rapid fall to 1,669·82 ft. at 31st March, 1947.

The rainfall for the year 1946 was 35·16 in. For the first time in at least forty years a snowfall of 2 in. was recorded as lying at the power-house in February.

A general overhaul of Nos. 1, 2, 7, and 8 units was carried out. No. 3 was repaired following the breakage of three guide vanes; the shaft alignment was tested, and middle bearing moved slightly, there being, however, little reduction

in the vibration present since the steel runner was fitted in 1939. Incidental repairs or routine maintenance only were required on each of the other machines—viz., Nos. 4, 5, 6, and 9.

A severe earthquake shock, thought to originate in the Birdwood Range, occurred at 00.35 hours on 27th June. Damage resulted at the lake outlet dam, where the concrete wing walls were cracked, and at the station, where some six dozen window-panes were broken, and all but three of the brick chimneys of cottages had to be dismantled and rebuilt. Repair work was completed in September.

*Machine-running Times*

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In Demand (Hours). | |
| 1 .. .. | 5,280 | 60·3 | 2,069 | 23·6 | 1,400 | 11 | 83·9 |
| 2 .. .. | 6,297 | 71·9 | 2,046 | 23·4 | 417 | .. | 95·3 |
| 3 .. .. | 5,904 | 67·4 | 2,520 | 28·8 | 336 | .. | 96·2 |
| 4 .. .. | 2,390 | 27·3 | 6,320 | 72·1 | 50 | .. | 99·4 |
| 5 .. .. | 2,349 | 26·8 | 6,389 | 72·9 | 22 | .. | 99·7 |
| 6 .. .. | 2,136 | 24·4 | 6,256 | 71·4 | 368 | .. | 95·8 |
| 7 .. .. | 2,235 | 25·5 | 5,297 | 60·5 | 1,228 | .. | 86·0 |
| 8 .. .. | 3,160 | 36·1 | 4,069 | 46·5 | 1,531 | .. | 82·6 |
| 9 .. .. | 3,822 | 43·6 | 4,935 | 56·3 | 3 | .. | 99·9 |

*Waitaki.*—The highest daily river flow was 34,522 cusecs on 19th October, and the minimum weekly average flow was 3,641 cusecs on 14th July. The average flow for the year was 10,942 cusecs, as compared with 15,157 cusecs during the year ended 31st March, 1946. The average daily flow for the week ending 31st March was 8,800 cusecs, as compared with 10,840 cusecs the previous year.

The rainfall recorded for the year ending 31st March was 19·71 in.

Cavitated areas in turbine runners and runner skirts were welded up and ground to shape. Circulating-pumps were put in the thrust-bearing lubricating-oil systems of Nos. 3 and 4 units. Two gate-arms and three breaking-links, broken on No. 4 due to an obstruction, were replaced from spares. Apart from resweating of No. 2 main exciter commutator risers, the generators gave excellent service and required only routine maintenance.

*Machine-running Times*

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In demand (Hours). | |
| 1 .. .. | 7,745 | 88·4 | 993 | 11·3 | 22 | .. | 99·7 |
| 2 .. .. | 7,467 | 85·2 | 1,209 | 13·8 | 84 | .. | 99·0 |
| 3 .. .. | 5,485 | 62·6 | 3,037 | 34·7 | 238 | .. | 97·3 |
| 4 .. .. | 4,963 | 56·6 | 3,031 | 34·6 | 766 | .. | 91·2 |

*Highbank.*—During this, its second, year of operation the station was run intermittently in March, 1946, and then practically continuously until 25th November, when it was shut down until 1st April, 1947, to allow the Public Works Department to clean out the head-race. The station's continuous running-capacity was a valuable contribution to system requirements.

Operation of the station was generally satisfactory, but continuous output is limited to approximately 23,000 kW., principally on account of screen trouble. Excessive debris and rubbish coming down the race cause undue restriction of screen area. Improved forebay screen arrangements are contemplated, but cannot be undertaken till next summer. Improvements in the cooling water-supply arrangements are also required, and difficulty is still being experienced with excessive wear of main generator slip-rings.

During the summer shutdown all power-house equipment was overhauled, main C.B. valve cylinder was dressed up, and a new dovetailed retaining-ring was fitted in the relief-valve.

*Machine-running Times*

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In Demand (Hours). | |
| 1 .. .. | 5,240 | 59·8 | 609 | 7·0 | 2,905 | 6 | 66·8 |

*Arnold.*—Throughout the year the Arnold River flow was maintained, and this station ran virtually continuously on full load until a fault on 21st February resulted in serious loss of output continuing past the end of the year.

When a fault developed in the voltage regulator wiring at approximately 01.30 hours on 21st February, the two units shed their load, as is usual, but on this occasion the main governor gate ring connecting link on No. 2 fractured, resulting in damage to the gates and the runaway of the machine. The operators are to be commended on their success in bringing the runaway machine under control without further damage in very trying circumstances. While a full set of new gates was being made in Christchurch, new main gate ring connecting links are being fitted to both machines, all underwater gear overhauled, and restanching of surge chamber gates carried out.

*Machine-running Times*

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In Demand (Hours). | |
| 1 .. .. | 8,590 | 98·1 | 170 | 1·9 | .. | .. | 100 |
| 2 .. .. | 7,794 | 89·0 | 222 | 2·5 | 744 | .. | 91·5 |

*Monowai.*—The normal operation of the station was interrupted on two occasions only, both due to loss of parallel with Waitaki Power-station, causing overload and necessitating load being dropped.

The rainfall for the year was 45·31 in., most of which fell between August and December. Floods occurred in October which necessitated sandbagging of the dam, and water was run to waste from October to December.

All equipment has been given schedule maintenance and has operated satisfactorily. A replacement for one O.C.B. damaged by fire in 1944 was installed.

*Machine-running Times*

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In Demand (Hours). | |
| 1 .. .. | 4,867 | 55·7 | 3,832 | 43·3 | 60 | 1 | 99·3 |
| 2 .. .. | 4,986 | 56·8 | 3,691 | 42·2 | 82 | 1 | 99·1 |
| 3 .. .. | 5,229 | 60·3 | 3,448 | 39·5 | 82 | 1 | 99·1 |

*Dobson.*—The Diesel station was called on for considerable running on account of system loading requirements. This running, approximately two shifts per day, commenced intermittently in May, and the Diesels were running almost continuously from early in June until the end of August. Similar running was again required at the end of February, continuing to the end of the year. The station also ran continuously to supply West Coast load in conjunction with Arnold when the Coleridge–Otira line was out from 27th to 29th November and on six other occasions for system maintenance purposes.

Further major failures were experienced on No. 4 engine, on which No. 9 piston-skirt broke in June. New walking-rod parts and piston-skirt were made in New Zealand. On reassembly and after a short period of running in February a further seizure occurred, this being attributed to a small sand acclusion in the piston-skirt casting. As a result of these failures, No. 4 unit was not available for most of the year.

A good deal of trouble was experienced with broken liner sealing-ring bolts, and smaller rubber sealing-rings are being used when fitting replacements.

The Diesels are rendering considerable assistance to the system, but their percentage availability is deteriorating rapidly because replacement parts are unprocurable.

*Machine-running Times*

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | | Percentage Availability for Service. |
|---|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Not in Demand (Hours). | In demand (Hours). | |
| 1 .. .. | 919 | 10·5 | 7,841 | 89·5 | .. | .. | 100 |
| 2 .. .. | 903 | 10·3 | 7,840 | 89·5 | 17 | .. | 99·8 |
| 3 .. .. | 936 | 10·7 | 7,746 | 88·4 | 78 | .. | 99·1 |
| 4 .. .. | 104 | 1·2 | 2,290 | 26·1 | 6,366 | .. | 27·3 |

## 2. Substations

### (*a*) *110 kV.*

*Hororata.*—The construction of a new line will increase the capacity of the existing three lines connecting Hororata with Addington, and the terminal point at Hororata is being installed.

*Temuka.*—On load tap-changing equipment was placed in service on 2nd July. Cable ducts which were leaking badly have been plastered.

*Timaru.*—"A" and "B" transformer banks were paralleled and placed on automatic control on 2nd May. All units on bottom selector switch of south bank potential transformers were replaced.

*Oamaru.*—A new 5,000 kVA. on load tap-changing transformer bank was placed in service on 29th September. The existing bank of three transformers and the spare transformer were dismantled and railed to Milton for erection there.

The spare transformer was transferred from Temuka to Oamaru and will be used as a spare for the new bank.

(*b*) *66 kV.*

*Addington.*—The maximum demand for the year was 68,280 kW. at 17.30 hours on 4th June. Air-break switches and isolators for the new fourth line between Addington and Hororata were installed.

*Otira.*—Though a severe storm on 12th August caused considerable damage to New Zealand Railways equipment, no perceptible damage was noticed on this apparatus.

*Arahura.*—New switchgear for Kumara and Arahura was received and stored.

(*c*) *33 kV.*

*Smiths Road.*—A defective transformer was taken off duty for repairs and a replacement effected satisfactorily.

*Waipara.*—A defective transformer was replaced. Repairs to the station building were undertaken.

*Gore.*—The substation supply was interrupted seven times, the longest, of 2 hours 44 minutes, being due to a failure of a transformer bushing, two to failure of the 110 kV. supply, and four to 11 kV. trouble.

*Invercargill.*—Supply was interrupted on thirteen occasions, all due to external causes. All apparatus received schedule maintenance and operated satisfactorily. Two 4,500 kVA. 11 kV. regulating transformers returned to England in 1945 were received back and reinstalled.

*Ohai.*—Fifteen interruptions to supply occurred, two due to blowing of 66 kV. transformer fuses and the balance due to failures on the 66 kV. or 110 kV. system.

*Winton.*—Supply was interrupted eighteen times. On two of these 66 kV. fuses blew, and three others were due to 11 kV. trouble, but all faults were external to the substation. The balance were due to 110 kV. or 66 kV. failures.

The greater reliability of supply at Gore due to the 110 kV. supply is evidenced.

(*d*) *General*

Routine inspection and testing of all electrical and mechanical equipment, filtering and reconditioning of oil in transformers and switchgear, overhauls and repairs, replacements of defective bushings and insulators, &c., were carried out. Repairs to and maintenance of departmental cottages and non-residential buildings were undertaken. The workshops at some of the stations, principally at Addington, were engaged on repairs, reconditioning, and alterations to transformers, switchgear, condenser bushings, &c., for both the Department and several Supply Authorities.

## 3. Transmission and Distribution

### (*a*) *110 kV. Lines*

The erosion on the south bank of the Waitaki near a tower which carries the Glenavy–Oamaru A and B lines was intermittent throughout the year. Floods during September washed away a considerable portion of the bank. After the floods the main stream moved over to the north bank and erosion practically ceased. Remedial measures have been and are being taken to protect this tower.

### (*b*) *66 kV. Lines*

A deviation of about 2 miles in the Otira–Arahura line near Turiwhate was surveyed and bush cleared from the route. The deviation is necessary, as the original route was endangered by the Taramakau River. The deviation of the transmission telephone-line in this locality was completed.

### (*c*) *11 kV. Lines*

Three A.B. switches were erected at Addington to enable paralleling of the Barrington Street feeders. An A.B. switch was inserted in both the Lyttelton No. 2 and the Harbour Board No. 1 feeders.

A temporary 19/13 copper overhead line was run to the boys' high school to cope with the increased load in this locality. All joints were located and marked with cable bricks on the Milton 1 and 2A and B feeders.

The southern feeder in the Middleton Yard was diverted to allow reconstruction of the railways to proceed.

Temporary lines in Russley Road were dismantled.

### (*d*) *Distribution*

*Southland.*—This has been a busy year on distribution-lines, but only sporadic maintenance has been carried out. This, however, has included fairly extensive tree-cutting.

The work of changing over East Gore from 3·3 kV. to 11 kV., which actually is a rebuild of the distribution on concrete poles, is practically completed. Also, a change-over of South Invercargill from 3·3 kV. to 11 kV. involving rerouting and rebuilding on concrete poles is well in hand.

For practically the whole of the year the available distribution gangs were engaged on lines extensions. A new feeder has been built from Ohai Substation to feed the Morley and Wairaki State Mines and the Linton Mine. Some 493 new consumers were connected, necessitating 63 miles of new lines. Several limeworks and new sawmills have been connected to the system. A good deal of regrouping of existing consumers has been carried out. Numbers of transformer and A.B. switch poles, as well as defective ones, have been replaced by concrete poles. Material shortages and shortage of labour still prevent many prospective consumers from being supplied with power.

### (*e*) *Consumers, &c.*

A period of ten complete financial years of State ownership and administration of the Southland electric-power supply matured on 31st March, 1947, and the occasion is an appropriate one to comment upon the progress made in that time by State enterprise governing the generation, reticulation, and retail and wholesale distribution of electric power in the Southland District, which is the most widespread electric-power district in the Dominion. For this purpose the following figures for the year ended 31st March,

1936—before the Government acquired the Southland Electric-power Board's undertaking—with the corresponding figures for the year ended 31st March, 1947, are quoted, giving also the percentage increases where possible :—

| Item. | Year ended 31st March, 1936 (before the State acquired the Undertaking). | Year ended 31st March, 1947. | Percentage Increase. |
|---|---|---|---|
| Land rates levied and collected .. .. | £32,232 | (*a*) | .. |
| Meter-rents collected .. .. .. | £3,500 | (*b*) | .. |
| Price charged per unit, retail (average) .. | 1·966d. | 1·667d. | 15·2 (decrease). |
| Units sold per retail consumer .. .. | 1,322 | 2,171 | 64·2 |
| Units sold in bulk (in millions) .. .. | 6·627 | 19·158 | 189·1 |
| Units sold, retail (in millions) .. .. | 13·487 | 29·173 | 116·3 |
| Total units sold (in millions) .. .. | 20·114 | 48·332 | 140·3 |
| System's maximum demand, including bulk supply (in kilowatts) (*c*) | 6,600 | 14,822 | 124·6 |
| Maximum demand of bulk consumers (*d*) .. | 2,181 | 6,457 | 196·1 |
| Number of consumers .. .. .. | 10,198 | 13,441 | 31·8 |
| Number of water-heaters .. .. | 380 | 1,726 | 354·2 |
| Number of electric ranges .. .. | 1,360 | 2,631 | 93·5 |
| Number of electric motors, retail .. .. | 3,735 | 9,793 | 162·2 |
| Miles of transmission-lines .. .. | 145 | 176 | 21·4 |
| Route miles of distribution-lines .. .. | 2,263 | 2,562 | 13·2 |

NOTES.—(*a*) No land rates have been levied by the Government since it acquired the undertaking. (*b*) Meter-rents were abolished immediately the Government assumed control. (*c*) The maximum demand has completely outstripped the capacity of the Monowai Generating-station, thus the value of the step taken by the Government to interconnect the Monowai plant with the Waitaki and Coleridge Generating-stations is clearly demonstrated; in the year ended 31st March, 1947, the Waitaki Station was called upon to supply 28,500,000 units to Southland. (*d*) Bulk consumers (distributing authorities) comprise the Invercargill City Council, Otago Electric-power Board, and the Bluff Borough Council; supply from Southland to the Otago Electric-power Board commenced in March, 1947.

The capital expended in extending the Southland undertaking amounted, in the ten years of Government ownership, to £306,000, of which £114,000 was devoted to the erection of additional electric distribution-lines to reach rural retail consumers. In the same period a sum of £148,000 was expended on renewals and replacements to improve the supply to consumers.

In addition to the saving to the residents of Southland by the action of the Government in abolishing Power Board land rates and meter-rents, there has been considerable benefit to consumers through the State's introduction of reduced prices for electricity and, in some cases, through reduced minimum annual guarantees. For example, consumers who were required to pay £7 11s. plus land rates and meter-rents to the Power Board, to-day obtain the same service under State enterprise for £6 12s. with no land rates and no meter-rent. Small industries which previously paid £51 15s. a year for power now obtain the same quantity of energy for £43.

During this financial year arrangements were made to give future bulk supply to the Bluff Borough Council on a maximum-demand tariff in lieu of the unit-charge basis which had been in force for many years. This changeover should prove to be of material benefit to consumers in Bluff.

Applications to the Rural Electrical Reticulation Council for subsidies to assist in the problem of making a supply of electricity to settlers in the sparsely populated areas of Slope Point, Happy Valley (Tuatapere), and Tussock Creek - Forest Hill have been granted, and shortly it should be possible to proceed with the erection of the necessary additional distribution-lines to the districts named.

### 4. COMMUNICATIONS

There is room for considerable improvement as to quality, and to this end transmission-loss tests were carried out by the Communications Engineer on the Addington – West Coast, Addington–Dunedin, and Addington–Waipara trunk circuits. Line and installation details were comprehensively reviewed, and alterations desirable to improve quality of speech transmission are in hand.

Plans for experiments with two-way radio communication, particularly with fault trucks, are in hand.

### 5. Test Department

Equipment for paralleling with Kanieri Electric, Ltd., and for two-way metering was installed at Arahura and paralleling was satisfactorily instituted.

A new 11,000/400 v. substation with two re-routed existing 11 kV. cables and an 11 kV. incoming O.C.B. was put into service at Sunnyside after tests were carried out.

Routine tests were conducted on rubber gloves, insulators, relays, revenue meters, oil circuit-breakers, master electric clocks, &c.

Heat runs were conducted on switchgear, clamps, cables, &c. Tests at 220 kV. upon line and busbar clamps were made under the supervision of Head Office Engineers.

### 6. Plant and Vehicles

*Plant.*—Three tractors are in use and a further 4 are on order. The present tractors are all over five years old, but are in reasonable mechanical condition.

Good use was made of the available machines and tools in the workshops repairing equipment and making up essentials such as CT boxes, LT links, transformer fuses, screw anchor rods, earth guards, &c. At Addington a snow-plough truck attachment was built.

*Vehicles.*—All but a few vehicles are in a well-worn condition and some will require early replacement. As in the North Island, the demand for vehicles is so urgent that release for essential repairs only is possible.

Of the 157 vehicles, only 3 are less than five years old, 95 are from five to ten years, 56 from ten to fifteen years, and 3 are over fifteen years old.

The maintenance of the present transport system will depend on the early arrival in the new year of the 34 vehicles on order.

## C. CONSTRUCTION

### 1. Power-stations

*Coleridge.*—Much work has been carried out in connection with the construction of the new outdoor steelwork, and one section, including No. 1 unit and its transformer bank and all accessories, has been placed in commission. Coleridge–Otira A line was connected up to the new structure on 16th March, and B line a week later.

*Arnold.*—Replacement gates are being constructed for No. 2 machine. A new water-supply system was installed to replace the rain-water supply previously in use.

*Dobson.*—The installation of a second bank of transformers is well in hand. Concrete for the transformer and O.C.B. pads have been poured. The poles and overhead bus work has been finished and both air-break and isolating switches have been installed. Excavation has been made for the traverser track and a drain put in.

Two new cottages were completed by the contractor, and single men's quarters are being built.

*Tekapo.*—Overcoming technical difficulties and penetrating beyond the end of the test drive that had made tunnelling so difficult, progress was maintained on both headings of the tunnel at a fairly satisfactory rate. Progress has been made on other works, but it has been retarded by the transfer of plant for urgent work at Pukaki.

*Pukaki.*—Work on the dam and sluiceways is virtually complete and contracts have been entered into for the reinforced-concrete structure and for the gates and operating machinery.

### 2. Substations

*Methven.*—Preparations for the erection of a new substation are well advanced. Equipment dismantled at Sockburn has been delivered and construction has commenced.

*Addington.*—Installation of an O.C.B. and air-break and isolating switches for the new fourth line—linking Addington with Hororata—is proceeding. This additional line will increase the carrying-capacity of the existing three lines.

*Hororata.*—The concrete pad for the O.C.B. controlling the new fourth line CH/D has been poured and cable ducts have been extended.

*Milton.*—An 110/11 kV. 4,500 kVA. transformer bank and associated equipment was completed. This substation supplies five auto reclose feeders to the Otago Electric-power Board. The equipment is housed in a ferro-concrete building built by the Department after tenders had been called unsuccessfully. The substation went into service on 31st March, 1947, and is unattended.

*Ohai.*—Rebuilding of this substation to supply a growing mining load in the Ohai coalfields and to meet the electrification of sawmills in the Tuatapere district is well in hand. A concrete switch-house has been erected by the Department and the installation of four auto reclose feeders is in hand. The present transformer bank of 750 kVA. is being replaced by a 2,250 kVA. bank.

*Edendale.*—A concrete switch-room has been erected by the Department preparatory to construction of an 110 kV. substation.

### 3. Transmission-lines

A new fourth line — linking Addington and Hororata — has been erected from Addington to the Waireka River. About 7 miles of further erection will complete this important work.

Extensions and alterations were carried out near Coleridge Power Station to the two lines linking Coleridge with Otira to enable power to be supplied through the new steelwork.

Plans for the Gore–Invercargill 110 kV. line were completed and some poles and conductors were delivered. Enough material has not yet been received to warrant commencement of construction.

A reconnaissance has been carried out on the Gore–Coal Creek 110 kV. and a route has been selected.

A route has also been located for the Invercargill–Bluff and Invercargill–Riverton 66 kV. lines.

A commencement has been made on a 4½ mile 33 kV. line on concrete poles to connect a 500 kW. steam auxiliary at Kaitangata Coal-mines into the Otago Electric-power Board system at Stirling.

## NELSON-MARLBOROUGH SECTION

### A. System Operation and Load Despatch

### 1. Load

The maximum load on the system was 8,240 kW. on Wednesday, the 17th July, an increase of 14·75 per cent. compared with last year's peak of 7,180 kW., and there was a 20 per cent. increase from 34,288,308 to 41,143,020 in the number of units generated. The greatest weekly generation was 886,194 units for the week ended 28th July, 1946, this being 12½ per cent. higher than last year's figure of 787,700 units for the week ended 22nd July, 1945. The system annual load factor was 57 per cent., and 5·4 per cent. of the units generated were unproductive.

Units generated (compared with 1945–46) are as follows:—

| Station. | Year ended 31st March, 1947. | Year ended 31st March, 1946. | Percentage Increase. |
|---|---|---|---|
| Cobb Power-station .. .. | 36,530,900 | 33,464,800 | 9·1 |
| Auxiliary and standby stations .. | 4,612,120 | 823,508 | 460·1 |
| Total units .. .. | 41,143,020 | 34,288,308 | 20 |

Due to the extremely dry period from December to March, all auxiliary and standby stations were operated, as far as possible, at their maximum and resulted in these stations generating 11·2 per cent. of the total, compared with 2·8 per cent. last year.

Shortage of coal practically prevented the Golden Bay Cement Co. from using their generating-plant, but the company assisted materially by keeping their demand as low as possible. In an endeavour to prevent rationing, various lakes in the Cobb catchment area were tapped, but for about a fortnight from 10th March rationing cuts of 10 per cent. to 20 per cent. were necessary. The position would have been worse if the various Power Boards and other consumers had not co-operated and practised voluntary rationing.

### 2. Reliability of Supply

Although the number of accidental interruptions shown on the chart below is 27, no less than 16 were due to snow conditions on the 11 kV. line between the power-house and the dam. Of the remainder, only 5 affected all Power Boards: one on 12th June, 1946, was due to lightning, and the other 4 all occurred on 13th August, 1946, as a result of the screens at the dam becoming blocked. The following table gives an analysis of both accidental and prearranged shutdowns:—

*Faults and Shutdowns on Departmental System*

| Description. | Year ended 31st March, 1946. | Year ended 31st March, 1947. | | | |
|---|---|---|---|---|---|
| | | Accidental. | Prearranged. | Duration. | Distribution Authorities affected. |
| | | | | H. m. | |
| 1. 66 kV. lines: Defects | .. | .. | 2 | 3 45 | .. |
| 2. 66 kV. lines: External causes | 1 | .. | 3 | 5 27 | .. |
| 3. 11 kV. lines: Defects | .. | .. | 1 | 3 05 | .. |
| 4. 11 kV. lines: External causes | .. | 1 | .. | 0 06 | .. |
| | .. | .. | 1 | 0 30 | .. |
| 5. Lightning | 1 | 1 | .. | 0 04 | 2 |
| | | | | 0 27 | 1 |
| 6. Storms | .. | 16 | .. | 17 06 | .. |
| 7. 6·6 kV. apparatus | .. | .. | 3 | 0 18 | .. |
| 8. 11 kV. or 33 kV. apparatus | .. | 1 | .. | 0 08 | 1 |
| | .. | .. | 6 | 5 06 | .. |
| 9. 66 kV. apparatus | 1 | .. | 1 | 3 41 | .. |
| 10. Generators | .. | .. | .. | .. | .. |
| 11. Relays | .. | 1 | .. | 0 02 | 1 |
| 12. Control circuits and batteries | .. | .. | .. | .. | .. |
| 13. Operation: Mistakes | .. | .. | .. | .. | .. |
| 14. Operation: Accidents | 1 | .. | .. | .. | .. |
| 15. Faults and overloads on consumers' systems | 1 | .. | .. | .. | .. |
| 16. Other causes | 3 | 6 | .. | 0 01 | .. |
| | | | | 1 33 | 3 |
| | | | | 0 05 | 1 |
| 17. Causes unknown | .. | 1 | .. | 0 03 | .. |
| Totals | 8 | 27 | 17 | 41 36 | 9 |

## B. OPERATION AND MAINTENANCE

### 1. Power-stations

*Cobb.*—The station peak of 8,100 kW. on 14th November, 1946, was a 16 per cent. increase on the 1945–46 M.D. The rainfall from April to December was sufficient to maintain a fair river flow, being continuously above 100 cusecs from the middle of July to the end of December.

On 13th August a flood again caused the screens to block, with results similar to those reported last year, and auxiliary stations were quickly brought in. The Cobb generators were off load on four occasions during the day, the total interruption period being 1 hour 33 minutes. During the first three weeks of January the river flow fell gradually and standby plant operated as from the 20th, and by 29th all normal auxiliary stations were operating but the position was still deteriorating. Investigations

in the Cobb catchment area showed that relief could be obtained from various lakes, and with some effort water equivalent to 750,000 units was obtained from these sources. As this represents 10 per cent. of the total units generated during the dry spell, it was of very material assistance and had the effect of considerably shortening the period of rationing. During low-river-flow periods it has been found expedient to raise the weir-level with the sandbags to provide some storage to meet peaks and emergencies and to conserve water at low-load periods. The rainfall as recorded at the Cobb Power-house was 73·005 in. as compared with 67·79 in. in 1945–46.

Although the turbines again received severe punishment, due to the passing of gravel down the pipe-line, all power-house plant is now in good order, the spears, nozzles, and servomotors of all machines having been overhauled and governor gear checked. The No. 2 turbine C.B. valve body developed cracks which were welded, and the unit was put back into service pending the arrival of a new part now on order. Apart from these works only normal maintenance has been required at the station.

The following table shows the running-time for the various machines and their availability for service :—

| Generator No. | Time on Load. | | Time Idle. | | Time under Repair. | Percentage Availability for Service. |
|---|---|---|---|---|---|---|
| | Hours. | Percentage. | Hours. | Percentage. | Hours. | |
| 1 .. .. | 5,214 | 59·3 | 3,545 | 40·6 | 01 | 99·9 |
| 2 .. .. | 4,401 | 50·2 | 4,346 | 49·7 | 13 | 99·8 |
| 3 .. .. | 5,357 | 61·2 | 3,346 | 38·2 | 57 | 99·4 |
| 4 .. .. | 5,117 | 58·4 | 3,540 | 40·4 | 103 | 98·8 |

*Stoke Diesel Station.*—During the year, 664,360 units were generated at this station, the machines being run as required for standby generation. The non-arrival of the full complement of spares on order has delayed the overhaul of the engines and as a result some troubles have developed during running. It is hoped that sufficient parts will be available to enable an extensive overhaul during the coming year, as it is anticipated that the demand on the plant will increase. Machine-running times are : No. 1 machine, 915 hours 39 minutes ; No. 2 machine, 1,206 hours 59 minutes.

## 2. Substations

At all substations only routine maintenance was required, all apparatus functioning normally, except for a fault which occurred to an 11 kV. A.B.S. at Motupipi, and for the shattering of an insulator on the 33 kV. O.C.B. isolator at Blenheim which was due to birds carrying straw. At the Tarakohe 11 kV. substation several dirty insulators were cleaned or changed.

## 3. Transmission and Distribution

*66 kV.*—There were no breakdowns on these lines. A damaged dropper on the Upper Takaka–Moutere section was replaced, line-weighting adjustments were made, and considerable access work done.

*11 kV.*—Interruptions were confined to the power-house–dam line and were due to snow conditions. Steps are being taken to counteract a repetition of this trouble. A general check over of the Motupipi–Tarakohe section was made during a shutdown.

*General.*—Pole stubs were set up as a means of testing belts, strops, crossarms, and fittings, &c., and a live-line test bus was established at Stoke. Testing-sticks and drying-ovens were built in preparation for work next summer. There were no pole replacements.

## 4. Communications

A number of faults were experienced during the year, mostly due to external causes where our lines pass through heavily timbered country. Inspection surveys of the lines have been made and data is being collected for the preparation of a communication route plan. An oscillator and amplifier was installed for use in conjunction with the water-level indicator at Cobb. The replacement of fuse-switches with gas-arresters is proceeding.

### 5. Testing

Besides carrying out the routine tests of installed equipment, the staff has been fully engaged in testing new apparatus going into service, tracing and checking faults and carrying out the necessary alterations and adjustments, and installing and testing metering equipment and alarm and recording systems.

### 6. Plant and Motor-vehicles

Generally speaking, the motor-vehicles in use in this district are fast reaching the state where their reliability is in question and their repair and maintenance costs are becoming excessive. Of the 2 cars, 19 trucks, and 2 motor-cycles, at least half of the vehicles have now been in use ten years or more, much of their work having been on construction or survey in very rough country. No new vehicles have yet been allocated to this district. The additional trucks received are all second-hand and some have had strenuous Army service. Additional vehicles for the Cobb Station Superintendent and the Distribution Engineer are urgently required, and if transmission-line construction work is to proceed, further vehicles must be made available. Of the 2 ambulances, ex-Army, received during the year, 1 has been fitted up as a line truck and a similar body will be built for the second during the coming year.

## C. CONSTRUCTION

### 1. Power-station

*Cobb.*—The main work undertaken has been the construction of a social hall, which is now well under way. Other building included the provision of further temporary accommodation and a drying-room at the hostel, and village fences, walls, &c. At the power-house the pumping-unit for the water rheostat was placed in position and suitably housed, while the new local service panel was also put into service.

### 2. Substations

*Stoke.*—Control panels for the O.C.B. relays were set up and put into operation and the installation of the temporary 6,000 kVA. transformer bank is in progress.

*Blenheim.*—A new 33 kV. O.C.B. with metering P.T.s and C.T.s was installed, and, on transfer from Addington, the 5,000 kVA. transformers were assembled and relays have been fitted. The bank will be put into service during the coming year. An order has been placed for an outdoor-type voltage-regulating transformer, which should arrive from England towards the end of this year.

*Motupipi.*—Incoming-supply metering-equipment was installed.

*Upper Takaka.*—The 66 kV. O.C.B.s were prepared and put into service and an 11 kV. feeder panel was installed for additional supply to the Golden Bay Electric-power Board.

### 3. Transmission and other Lines

The survey work in connection with the Stoke–West Coast line is now almost completed.

Extensions to 11 kV. lines, an 11 kV./400 v. substation, and additional 400 v. mains have been erected at Cobb.

A second telephone-line was installed between the power-house and the dam to handle the increased construction traffic.

### 4. Workshop

*Nelson.*—The new workshop building, commenced in October, 1945, is slowly nearing completion and may be ready by June, 1947.

## D. CONSUMERS

All consumers co-operated to the fullest extent during the difficult dry weather period, and good relations persisted throughout the year.

## DESIGN AND PROJECT PLANNING

### (*a*) Hydraulic Section

*Karapiro.*—All design details were completed during the year and all operating mechanism tested and proved effective.

Checking of ground-water levels for change in the vicinity of the dam, with special reference to the valley of the Karapiro Stream, continued. In May, 1947, after two months, stability has not yet been reached, but there are no untoward developments.

*Maraetai.*—The schematic and functional designs have all been worked out and co-ordinated. Structural designs are in hand, including river diversion, dam, spillway, penstocks, and the intake and spillway gates.

*Whakamaru.*—Studies were continued of the very complex area with a view to determining the most favourable layout.

The Lands Department has commenced land-development in this area with a view to the supply of fresh foods to the workers in the Mangakino Town and associated communities.

*Waikaremoana.*—Except for a few minor details, most of the upper development design is complete and attention has been given to the last stage—sealing the leaks in the lake margin.

*Cobb River.*—Investigations were continued with the collaboration of the Geological Survey. The site and form of a dam have now been decided on and preparations are being made for construction.

*Clarence Valley.*—Valuable assistance has been given by the Lands and Survey Department in preparing contour plans from aerial surveys, and these are being co-ordinated with the field-work so that a scheme or schemes of development may be outlined.

*Tekapo.*—Much has been done on the intake gates and on the surge chamber and penstocks.

*Pukaki.*—The greatest need in the South Island system at the present time is to store water for further use at Waitaki. To meet this, plans were prepared to build a dam and regulating-sluices that would enable Lake Pukaki to be filled and held 30 ft. above its normal level. Special arrangements were made to build the dam, and good progress was obtained. A small amount of storage was obtained for this water, and it is hoped that the work will be far enough advanced to make a much larger quantity available for the winter of 1948.

*Clutha River.*—The site above Roxburgh was examined by bores, shafts, and drives. A start was made to prove by drive under the river the continuity of the rock structure, all findings being examined by a geologist.

*Waitaki River* (*Black Jack's Point*).—Surveys of this area, including the lake that will be formed, are about complete. It has not been possible to do any foundation testing at this site.

*Hydrology.*—Records have been kept and special studies made in connection with the North and South Island systems.

### (*b*) Structural Section

The design of the Maraetai Power-station is well in hand. The building which will contain five main units each 40,000 kVA. and two auxiliary units each 750 kVA., will be 320 ft. long, 90 ft. wide, and 110 ft. high from draught tubes to parapet. The floor area at generator-floor level, including the workshop annex, is approximately 29,000 square feet and provides for a control-room and general offices in connection with the administration of the station.

Three overhead travelling cranes, two of 100 tons and one of 50 tons lifting-capacity, are to be installed. At the rear of the building and over the five 16-ft.-diameter penstocks a large concrete platform has been planned to accommodate the transformer banks, circuit-breakers, and switches, also to provide facilities for transversing transformers to the workshop. Provision is being made on the roof for a bus-bar and air-break switching system and for a tall steel structure to support the outgoing lines to the outdoor station. Plans for a lift shaft, penthouse, and adits have been completed. This lift is being made to take up to twenty workmen and light materials from the top of the gorge to the access road, a drop of 193 ft., which saves one mile travel by road, and it will be a permanent installation. Combined with this is a cable shaft for control cables from the power-house to the outdoor station.

Detailed design of the Tekapo Power-house neared completion as manufacturers' details came to hand, but the final foundation details will be done after excavation of the site.

To install additional larger generating-units at Cobb requires an enlarged power-house twice the length of the present inadequate timber structure and of increased span and height with a travelling crane running the full length. Preliminary sketch plans were prepared to enable tenders to be called for machinery, and, working on estimated clearances, design proceeded on the structural frame.

Plans for drainage and roading at Bunnythorpe 220 kV. substation were prepared in addition to plans and specification for the synchronous-condenser building and main control block, whilst a contract was let for ten cottages forming the initial housing units of the proposed village for the operating staff.

Plans and specification were completed for switch-rooms at eight substations and for extensions to the load despatch office at Hamilton.

Designs and drawings were completed and specifications prepared for a traverser track and turntable for Maraetai and Bunnythorpe to take 60-ton and 80-ton transformers respectively as well as a traverser track for Otahuhu to take 80-ton auto-transformers.

Plans were prepared for additional married accommodation at practically all stations as a result of increased staff. Various proposals for increase of Head Office staff accommodation were also prepared.

### (*c*) Electrical Section

*Power-stations.*—The main design work for Maraetai included the layout of 220 kV. equipment and arrangement of cables. Tenders for control and protective equipment and 400 v. switchgear were analysed, and orders placed. Preliminary work was done on the power and lighting installation for Maraetai, whereas this design work for Tekapo is virtually complete.

Specifications were drafted for two 14,000 b.h.p. turbines, two 10,000 kW. generators, and two 11,000 kVA. transformer banks for Cobb, whilst specifications are being prepared for the control equipment and 66 kV. structure. Inquiries were dealt with as erection work proceeded at Karapiro. Kaitawa design work was completed and drawings issued. A report was prepared on the acceptance tests for Highbank Station, work was done on Whakamaru Switching-station and Waitaki No. 5 unit, and minor matters concerning most other power-stations.

General matters included a survey of existing power and lighting fittings with the object of standardization in future, a survey of the life of various types of station batteries, an inventory of equipment in test laboratories, and drafting specifications for sine-wave sets and standardized laboratory equipment.

*Substations.*—Detailed design and layout drawings were well advanced for the 220 kV. substations at Otahuhu and Bunnythorpe, specification drawings being prepared for steel structures, insulators, hardware, 11 kV. switchgear, and miscellaneous equipment. Preliminary layout and structure drawings were prepared for the proposed 220 kV. substation at Haywards, and preliminary investigations made for a 220 kV. substation at Islington.

To provide distribution facilities for increasing quantities of power, new substations are being planned at Dargaville, New Plymouth, Waverley, Longburn, Fernhill, Reefton, Papanui, and Studholme, and specifications covering transformers, switchgear, and associated equipment for these were prepared. Additional transformer capacity was also planned at Maungatapere, Henderson, Takapuna, Bombay, Ongarue, New Plymouth, Stratford, Wanganui, Stoke, Ashburton, Oamaru, Half-way Bush, and Invercargill, and this required the design and specification of the necessary switchgear and steelwork. The re-design of the Maungatapere Substation on a new site was necessary to provide the switchgear required at the termination of the new 110 kV. Henderson–Maungatapere line.

Switchgear alterations and additions were also designed for Edgecumbe, Lichfield, Te Awamutu, Upper Takaka, Temuka, Gore, and Edendale.

A specification for a voltage-regulating transformer was prepared for Blenheim Substation. To facilitate the control of the transmission system, specifications were prepared and tenders called for a second 15,000 kVA. synchronous condenser for Hororata.

The ratings of existing oil circuit-breakers were investigated in view of the increased capacity of the transmission system and new equipment specified as found necessary.

Designs for new equipment or designs of new substations included in this report affect thirty-two substations.

*Communications.*—Basic design work proceeded on system communications, and installations were made in substations and power-stations. Carrier-current-telephone equipment which came to hand is being installed, and further installations in the North and South Islands have been planned. Investigations are being made into the use of mobile radio services, and orders were placed for equipment for an emergency radio network in the South Island.

*Protection.*—Detailed short-circuit calculations were undertaken to determine probable future circuit-breaker duties and current distributions for the following conditions :—

(*a*) North Island—

(1) With Maraetai and Whakamaru Power-stations complete—*i.e.* approximately 600,000 kVA. in the Waikato development.

(2) With Waikato development complete—*i.e.*, approximately 850,000 kVA.

(*b*) South Island—

(1) With Coal Creek Power-station partly complete, 166,000 kVA. and 220 kV. transmission-line, Coal Creek–Christchurch, complete.

(2) With Coal Creek Power-station completed, 333,000 kVA. and Lake Rotoiti development partly complete, 33,000 kVA.

Other calculation work included solution of inductive interference and miscellaneous switchgear problems.

Specifications and drawings were prepared for carrier-current and pilot-wire protective relay equipment for the Otahuhu–Whakamaru–Maraetai–Bunnythorpe 220 kV. and the Otahuhu–Penrose 110 kV. transmission-lines.

Analyses were made of system interruptions.

### (*d*) Transmission-lines

Contracts were placed for towers, insulators, and conductors for the 220 kV. lines Whakamaru–Otahuhu and Whakamaru–Bunnythorpe. Due to delays in the supply of machines and galvanizing-plant the New Zealand contractors for the supply of towers were not able to commence production.

Specifications were drawn for the insulators and conductors for the above-mentioned 220 kV. lines and for towers, insulators, and conductors for the Henderson–Maungatapere line.

Conductor tensions for the 110 kV. line Henderson–Maungatapere were investigated and stringing charts prepared. Strength charts for the towers and charts for the control of the swing of suspension insulators were prepared and supplied to field parties.

Outline drawings were made of the towers for the Nelson–West Coast line and a start made on the drawings of the specification for their supply. An aerial inspection was made of this line to determine the sections which should be built in steel towers and those which should be built in wood poles.

Investigations were made into the types of structures to be installed to carry six 66 kV. circuits from the proposed new substation at Islington, Christchurch, four circuits to the proposed substation at Papanui, and two to North Canterbury.

## REGULATIONS, LINES INSPECTION, ETC.

The King-country Electric-power Board commenced trading operations and the erection of its electric lines. The Manunui Town Board and part of the area of supply of the Taumarunui Borough Council will now be in the King-country electric-power district.

Four licences were issued to erect electric lines (2 to private persons, and 2 to Electric-power Boards for electric lines in extended areas of supply).

Seven licences were issued to use water-power for the purpose of generating electricity (6 to private persons and 1 to an Electric-power Board).

Four electric lines licences (private persons) were revoked.

One permit was issued to use water-power for the purpose of generating electricity, and 1 permit was revoked (both with respect to private persons).

Seven assignments of licences to use water-power for the purpose of generating electricity were effected (private persons).

One hundred and fourteen permits to carry out electrical-wiring work in connection with private generating-plants were issued.

The electric lines and works of 37 Electrical Supply Authorities were inspected.

Sixty-two Electrical Supply Authorities gave notice of their intention to make extensions to their electric lines. The total number of extensions notified was 621.

There were 5,345 broken wires reported and 401 broken poles reported by Authorities. The principal causes of the wires being broken were: trees 2,167 (40·5 per cent.); contact, 1,716 (32 per cent.); gale, 456 (8·5 per cent.); binder failure, 132 (2·5 per cent.); pole hit by vehicle, 107 (2 per cent.).

The following table shows the number of electrical accidents reported for the year under review compared with the previous year:—

| — | Year ended 31st March, 1947. | | | Year ended 31st March, 1946. | | |
|---|---|---|---|---|---|---|
| | Fatal. | Non-fatal. | Total. | Fatal. | Non-fatal. | Total. |
| Child (up to seven years inclusive) .. | 2 | 3 | 5 | .. | 1 | 1 |
| Commercial shops, offices, &c. .. .. | .. | .. | .. | .. | 2 | 2 |
| Domestic (hotels, boardinghouses, &c.) .. | 1 | 3 | 4 | .. | 1 | 1 |
| Electrical lineman .. .. .. | 1 | 5 | 6 | 2 | 8 | 10 |
| Electrical worker (other than lineman) .. | 2 | 4 | 6 | 1 | 6 | 7 |
| Fireman .. .. .. .. | .. | .. | .. | .. | .. | .. |
| General public .. .. .. | 4 | 3 | 7 | .. | 3 | 3 |
| Industrial (factories, workshops, &c.) .. | .. | 1 | 1 | 1 | .. | 1 |
| Other trades .. .. .. .. | 2 | 5 | 7 | 1 | 2 | 3 |
| Other workers .. .. .. | 2 | .. | 2 | .. | 1 | 1 |
| Painter .. .. .. .. | .. | .. | .. | 1 | .. | 1 |
| Plumber .. .. .. .. | .. | .. | .. | .. | .. | .. |
| Suicide .. .. .. .. | .. | .. | .. | .. | .. | .. |
| Telephone lineman .. .. .. | 2 | 2 | 4 | .. | .. | .. |
| Welder .. .. .. .. | .. | .. | .. | .. | .. | .. |
| Young person (over seven but not over fifteen years) | .. | 1 | 1 | .. | 3 | 3 |
| Total .. .. .. | 16 | 27 | 43 | 6 | 27 | 33 |
| Mechanical (fall from pole, &c.) .. .. | .. | .. | .. | .. | 5 | 5 |
| Stock .. .. .. .. | 23 | .. | 23 | 43 | .. | 43 |

The following table shows the number of electrical fires reported for the year under review compared with the previous year :—

| — | Year ended 31st March, 1947. | Year ended 31st March, 1946. |
|---|---|---|
| Accessories | .. | .. |
| Appliances (electric sign and welding-set) | 2 | 1 |
| Contact between aerial conductors | .. | 1 |
| Contact between steel conduit and composition gas-pipe | 3 | 3 |
| Defective fuse contact | .. | 1 |
| Fittings | .. | .. |
| Fixed wiring (sub mains and sub circuits) | .. | .. |
| Flexible cables and cords (under lift) | 1 | .. |
| Improper use of appliances (irons, radiators, ovens, and urns left switched on) | 5 | 2 |
| Lightning | .. | 1 |
| Rodents | 2 | .. |
| Service mains | 3 | .. |
| Substations | 2 | .. |
| Switchboards (wiring behind and accessories on) | 9 | 8 |
| Total | 27 | 17 |

## REGISTRATION OF ELECTRICAL WIREMEN

Examinations were held for electrical wiremen, electrical servicemen, radio servicemen, radio experimenters, cinematograph operators, and luminous-discharge-tube installers.

A large number of candidates sat the regular wiremen's and servicemen's examinations in New Zealand during the year, 1,331 candidates sitting the September, 1946, examinations, and 1,098 candidates the March, 1947, examinations, a grand total of 2,429 candidates. Of this number 1,422 sat the wiremen's examinations—*i.e.*, 843 the written part and 579 the practical part. The September, 1946, examination constitutes a record number of candidates for all time.

A steady flow of applicants desiring an assessment of credit for rehabilitation trade-training purposes continues to occupy the time of the Registration Board, and credits have been assessed for both full and limited registration.

During the year the Registration Board finalized its deliberations on the proposed amendments to the Electrical Wiremen's Registration Act.

Seventeen provisional licences were issued during the year, the majority of which represent new arrivals to this country from Great Britain and Australia.

## PERSONNEL

At the 31st March, 1947, a total of 4,269 employees were engaged on hydro-electric works. Of these, 2,100 were directly employed by this Department and the remaining 2,169 were on construction under the immediate control of the Public Works Department.

The total under the control of this Department comprised 1,475 on operation and maintenance and 625 on construction.

It is with regret that I report the absence of Mr. R. G. MacGibbon, District Electrical Engineer, Christchurch, who has been on sick-leave since the 30th September, 1946.

I record my appreciation of the efforts of all staff and workmen throughout the year. The year 1947 has brought its share of new problems and difficulties, but the burden of these additional worries has been cheerfully borne by operating, administrative, and construction staff alike.

I have, &c.,
F. T. M. Kissel, B.Sc., M.I.E.E., A.M.I.C.E.,
General Manager.

## APPENDIX B.—ANNUAL REPORT OF THE RURAL ELECTRICAL RETICULATION COUNCIL FOR THE YEAR ENDED 31st MARCH, 1947

The CHAIRMAN to the Honourable MINISTER IN CHARGE

Wellington, 29th May, 1947.

SIR,—

In accordance with the requirements of section 21 of the Electricity Act, 1945, the Rural Electrical Reticulation Council has the honour to submit its first annual report for presentation to Parliament. The report covers the period from 1st April, 1946, to 31st March, 1947.

### GENERAL

The Council was set up under the Act to assist in making available a public supply of electricity in the more sparsely settled parts of the Dominion where, under ordinary electric-supply conditions, the guarantees of revenue required from electricity consumers would be too high for them to meet. The Act requires all Electric Supply Authorities to contribute to a central fund each year a levy of 5s. per cent. on sales of electrical energy, and from this fund the Council may approve grants to make up any deficiency between revenue and annual costs on approved rural line extensions.

On the inception of the rural subsidy scheme it was known in a general way that about 3 per cent. of the population of New Zealand were outside the reach of power-lines, but the exact number and where they were located was not known. It is usual to require prospective consumers in rural areas to enter into guarantees of the minimum revenue that would be paid for a supply of power, and for these guarantees to be expressed as a percentage of the capital costs of the line extensions. Line-construction costs vary considerably between the various Supply Authorities, however, and as the amount of the subsidies would vary with capital costs it was apparent that some figure for maximum capital cost per mile of line would have to be determined for the purpose of computing subsidies on a uniform and equitable basis.

Following its first meeting in May the Council asked each Supply Authority to supply maps showing the location and numbers of all prospective consumers and the miles of lines which would have to be built. This information has not yet been supplied by all Authorities, but it is possible to say that probably some three to four thousand miles of new line giving supply to some five thousand consumers will come within the scope of the subsidy scheme. Each Authority was also asked to supply details of the cost of new lines. From the information supplied, and after having discussed the matter with the Electric-power Boards and Supply Authorities' Association, the Council standardized the cost of power lines, for the purpose of computing subsidies, at £350 a route mile single-phase and £450 a mile three-phase, although it remains open to individual Supply Authorities to make representations for somewhat higher costs in special cases.

A number of Power Boards have advised the Council of their intention to complete the reticulation of their rural areas and meet any deficiencies between cost and revenue out of their own funds. In the opinion of the Council the general financial position of some other Boards would allow the adoption of a similar policy. The Council has therefore decided that, particularly in the initial stages of the subsidy scheme, it would have regard to the financial position of a Supply Authority submitting applications for subsidies.

Proposed line extensions are based upon estimates of capital cost and revenue, and subsidies approved in the first instance are therefore provisional only. No payment of a subsidy can be made until after the line has been built and operated for one year and the costs and revenues accurately ascertained.

## APPLICATIONS FOR SUBSIDIES

Applications for subsidies were invited by the Council in September, 1946, and the Supply Authorities were asked to forward only those proposed line extensions which would be at least substantially started in the ensuing year. No good purpose would be served by the Council allocating some of its funds on work which would not be started for more than a year. Applications closed in December, and altogether 132 were received from 27 Electric Supply Authorities. Details of these are given in Table I. Of the applications received, 90 have so far been approved for subsidies covering the building of 603 miles of line to which will be connected 992 new consumers. The estimated capital cost of this work is £292,469. The density of consumers in the areas to be reticulated is about only 3 consumers to every 2 miles of line. The subsidies provisionally allowed are 4·2 per cent. of the estimated capital cost, which figure is within the $7\frac{1}{2}$ per cent. maximum allowed under the Electricity Act.

TABLE I.—RURAL ELECTRICAL RETICULATION COUNCIL: SUMMARY OF APPLICATIONS RECEIVED AS AT 31ST MARCH, 1947

*Approved*

| Supply Authority. | Number of Applications. | Route Miles. | Number of Consumers. | Estimated Capital Cost. | Provisional Subsidy, per Annum. |
|---|---|---|---|---|---|
| | | | | £ | £ |
| Ashburton Electric-power Board .. | 22 | 51 | 69 | 14,195 | 857 |
| Central Hawke's Bay Electric-power Board | 4 | 52 | 65 | 24,944 | 1,046 |
| Central Waikato Electric-power Board .. | 2 | 11 | 15 | 5,453 | 153 |
| Dannevirke Electric-power Board .. | 11 | 18 | 31 | 11,010 | 274 |
| Franklin Electric-power Board .. | 5 | 22 | 21 | 8,075 | 427 |
| Golden Bay Electric-power Board .. | 1 | 12 | 27 | 7,000 | 280 |
| King-country Electric-power Board .. | 2 | 106 | 178 | 38,953 | 2,058 |
| Manawatu-Oroua Electric-power Board .. | 2 | 14 | 22 | 8,080 | 150 |
| North Auckland Electric-power Board .. | 6 | 24 | 64 | 11,087 | 495 |
| North Canterbury Electric-power Board | 4 | 25 | 28 | 7,586 | 474 |
| Poverty Bay Electric-power Board .. | 1 | 77 | 67 | 46,500 | 2,081 |
| Springs-Ellesmere Electric-power Board | 3 | 4 | 4 | 1,828 | 115 |
| South Canterbury Electric-power Board | 1 | 4 | 5 | 1,593 | 40 |
| Southland Electric-power Supply .. | 3 | 20 | 37 | 7,240 | 530 |
| Tararua Electric-power Board .. .. | 2 | 16 | 26 | 8,328 | 336 |
| Tauranga Electric-power Board .. | 8 | 19 | 55 | 9,373 | 210 |
| Waimea Electric-power Board .. .. | 1 | 39 | 163 | 29,891 | 598 |
| Wairarapa Electric-power Board .. | 1 | 66 | 82 | 39,776 | 1,750 |
| Wairoa Electric-power Board .. .. | 1 | 10 | 8 | 6,352 | 254 |
| Waitaki Electric-power Board .. .. | 9 | 7 | 11 | 2,805 | 202 |
| Waitomo Electric-power Board .. | 1 | 6 | 14 | 2,400 | 48 |

*Referred back for Amplification*

The applications of 4 Supply Authorities were referred back for additional details to be supplied.

*Deferred*

The applications of 3 Supply Authorities were deferred.

TABLE II.—RURAL RETICULATION FUND AS AT 31ST MARCH, 1947

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| Receipts from annual levy .. .. .. .. | 23,171 | 3 | 2 | | | |
| Interest on investments .. .. .. .. | 262 | 4 | 3 | | | |
| | | | | 23,433 | 7 | 5 |
| Administration costs and expenses .. .. .. .. | | | | 34 | 10 | 10 |
| Cash balance .. .. .. .. .. .. | | | | 23,398 | 16 | 7 |
| Sundry creditor—Electric Supply Account: Administration costs and expenses .. .. .. .. .. .. .. | | | | 100 | 0 | 0 |
| Net balance in Fund, 1st April, 1947 .. .. .. | | | | £23,298 | 16 | 7 |

I have, &c.,
F. T. M. KISSEL, B.Sc., M.I.E.E., A.M.I.C.E.,
Chairman.

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