

1921

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Dec 13 1921

COLONIAL

DATE
DECEMBER 1921

REGULATION

SUBJECT

WIRELESS TELEGRAPHY COMMISSION

Copy of Report to Cabinet.

- M. Grindle
- S. H. Lambert
- S. H. Read
- V. Masterton Smith.
- H. Wood
- M. Churchill

Previous Paper

MINUTES

no
61940

Br. Fooks (Chairman of the C^o) is
 revising the and adding a
 "preamble" explaining it. No
 action needed till a complete copy
 (in print) is available

JH 16/12/21 at once

Subsequent Paper

CO/225 2/22

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REC-13 DEC 21

GENERAL POST OFFICE.

IMPERIAL WIRELESS CO-ORDINATING COMMITTEE.

C R E T

C.C.No.3.

The following copy of The Wireless Telegraphy Commission's Report to the Cabinet, dated 5th December 1921, is circulated for information.

The blue prints referred to in the Report are not yet available.

The Report has not yet been considered by the Cabinet.

(Sgd.) C.G. Crawley,
Secretary.

9th December, 1921.

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REPORT.

To the Cabinet.

1. On the 23rd December 1920 the Wireless Telegraphy Commission was summoned under the following letter of appointment:-

The Cabinet have decided to appoint a Wireless Telegraphy Commission as follows:-

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(Chairman)

W.H. Eccles Esq. D.Sc. F.R.S. (Vice-Chairman)

L.B. Turner Esq. M.A., M.I.E.E.

E.H. Shughnessy Esq. O.B.E., M.I.E.E.

Lieut-Colonel C.G. Crawley, R.M.A., M.I.E.E.
Secretary.

with the following terms of reference:-

- (i) To decide upon the wireless plant most suitable for carrying out the scheme of Imperial Wireless Communications recommended by the Imperial Wireless Telegraphy Committee, bearing in mind the necessity for the co-ordination of the Chain with existing telegraph services, and to design the necessary stations.
- (ii) To make recommendations regarding the actual sites for the stations proposed by the Imperial Wireless Telegraphy Committee.
- (iii) To advise generally upon the preparation of specifications for machinery and apparatus, the making of contracts and the construction of the stations

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- (iii) To advise generally upon the preparation of specifications for machinery and apparatus, the making of contracts and the construction of the stations.

2. The Recommendations of the Imperial Wireless Telegraphy Committee 1919

- (1) That a scheme of Imperial Wireless Communications be established connecting the communities of the Empire by geographical steps of about 2,000 miles each, as indicated on the accompanying map.
- (2) That the wireless system employed be that involving the generation of radiotelegraphic energy by thermionic valves.
- (3) That the service of communication between Leafield and Cairo by Poulsen arcs, shortly to be in operation by the Post Office, be the first link in the chain of communication with the British Communities in Africa, and that this communication be continued by a valve station near Nairobi, in East Africa, and by the alteration of the ex-German station at Windhuk to a valve station, to complete the connection with the Union of South Africa.
- (4) That for communication with India, the Far East, or Australia, valve stations be erected in England, near Cairo, at Poona (or other Indian station), at Singapore or Hong Kong, and in Australia at Port Darwin or Perth.
- (5) That similar communication be established by valve stations between England and Canada, subject to decision in conference between the Imperial and Canadian Governments.
- (6) That the stations be planned by a Wireless Commission of about four members, as herein described, whose functions would probably cease with the completion of the stations, and that the construction of the stations be entrusted to the Engineering Department of the General Post Office and the corresponding Dominion and Indian authorities, according to the plans furnished by the Wireless Commission.

3.

3. The first meeting of the Commission took place on the 3rd January 1921 and forty-six formal meetings have been held. In addition there have been meetings in Sub-Committee and visits of inspection to wireless stations at home and abroad.

4. As the thermionic stations projected by the Imperial Wireless Telegraphy Committee were of unprecedented magnitude and of a new type, nearly every item of the equipment of the wireless stations has had to be specially considered; this work will be described briefly under the headings Development of High Power Thermionic Sets, Choice of Wavelength, Transmitting Antennae, Masts and Towers, Earth Screens, Power Supply and Electrical Machinery, Emergency Receiving Gear and Operating Apparatus, Methods of Reception and Design of Receiving Stations, Sites and Buildings. All these factors are mutually dependent.

Development of High Power Thermionic Sets.

5. The Imperial Wireless Telegraphy Committee recommended that the thermionic transmitter should be capable of delivering at least 120 kilowatts to the antenna and indicated that double this power appeared to be within the bounds of possibility at an early date. The Commission have therefore made it their first duty to watch progress in these matters in all parts of the world. At home the work of the Admiralty is especially notable; at Signal School, Portsmouth, very large silica valves have been constructed and used. Every effort has been made by the Admiralty to hasten the establishment of an industry for the manufacture of these valves. At the present date the 24 kilowatt silica valves are being produced at the rate of about four or five per week.

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6. In order to equip a typical Chain Station with silica valves about 24 would be required to deliver 120 kilowatts to the aerial, not allowing for spares. The annual consumption of valves by such a set working 24 hours every day without cessation would be, according to our information, between 36 and 108 per station. A more precise estimate cannot be made because insufficient time has elapsed since the manufacture of these tubes began. Thus, on the basis of incessant operation eight Chain Stations would consume between 288 and 864 valves per annum. It may be concluded that the silica valve industry is only gradually approaching the condition of being able to cope with the possible demands of the Chain Stations over and above those of the Admiralty and other services.

7. If, on the other hand, glass valves be used instead of silica about four times as many would be needed for equipment and renewals; that is to say between 135 and 405 glass valves per annum would be required per station assuming incessant operation. In round numbers between 1,080 and 3,240 glass valves would probably be required per annum by the Chain Stations if all were to operate continuously. There is reason to believe that this demand could be met.

8. The most important aspect of this question is the cost of valve renewals. The glass valves cost at present when purchased in small quantities about £15 each. The above rates of renewal of glass valves may cost therefore between £2,025 and £6,075 per annum per station. The silica valves cost at present about £60 each and the expenditure upon renewals would therefore be between £2,160 and £6,480 per annum per station. It is claimed however that burnt filaments can be renewed in either glass or silica valves at small cost and that the above estimates of costs of renewal of silica valves can thus be materially reduced. These claims have not yet been tested practically by any large user. In all cases, it should be emphasized, estimates of the consumption of valves will be

profoundly

profoundly affected by the care taken in manufacture and by the absence or presence of skilled attention during use.

9. The above estimates of the cost of renewals relate to the method of operation in which high voltage direct current generators are employed. If alternating current were used the initial capital outlay on machinery would be greatly reduced but the cost of valve renewals would be increased by 50 per cent for the silica valves and by about 66 per cent for the glass valves. The estimates are based upon an average filament life of from 6,000 to 2,000 hours, which, though not yet demonstrated, can reasonably be expected to be achieved in the course of valve development.

10. Apart from the problem of manufacture of the valves the problem of assembling them as thoroughly practical telegraphic transmitters remains. The Commission is collaborating with the Admiralty upon this problem. A set of valves which is designed to utilise 67 kilowatts is now being erected at Signal School on the Commission's responsibility.

11. Besides the Admiralty the Marconi Company have in this country been very active in the development of large thermionic sets. They have established commercial traffic across the Atlantic by means of thermionic stations of less than 30 kilowatts input at Clifden, Ireland and at Glace Bay, Canada. In Central Europe the Telefunken Company have erected plants of about the same power at two stations. In the United States of America the development appears to have been confined principally to the laboratories, and the Commission have no information regarding commercial working of large thermionic stations.

12. On the 19th and 20th September of this year at the invitation of the Marconi Company the Commission visited the Carnarvon Station and took part in trials of the largest thermionic set yet constructed. It is an assemblage of 48 glass valves and is capable of working with an input of about

about 100 kilowatts. This is the largest set in existence and is approaching the order of magnitude laid down as desirable by the Imperial Wireless Telegraphy Committee. The set was overloaded at the trials until the input was about 150 kilowatts. The trials, which were of short duration, were very successful and included the transmission of messages across the Atlantic (of which receipt was acknowledged by wireless) and the transmission of messages to Australia and India during what are known to be the best hours of the day for reception in those parts of the globe. The receipt of the message to Australia was acknowledged next day by a cable from Melbourne. The engineers of the Marconi Company have spent much time and great ingenuity in the building up of this set and we are confident that on the lines they have followed they would now be able to erect a set fulfilling the minimum requirements laid down by the Imperial Wireless Telegraphy Committee.

Choice of Wavelength.

13. Into the problem of choice of wavelength two factors enter, the international and the physical. An opportunity of dealing with the former factor arose in May last when in accordance with a decision of the Washington Conference on Electrical Communications a meeting of the representatives of the Governments of the Allied and Associated Powers was summoned to Paris to discuss as a technical committee the allocation of wavelengths and related matters. The Imperial Communications Committee requested the Commission to hold preparatory discussions on these matters with Government Departments and with commercial companies. Nineteen meetings were held and a Report made to the Imperial Communications Committee from which the instructions for the British Delegation to Paris were drawn up. The Provisional Technical Committee met in June, July

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and August and Mr. Shaughnessy, one of the Commissioners, attended their meetings. This international aspect of the matter has been borne in mind by the Commission in the formulation of their recommendations.

14. The physical factors in the choice of wavelength have been closely studied both theoretically and experimentally and by means of accumulated records. Mr. Turner spent the month of September in Egypt observing the readability of pre-arranged signals dispatched from the Admiralty station at Horsea. For the purpose of these trials this station was equipped with a thermionic set of about 30 kilowatts input and it emitted according to programme a series of signals at various wavelengths at all hours of the day and night upon selected days. Mr. Turner has written a report upon this work which has been discussed by the Commission. The main conclusion is that for distances such as those in the links of the Imperial Chain the best signals are those obtained at night by the use of relatively short waves, while the best day signals are those using long waves. The month of the trials is one of the worst months of the year for atmospheric disturbances in Egypt.

Transmitting Antennae, Masts and Towers.

15. Perhaps the chief of the various considerations that enter into the choice of an antenna for a new type of transmitter may be expressed by saying that the choice lies between low antennae of great area on the one hand and high antennae of smaller area on the other. In cases where the generation of oscillatory energy is expected to be cheap and the supply abundant the former alternative may be taken, but in the case of thermionic oscillators where plant large enough for the task is being made with difficulty the high antennae of relatively small area is preferable. The preference is independent

supported

supported by a deeper study of the better wavemaking properties of high as compared with low antennae. From the nature of the thermionic oscillator, moreover, it can be shown that a symmetrical antenna is more suitable than an unsymmetrical one, whether a low or a high antenna is concerned.

16. The masts or towers used for supporting the antenna constitute the most costly item of a wireless station. Moreover unless properly designed they affect by their presence the emission of waves from the antenna and cause great loss of the oscillatory energy generated by the thermionic apparatus. The ideal mast or tower would be built of insulating material; wooden structures are an approximation to the ideal but are unsuitable for the tropics, at any rate. Steel structures on the other hand are conductors and cause considerable electrical loss as ordinarily erected. A great deal of this loss can be avoided and an approach to the ideal attained by making the mast or tower in sections with insulating portions and standing the mast on an insulating base. By varying the dimensions of the insulating portions a close approach to the ideal may be made. There are some mechanical difficulties in this mode of construction and the consideration of these details will fall within the purview of the constructing authorities, assisted by the Commission as necessary. They do not greatly affect the capital cost and may be regarded as subsidiary detail. The above remarks apply alike to self-supporting towers and to masts supported by guys, the guys also being supported by insulators in the latter case. The cost of masts is much less than that of towers.

Earth Screens.

17. The high frequency currents in an antenna are accompanied by similar currents in the earth under the antenna unless the earth is screened by a suitable grid of copper wires. Such earth currents cause great loss of electrical energy. In the case of the thermionic transmitter it is especially

especially necessary to reduce this loss and therefore the utilisation of efficient earth screens at all the Chain Stations is advised.

Power Supply and Electrical Machinery.

16. The electrical machinery needed for the supply of energy to a large thermionic set presents no difficulty and need not be discussed here.

Emergency Receiving Gear and Operating Apparatus.

19. In the event of breakdown or interruption of the telegraph lines connecting the transmitting and receiving centres of a duplex station the whole traffic must be conducted by simplex operation from the transmitting station. It is therefore necessary to instal at each transmitting station an emergency set of receiving gear and operating apparatus.

Methods of Reception and Design of Receiving Stations.

20. The Commission have scrutinised all the modern literature and have individually or collectively interviewed experts of this and other countries and have visited receiving stations at home and abroad. A number of alternative types of apparatus and several types of receiving antennae were tested in Egypt during September of this year and the months following. The signals from Horsea and Leafield and other European stations were utilised in Egypt. For these trials the War Office constructed specially a complete set of apparatus comprising improvements on that already in operation in the Aldershot-Cologne military service, and then lent to the Commission the services of an expert officer who has spent more than two months in Egypt with this and other apparatus studying the reception of long distance signals in that difficult climate. A complete set of apparatus of new type was also supplied by the Post Office for the purpose of these trials and one of their engineers is at the present moment in Egypt continuing the work.

21. On the 19th November the Commission visited the transatlantic receiving station of the Marconi Company situated

situated at Town and saw a demonstration of Mr. Franklin's double directional antenna. The atmospheric disturbances in this country in November are, however, not comparable with those in Egypt during the hot weather and therefore the demonstration proves nothing as regards the performance of this apparatus under the tropical conditions of many of the Chain Stations. An examination of the apparatus tends to confirm the opinion that it was no anti-atmospheric merits other than those possessed by various forms of directive apparatus.

22. The Imperial Wireless Telegraphy Committee recommended that each station of the Chain should be one-way duplex, but it would seem that better use of the plant could be made if each station were provided with as many receiving posts as there are stations with which it will communicate; and, further, that each of the Egyptian stations shall be assumed to communicate with both East Africa and India. Such an arrangement is quite feasible and offers the following advantages:-

(1) Until the routes are fully loaded it allows of improved working during periods when the flow of traffic in one direction is greater than in the other direction.

(2) During periods when bad atmospheric conditions prevail at one station and not at the adjacent stations the one station can be sending to either of the others, and when the good reception period at the one station comes the time lost can to some extent be made up by receiving from all adjacent stations at once.

23. For economy of staffing and for traffic reasons, it is highly desirable that all the receiving posts of one station shall be situated together. At each of the intermediate stations, therefore, (Egypt, East Africa, India, Singapore), the receiving posts should be grouped together at one spot, distant 20 to 40 miles from the transmitting station. In Egypt, East

Africa and India, where the routes diverge through much less than a right angle, the line joining the transmitting site to the receiving site should be approximately perpendicular to the average direction of the signalling routes at the station; but at Singapore, where the branch to Hong Kong is nearly perpendicular to the average India-Singapore-Australia route, the receiving site should be situated approximately on the line joining Singapore to Hong Kong. In South Africa and Hong Kong the receiving site should preferably be situated 20 to 40 miles from the transmitting site approximately on the signalling route. In England the receiving post of the new station should preferably be placed with the existing receiving post at Banbury. In general the receiving site should be chosen so as to comprise a central plot 250 yards by 50 yards for the operating building and two other plots each 220 yards square suitable for containing a mast 300 feet high, about 550 yards from the central plot and on opposite sides of it. The general direction of the three plots should lie along the average direction of the signalling route.

24. Experience recently gained in England and Egypt has shown that atmospheric interference may be markedly reduced by each of three distinct methods, which may be referred to as:-

- (a) Atmospheric balancing
- (b) Limiting
- (c) Barraging.

Designs are in progress for applying all these simultaneously in Egypt. If the benefits obtainable justify the expenditure the other stations of the Chain can be similarly equipped in due course.

Sites.

25. The Admiralty have lent to the Commission the services of two officers who are now in Egypt on their way to East Africa and to South Africa taking with them apparatus for making a radio telegraphic

telegraphic survey and instructed as to the other requirements the sites must fulfil and the data to be collected. They will probably visit Singapore and Hong Kong. At the invitation of the Indian Government an engineer from the Post Office will visit India in connection with receiving tests organised by the Indian Government and will place his services at the disposal of that Government in respect of the choice of a site if desired.

26. It should be remarked that a considerable amount of information regarding possible sites in East Africa, Singapore and Hong Kong has been collected by previous expeditions in connection with the old Imperial Chain proposals and has been placed in the hands of the Commission.

27. The Imperial Wireless Telegraphy Committee recommended (1920) the use of the ex-German Windhuk station as the South African terminal station of the Chain, being under the impression that Windhuk was adequately connected by land lines with the political and commercial centres of the Union. Later information put before the Commission by representatives of the Union Government have shown that new land lines would be required and that the maintenance of these lines would be costly. Under these circumstances the Commission, at the request of the representatives of the Government of the Union of South Africa attending the Imperial Conference, drew up a memorandum upon the possibility of erecting an entirely new station near Johannesburg as the terminal station of the African Chain. The capital outlay would be greater than that needed for the adaptation of Windhuk but the cost of maintenance would be less, much retransmission of messages would be avoided, and better conditions for the staff could be provided. A radiotelegraphic survey of the region by aid of portable receiving apparatus will decide whether Johannesburg is sufficiently free from atmospheric electrical disturbance to be a suitable site.

Buildings.

26. The advantages of a symmetrical antenna have been referred to in paragraph 15. In order to ensure symmetry the buildings for housing the transmitting plant should be placed at the centre of the transmitting site. In general there will be a boiler house, an engine room and a high frequency room, together with workshops and an emergency operating room; but when power can be drawn from an outside supply the boiler house is not required. In view of the recommendations of the Imperial Wireless Telegraphy Committee it is important to plan the buildings in such a way that the boiler house, engine room and high frequency room can each be extended easily. The form adopted in this Report is a very economical one; it consists of two or three equal bays, as the case may be, in parallel formation with panelled ends, each lighted from the roof which may be of saw tooth type. The buildings may be oriented in any direction appropriate to the locality. The dimensions shown on the appended blue prints of the English station must be altered to suit the climatic conditions of each country.

The buildings for housing the receiving apparatus call for no special remark. They should follow generally the lines indicated on the blue prints of the English receiving buildings, but should be altered in dimensions to suit local conditions and to provide for the recommended number of route circuits.

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GENERAL RECOMMENDATIONS.

The Commission recommends that

(1) The Transmitting Stations in England, Canada, Australia, the Union of South Africa, India and Egypt be equipped with thermionic valve plant in the manner described in detail below. But in view of the amount of skilled attention demanded by this plant in its present stage of development and having regard to the isolated nature of the stations in East Africa, Singapore and Hong Kong, these three stations should be equipped for combined arc-valve transmission; the arcs alone should be installed immediately and the thermionic valve plant should be added after practice has become standardised.

(2) Each Transmitting Station should be capable of working with either of two wavelengths as may be appropriate to the time of day and the atmospheric conditions.

(3) Each Receiving Centre should be provided with antennas and apparatus sufficient for working simultaneously with the other stations normally communicating with it and all the receiving and operating apparatus should be in one and the same building.

DETAILED TECHNICAL RECOMMENDATIONS.ENGACTransmitting Station

(4) Masts.

The masts should be of steel each 250 metres high guyed three ways with six concrete anchorages, both masts and guys insulated in sections, and designed to take a horizontal pull of 10 tons at the top and a wind load of 60lb. per square foot with a factor of safety of 3. Four masts should be erected, one at each corner of a square not exceeding 400 metres side.

15.

The site should allow of extension of the antenna by the addition of two masts at each end, and the whole area available should therefore be about one mile by half a mile.

(5) Antenna.

The antenna should be designed so as to reduce corona to a minimum and should be especially highly insulated. Its electrical capacity should be about one fortieth of a microfarad.

(6) Earth Screen.

The earth screen should be a series of copper wires radiating from the centre of the site to its edges and supported at not less than eight feet from the ground by insulators.

(7) Antenna Tuning Coil.

The tuning coil should be designed for an antenna current of 500 amperes provided with tappings for tuning the antenna to wavelengths between 3,000 metres and 16,000 metres. The high frequency resistance of the part in use should not exceed one-third of an ohm at the corresponding frequency.

(8) Thermionic Valve Set, provided in duplicate.

A thermionic valve set capable of delivering at least 120 kilowatts of high frequency power to the antenna, with the necessary connections to the antenna coil, with control gear and protective devices in the anode and filament circuits, with grid leaks and condensers, relay and hand keys, air piping for valves and keys, compressor and instruments, all connected up. The set should be capable of sub-division in stages so that a convenient fraction of the total power may be taken to the antenna at will. It should also be capable of extension until 240 kilowatts can be delivered to the antenna. Current may be supplied either from high voltage D.C. machines (10,000 - 12,000 volts) or by rectifying alternating current; tenders will show which is preferable from the point of view of economy.

The set should be guaranteed with respect to constancy of wavelength, purity of wave, overall efficiency at each wavelength and average cost of renewals. It must be capable of transmitting continuously at hand speed and at 90 words per minute at full power for reception at 2,500 miles.

It is suggested that the Marconi Company be invited to tender for the apparatus recommended under the headings Earth Screen, Antenna Tuning Coil and Thermionic Valve Set. If their quotation should not be acceptable thermionic plant etc. could be designed by the Commission after the conclusion of the work now being undertaken at Horsea, erected in England, tested and proved designs recommended to the Dominions and to India.

(9) Power Supply and Electrical Machinery.

For the generation of the electrical power supply water tube boilers burning oil or coal should be used. The requirements are:-

three water tube boilers each evaporating 7,000 lb or two each evaporating 10,000 lb. of water per hour with superheaters and economisers, pipe work, water softeners, feed pump together with condensers and cooling plant.

* two 250 kilowatt turbo alternators three phase 50 cycles 3,000 volts between phases.

* two 250 kilowatt three phase transformers giving 15,000 volts.

two turbines each driving one 50 kilowatt D.C. machine 220 volts and one 30 kilowatt D.C. machine 20 volts.

High and low tension switch gear.

The alternative mentioned in Recommendation (8) would

require

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D.C. machine 220 volts and one 30 kilowatt

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High and low tension switch gear.

The alternative mentioned in Recommendation No. 1

require

require the substitution of the following two items for the three items marked with an asterisk:-

Two 200 kilowatt steam driven sets giving
10,000 to 12,000 volts D.C.

Two 20 kilowatt sets giving 20 volts
D.C.

Later extensions would be one boiler, one turbo alternator (or one 200 kilowatt 10,000 - 12,000 volts D.C. set) one transformer, one D.C. turbo generator 50 K.W. D.C. one set 20 kilowatts, 20 volts D.C. switch gear etc.

(10) Buildings.

The Transmitting Station buildings should be at the centre of the site. They comprise the sections mentioned in Para. 28. A travelling crane is required in the boiler house and the engine room. Blue prints showing the dimensions are appended.

(11) Emergency Receiving Gear and Operating Apparatus.

The emergency arrangements should comprise a small aerial, a receiving set of the Post Office pattern, perforators, automatic transmitters and recording apparatus.

Receiving Station for Duxley.

(12) The Receiving Station should be situated at Banbury and provided with two sets of apparatus similar to that being installed at Banbury for the Leaffield - Abu Zabal link of the Chain but supplemented by limiting apparatus. Details appear in Para. 23. As soon as Canada enters the Chain scheme an additional aerial system and set of receiving apparatus will be needed.

Telegraph lines in duplicate connecting Banbury to the Transmitting Station will be required.

CANADA.

(13) Should the Canadian Government decide to have stations
at

at Montreal and Vancouver the former could maintain a good service with the station in England and the latter would be able to communicate during part of the day with England and with Australia. Both stations might be as described in Recommendations (4) to (12). The Commission would be happy to confer on technical details with the Canadian authorities. A conference should be convened at an early date.

AUSTRALIA.

(14) The Transmitting Station should be as described in Recommendations (4) to (11), unless an ample public supply of electricity is available. In this latter event the Transmitting Station might be similar to that described in Recommendation (15).

(15) The Receiving Station should have one receiving aerial and two sets of receiving apparatus. The site required and the buildings are as indicated in paragraph 23 and the appended blue prints. When a station is built in Vancouver additional receiving equipment will be required. Apart from this additional receiving equipment will be necessary if the Chain station is required to work across the Continent of Australia. The aerial for each Receiving-Station consists of a pair of horizontal wires each about 250 feet long supported upon two 75 feet poles.

A 12 kilowatt D.C. supply (Public or oil engine) will be required for lighting, charging batteries, and running telegraphic apparatus.

Telegraphic lines in duplicate connecting the Transmitting Station to the Receiving Station will be required.

The Commission have been informed that the Australian Government prefer to have the Chain station situated at Perth rather than at Port Darwin.

SOUTH AFRICA.Transmitting Station

(16). If the Transmitting Station is placed near Johannesburg the masts, the antenna, the earth screen, the tuning coil, the thermionic valve set and the emergency gear should be as described in Recommendations (4) to (8) and (11). The power supply and electric machinery should be

- * two 250 kilowatt three phase transformers
15,000 volts
- * two 30 kilowatt three phase transformers
20 volts.
- two 10 kilowatt lighting transformers 220
volts.
- two transformers supplying two 40 kilowatt
rotary converters giving 220 volts D.C.
- High and low tension switch gear
- Overhead transmission lines in duplicate

Later extensions would be one single set of transformers and gear as scheduled.

The alternative mentioned in Recommendation (8) would require the substitution of the following two items for the two items marked with an asterisk:-

Two 200 kilowatt motor generators 10,000 to 12,000
volts D.C.

Two 20 kilowatt three phase transformers 20 volts.

In each of the above schedules a mercury rectifier may be substituted for each rotary converter.

The buildings of the Transmitting Station should be planned with two bays in parallel formation on the lines indicated in Para. 28.

Receiving Station

(17) The Receiving Station should have one aerial system and two sets of receiving apparatus in the first instance

instances. The nature of the buildings is indicated in Para. 26, and the site in paragraph 25.

A 12 kilowatt D.C. supply (public or oil engine) will be required for lighting, charging batteries and running telegraphic apparatus.

Telegraph lines in duplicate connecting the Receiving Station to the Transmitting Station will be required.

INDIA

(18) The Transmitting Station should be as described in Recommendations (4) to (11).

The Receiving Station should have three aeriels and four receiving sets with accommodation for the addition of a fourth outfit for direct communication with Nairobi should this prove desirable. The site and buildings should be as described in Paras 25, 26.

A 12 kilowatt D.C. supply (public or oil engine) will be required for lighting, charging batteries and running telegraphic apparatus.

Telegraph lines in duplicate connecting the Receiving Station to the Transmitting Station will be required.

EGYPT.

(19) The Transmitting Station, unless placed at Abu Zabal, should be of the type described in Recommendations (4) to (11).

The Receiving Station should have four aerial systems and five sets of receiving apparatus.

The site should consist of a central plot 200 yards by 50 yards containing the operating building etc. and two other plots 220 yards square each containing a 300 feet mast 550 yards away in opposite directions from the central plot. The three plots should be connected by cable.

A 12 kilowatt D.C. supply (public or oil engine) will be required for lighting, charging batteries and running telegraphic

telegraphic apparatus.

Telegraph lines in duplicate to Abu Zabal and to the new Transmitting Station will be required for the purpose of remote control of both stations.

EAST AFRICA

Transmitting Station

(20) The masts, antennae, earth screen, tuning coil, and emergency gear should be as described in Recommendations (4) to (7) and (11).

(21) Arc Converter

Two 250 kilowatt arcs should be installed each provided with chokes, condensers, contactors, resistances, instruments, keying inductances, keys and auxiliaries similar to those at Leaffield.

(22) Power Supply and Electrical Machinery.

The hydroelectric project at Thika reported upon by the Public Works Department, Nairobi on March 30, 1914, should be carried into effect, at least in part, if, as seems probable, the wireless transmitting site is near to the falls. For the purposes of the wireless station the water of the Thika is sufficient, and the proposed simultaneous utilisation of the Ghania might therefore be reserved for any eventual enlargement of the wireless station.

The electrical machinery should consist of:-

Two 250 kilowatt water turbine-dynamo D.C. sets
delivering 350 amperes with voltage regulation
between 500 and 1,000 volts.

Two 50 kilowatt water turbine-dynamo D.C. sets
220 volts.

Switch gear

Two overhead transmission lines from the hydroelectric house to the wireless transmitting station.

(23) Should the hydroelectric project be for any reason impracticable the electrical supply should be generated by steam

as described in Recommendation (27).

(24) Buildings

A hydroelectric building should be provided at Thika River. The Transmitting Station buildings should be as indicated in the blue prints appended.

Residences for a staff of approximately six whites and twenty others should be provided.

The Receiving Buildings should be as shown in the appended blue prints and in addition residences for the operating staff should be provided.

Receiving Station.

(25) The Receiving Station should have three aerial systems and four receiving sets with accommodation for the addition of a fourth outfit for direct communication with India should this prove desirable.

The site should be so chosen as to permit of the erection of a pole line 250 yards long across the central plot, but otherwise conforming to the description in Para. 23.

A 12 kilowatt D.C. supply (public or oil engine) will be required for lighting, charging batteries and running telegraphic apparatus.

Telegraph lines in duplicate connecting the Receiving Station to the Transmitting Station will be required.

SINGAPORE

Transmitting Station.

(26) The masts, antenna, earth screen, tuning coil and emergency gear should be as described in Recommendations (4) to (7) and (11).

The arc equipment should be as described in Recommendation (21).

(27) Power Supply and Electric Machinery.

Three boilers each evaporating 7,000 lb. or two each evaporating 10,000 lb. of water per

hour, with superheaters, economisers, water softeners, feed pump together with condensers and cooling plant.

Two 250 kilowatt reciprocating engine and dynamo sets 250 amperes D.C. with voltage regulation between 500 and 1,000 volts.

Two 60 kilowatt reciprocating engine and dynamo sets 220 volts D.C.

Switch gear.

(28) The buildings at the Transmitting Station should be as indicated in the appended blue prints.

Residences should be erected if necessary, for a staff of six whites and thirty-two others.

At the Receiving Station the buildings should be as indicated in the blue prints and residences may also be necessary for the operating staff.

Receiving Station:

(29) The Receiving Station should have three aerial systems and four sets of receiving apparatus.

The site should be 250 yards by 50 yards with facilities for a pole line 250 yards long running across it, and should conform to Para-23.

A 12 kilowatt D.C. supply (electric or oil engine) will be required for lighting, charging batteries and receiving telegraphic apparatus.

Telegraph lines in duplicate connecting the Receiving Station to the Transmitting Station will be required.

HONG KONG

Transmitting Station:

(30) The masts should be of steel 200 metres high girded three ways with six concrete anchorages, both masts and guys insulated in sections, and designed to take a horizontal pull

of 10 tons at the top and a wind load of 50 lb. per square foot, with a factor of safety of three. Four masts should be erected one at each corner of a square not exceeding 400 metres side.

The site should allow of extension of the antenna by the addition of two masts at each end, and therefore the whole area available should be about one mile by half a mile.

The antenna, earth screen, tuning coil, and emergency gear should be as described in Recommendations (5) to (7) and (11).

The arc equipment should be as described in Recommendation (21).

The power supply and electrical machinery should be as described in Recommendation (27).

The buildings should be as described in Recommendation (26).

Receiving Station

(31) The Receiving Station should be generally the same as that described in Recommendation (17).

The Commission desires to place on record their cordial thanks for the helpful co-operation unsparingly given by the Admiralty, the War Office, the Air Ministry, the Post Office and the Radio Research Board of the Department of Scientific and Industrial Research during the past twelve months. All these Departments have placed at the disposal of the Commission their technical records, their accumulated experience and material facilities for undertaking practical trials of methods and apparatus. The Admiralty, the War Office and the Post Office have lent officers for work at home and abroad besides constructing special trial sets of apparatus at the request of the Commission. Without this assistance the work of the Commission would have been greatly protracted.

The Commission also desire to express their great appreciation of the valuable aid afforded by Colonel Sir S.H. Wilson, C.B., C.M.G., Principal Assistant Secretary to the Committee of Imperial Defence, by keeping them in touch with all the Departments of State consulted by the Commission upon matters relating to the Imperial Wireless Chain.

The Commission is especially grateful to Lieut. Colonel C.G. Crawley, R.M.A., Secretary to the Commission, who has carried out his work with very great efficiency.

(Signed) W.H. Eccles,

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