1926.

NEW ZEALAND.

ORGANIZATION OF SCIENTIFIC AND INDUSTRIAL RESEARCH IN NEW ZEALAND

(STATEMENT BY THE RIGHT HON. THE PRIME MINISTER IN CONNECTION WITH), TOGETHER WITH REPORT BY SIR H. FRANK HEATH, K.C.B., SECRETARY TO THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, LONDON, ENGLAND.

Presented to both Houses of the General Assembly by Command of His Excellency.

STATEMENT.

Prime Minister's Office, Wellington, 25th May, 1926.

It is generally recognized that feeling has increasingly grown during the last few years amongst progressive farmers and industrialists and others that the time has arrived for a better linking-up of science with our national industries, primary and secondary. It has also been recognized by Government that need exists for a central authority to exercise control and to overlook the research work carried on by Government Departments; to suggest means for co-operation and co-ordination of the research work carried out by University colleges, other institutes, and private workers; to prevent overlapping, and to advise Government in the subsidizing or endowment of research by grants, &c. The only agency undertaking any part of this work, other than research grants, at present is the Board of Science and Art; but that body, appointed primarily to control the Dominion Museum and Art Gallery, is obviously not the most suitable body to function as a new Department.

The difficulty which presented itself to Government, however, was to arrive at some practical method of reaching the objective. With this aim in view, a Committee of Scientific and Industrial Research, consisting of certain heads of Government Departments and representatives of the industrial associations (presided over by Dr. Marsden, Assistant Director of Education), was formed early last year.

While certain conclusions were arrived at, no definite programme was formulated by the Committee, the matter being held in abeyance pending visits to the Dominion by Sir Ernest Rutherford and Sir Frank Heath.

Sir Frank Heath is head of the Department of Scientific and Industrial Research in England, a Department specially created during the early stages of the war primarily to meet the national difficulties arising from the shortage of essential supplies previously secured from foreign sources. On the cessation of hostilities it was realized that great good would result in the work of reconstruction if the functions of the Department were enlarged, the success which had been obtained revealing more and more the necessity for the continued and systematic encouragement and organization of scientific research in every phase of national life.

Sir Frank Heath had been invited by the Commonwealth Government to inquire into the possibility of closer co-operation between his Department and similar organizations in Australia, and into the prosecution of scientific research as it affected industry. Government felt that opportunity should be taken of the visit of Sir Frank to Australia to ask the Home authorities to be good enough to allow him to extend his visit to New Zealand, if only for a short time, so that we might have the advantage of his wide organizing experience and knowledge.

Considering the short time spent in New Zealand by Sir Frank, the report is of great value, enunciating as it does broad principles for the foundation of a far-sighted policy in the matter of research.

The report has been carefully considered by Government, and immediate steps will be taken to give general effect to the recommendations which have been made, though in certain matters it will be necessary to obtain legislative sanction.

The new organization will be constituted on lines suggested by Sir Frank Heath, and based largely on that followed in England in connection with the Department of Scientific and Industrial Research. The new Department will be entrusted with the better organization of present Government scientific activities; it will aim at ensuring greater co-operation between existing scientific institutions with industries whose problems await solution, and also at co-ordinating our activities with other units of the Empire in the solution of problems of common interest.

It is not to be expected that the creation of this new Department will be a short-cut to the millennium; nor, as Sir Frank Heath says, can extensive immediate results be looked for. In the first place, our supply of research workers fully competent to undertake immediately the problems awaiting solution is insufficient, and in the second place it is essential that there must be fostered a healthy spirit of co-operation amongst all concerned: as has been said, the men of science, men of business, working men, professional and scientific societies, Universities and colleges, local authorities, and Government Departments—all must be got together. "Team-work" is necessary to deal with the varied problems which arise, and which are too manifold and too complicated to be dealt with by individual firms, associations, or Government Departments.

Sir Frank Heath's report sets out the organization for dealing with the problem, and I think we can anticipate with good reason that our hopes will be fully justified by results, and that scientific research in this country will be placed on a sound educational and financial basis.

A long-sighted policy is the precedent and first essential to success. I propose therefore that the new Department will undertake as its first duty a careful review of the research work at present being carried out in the Universities and other research laboratories. It is essential for future progress that steps be taken to promote a full and regular interchange of information between the various research institutes on the methods and results of their experimental work; it will lead to concentration and economy of effort, and also of expenditure. The corner-stone of the whole structure of the new organization is research—organized research; and I am sure Government will have the whole-hearted support of the community in hoping that this stone will be well and truly laid.

Government is concerned with the well-being of the people, and the position immediately facing us is to ensure that they should be enabled not only to exist but to prosper. Our well-being is largely dependent on the export and satisfactory disposal of our primary products. The secondary industries must not be overlooked; their operations are, however, largely confined to our internal market. Our efforts must in the main be directed to increasing the quantity and improving the quality of our primary products. This problem, however, will not be near solution until producers generally recognize scientific research as essentially part and parcel of their organization.

There is one particular matter to which special attention is drawn by Sir Frank Heath—viz., the creation of the new Agricultural College. The details in connection with the establishment of the College are practically finalized; and in connection with the establishment of the College the question arises as to the relation of the College to research. I intend to refer at present to one particular phase only—viz., that of the dairy industry. Government fully recognizes that, while very marked progress has been made in dairying on the instructional side, less has been attempted on the scientific side than in the case of other industries.

Government has had under consideration the constitution of a special branch of the Department of Agriculture dealing solely with problems affecting the dairy industry. The proposal under consideration was to establish a special laboratory and staff at Wallaceville, where the research in dairying would be carried out in conjunction with the other activities of the Department. I am, however, convinced that the proposal of Sir Frank that this special work should be attached to the Central Agricultural College is the correct one, and immediate steps will be taken to give full effect to his recommendation.

One other matter referred to by Sir Frank Heath is that of a scientific study of our fuel resources, both in relation to production and consumption. This matter was recently the subject of investigation by a special Committee, which dealt more particularly with the possibility of extending the uses of our coal-supply by the Railway authorities. I am convinced that further special attention will need to be directed to the use of our fuel-supply to the best advantage, the proper application of our various kinds of fuel to their appropriate purpose, and generally the adoption of the most economical and efficient means for the use of our fuel in industry. The matter has already received the attention of the Director of the Dominion Laboratory and of the Mines Department, and a highly qualified officer of the staff of the Dominion Laboratory has been detailed to make investigations while visiting the United States and England. This matter is one of such great importance, and, as I am advised our present facilities for research are sufficient immediately to attack this problem, I propose to arrange that it shall receive the immediate attention of the new Department.

In so far as our secondary industries are concerned, while I fully recognize that there are certain matters in which scientific and industrial research is required, I feel that the problem to be tackled in this Dominion is one more of investigation and adoption of improved processes and machine methods, lay-out, lighting, &c., rather than of an expensive and extensive campaign in the matter of scientific research.

The main requirements are instruction and advice on technical matters of general importance, and the dissemination to manufacturers and others of technical information from overseas.

In so far as there is a need for scientific research in the secondary industries, I consider that this can best be provided for by an extension of existing facilities. Provision will also require to be made for the testing of raw materials and products in various stages of manufacture. Encouragement and assistance will be given for the organization of research associations in various trades and industries.

Sir Frank suggests the appointment of technical field officers attached to the Department of Industries and Commerce; and I feel sure great benefit would result from the appointment of the "right man," not merely to keep the Department advised as to difficulties experienced, but rather to keep manufacturers fully advised of the latest improved processes and, where necessary, to instruct and advise them on modern factory organization and practices.

The co-ordination under central authority of the various scientific activities conducted by Government will be given effect to as early as possible.

I look forward with confidence to the assistance and full co-operation of the Universities, since it is to the Universities that the country must primarily look for its scientific workers. Scientific research is a slow, long process, and a steady policy is far more important than an ambitious one. I cannot promise large grants for research in the immediate future. I am convinced, however, that, from the viewpoint of the State, the expenditure of the public funds in the supervision and encouragement of scientific research, particularly in its relation to primary industries, must prove an extremely profitable investment. As stated previously, the idea is to develop a policy, and, having due regard to the relative urgency of the problems requiring solution, to do "first things first"; to create a spirit of co-operation between farmers, industrialists, scientists, and others which will be helpful to all by increasing production and preventing waste.

J. G. COATES.

REPORT ON THE ORGANIZATION OF SCIENTIFIC AND INDUSTRIAL RESEARCH IN THE DOMINION OF NEW ZEALAND.

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APPENDIX B.

To the Right Hon. the Prime Minister.

SIR,— Wellington, 12th March, 1926.

I have the honour to submit the following report on the organization of scientific and industrial research in the Dominion of New Zealand.

I. Order of Reference and Itinerary.

1. The order of reference under which I have conducted my inquiries in the Dominion is as follows: "To consult with Ministers, Government officials, and others concerned with the industries of New Zealand, both primary and secondary, with a view to advising on the outlines of a suitable organization for promoting the application of science to these industries and facilitating co-operation with Great Britain and the dominions in work of this kind."

2. Since I arrived on 2nd February last I have visited all the provinces of the Dominion except Southland. Of the cities, Wellington has naturally claimed most of my time, but I have spent several days in Auckland, Christchurch, and Dunedin. My activities in these centres and their neighbourhood are briefly described in paragraphs 9 to 12 below.

3. In the South Island I spent two days in Nelson and the neighbourhood, and made careful inquiry into the work of the Cawthron Institute. I visited the Moutere apple-growing area, inspecting the orchards, and visited a progressive undertaking which had grown into successful production under scientific guidance. It was noticeable that the owners had placed part of their holding under *Pinus insignis* as a future source of supply for fruit-boxes. I also visited the Onakaka Ironworks, and Messrs. Kirkpatrick's jam and canning factory.

I visited the West Coast, and in particular Westport, Reefton, and Greymouth, and met representative citizens at each place, visiting a local engineering-works in the last-named town. On my way north from Dunedin I spent two days in Central Otago, visiting Lawrence (including Gabriel's Gully), Roxburgh, Clyde, Cromwell, Alexandra, and the Ida Valley, and meeting the fruitgrowers and others in each centre. I saw a number of orchards, and discussed the irrigation systems in work and projected with the Resident Engineer of the Public Works Department, who accompanied me throughout my trip.

4. In the North Island I spent three days in Hamilton and the district, studying the dairy industry of the Waikato, and visiting the Hautapu Dairy Factory of the Cambridge Co-operative Dairy Company, three of the factories of the New Zealand Co-operative Dairy Company, including their large and progressive box and butter works at Frankton Junction. At this works interesting research work is going on in their own laboratory. I also saw Mr. Hector McLeod's experiments in the precipitation of additional solids from whey and buttermilk for cheesemaking. I spent some hours in the works of Messrs. Glaxo at Matangi, and in their laboratories at Hamilton.

While in this district I visited the State Farm of Instruction at Ruakura and the hydro-electric station at Horahora. I also inspected the works under construction at Arapuni. From Hamilton I travelled by car to Rotorua in order to see the difficult pumice lands of that district, and throughout these journeys I had the willing and helpful assistance of Mr. A. H. Cockayne and Mr. B. C. Aston, of the Department of Agriculture.

5. At Rotorua I visited the State Forest nursery, and spent some hours in a careful inspection of the State Forest plantations in the neighbourhood.

6. From Rotorua I travelled by road across the Kaingaroa Plains, for which as yet but little economic use has been found, and thence across the limestone hills to Napier and Hawke's Bay. On my way south to Wellington I was accompanied for part of the journey by a Veterinary Officer of the Department of Agriculture, who gave me information as to the pastoral industry of that famous district.

7. I have also visited the State Farm at Weraroa, near Levin, on my way to the flax-mill and swamps owned by Messrs. Seifert. I spent some hours here in the field, the experimental plots, and the works. Thence I went on to Hawera, where I met representative citizens, and carefully studied the most interesting and promising laboratories established by the co-operation of the local butter and cheese factories with the assistance of a grant of £1,000 a year for three years from the Department of Agriculture. The laboratory, under good scientific guidance, managed by a committee of farmers who are keenly and intelligently interested, is doing excellent work in establishing a scientific control of the butter and cheese industries, and has already succeeded in solving one or two of the difficulties experienced by the works. This example of active and financial co-operation between an industry and the Government is significant, and full of hope and suggestion for future developments. During too short a stay at Hawera I visited two local farms to see milking-appliances and stud herds.

8. From Hawera I turned eastwards and passed through the Marton agricultural district, extending my observations as far north as Taihape. On my journey south I saw the small forest plantations near Foxton, called on Sir James Wilson, and had a long conversation with him on the proposed agricultural college to be managed jointly by the Auckland and Wellington University Colleges, and travelled through the large native forests on the hills above the Upper Hutt Valley.

9. Turning now to my activities in the cities, I visited first a number of factories in and around Auckland—a well-known rug and upholstery works, a flour-mill and biscuit bakery, a dairy-appliances works, a lead-sheet-rolling mill, the Australian Glass Company's works, the admirable superphosphate

works of Messrs. Wright, Stephenson, and the sawmills of the Kauri Timber Company. In Auckland, as in all the other cities of the Dominion, I have had several opportunities of meeting the Chambers of Manufacturers and Commerce, the Rotary Clubs, or other societies of business men and industrialists. I have also visited each of the University colleges, in particular the science laboratories, and I have had long discussions with the professors.

10. In Christchurch I visited a typical furniture factory, a boot-factory, the Dominion Compressed Yeast Company (Limited), Messrs. Whitcombe and Tombs' printing-works, Anderson's steelworks, and the factory of the New Zealand Gelatine Company. I also visited Lincoln College, and studied in particular the wheat-breeding work of Professor Hilgendorf. I made a short visit to Riccarton Bush, a small area of native forest that might become very useful in the study of some of the many unsolved problems connected with native trees and their economic handling.

11. In Dunedin I made many visits to the Exhibition, for its admirable arrangement and exhibits enabled me to get a bird's-eye view of New Zealand's developments in district and State activities that would otherwise have been impossible without a prolonged stay in the Dominion. I visited Messrs. Methven's engineering-works, Messrs. Donaghy's ropeworks, and the famous Roslyn Mills. I had already visited a small but modern and up-to-date woollen-mill at Oamaru on my way to Dunedin, and I took the opportunity this visit afforded of visiting the Waitaki Boys' High School, which I found to be a very live institution with many interesting activities, not least of which is the success it has been having in attracting the boys to its agricultural side. While in Dunedin I had the privilege of meeting and addressing the Senate of the University, and of meeting some of its members as well as the Professors of Science in the Otago University who happened to be in town. In this city I had several opportunities of meeting and discussing the need for science in industry with leaders in the business and industrial world.

12. In Wellington I have had the privilege of meeting the Committee on Scientific and Industrial Research under the chairmanship of Dr. Marsden on two occasions; I have met the Council of the New Zealand Institute, and the Board of Science and Art, as well as representatives of the Dairy produce Control Board, the Fruit Control Board, and the New Zealand Meat-producers Board.

The Dominion Laboratory (both the Government Analyst and the Agricultural Chemist), the biological laboratories of the Department of Agriculture at Kelburn, the Veterinary Laboratory at Wallaceville, as well as the College laboratories, have been visited, and their work discussed with the officers in charge. I have also had the pleasure of discussing the problems of silvicultural and forest-products research with the Director of Forestry (Mr. L. Macintosh Ellis), the Engineer of Forest Products (Mr. Entrican), and the Secretary (Mr. E. Phillips Turner). Finally, I have had two long conversations on questions of organization with the Public Service Commissioner (Mr. Verschaffelt) and his Inspector (Mr. B. L. Dallard), at present acting as Controller-General of Prisons.

13. Throughout my journeyings I have had the constant and ungrudging assistance at one time or another of Dr Marsden, the Assistant Director of Education; of Mr. B. C. Aston, the Agricultural Chemist; of Mr. A. H. Cockayne, the Director of the Fields Division of the Department of Agriculture; and of Dr. Maclaurin, the Dominion Analyst, who accompanied me on my South Island tour.

While at Dunedin and Christchurch I had the great advantage of the company and help of Mr. J. W. Collins, the Secretary of the Department of Industries and Commerce, without whose guidance it would have been impossible for me to compass what I wished. His officer, Mr. Schmitt, was with us at Nelson and on the West Coast, and was of great assistance to me; while Mr. Clinkard ably represented the Secretary during my stay in Auckland and in the Hamilton district.

My visit to Central Otago was made the more profitable by the information on local history and affairs which Mr. Peter Barr, who travelled with us, was so well able to give in the most attractive way.

Above all am I indebted to the Under-Secretary for Internal Affairs, who, whether with me or not, has been a constant stand-by, making my way smooth and ensuring that at every turn my task might be as easy as the short time at my disposal would permit.

II. Introductory.

14. It will not be necessary in this report to bring arguments in support of the need or desirability of establishing a suitable organization in the Dominion for the encouragement of original scientific work and for the promotion of better scientific practice in the primary and secondary industries of the country. The question has been discussed at length by many different bodies at short intervals of time since 1916, when the British Committee of the Privy Council for Scientific and Industrial Research first invited the Dominion to set up machinery comparable to its own which would be able, among other things, to co-operate with the Home-land in the solution of problems of common interest. (*Cf.* "Report of the Committee of the Privy Council for Scientific and Industrial Research for 1915–16," London, Appendix V, pp. 52, ff.)

15. The invitation which you issued last year to my Government and which led to my presence here, and to the order of reference quoted at the head of this report, may be taken, it would appear, to signify the agreement of your Government as to the need. The problem now, as heretofore, is to discover the best way of establishing the new organ and the means necessary for maintaining it. I have been astonished at the interest in scientific work shown by all classes of the community with which I have come in contact in the cities, the townships, and in the country, the keenness with

which they feel the need for scientific help, and the sincerity of their desire to help forward any promising movement in every possible way. The farmers, no less than the manufacturers, and particularly the younger men, recognize their ignorance of many things essential to their success, and their realization of problems requiring scientific aid is a hopeful augury for a well-considered scheme. Without exception I found them willing, and even enthusiastic, when it was suggested that they should help themselves by contributing funds for the work and by actively helping it forward with their time and brains. Nor is this really surprising when one considers the position in which thoughtful men find themselves. The day of the pioneer is almost over. The men who broke in the soil gave place to a generation of empirical farmers and pastoralists who made good with the powerful aid of a natural and virgin fertility in the soil. To-day the third generation realizes that Nature's bank has a balance which may be exhausted like their own; that her capital must be carefully husbanded and put out wisely to the most profitable use; that more intensive cultivation brings its own difficulties of infection and disease; that increasing crops must find markets overseas which are in the grip of international competition and where the prize goes without favour to the best product with the most regular supply. Year by year the problem becomes more complex, and if nations are to be free from the anxieties of war their energies will be devoted to the arts of peace and to the increased competition that must inevitably follow. The manufacturer finds the artificial stimulus of war conditions has left him with a capacity for production beyond his power to use. The hard conditions in Europe are forcing down the prices of articles imported here. The rapidly growing wealth and population of the United States of America enable them to produce with ever-narrowing margins of profit. Rich and poor nations alike are pressing science more and more systematically into their service, and the manufacturer here is growing anxious. In these conditions the starting of new industries calls for the utmost circumspection, and, above all, for sound scientific, technical, and economic guidance. The younger men naturally fear ever a temporary set-back to the present prosperity with more apprehension than those who have come through bad times in the past and have built up reserves of capital and experience, and, broadly, the younger men are right, for the conditions are very different to-day, and the power of the State to help more limited in range. The heroic policy of a Vogel is impossible even if it were attractive. What is needed and, unless my judgment is profoundly astray, what the industries want is a steady long-sighted policy of help and advice from the State in a national movement for the co-operative attack on scientific problems similar to that successfully initiated here in the marketing of products overseas. Side by side with the traditional tendency to lean on the Government as an ever-present help in time of trouble there is undoubtedly an instinctive feeling, which I believe to be sound, that the problem of industry must be solved by the industries themselves. But they want help and guidance.

16. If this be so, it may be possible on the foundations of a widespread popular instinct to lay the basis of a gradually extending and developing service without too severe a call upon the resources of the taxpayer—a service guided and encouraged by a central organization and clearing house of moderate size which will make the utmost use of all good work wherever it is being done, will stimulate team-work not only between farmers and between manufacturers for their common good, but also team-work between the scientific workers in the University colleges, in endowed institutions like the Cawthron or the New Zealand Institute, and in the scientific establishments of the Government itself. Imbued with this spirit the new organization would start with a careful review of all the productive work at present being done, would seek to bring it within the ambit of a carefully considered plan without destroying the initiative of independent organizations, and would consistently avoid centralization until it became obvious to all concerned that centralization had become necessary in the interests of efficiency and economy. And the centre, if centre there had to be, for some important block of work would be the best centre for that particular work, and by no means necessarily nor probably the seat of Government. Thus would local interest be best maintained and the influence of the scientific service felt throughout the Dominion.

17. These are the basic ideas that lie at the root of the proposals submitted in the following paragraphs.

For the sake of convenience of reference, the following sections deal respectively with—III, the primary industries; IV, the secondary industries; V, certain State scientific services; VI, the other State scientific services, and particularly those of the Department of Agriculture; VII, the organization of the new central scientific service; VIII, miscellaneous recommendations; IX, summary of recommendations.

18. It may be added that valuable reviews have been made in the past by various bodies and persons of the need for some organization of scientific work in the Dominion, of the existing State services, and of possible methods of organization, but it is not proposed here to traverse this ground again, to discuss their merits, or the reason for the failure of some of them to secure general support. But there are passages in certain of these documents which appear to me to be specially relevant to the present inquiry and to bear directly on the recommendations I propose making. Accordingly they are reproduced in Appendix A to the present report, with the necessary dates and references.

III. The Primary Industries.

19. There is a widespread appreciation of the importance of science systematically applied to the primary industries, and manufacturers are concerned to show that they agree in the prior claims of these industries. This acknowledgment has been repeatedly made in conversations and speeches to which I have listened. The most cursory examination of the national balance-sheet shows the dependence of the country's purchasing-power, and consequently the prosperity of the secondary

industries, which are confined to home markets, upon a favourable balance of external trade. This balance is provided by the primary industries, and during a period of falling prices can only be secured by increased export. At the present moment, when prices are sagging, the farmer is naturally anxious to use any means likely to help him to avoid losses in his crops or to increase the productivity of his land, his sheep, or his cattle.

20. The problems and difficulties with which a young country is faced are so numerous, the cost both in time and money of an adequate attack upon them so material, the supply of competent scientific workers so difficult to come by, that a wise policy must perforce establish an order of priority in the subject selected for investigation. All the problems may be important, and even urgent, but in scientific work nothing is more wasteful and more likely to impair public confidence in its value than the attempt to cover a wider field than the available money and men can compass efficiently. On the other hand, one problem successfully solved often leads systematically to the solving of others, and it always reacts on others by drawing attention to the methods which have made for success. It is better to postpone or abandon an investigation than to attempt it in conditions that place a number of loose ends unexplored though recognized as vital to a solution. As in military affairs, the width of the attack must be determined by the strength of the forces at disposal. Moreover, tinkering not only induces lack of confidence, it leads in turn to spasmodic effort. Effective work in science is only possible when there is some assurance that plans can be carried through to the end within the limits once laid down. The failure in England to discover the cause and cure for foot-and-mouth disease has been almost entirely due to a neglect of these considerations. If it is impossible for the Dominion to grapple simultaneously with all the difficulties which science can help to remove, she must select the fields in which the need is most urgent for her principal efforts, and be content to go slow elsewhere. I have no doubt that the primary industries and those which directly serve their needs must be given the first place. Even so, it will be necessary, on financial grounds alone, to secure the utmost assistance from the industries concerned in support of the work. But there are other and deeper reasons for seeking and welcoming this aid. The active help of those whose prosperity will be directly affected by the work is greatly to be desired as a means of educating them in the methods as well as the limitations of science, and as a means of gradually building up a reasoned appreciation of its value in their lives. This will make for a steady national policy—and a steady policy is a condition precedent to success.

21. The most serious difficulty in any plan for a systematic organization of effort on behalf of the primary industries is the shortage of well-trained and competent workers. There is as yet no institution in the Dominion of University rank devoted to the training of leaders in these industries and to the prosecution of research, which is an essential part in the training for leadership. As the committee of the Auckland Institute well pointed out in a report on the co-ordination of science and industry issued in 1916, the worst trouble is to be found in the weakness of the educational provision. It was not within my order of reference to study the educational system of the Dominion, but the supply of competent investigators depends so entirely upon what is being done to produce them that I could not altogether neglect this aspect of the question. (*Cf.* "Report of Royal Commission on University Education in New Zealand," page 42, para. 2.) My impression, based on a visit to the Government Farm of Instruction at Ruakura and to Lincoln College institutions, which represent two necessary types of agricultural school below that of a University, leads me to the conclusion that science, especially on its practical and experimental side, receives even in these grades of institution less than its due attention. At Ruakura there are no science laboratories, though there is instruction in science. At Lincoln the laboratories are less well-found and maintained than is desirable, and, with the exception of the valuable work in wheat-breeding and grass-selection, the standard and efficiency of the work in science seem to me to fall below that necessary for young men, some of whom are intending to become teachers of agriculture.*

22. But the principal gap is on the University plane. Without a college of the highest rank devoted to investigation and teaching, no systematic approach to the scientific problems of the primary industries will be possible. Particular difficulties may be dealt with by individual workers in science at the University colleges and other institutions such as the Cawthron Institute at Nelson, or by the scientific staff of the Department of Agriculture, but the number of qualified men available will remain too few unless workers are imported from overseas, while the advances of knowledge will remain partial and sporadic in the absence of a body whose duty it is to envisage the whole field without the limitations necessarily imposed upon local organizations, or the embarrassments, both administrative and political, which must beset an executive Department of State. The respective spheres of an agricultural college of the first rank and of a State Department of Agriculture are admirably defined in a report of the Special Legislative Commission appointed by the State of California in 1921 (pp. 60, 61). The passage was drafted by the Director of Agriculture and the Dean of the College.

"The Commission found no better working arrangement in any State than the agreement between Director Hecke and Dean Hunt, which is set forth below:—

"The State Department of Agriculture should exercise executive and regulatory powers. The College of Agriculture should devote its energies to research and education, both resident and non-resident. It is quite certain that it is not in the interest of the public welfare that it should be charged with police duties. It is the function of the executive branch of the State, whose head is the Governor, to enforce the laws relating to agriculture through the Director of Agriculture and his subordinates, and those relating to forestry through the Commission of Forestry. The functions of the University, and hence of the College of Agriculture, are investigation and teaching. The college

* Since writing the above my attention has been called to the "Report of the Board of Agriculture on Agricultural Instruction in New Zealand," 1925, pp. 9, 10, and 15, in which recommendations are made to meet these defects.

should not seek to control the action of any person. Its primary function is to determine the truth and state it accurately. The college should not have placed upon it any commercial, executive, or police duties, nor should it be the policy of the State to appropriate money to the State Department of Agriculture for education or investigation, nor should it be the policy of the State to appropriate money to the College of Agriculture for regulatory purposes."

This differentiation of function the Commission found to be general throughout the United States of America except in Indiana, where opinion favoured the transference of regulative functions to the College of Agriculture. It is also (with a reservation to which reference will be made immediately) the practice in Great Britain, where research is left to the University colleges and endowed institutions such as the Lawes Agricultural Institute at Rothamsted and the John Innes Institute at Merton. The action of the Federal Government of the United States of America in establishing and maintaining great laboratories for research into the many aspects of agriculture is not really a contradiction of this principle and practice, for it is to be remembered that the United States Government has no administrative or regulative functions in this field, except possibly in Alaska and in its overseas dependencies. While it seems to me obvious that the college must be the central research organ, it appears to me to be both convenient and desirable that a Department of Agriculture should possess a scientific staff competent to undertake investigations into problems of immediate urgency with which the Government may have to deal administratively. It is not, as has been suggested, so I am informed, that the Department should limit itself to "applied" research as distinct from "pure" research, for the only distinction between the two is one of motive or aim. The method of both is the same. If work is done in order to solve a specific practical difficulty the research is "applied"; if the motive is merely the advance of knowledge it is "pure." The distinction I would draw is one of urgency, not in the scientific or agricultural but in the administrative or political sense. Administrative Departments of State which are the engines placed at the disposal of Ministers must in the main be directed by the policy of their political superiors, and Ministers are restricted in their policy by many forces over which they have at the best but limited control. What is needed for agriculture is a scientific organization free from these limitations—aided and supervised by the State, but trusted because it is competent.

Proposed New Agricultural College.

23. The recent agreement between the Colleges at Auckland and Wellington to pool their resources for agricultural education as the nucleus of a new national college of the first rank seems to me to be very hopeful. With a well-qualified staff on a scale generous enough to give them time for original investigation, it will produce the men that are needed for the industry; for the special institutes that must gradually come into existence for the intensive study of its particular branches; and for the service of the Government itself. Ultimately it is likely to attract to itself other University studies in the interests both of the students and of economy, and so to become, as did the University of Wisconsin in America, and more recently the University College at Reading in England, a full fledged multi-faculty University.*

Special Institutes for Particular Branches of Agriculture.

24. It is assumed that the Agricultural College, if established, would be aided from the votes of the Department of Education like other University institutions; but I suggest that around it and in close intellectual co-operation with it, but distinct from it in management and finance, there should be established, as opportunity offers, a group of specialized institutes devoted to the study of particular branches of the industry, and financed partly by funds contributed by the industry itself and partly from the general funds provided by the Government for scientific research. Each institute should be managed by a Committee on which men of science (selected by the central organization), the appropriate administrative Department or Departments of Government, and the industry would be represented, and in this way the views and activities of each of these three groups would be brought under a single review and the necessary team-work secured (each organization represented should be required to table its plans). Experience at Home has shown that it is useless to direct Departments or institutions to co-operate with each other, but that if the scientific workers in each can be brought together round a table with a common purpose the desired co-operation comes about. At present this spirit of co-operation is absent, and I have found evidences of an unwillingness to consider it so long as the present separation of authorities exists.

An Institute of Dairying.

25. The first and most urgent need, in my opinion, is the establishment of an Institute of Dairying. The dairy industry is the one branch of agriculture which shows marked expansion of production in recent years. Indeed, there has actually been a general falling-off in the production of wheat, wool, and meat. Yet less scientific work has been done for the dairy industry than for any branch of agriculture, not excluding fruit or forestry. In the by-products of the industry—*e.g.*, casein (and its derivative products), sugar of milk, and lactose—the little work done has been by private effort. It is not suggested that expensive or elaborate buildings should be provided in the first instance. To begin with, room could probably be found for the work in the College laboratories. Nor should a large special staff be required at first. The professor would naturally be the head of the Institute, and a carefully selected assistant or two for research, assisted and supplemented as time

* A site to be suitable should be easy of access from all parts of the Island, adjacent to but not within the boundaries of a town of size sufficient to supply the necessary supplementary services, and on soil neither too good (for in that case the possibilities of experiment will be restricted), nor too poor (for, alternatively, it will be impossible to show results of wide application). Soil-variety within moderate limits is to be desired.

goes on by the best graduates of the College, would probably meet the needs of the first few years. The Institute should lay down a definite programme of work, with estimates for the approval of the supervising committee, which in turn would be subject to the general supervision of the central scientific authority I am recommending, and receive from it the Government contribution towards the cost of maintaining the Institute. The contribution from the industry would be made, I suggest, as a grant to the central organization for the purposes of dairying science for a period of years—say, five—by the Dairy Products Control Board. I have discussed this possibility with representatives of the Board, who entirely endorsed the proposal. Indeed, Mr. Brash suggested it himself. The committee of management should consist of—

(i.) Representatives of science appointed by the central authority;
(ii.) Representatives of the Department of Agriculture's scientific staff; and
(iii.) Representatives of the industry nominated by the Control Board.

The chairman of the committee should be chosen by the central research organization. There should be a rota of retirement for its members. It should be the duty of the committee to encourage and bring into their programme work being done in other localities, such as that of the Federated Butter-factories' laboratory at Hawera, and that of the New Zealand Co-operative Dairy Company at Frankton Junction; while the central organization should use the funds at their disposal not only for the maintenance of the Dairy Institute attached to the College, but for assistance to these outlying co-operative centres. Indeed, the central organization and the committee should do everything in their power to induce other districts to follow suit. In drafting their programme the committee should also have regard to the work being done by the Department of Agriculture. Accordingly I suggest that the £1,000 a year now found on the votes of the Department of Agriculture for the Hawera laboratory should be transferred to the new central organization.

26. In considering the programme and estimates submitted annually by the committee of the Institute, the central organization would be careful to envisage the work being done or proposed to be done by the science laboratories of the State, and especially those of the Department of Agriculture, as well as the work done or proposed in University laboratories or in endowed institutions such as the Cawthron Institute. In this way they should be able, by consultations with representatives of these organizations, to see the totality of the work done covered the ground so far as available means and men permit. In Section VII I describe the means suggested for securing this consultation.

27. It has been suggested, I understand, that the Department of Agriculture should itself establish a dairy research institute at Wallaceville for a general attack upon the problems of this industry; but I hope that what I have said may lead to a reconsideration of this plan in the interest of economy and, I may venture to add, efficiency; for, apart from the difficulties inherent in a comprehensive plan of investigation in any field by an administrative Department of State, to which I have already referred, I am inclined to think that Wallaceville is not a suitable site for such an institution. A dairy institute should be centred in a district engaged in the butter and cheese industry if it is to establish that intimate contact with the industry and its needs that the circumstances demand; and an institution which had to send to Wellington for supplies of milk from other than official herds would find it physically impossible to attack many of the problems before it. There is another point in this connection of some importance. It is essential for the success of a research institution, especially in a new country, that the staff should be in close touch with the people affected by its work. The success of the Cawthron Institute is largely due to this cause. The staff of the Institute should spend part of their time regularly in the field explaining to the farmers, factory-managers, and field officers what they are aiming at and what they have achieved. Short lectures, demonstrations, and ten-minute talks on the wireless should all be pressed into their service, as well as visits to the laboratories by those who should be interested in the work. It is obvious that the nearer the institute is to a dairying area the easier it will be to do all this with the minimum loss of time to those concerned.

28. Just as the staff of the research institutes, whatever their scope of work, should go out into the field—because printed publications can never reach more than a few of those who ought to study them—so the Agricultural College itself should have the facilities and means, I submit, of sending its young graduates into the field for a time, after their course of instruction is over. Here again co-operation with the Department of Agriculture is necessary and desirable. The young graduate should work as an adjutant to the field officer of the Department. He would learn from the trained official many things untouched in his University course, and he would be able to give something in return—a youthful enthusiasm and a leaning towards new views, which would enrich the departmental service. Incidentally the Department would find such an arrangement the best possible training-ground for the field officer of the future.

Other Institutes.

29. The foregoing description of the proposed Dairy Institute would apply, *mutatis mutandis*, to other special institutes which will undoubtedly be called for as time goes on. There should be a similar institute for grain and grass crops*; for fruit and fruit transport; for cattle, sheep, and meat transport; but these will probably have to await the development of the College into a multi-faculty institution. But even more important than these perhaps is an institute for the study of the economics and accountancy and finance of farming, which is a business and needs to be put on a business

* It will be very difficult, if not impossible, to select any site for the new College which will be suitable for research and experiment in wheat breeding and growing. The South Island is the natural place for this work; a beginning has already been made at Lincoln College, and a special wheat institute dealing possibly with other grains should come into existence in close connection with Canterbury College, Christchurch, financed and managed on the lines already described, under the direction of the central organization.

footing. This institute might well be attached to one of the other colleges of the Dominion. Meantime the central organization should forthwith appoint committees of similar constitution to study the existing provision for work in these fields, to encourage and develop it along lines conformable to the ultimate plan, and to facilitate co-operation with the corresponding organizations at Home. In particular, the problems of fruit transport and the related problems in the orchard need bringing into a well-conceived attack, and here again the Fruit Control Board and the Meat Producers Board would be ready, I understand, to assist financially and in other ways.

In preparation for this work I suggest an able and well-trained young man should be sent to England by the new central organization and attached to the staff of the Low Temperature Research Station at Cambridge, in accordance with the invitation extended through me by the British Government. (For a diagrammatic representation of the new organization see Appendix B.)

Forestry and Forest Products Institute.

30. There remains the problem of research in forestry and forest products. For this, too, a special institute should, in my opinion, be established in close relation to the Agricultural College and upon the same site. The need for economy both in expenditure and men calls urgently for this solution of a pressing and most important national problem. At present there is no institution in New Zealand devoted to the study of silviculture in its two phases of (i) the life-history, regeneration, and economic exploitations of the native bush, both trees, bushes, and creepers; and (ii) the afforestation of exotic trees. Work on forest products is being done for the forestry authority at Auckland University College and at Canterbury College, Christchurch, but the Director of Forestry has earnestly recommended the Government to authorize the establishment of a forest-products laboratory and a forest experimental station in the North Island (*cf.* First Quinquennial Review of the Department of Forestry, 1925, page 8). For exactly the same reasons as those that apply to a Dairy Institute, forest-product research should be related to the new University College and financed by contributions from the timber-milling industry and by grants from the central research organization. The expense of establishing a self-contained institute to deal with these matters is shown by the experience of the Indian Government at Dehra Dun. Botanists, bacteriologists, chemists, physicists, engineers, statisticians, and economists are all needed for an effective institution, and the support a University can offer, especially if it is engaged in training the higher grade of forest officers as it should be, is obvious. The new Forestry Institute at Home has been located at Oxford, where the training is done, and the new forest-products laboratory is but an hour's distance away. It would have been brought right into its neighbourhood could a suitable site have been found.

A Forest Policy.

31. The question of forestry is referred to as a pressing and most important national problem. It is more than this: it is pressing and important for the Empire as a whole. The best authorities anticipate a serious world shortage of softwoods within the next twenty years, and Great Britain, which to-day is spending at least £40,000,000 a year on imported timbers, needs the help of the dominions and her colonies in substituting an imperial for a foreign trade in this vital necessity of man. Substitutes for the present softwoods will have to be found and the present supplies greatly increased. Unless it can become entirely self-sufficing, rising prices will affect the Dominion equally with the Mother-country, and if prices are high, why should New Zealand neglect the development of a new and profitable market overseas? Moreover, effective forestry, if it can be pursued as it is now pursued in France, Germany, Norway, and Sweden, means, in the opinion of competent judges, a new and large population on the land, much greater in numbers to a given area than can be the case with the pastoral industry or farming on a large scale. There are undoubted difficulties in the formulation of a forest policy on a big scale, but the promise and possibilities appear to me to be so great, while there are so many difficulties to be considered, that I venture to trespass to this extent beyond the strict terms of my order of reference, and to recommend that the Government should invite the best forester they can secure to visit New Zealand, to survey the whole present position both as regards the native bush and the planted areas, including State and private enterprise, and to report upon the possibilities of a big forward movement. Should he recommend modification in the present policy I suggest that the Government should then appoint a strong committee, including the Director of Forestry, to prepare a plan of forest development and to consult with the British Government for the initiation of a forest settlement scheme. It should be observed that forestry is able to absorb usefully healthy men of greater age than agriculture can, unless they have already been used to country life.*

Proposed Committee on Forestry and Forest-products Research.

32. Be this as it may, however, there remains the need, in consonance with the present scope of the work, for the early establishment of a Forestry and Forest Products Institute. The Professor of Forestry at Auckland would naturally be connected with the Institute, while the work being done at Christchurch would be brought into the scheme from the beginning. To this end I recommend that the central organization for research should establish a committee of University representatives, the State Forest Service, and timber-millers to work out a programme of work and estimates of cost. The Director of the Forest Service would naturally be the chairman of the committee, and it would be found possible, I think, from conversations I have had with timber-millers, to secure their support for a levy on the amount of timber felled or produced.

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* I have discussed this matter with Professor Condliffe, who agrees that the only way of increasing the present immigration ratio is to find new avenues of employment.

Fuel Research.

33. There is one other branch of work affecting the primary industries of mining which appears to be of great importance to the secondary industries and to the nation as a whole: I refer to the study of the natural fuels of New Zealand and of possible synthetic fuels. Some work is already going on in this field, notably by the Government Analyst on briquetting, and at Canterbury College, Christchurch; but there is a real necessity for better knowledge, not only of the extent but even more of the characteristics of New Zealand's fuel resources, which the interest shown in the development of electric power is tending to obscure. It must be remembered that the expenditure of heat in industry is, on the average, much higher than the expenditure of power, and that electricity is an expensive source of heat, which is not economically justified unless the factory is putting out products of very high grade, or requires the application of heat under very accurate control or in closely defined areas. This is one reason why Norway, though possessed of cheap electric power, has not developed into a great manufacturing country: she is destitute of fuel. New Zealand, on the other hand, has considerable fuel resources, for which there must always be a demand in industrial operations. Her fuels, broadly speaking, have certain advantages, such as relative freedom from ash and sulphur; but they also have disadvantages, such as friability and a suitability less than the best for steam-raising. A complete chemical and physical survey of the coal-seams needs to be made, with the assistance of the owner, and in accordance with the procedure worked out by the Fuel Research Station attached to the Department of Science and Industrial Research at Home. The results of this survey will give indications as to the coals which should first be studied with a view to more economical use and better treatment. In this my Department at Home is willing and anxious to assist. They would place the resources of the Fuel Research Station at the disposal of the New Zealand Government for large-scale experiments on consignments of coal in return for actual out-of-pocket expenses, and thus save the Dominion from the expense of erecting a large station. But there should be facilities here for the necessary preliminary work to be carried on in close agreement with the methods successfully laid down at Home. It is now certain that it will be possible to produce by suitable treatment fuel, oils, and spirits from coal distilled at temperatures lower than those used in gasworks or coke-ovens, with the concurrent production of a soft and smokeless coke that burns as easily in an open grate as raw coal. This work done at the Fuel Research Station needs repeating and probably modifying to suit New Zealand fuels, for any process that would help to release the Dominion from entire dependence on imported liquid fuels is important, not only economically but also from the point of view of defence.

34. Accordingly I recommend that a committee be set up under the research organization to prepare a plan for the systematic study of the Dominion fuel resources in consultation with my Department at Home; that it prepare estimates of cost for submission to the central organization, and that meantime a young man of science should be attached as soon as possible to the staff of the Fuel Research Station at Greenwich for a period of years in order to acquaint himself with the principles and details of our methods.*

IV. The Secondary Industries.

35. I have taken great care to try and obtain a broad general view of the secondary industries of New Zealand and to meet representative manufacturers in each centre I have visited. All are agreed that more science is needed, and some are taking steps to appoint scientific men in their works, as others, and the more progressive, have already done. It is natural that the industrialists should be rather vague as to the best means of attaining the end they desire, for the majority of factories are too small to make it possible for them to face the expense of the smallest scientific organization in their works. It is noticeable that the Statistical Report on Factory Production, 1925 (page 23), shows over 80 per cent. of the factories in the Dominion employ less than twenty-one workers apiece, while there seems to be a tendency for the proportion of small works to increase—though the tendency is far less marked than in Australia. Everywhere I have pointed out to manufacturers that the State could not possibly employ a staff adequate to solve all the manifold problems arising in the course of production in the many industries now carried on, and that even a staff adequate in numbers and scientific qualifications could not hope to solve these difficulties unless they were actually attached to the works. Here, as elsewhere, a choice must be made of the more urgent problems, and considerations both of economy and of man-power suggest that the firms in each industry should combine to finance, with some Government assistance in suitable cases, the conduct of research work on one or more problems of common interest to them all. In the case of the bigger industries co-operative research associations might be formed on a model similar to that adopted in the Old Country, while in the case of smaller and poorer industries a research worker might be selected by a suitable professor and directed to work at selected problems under his guidance. But either plan would necessitate the free access to the works of all contributors for the scientific worker, and full facilities for the making of works experiments. This suggestion was received with considerable sympathy in all quarters, especially when I emphasized the importance of initiative and individual effort for successful business, and the danger a State-controlled scheme would bring with it, of destroying these virtues just in proportion as it was successful. A relatively small sum of money placed at the disposal of the new central organization, to be expended in grants under proper conditions, to co-operative efforts of the kind indicated, would produce the maximum effect and would have all the advantages of an experiment which could be abandoned if it

* I understand that an 1851 Exhibition Scholar is now in England who might be suitable for this duty on the expiry of his scholarship.

proved unsuccessful. It is essential, however, that an experiment of this kind should have a fair trial, and manufacturers should be required to find a contribution of amount sufficient, with any State subsidy, to pay the salary and expenses of one well-qualified man of science at the least, and to guarantee a continuance of the contribution for at least five years. I strongly recommend that the central organisation should press for a compulsory levy on the industry for this purpose, as is the practice in the dairy, meat, and fruit industries for marketing purposes, and that it should be very slow to accept voluntary contributions which it will be difficult to collect or to continue in times of bad trade.

36. For the rest, the State assistance to the secondary industries should be rendered by the work that it is hoped will be undertaken in the economical use of fuel, and by the work on the testing and standardization of materials and instruments, which is dealt with in Section V of this report. In addition, it should be possible for the new organization to give advice to industries as to the sources from which special information can possibly be obtained through a section of records which I shall recommend should be established; by the organization of the science libraries of the country, which should be undertaken as part of the duties of the central authority; and by its close liasion with the Research Department at Home and similar organizations in other dominions of the Empire.

37. The new central organization will need all the assistance it can obtain in forming a just estimate of the needs and attitude of the secondary industries if mistakes are to be avoided and useful work is to be done. For this help it will naturally look to the Department of Industries and Commerce, which appears to me to be getting into daily closer touch with the manufacturers and business men of the community. In a later paragraph I recommend the Secretary of this Department should, with other high officers from other Departments, be appointed as assessor to the Advisory Council of the new organization; but this does not seem to me to be enough. I suggest that the Department of Industries and Commerce should include upon its staff two or more well-qualified field officers of technical training and experience—one, say, on the engineering side, the other on the chemical—whose duty it should be to study the secondary industries of the Dominion at first hand and keep the Secretary informed of their technical difficulties and successes. The powers entrusted to the Department under the Act are so wide that some provision of this kind appears to me to be desirable in any case. If the industries are to be assisted scientifically by the new body, which will have many other scientific responsibilities upon its shoulders, this strengthening of the staff of the Department of Industries and Commerce appears to me to be necessary.

V. Certain State Scientific Services.

A Laboratory for Standards and Tests.

38. The report by Dr. Marsden endorsed by the Committee on Scientific and Industrial Research recently appointed to consider the proposals submitted to the Government by the committee of the Canterbury Industrial Association (see Appendix A, Section (8)) expressed the view that "the real foundation for such help as the industrialists require should be the extension of Dr. Maclaurin's laboratory to include tests of a physical nature." In other words, the committee, with which I had the privilege of consulting on two occasions, recommended the establishment of the nucleus of a State laboratory similar in functions to those of the National Physical Laboratory at Home. Apart altogether from the demands of the manufacturers for help, I have been brought to the conclusion that the Government needs an organization of the kind suggested for its own purposes. The National railways have testing laboratories on which about £300 is expended annually, but when the new workshops in the Hutt Valley are finished the amount and scope of the testing will have to be enlarged. Similarly, the Hydro-electric Branch of the Public Works Department needs the assistance of a staff and equipment for the testing and investigation of electrical gear and apparatus, and has already made proposals, I understand, for the establishment of a laboratory for these purposes. It appears that the Public Works Department and Main Highways Board are spending some £800 a year on testing high-tension insulators, cement, road materials, and the like. Testing-work is also being done for public authorities and others in the laboratories of Otago University and Canterbury College, Christchurch, and to some extent also in the other two colleges. Yet there is no general supervision available either for the present work or the proposed developments, and it is difficult to discover how much the State is spending on these services.

39. There is general agreement that a start should be made in the foundation of a national laboratory for testing and investigating materials and scientific apparatus, and for the establishment of constants and standards in collaboration with the National Physical Laboratory and other great laboratories of the same kind, such as the Bureau of Standards in Washington, and the Chemische-physicalische Reichsanshalt in Berlin. It may be noted in passing that Japan has established such a laboratory, and that Siam is in process of founding one. But institutions of this kind are expensive to build, equip, and staff, and in my opinion the right approach would be by the following steps:—

(*a.*) To earmark a site of 10 or 15 acres in proximity to the new railway workshops in the Hutt Valley, for the purposes of the future laboratory, with convenient railway-siding accommodation, but at a sufficient distance from the shops where heavy work is done to avoid undue interference through vibration and noise. Care will need to be taken to prevent rover currents when the line is electrified.

(*b.*) To build in the first instance only such laboratories and install the plant that is necessary for the work that must be done on the spot and cannot be done in one or other of the University laboratories.

(*c.*) To use existing University laboratories as far as possible in the meantime, but to separate the finance of all testing-work done in them from the general finance of the college.

(*d.*) To include Dr. Maclaurin's laboratory and staff in the new organisation, and to remove his laboratory to the new site on convenient opportunity.

(*e.*) To place the whole responsibility for testing and investigatory work into materials and scientific instruments, apparatus, &c., the establishment of constants and standards, on the new central organization, which should appoint a special committee for the purpose, including representatives of the railways, the hydro-electric service, the Post Office, the Public Works Department, as well as independent men of science. The cost of routine tests conducted for administrative Departments of State should be paid for by those Departments, otherwise they will be tempted to use less care than is desirable over expenditure on this kind of work; but any investigations or researches necessary to or arising out of the tests should be borne on the vote of the new organization. It would be the duty of the supervising committee to prepare a programme of work, with estimates of costs, for each coming year, showing whether it will be done in the central or in provincial laboratories. The new central organization and the Government will then know how much this service is expected to cost and by whom it is being incurred. The accounts to be yearly rendered will be comparable with the estimates, and furnish a guide for future estimating.

40. In connection with these recommendations attention is called to the memorandum prepared by Professor Sir Ernest Rutherford, O.M., P.R.S. (*cf.* Appendix A, Section (9)), from which it will be seen that the principles he lays down are in conformity with these proposals, and in particular his recommendation that the University colleges should not be forced to undertake test work. If the cost of doing this work and any fees received are kept distinct from the college accounts it will be possible to provide a staff for it who are not part of the teaching corps of the college, should this be desirable, as it probably will be. On the other hand, when the bulk of the test work done begins to encroach upon the use of plant and accommodation needed for teaching and research purposes, a clear indication will be given that the time has come to transfer the test work to the central laboratories in Wellington, and it will be possible to make the transfer without affecting the financial interests of the teachers.

41. The establishment of an organization of this kind will undoubtedly assist the manufacturers, as is pointed out in Dr. Marsden's report, and it will be possible, no doubt, to undertake a certain amount of investigatory work for groups of firms or single businesses, so far as the needs of the Government permit, provided the full cost is borne by the firm or firms for whom the work is done. Care will, however, be needed in laying down conditions as to the availability of results, but in this matter my Department will be able to render useful assistance and advice, if required.

42. Dr. Marsden's report gives in some detail the scope of the work such a laboratory should undertake, and estimates the initial capital cost of the new central establishment at £20,000, and the additional salary cost at about £1,600 a year. But these figures should be reviewed by a committee to be set up immediately, and by the new central organization to which the committee would be attached, after a careful survey of the available provisions in the provinces and the cost of rearranging the finance of the test work done in the colleges. Meantime I desire to endorse his recommendation that the physicist selected for appointment, who will certainly be required, should be sent to the National Physical Laboratory for one year's training and experience.

The Geological Survey, Meteorological Office and Hector Observatory.

43. If a single scientific authority is desirable for the control of test work and investigation, this is no less the case with the Geological Survey, which costs at present nearly £6,000 a year; the Meteorological Office, which costs nearly £5,000 a year (largely expended on telegrams); the Hector Observatory, at present under the Department of Internal Affairs, which costs about £1,400 a year; and the Magnetic Survey, under the Department of Lands and Survey, which costs about £1,000 a year.

44. There is at present no authority competent to review the programmes of work undertaken by these services or to judge of their relative claims upon the State for support. A properly constituted scientific organization would be able to judge their claims with sympathy and discernment, and be in the position to recommend expenditure on them comparable to their relative importance to the nation, within the means available for the scientific services as a whole.

45. But, apart altogether from these administrative and financial considerations, it is very important that a service like the Geological Survey, upon the work of which the successful mineral development of the country must ultimately depend, should be entirely removed from the administrative or police duties of ordinary Departments, for its findings must be beyond suspicion of any interests, either regulative, political, or financial. It is no less important that the meteorological service should be brought into close touch with the need for scientific help in agriculture, no less than is obviously the case with the marine, naval, military, and air services. It should serve all alike, and will best do so if it is attached specifically to none of them, but is subject to the criticism and inspiration of competent scientific judgment. Even the Magnetic Survey and the Astronomical Observatory will gain in usefulness and reality if their activities are brought into the common flow of scientific thought, as they will be if placed under a scientific rather than a lay control.

The Samoan Scientific Service.

46. The foregoing remarks hold with equal force in the case of the scientific work being done in Samoa under the Department of External Affairs. I have been unable to acquaint myself with this work at first hand, but I gather that it is a valuable service which has already established international relationships in meteorology. If only on this ground it is important to link it up with the meteorological service of the Dominion; but there can be no doubt that a well-found scientific service in Samoa is likely to have results of profound economic and practical importance. The present cost of this service is nearly £2,000 a year, less recoveries estimated at £800 a year. I recommend that the Board supervising this service be transferred to the new scientific organization.

VI. The other State Scientific Services, and particularly those of the Department of Agriculture.

47. It will have been gathered from my remarks in paragraph 22 above that I do not recommend the transference to the new authority of the scientific services of the Department of Agriculture. There are good reasons why a Department of Agriculture should have on its staff scientific men ready and able to deal with problems bearing directly on matters for which the Department is administratively responsible. Moreover, the ancient art and craft of agriculture stands so greatly in need under modern conditions of a scientific spirit in those who control it on behalf of the State that it is most important for the administration to be kept constantly and intimately in contact with the scientific point of view, not only at headquarters but by its field officers. A scientifically minded Department of Agriculture will both gain from and give strength to the free activities of a University or an endowed institution for research. But it must perforce adapt its own scientific activities to the administrative necessities of its work. It cannot cover the whole field even if it would. It should therefore work out its programme of research and investigation with the active help of its scientific officers in such a way as to contribute its share to the complete national scheme, in the way and along the lines most conformable to its directive and regulative responsibilities. My strong impression is that the Department has among its scientific officers men of high capacity and great enthusiasm who would gain much by being brought into a well-considered plan of work in which all available institutions would take their part. But though the statement of the work being done in the Department, or proposed to be done, covers a very wide field, I find it difficult to trace the evidence of a considered plan; and though the workers in its laboratories have many of them put forth a great deal of scientific work, much of it has been the result of personal effort in their spare time. Their official programme is to do the things "sent down by the office," and for the rest the direction in which they work, the time in which it is done, and the means of publishing it seem largely a matter of hazard. It is difficult in these circumstances to develop the team spirit or to create a scientific policy. Much of this would disappear if the control of the scientific services were entrusted to men of science, leaving matters of administrative policy, of finance, and of discipline to the trained administrator who is best able to deal with these things, and if the initiative in proposing the programme of scientific as opposed to routine work were left to the scientific staff acting in committee. The programme would, of course, be subject to modification in the light of financial, administrative, or political necessity, of which the administrator is best able to judge, but the impact in scientific research needs to come from men of science.

48. In any case I feel convinced that the organization I have proposed, which will place the scientific supervision of systematized institutes for the study of the different branches of agriculture in the hands of men of science and practical farmers, working in close touch with a college or colleges of University rank, under arrangements which will bring scientific officers of the Department into active consultation with their unofficial brothers, will do much to bring about the co-ordinated national policy that is so necessary in a vast field of work. There is more than enough room for each type of organization—Department, University, and Research Institute.

Technical Officers for the Department of Industries and Commerce.

49. In paragraph 37 I have recommended the appointment of two qualified technical field officers by the Department of Industries and Commerce, and I need not add anything to the remarks made there beyond saying that these officers should not, in my opinion, be considered as life appointments. Competent men are likely to find remunerative posts outside the service when they have gained experience of the industries, and the Department will benefit as greatly as the men by the occasional bringing-in of a fresh mind to the work.

Repeal of Part of the Science and Art Act, 1913.

50. The recommendations contained in this report will necessitate legislation, and further reference is made to this matter in Section VII below; but the Bill to be submitted should repeal section 9 (1) (*b*) and section 9 (2) of the Science and Art Act, 1913. The duty imposed on the Board of Science and Art by section 9 (2) will be transferred to the new authority. Section 9 (1) (*b*) is not, so far as I have been able to gather, now operative, and I have considerable doubt of the scientific usefulness of a miscellaneous collection of scientific papers of very varied subject, origin, and purpose, especially in these days of high prices for printing and binding.

VII. The Organization of the Central Scientific Authority.

51. I recommended that the central scientific authority should be a special Department of the Government without any administrative authority, but with executive power in the conduct of scientific work for the State and for the benefit of industry. It should not be attached to any of the

administrative Departments of the Government, but it should be ready to assist them all within its means and power. Its findings should find acceptance entirely on their merits, and for this reason it must be free from any suspicion that they are influenced or conditioned by the necessities of the regulative or productive organs of the State or by political exigency. I am accordingly of the opinion that the new Department of Scientific and Industrial Research should be under the immediate supervision of the Prime Minister, who stands for the Government as a whole, and in times of peace is as much responsible for the systematic progress of the nation, which the new Department is intended to promote, as he is for its defence in time of war.

52. In scientific things the Prime Minister must, I suggest, seek the advice of men of science of independent mind and sound judgment, as in executive things he must be advised by trained administrators. The organization here proposed seeks to give expression to this differentiation of function.

An Advisory Council.

53. I recommend accordingly that the Department should include a small Advisory Council of scientific men and men of affairs responsible for advising the Prime Minister on the programme and cost of work to be undertaken by the several establishments attached to the Department, and on the grants to be made to individuals, or to outside bodies—*e.g.*, research associations or co-operative laboratories for the finance of which the Department is not responsible. The Council should also be entrusted with the appointment of persons, whether officials or otherwise, to the committees in scientific supervision of its own establishments. But officials of the Government should not be members of the Council itself, which would be appointed by the Prime Minister after consultation with the National Research Council if and when this body is established, and, until this happens, with the governing body of the New Zealand Institute. Much will depend on the selection of the right man as chairman of the Council. He should be a man wise in counsel, wide in outlook, with an interest in scientific things, a sense of proportion, and a capacity for getting men to pull together. He will not have any executive duties, but he will play an important role in framing policy for the Prime Minister's consideration. The ordinary meetings of the Council should be held monthly, except during the usual recesses. It is suggested that the chairman and first members of the Council should be appointed for a period of four years, and that thereafter the members should retire according to a rota. The number of the Council in the first instance should not exceed six. The powers and duties of the Council should be—

(i.) To consider and report to the Prime Minister upon the scientific aspects of all proposals made to the Department for the encouragement of scientific research or the organization of industrial research from whatever source they may arise; and to initiate such proposals themselves if they think fit.

(ii.) To submit annually to the Prime Minister a programme of the work, with estimates of cost, for each of the scientific establishments under the control of the Department, together with detailed estimates of all moneys proposed to be expended by the Department in grants to individuals or to outside bodies.

(iii.) The Council should also have the power of tendering advice to the Prime Minister on the scientific aspects of any proposals made by other Departments affecting the scientific or industrial interests of the people.

(iv.) The Council may appoint such committees as they think fit.

Honoraria and Quorum of Council, &c.

54. The members of the Council should receive an honorarium for their services, paid, I suggest, annually, and not according to attendance; and the chairman, in view of his greater responsibilities, should receive a salary for his part-time services. The payment of a fee for each attendance is apt to lead members of a committee to think they may fairly absent themselves if it is not quite convenient to attend. It is important, however, that attendance at the Council should be regular, and the receipt of a yearly honorarium makes the responsibility for absence a serious one. Leave of absence should always be sought in writing from the chairman.

55. In view of these considerations I recommend that the quorum of the Council be three.

56. The ordinary travelling-expenses and subsistence allowances should be payable to members of the Council and of the supervisory committees of scientific establishments and institutes under the control of the Department.

57. In order that the Council may be in the position to review the activities and expenditure of the Department on scientific work before submitting the annual programme and estimates to the Prime Minister, the several committees of supervision for the laboratories, services, and institutes under the administration of the Department should be required to submit annual programmes of work, together with estimates of cost, for the consideration of the Council.

58. In order that the Council may be made aware of the policy of other Departments in scientific matters, and that those Departments may know the proposals of the Council and consult with them so as to secure unity of purpose and action, I recommend that the several Departments of State concerned in any aspect of scientific work should nominate their chief administrative officer to act as assessor at the ordinary meetings of the Council. An assessor should receive the agenda paper and minutes of all ordinary meetings of the Council, and should have power to attend and take part in the proceedings of the Council but not to vote.

The Executive.

59. The financial and executive powers of the Department should be in the hands of a permanent secretary with the necessary subordinate staff. The secretary of the Department should also be the secretary to the Advisory Council and act as the liaison officer between that body and the Prime Minister. It is essential that he should be a man of high administrative capacity and experience, and if he also has scientific qualifications so much the better. But administrative powers are the first necessity. As he will necessarily furnish the driving-force for a new and difficult undertaking, he should also be a man in the prime of life ; and, since the success of the new Department will largely depend upon the degree to which it can secure the sympathy and co-operation of other Departments, he should be well endowed with judgment and tact. His status in the Service and his remuneration should be comparable with those of other heads of Departments.

60. The secretarial staff of the Department would be used, among other purposes, for supplying secretaries to the various supervisory committees to be appointed under the Department and for taking the necessary executive action. The executive staff of any laboratories, services, or institutes of the Department established or transferred under the scheme outlined above would be officers of the Department for the purpose.

The organization of the Department is represented diagrammatically in Appendix B.

Functions of the Department.

61. The functions of the Department should be defined, I suggest, in broad terms, which might be further defined, as necessity arises, by Order in Council. The following definition is suggested :—

(i.) To encourage scientific research and to organize its application to the primary and secondary industries.

(ii.) To maintain and administer—

- (*a.*) The Geological Survey.
- (*b.*) The Magnetic Survey.
- (*c.*) The Meteorological Office.
- (*d.*) The Hector Observatory.
- (*e.*) The Samoan Scientific Service.
- (*f.*) A Laboratory for Standards and Tests, to include the present Dominion Laboratory (Government Analyst's Department), the laboratory of the Public Works Department and Main Highways Board, the testing laboratories of the Railway Department, and such local provision for similar work as may be thought desirable.
- (*g.*) Such other State laboratories as may hereafter be transferred to it.
- (*h.*) Such special institutes as may hereafter be established by Government for research or for the application of science to the primary or secondary industries.

(iii.) To advise Government on scientific policy.

(iv.) To hold and administer land and other property (whether under trust or not) for the promotion of scientific or industrial research.

Finance.

62. It is very difficult to form an estimate of the cost of the proposed Department to the Exchequer. If it is successful and wins the confidence of the people its expenditure will undoubtedly grow, and the growth will be justified. At first, however, its work will largely consist in the review and co-ordination of already existing expenditure on the State laboratories and services enumerated in (ii) (*a*) to (*f*) above and in making careful plans for the developments recommended in this report. In its first year of existence the cost to the State, additional to the expenditure already sanctioned, should not, I think, exceed £7,000, exclusive of office accommodation, furniture, stationery, routine printing, and the like. As its plans develop, however, with the sanction of the Government, the expenditure is certain to expand, though a large part of the increase will bring with it corresponding contributions from the industries concerned.

VIII. Miscellaneous Recommendations.

Records Section.

63. The central authority I recommend should be established will itself be responsible for the collection of a wide range of scientific papers and reports by the various establishments and organizations under its ægis. These papers and reports should include those prepared by scientific workers employed by co-operative bodies aided by the central authority, whether, like that at Hawera, they are connected with a primary industry, or with a secondary industry under one or other of the methods of co-operation proposed in paragraph 35. It should be a condition of all grants in aid of a research organization that all results are sent at once to the central authority. A small section of the head-quarters office should be devoted to the collation and abstracting of these results, and, in so far as they are not confidential to a particular industry or group of manufacturers, the results should be circulated at regular intervals, not only to the research bodies connected with the Department but to the corresponding central authorities at Home and in other Dominions, in the same way as monthly abstracts from my Department are sent to the Dominion. This arrangement will help to keep the Empire informed of the progress of scientific work in each of its parts. It will also be of great help and assistance to the industries that are taking an active part in the work.

A Science Library.

64. The Report of the Select Committee of the House on industries issued in 1919, and Dr. J. Allan Thomson in a memorandum submitted to the Government Committee in 1925 (see Appendix A, Sections 5 and 6) call attention to the inadequacy of the scientific libraries in New Zealand, and to its hampering effect upon the scientific worker. The committee recommended the establishment of a central reference library, while Dr. Thomson recommended "the publication of adequate library catalogues." A really representative library of scientific literature centrally placed would undoubtedly be of the greatest value to science, but the capital cost of bringing it into existence rapidly and supplying the necessary housing would be very great indeed, especially if it was to be additional to existing libraries in Wellington. It is much to be hoped that all the present scientific books and pamphlets in the different libraries in the capital, both those in Government and those in other institutions, may ultimately be housed under a single roof and arranged in such a way as to make them the nucleus of such a library as the committee desired to see. But there are many difficulties to be overcome before such a plan could be put into effect, and in the meantime some improvement on the present unsatisfactory condition is urgently called for.

65. Dr. Thomson's suggestion of adequate library catalogues published for the use of scientific workers would do something if carried into effect, but I venture to think that it is possible to improve upon his plan without too serious an increase of cost and with a great improvement in convenience and utility. I recommend that it be the duty of the new central scientific authority to prepare and publish a catalogue of all scientific books, pamphlets, and journals in the public and (so far as possible) in the private libraries of the Dominion, with an indication of where copies of each publication are to be found, and the number of copies available. Each library should agree to lend copies on suitable conditions to serious workers wherever they are working. The central authority should itself make good any gaps of importance in the combined list, and keep these supplementary copies in their own charge for loan or consultation. Books or journals for which there is considerable demand (other than text-books) the supply of which is inadequate in existing libraries should also be added to the central store. In this way a complete scientific lending library might be brought into existence at the minimum of cost, though with the inevitable delay in availability due to its dispersal throughout the Dominion. But delay is less serious than denial. The Workers' Educational Association has established just such a supplementary lending library in London with conspicuous success. Each scientific centre and worker would know at once from the general catalogue where what was needed could be found, and the annual publication of a list of accessions would keep the original volumes up to date. It would probably be necessary, in the interests of economy, to confine the actual publication to authors and titles, but a subject catalogue should gradually be prepared on cards at the headquarters office, which could be consulted by the public and supplied to institutions at the bare cost of copying them.

National Research Scholarships.

66. What has already been said of the serious shortage of qualified research workers in the Dominion makes it necessary that the new central authority should place the provision for the training of promising young persons in scientific research and the encouragement of research by existing investigators in the forefront of their programme. If they do not, it is certain that competent workers will not be forthcoming for the various scientific institutes and co-operative undertakings which it will be the duty of the new authority to promote. Young men and women of the requisite ability will undoubtedly be forthcoming to undertake the necessary training if once it is realized that there will be openings for them afterwards. Accordingly I recommend that the funds at present available for the granting of National Research Scholarships be transferred to new authority, and that, together with some additional money, it be expended in maintenance grants to promising young workers in science. The awards should be made by the authority itself on the recommendation of the student's professor, and should be sufficient, together with any assistance he can obtain from his college or other local sources, but not more than sufficient, to meet his expenses for a period of two years. The authority should be empowered to make the grant conditional on the student going elsewhere, whether in the Dominion or beyond it, if such a course is thought to be necessary. But one of the objects of the grants should be to help professors of original powers gradually to build up a school of research. Students in receipt of grants should be encouraged to do a strictly limited amount of teaching in the laboratories of the college—but not more than six hours a week—not in the interests of the college so much as in the interest of the student in training himself.

67. Means should also be provided to enable the central authority to make grants to professors and others engaged in research work of value, to be expended on the payment of research assistants or the purchase of special and expensive apparatus. In this way the productivity of existing original workers would be increased. These grants should not be used to supplement the salaries of existing teachers but for the employment of full-time workers. The central authority should enter into an agreement with the New Zealand Institute to prevent any overlapping between their own grants and those of the Institute. Such an arrangement has been made between the Department of Scientific and Industrial Research at Home and the Royal Society with very satisfactory results.

The cost of these two services should not exceed £2,000 a year for some years to come, part of which is already covered by the present expenditure on National Research Scholarships.

The New Zealand Institute.

68. I recommend that the present grant to the New Zealand Institute be continued; that they be assisted to pay off their heavy overdraft to the Government Printer; and that thereafter they be required to make their own arrangements for printing.

A National Research Council.

69. If the encouragement of scientific research and the organization of industrial research is to become a declared function of the Government as recommended in this report, it appears to me to be of great importance that the men of science in the Dominion should be encouraged to organize themselves on a completely unofficial basis. Such an unofficial body of the best scientific opinion, if fully representative of all branches of science (including medicine and engineering), would be a most valuable support to the Government in influencing public opinion and by offering friendly criticism and suggestions to the Government on its official policy. The best of Departments is the healthier and better for instructed outside criticism, while occasions may well arise—*e.g.*, the selection of representatives of the Dominion at important international science congresses—when the Government would be glad to seek the advice of an independent body other than itself. The New Zealand Institute has many but not all the qualifications needed in a body of this kind. It is specially strong on the biological side, in geology and chemistry; but it is not representative of engineering, nor of medical science; and I understand that the astronomers have recently formed a society of their own. Moreover, the Board of Governors is in large part elected on a popular basis by local institutes in a manner that gives no assurance of a suitable balance of the sciences in the governing body, while two are official members and a further four of its members are appointed by the Government. It is an old and distinguished foundation which is obviously doing most valuable work, and it would be doubtfully wise to suggest any change in its constitution. But it might well be invited by the Government to take a leading part in bringing a body into existence which would be truly representative of the best men the Dominion has in all branches of science. Such a body, if elected by the leading representatives in each field of work, would become the National Research Council for New Zealand. It would become affiliated to the International Research Council, like the National Research Council of Australia. The Dominion would take her proper place in the international world of science, and her Council would exercise naturally and inevitably the valuable functions referred to at the beginning of this paragraph. On this Council the Fellows of the Institute would certainly hold an important place.

70. As I understand that the rate of subscription by National Research Councils to the International Council is based upon a minimum population of five millions, I suggest that the Government might suitably make a grant-in-aid to the National Research Council, if and when established, towards the cost involved.

Scientific Liaison Officer in London.

71. Finally I recommend that a well-qualified scientific man of wide interests should be attached to the High Commissioner's Office in London to act as a liaison between the Department of Scientific and Industrial Research and the new Department in the Dominion. I believe a trained man of science who would in time become acquainted with the principal centres for scientific work at Home, and would have a general first-hand knowledge of what was going on, could not fail to be of great assistance to the High Commissioner and to the Dominion Government in dealing with many of the offers and proposals made by people with schemes to push. He would also be able to help, no doubt, in connection with the business of the Imperial Institute, of which the High Commissioner is an *ex officio* Governor, and with the business of the Committee of Civil Research of the British Cabinet, of which the High Commissioner will also be a member, when it is dealing with matters affecting the Dominion. The officer would further, I suggest, be of service as an adviser to young men of science whom the Dominion Government may attach to one or other of the research establishments of the Home Government in accordance with the recommendations contained in paragraphs 29, 34, and 42.

IX. Summary of the Principal Recommendations.

72. My recommendations may be summarized as follows:—

(1.) A new Department of Scientific and Industrial Research should be established by Act of Parliament under the charge of the Prime Minister. (Paragraph 51.)

(2.) The functions of the Department should be—

(i.) To encourage scientific research and to organize its application to the primary and secondary industries (paragraph 61):

(ii.) To maintain and administer—

(*a.*) The Geological Survey (paragraphs 43–45):

(*b.*) The Magnetic Survey (paragraphs 43–45):

(*c.*) The Meteorological Office (paragraphs 43–45):

(*d.*) The Hector Observatory (paragraphs 43–45):

(*e.*) The Samoan Scientific Service (paragraphs 43, 44, 46):

(*f.*) A laboratory for standards and tests, to include the present Dominion Laboratory (State Analyst's Department), the laboratory of the Public Works Department and Main Highways Board, the testing laboratories of the Railway Department, and such other local provision for similar work as may be thought desirable (paragraphs 38–42):

(*g.*) Such other State laboratories as may hereafter be transferred to it:

(*h.*) Such special institutes as may hereafter be established by Government for the application of science to the primary or secondary industries (paragraphs 24–26, 29, 30, 32–34, 35)

(iii.) To advise Government on scientific policy:
(iv.) To hold and administer land and other property (whether under trust or not) for the promotion of scientific or industrial research.

(3.) The Department should include an Advisory Council of not more than six members, who should not be Government officials, to be appointed by the Prime Minister after consultation with the National Research Council of New Zealand when this body has been established, and pending its establishment, with the New Zealand Institute. (Paragraph 53.)

(4.) The Chairman of the Council should be appointed by the Prime Minister and receive a salary for his part-time services. (Paragraphs 53, 54.)

(5.) The members of the Council should receive a yearly honorarium, and they should seek written leave of absence from the chairman from the Council meetings. (Paragraph 54.)

(6.) The Council should meet monthly, with the usual recesses. (Paragraph 53.)

(7.) The Chairman and members of the Council should be appointed in the first instance for four years, and retire thereafter according to a rota. (Paragraph 53.)

(8.) The Chairman and members of the Council and members of the committees charged with the scientific supervision of laboratories, services, or institutes under the administration of the Department should receive the travelling and subsistence allowances usual in the public services. (Paragraph 56.)

(9.) The quorum of the Council should be three. (Paragraph 54.)

(10.) The powers and duties of the Council should be—

(i.) To consider and report to the Prime Minister upon the scientific aspects of all proposals made to the Department for the encouragement of scientific research or the organization of industrial research from whatever source they may arise; and to initiate such proposals themselves if they think fit.
(ii.) To submit annually to the Prime Minister a programme of the work, with estimates of cost for each of the scientific establishments under the control of the Department, together with detailed estimates of all moneys proposed to be expended by the Department in grants to individuals or to outside bodies.
(iii.) The Council shall also have the power of tendering advice to the Prime Minister on the scientific aspects of any proposals made by other Departments affecting the scientific or industrial interests of the people.
(iv.) The Council may appoint such committees as they think fit. (Paragraph 53.)

(11.) The permanent Secretary of the Department should be Secretary of the Council. (Paragraph 59.)

(12.) The several Departments of State concerned in any aspect of scientific work should nominate their chief administrative officer to act as assessor at the meetings of the Advisory Council. An assessor should receive the agenda paper and minutes of all ordinary meetings of the Council, and should have power to attend and take part in the proceedings of the Council, but not to vote. (Paragraph 57.)

(13.) The scientific laboratories, services, and institutes administered by the Department should be under the immediate scientific supervision of special committees (appointed by the Council), who shall submit annual programmes of work, together with estimates of cost, for the recommendation of the Council to the Prime Minister. (Paragraphs 24, 58.)

(14.) The committees of scientific supervision for institutes should consist of (*a*) representatives of science, (*b*) scientific members of the appropriate Departments of State, and (*c*) representatives of the industry concerned, nominated by the appropriate Board of Control for the industry where such a Board exists. (Paragraphs 24, 25.)

(15.) The Departments should forthwith appoint committees to work out plans for and subsequently supervise scientifically the proposed laboratory for standards and tests, research into the transport of meat and fruit, into fuel and into forestry and forest products. In making their plans the utmost use should be made of local facilities. (Paragraphs 29, 32, 34.)

(16.) The Government should invite a forester of the highest standing to visit the Dominion, survey the whole position of forestry, both native bush and planted areas, and report as to the feasibility of a more extended forward policy. (Paragraph 31.)

(17.) The first institute to be established should be that for dairying on the site of the proposed College of Agriculture. (Paragraph 25.)

(18.) The Department should encourage and aid the formation of co-operative research organizations by the secondary industries. (Paragraph 35.)

(19.) The Department should establish a section of records under the Permanent Secretary, and a section for compiling and publishing a comprehensive catalogue of all scientific books, pamphlets, and journals in the public and, so far as possible, the private libraries of the Dominion. (Paragraphs 63–65.)

(20.) The Department should establish a central lending and reference library of scientific books and publications not found or available in existing libraries. (Paragraph 65.)

(21.) The executive of the Department should consist of a permanent Secretary of administrative experience and capacity, and of such subordinate staff as may be necessary. The secretaries of the special supervisory committees of laboratories, services, and institutes, and their executive officers, should be members of the executive staff of the Department. (Paragraphs 59, 60.)

(22.) The funds now available for National Research Scholarships should be transferred to the Department as part of a total provision of £2,000 a year for grants to students training in research and for grants to assist independent research work. (Paragraph 66.)

(23.) A National Research Council of New Zealand should be established and affiliated to the International Research Council, and a grant should be made to the National Research Council by the Government towards the cost of the necessary subscription on affiliation. (Paragraph 69.)

(24.) The present grant to the New Zealand Institute should be continued, and they should be assisted to pay off their overdraft to the Government Printer and be required thereafter to make their own arrangements for printing. Arrangements should be made between the Department and the Institute to prevent overlapping in the award of grants to individuals. (Paragraphs 67, 68.)

(25.) Two technical field officers should be attached to the Department of Industries and Commerce. (Paragraphs 37, 49.)

(26.) A well-qualified scientific man should be attached to the High Commissioner's Office in London, to act as liaison officer between the official research organizations at Home and the new Department here. (Paragraph 71.)

73. In conclusion I desire to record my indebtedness to my private secretary, Mr. T. J. Sherrard, of the Department of the Public Service Commissioner, whose willing and quiet service has been of the greatest assistance to me not only throughout my journeys but also in the preparation of this report.

I have, &c.,
H. Frank Heath.

APPENDIX A.

(1.) Organization of Scientific and Industrial Research in New Zealand: Report by Dr. J. Allan Thomson, 20th July, 1916.

In England, a large part of the failure to appreciate the value of research is ascribed to the classical education of permanent officials and politicians.

The belief that the expert—whether scientific or industrial—has to be controlled or guided by permanent officials having no special knowledge of the particular subject in hand is typical of our executive system. While such a state of things exists, most of the advantages of enlisting men of science for national services must remain unfulfilled. The various scientific committees which have been appointed have been able to give valuable aid in connection with problems submitted to them, but they would be far more effective if the chiefs of the Departments with which they are associated possessed a practical knowledge of scientific works and methods. Without such experience the executive is at the mercy of every assertive paradoxer, and cannot discriminate between impracticable devices and the judgment of science upon them. While, therefore, the country has at its disposal the work—either voluntary or nearly so—of experts in all branches of applied science, it cannot use these services to the best advantage unless the Department concerned with them have scientific men among the permanent officials, and this is not the case at present. . . .

Unless the national attitude to scientific investigation can be improved much more greatly than it promises to be, any scheme for the Government organization of research and its application to our primary industries and manufactures is doomed to poor success. It is easy for the Government by the provision of sufficient money to organize research, alike on the improvement of existing methods, on the utilization of raw materials and by-product at present going to waste, and on the creation of new methods and products, but without a body of industrialists prepared to co-operate with the scientific inventors the research will be wasted. . . .

Research in relation to industry differs from purely scientific research only in the nature of the problems to be solved and in the scale on which experiments must be conducted. Otherwise the methods are exactly the same. It cannot be too strongly insisted that the discoveries of pure science may at any time prove to have an economic value, and that the prosecution of industrial research cannot outrun the prosecution of pure science, but generally follows it at a distance. The German success has lain largely in the fact that her industrial scientific men have had a training in, and can appreciate, pure science, and have been able to keep the distance between the discoveries of pure science and their industrial application at a minimum.

It is probably a mistaken policy in New Zealand to offer research scholarships in industrial science to young graduates, for their training in research methods and their knowledge of the field of pure research must of necessity be extremely limited, while their knowledge of the methods and problems of industry is almost nil.

Such research work as has been carried on in New Zealand is hampered at all points by the lack of a reasonably complete and accessible scientific and technological library, and this lack is undoubtedly the reason that New Zealand research as a whole has not reached a higher standard both in pure and applied science. It is certain that any Government scheme for the organization of research must fall far short of the best results until such a library is constituted. . . .

The main needs of industry are research on special problems, some of which have already been defined and partially solved, while others await solution and in some cases even definition. Such problems are the utilization of inferior coals, the economic smelting of Taranaki ironsands, the recovery of kauri-gum from snags, the preparation of fibre from flax, the utilization of the waste in the fish and meat industries for oil and fertilizers, the exploitation of peat bogs, and many others. An important function of any body set up to organize research will be the survey of the industries of the Dominion with a view to a complete and exact definition of the problems awaiting solution. . . .

The weak points of the present system as regards science are that scientific men are placed under administrative officers who have little or no knowledge of science, there is a great danger of lack of co-operation between the scientific men of different Departments, and the various Departments each strive to build up a reference scientific library without any regard to the other Departments. There is no provision, such as exists in the Government of India, for a Board of Scientific Advice, which would review annually the proposed problems of those industries not directly provided for by department or sub-departments. . . .

(2.) Organization of Scientific and Industrial Research in New Zealand: Report by G. Hogben, Esq., C.M.G., and Dr. J. Allan Thomson, 2nd October, 1917.

At the annual meeting of the New Zealand Institute on the 31st January, 1917, the following resolutions, among others, were passed:—

(1.) That scientific research be endowed to a very much greater extent than has been done in the past.

(2.) That the importance of research in pure science be recognized as of equal importance with that in applied science. . . .

The subject was also considered on the 1st February, 1917, by the Board of Science and Art, and the following resolution, among others, was adopted:—

(1.) That, in accordance with section 9 (2) of the Science and Art Act, 1913, this Board advises the Government to constitute a General Advisory Board for the Co-ordination of Science and Industry. The Board so constituted should include representatives of the business, industrial, and agricultural sections of the community, and of scientific men and educational experts. That, further, Local Advisory Committees of similar constitution be formed in the chief centres. . . .

The General Council of Education in 1917 adopted the following recommendations:—

(1.) There should be a National Advisory Council on Research, consisting of (*a*) four scientific men, one of whom should be a scientific expert attached to a Government Department, (*b*) three members connected with the leading industries of the Dominion, one of whom should represent agriculture.

(2.) The National Advisory Council should—

(i.) Consider and allot to the proper persons for investigation all proposals for specific researches (or at its discretion such proposals). The proposals might be referred to it by the Efficiency Board, or might come from institutions or societies or private persons, or might originate in the Council itself.

(ii.) The Council might also consider the problems affecting particular industries, to determine along what lines research might be instituted.

(iii.) The Council should award and supervise the tenure of the Research Fellowships mentioned below, and should, on the request of the University of New Zealand, consult with and advise the Senate of the University in matters relating to the National Research Scholarships in the award of that body.

(iv.) The Advisory Council should consider and advise the General Council of Education as to the lines along which there could be brought about a general improvement in scientific education with a view to the training of experts, and should co-operate with that Council and other public bodies in taking such steps as may lead to the better appreciation of the aims and advantages of science on the part of producers and the general body of citizens.

(3.) In addition to the existing National Research Scholarships (the number of which should be increased) there should be established Research Fellowships tenable for two, three, or more years by men or women qualified and willing to conduct researches approved by the Council. (The fellowships should be of sufficient value to prevent the possible holders from being attracted away to other positions.) . . .

(3.) Co-ordination of Science and Industry: Report by a Committee of the Auckland Institute, 20th November, 1916.

Given a limited stage in the advancement of pure science on the one hand and, on the other, a stage in the development of an industry which may be called the "pioneering" stage, these "practical" qualities are far more speedy, labour-saving, and generally effective than the more tedious methods of intellectual guidance. With the increasing development and complexity of industry, however, the time arrives in many of its branches, later in some than in others, when the weaknesses inherent in a system of control which lacks accurate knowledge and is incapable of applying scientific methods becomes more and more glaringly apparent. Unorganized intuition and general good sense having spent their force, having reached their limit, then it is that those nations which first appreciate the necessity for a radical change of system are likely to capture all the industries which have advanced beyond the intuitive stage, leaving to the less intellectual nations those which require for their operations inferior powers of mind. . . .

(4.) Remarks by a Committee of the Auckland Institute on a Report circulated by the Industrial and Research Committee of the New Zealand Institute, 1916.

The indefinite and more or less irrational hopes which are in evidence at the present time as to the aid which science can give to industry are to some extent the product of a misunderstanding on the part of industrialists as to what initial sacrifices may be required of them in order to obtain and give effect to the recommendations of science, and, on the other hand, they are in a measure due to some lack of appreciation on the part of scientific men of the stage to which, empiricism, in the hands of men of acute common-sense, has brought industrial operations. The present state of feeling on the subject is an encouragement to establish some institution for the furtherance of the co-ordination desired; but if nothing further is done that feeling is likely to change, and the reaction will be a menace to success. . . .

(5.) Report of a Select Committee set up at the Request of the Government to report on Matters and encourage the Industries of the Dominion, Wellington, 27th August, 1919.

In few respects has the evidence impressed the Committee more forcibly than in this: that there are many pressing scientific problems awaiting solution in this country. These problems concern nearly every large industry, it may be even vitally—as, for example, in the case of the disease threatening the flax industry; while untold wealth awaits the result of scientific investigation into our coals, peats, oils, clays, timbers, and other natural resources, and in even greater degree the intensive application of science to the problems of agriculture.

The Committee, after careful consideration, has come to the conclusion that there will be a much greater prospect of such problems being promptly taken in hand if they can be referred to a body the almost sole duty of which it will be to deal with them, and which will not be subject to delays such as those due possibly to the exigencies of the political situation or the passing of a vote on the estimates, but have an assured finance. Such a body will also be able to organize and co-ordinate effort throughout the Dominion. . . .

The Committee further recommends that there shall be established a central reference library under the control of the Board, containing the most important works relating to trade, commerce, science, and industry, and containing also the trading and manufacturing journals; for without access to an efficient scientific and techological library an investigator must be greatly hampered in his work. The library should under proper regulation, be available for persons in any part of the Dominion. In order to avoid duplication it is suggested that existing scientific libraries in Wellington should be, as far as possible, merged.

(6.) The Memorandum submitted to Scientific and Industrial Research Committee by Dr. J. Allan Thomson, July, 1925.

All branches of research in New Zealand, pure research in all its branches, applied researches relating both to primary production (agriculture, forestry, fisheries, mining) and to secondary industries, are hampered by the inadequacy of the scientific libraries in New Zealand. As research is mainly carried on in the four main centres and in the Cawthron Institute, the resources available are necessarily spread over libraries in five centres, resulting in greater local efficiency, but a loss in efficiency of any one library in the Dominion as a whole. This is inevitable. An improvement in the position can be effected by greater co-ordination and co-operation between the various libraries with the two aims of minimizing duplication in the purchase of books and of making the whole library resources available to all workers in the Dominion. The latter aim would be best served by the publication of adequate library catalogues. . . .

An alternative proposal is that the industries should group themselves and combine for the purpose of themselves financing industrial research, perhaps with Governmental subsidy. Undoubtedly there are possibilities in this direction, but it would not meet the whole need for New Zealand. The industrial research that is needed in this country is not only that affecting large established industries like the freezing and flax industries, but that affecting new or weak industries such as papermaking. Any scheme adopted should recognize the probable increase not only in the size but in the number of the secondary industries in New Zealand. Perhaps the best form of Governmental assistance would be a system of subsidies to research associations of the larger industries, combined with direct endowment of research into problems affecting new or weak industries.

(7.) Research in New Zealand: Address by P. Marshall, M.A., D.Sc., President New Zealand Institute, 1926.

It would certainly improve the prospects of successful research if the efforts of investigators in this country were more organized. At the present time it may often happen that overlapping takes place. One and the same subject of research may be attacked by workers in different parts of the country, both of whom may labour over long preliminary observations and measurements without knowledge of one another's activities, and also without that encouragement and mutual assistance which results from comradeship, more especially in research than in other activities of life.

While it is a maxim with scientific men that no distinction can be drawn between pure scientific research and economic research, it still remains true that there are certain industries and pursuits that seem to require the aid of research in order to remove some difficulty in operation or to improve the quality of the product.

It is research of this kind that is most favoured and encouraged in New Zealand. While it is obvious that direct attack of the problem is the most promising, it may often be the case that the final solution will be obtained from some other line of research which may appear remote from the problem and devoid of bearing on it.

It is perhaps in connection with the utilization of brown coals that work on our mineral resources has its most promising outlook. The fragile nature of these fuels when burning renders them unsuitable for use on the railways. Much work is now being done with the object of treating them in such a way as to render them of service for this purpose. Success would ensure the employment of much additional labour, and the firing of locomotives in the North Island at least would be less costly.

(8.) Report by Dr. Marsden on Scientific and Industrial Research, unanimously endorsed by the Committee on Scientific and Industrial Research appointed by the Internal Affairs Department, Wellington, 1925.

The real foundation for such help as the industrialists require should be the extension of Dr. Maclaurin's laboratory to include tests of a physical nature. The cost would probably be some £10,000 for buildings and £10,000 for equipment, while there should be added to his staff one good engineer-physicist at a salary of approximately £600 per annum, one research physical chemist, and a first-class mechanic with a workshop. The physicist should be chosen and sent to the National Physical Laboratory, London, for one year's training. The functions of the Dominion Laboratory would then be extended by the following:—

(1.) The custody of the standards, which involves their care and preservation, and also the intercomparisons and researches necessary to maintain the constancy of such standards as are liable to change.
(2.) The construction of standards as required by scientific or technical progress.
(3.) Standardization of measuring apparatus for manufacturers as a test of their output, or for the user that he may verify instruments or materials independently.
(4.) Technical research upon problems connected with standards.
(5.) Determination of the properties of materials for general use in technology and trade. Tests of length, volume, trade weights and measures, time, electricity, conductivity, electrolysis, testing materials, cements, steels, clays, paints, twines, oils, mass, density, current voltages, resistance, photometry, heat and thermometry, concrete, bricks, inks, mucilages, ropes, paper.

The Bureau should also undertake all testing for Government Departments—Public Works, Railways, Defence (including aeronautics) and Department of Industries and Commerce. There is too much of a tendency for Departments to become watertight in regard to scientific work, and the sooner such an institution as outlined above is established the easier it will be to prevent this overlapping and waste expenditure.

Industrialists must realize that quality of goods depends upon definite measurable properties, and therefore such a laboratory, with standard measuring apparatus and facilities for all kinds of measurements, is really the best way in which they can be helped.

There is a great advantage in the association of the physical and chemical measurements under one head, since most industrial problems require for their solution a combination of these branches of science. Not the least important aspect of such an institution is the enormous part it would play in the event of this country being at war with another. This aspect was well exemplified during the late war by the important part played by the National Physical Laboratory in England, and Bureau of Standards in America. A library should be associated with the suggested central laboratory.

The Director of the Institution would make such use of the laboratories and staffs in the various University colleges and Government Departments as is considered desirable. He would be assisted in his work by the officers of the Department of Industries and Commerce, who would act as liaison officers between the industrialists and the laboratory.

In my opinion such an institution could well be placed under an Advisory Board consisting of representatives of the four chief industrial associations, together with four representatives of the Government. It should be noted that in America the laboratory is placed under the Department of Commerce, and I rather incline to the view that such should be the case in New Zealand.

(9.) Scientific and Industrial Research: Memorandum by Sir Ernest Rutherford, 12th November, 1925.

Dr. E. Marsden, chairman of your Committee on Scientific and Industrial Research, has placed before me the report of your committee, the report of the Canterbury Industrial Association, and reports from the head of the Dominion Laboratory, Secretary to the Department of Industries and Commerce, and Dr. A. Thomson's report on the research publications in the Dominion. I have also inspected the physical and chemical laboratories in each of the four University centres, and the engineering department of Canterbury College, from the point of view of their suitability for carrying out special industrial researches of a physical and chemical nature.

I agree in the main with the proposals put forward by your committee—viz., to make the Dominion Laboratory the nucleus of a Department to advise the Government and manufacturers on the various problems connected with industry and to form a centre for the special scientific investigation required.

The additional staff and equipment proposed—viz., one engineer-physicist, one physicist, and a first-class mechanic with a workshop—should suffice for a start, but it is clear that it will require supplementing as the manufactures develop and the usefulness of the institution becomes apparent.

In order to obtain good men, adequate salaries should be paid, and in no circumstances less than £600 per annum, increasing to a good maximum. The officers should be selected only after expert advice, and if necessary should be allowed to travel for a year to gain experience in the national laboratories of England and Europe. In this way they will become acquainted with the methods adopted in the large research institutions, which play such an important part in the development of industry in the older lands. For example, a visit of some duration to National Physical Laboratory, Teddington, would be advisable and of great value.

No doubt a considerable portion of the time of the new men appointed would be taken up in advising on technical problems, and there would not be much leisure for experimentation unless additional assistance were provided in some way. For this purpose I consider it very desirable that they should obtain the co-operation of such University instructors as may be in a position to help along special lines. For example, no doubt the Engineering School at Canterbury College would be able to give material help, for I understand it already is doing a considerable amount of testing of materials. In a similar way the various chemical and physical laboratories may be able to undertake special investigations. However, from what I have seen, it seems clear that the personnel of the University colleges is already largely occupied in routine duties, and that the professors and assistants would have little time to undertake such investigations themselves. They would, however, be able in many cases to supervise the work of a young investigator detailed to undertake an investigation along lines on which the professors are experts. I feel that much of the research work could be undertaken by young investigators in the laboratory under the supervision of the professors, provided the salaries of the investigators were paid by the Department and a reasonable sum allowed for expenses. (I understand that the National Research Scholarships are intended for some such purpose.) In this way the investigation could be carried out at a minimum cost, and with benefit both to University and State, by bringing scientific and State industrial interests more closely together.

The question as to whether any special research should be undertaken by any of the University colleges should be a matter entirely for its own discretion, since obviously the University retains full control of its laboratories and equipment. In addition, if a University department undertakes supervision of a considerable amount of work of this character, some arrangements should be made to give the professor concerned some assistance so that he may give more time to the work. It is essential for the success of such a scheme that the Department should co-operate with the Universities. There will undoubtedly be a tendency for the Department to undertake as much as possible of this work without using the University laboratories to a reasonable extent. In order to see that the work is properly allocated it is desirable to have a strong and independent Board to advise the Department and review each year's work. Such a Board might well have on it one member nominated by the University Senate (not necessarily confined to one of the members of the latter).

It will be important to have a good scientific library situated in or near the central laboratory. Possibly this may be developed in connection with an already existing library of this character. The ideal to aim at is a library such as that of the Patent Office, London.

With regard to the physical and electrical standards of the Dominion, these should be in the custody of the proposed laboratory, whose officers should be in charge and be the final authority on matters of accurate standardization.

(10.) Naval Mission to the Dominion of New Zealand: Report of Admiral of the Fleet Viscount Jellicoe of Scapa, G.C.B., O.M., G.C.V.O., August–October, 1919.

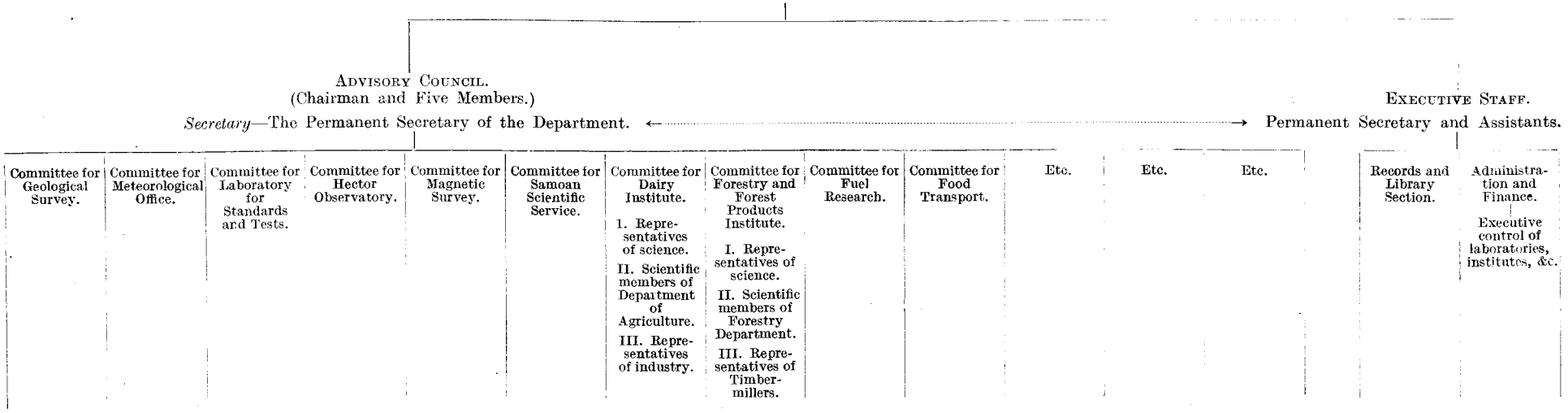
It is recommended that the Admiralty should be asked to keep the New Zealand Naval Board advised as to the progress made by the Scientific Research and Experiment Department. It is also recommended that an organization on similar lines should be provided in New Zealand when practicable.

A number of the best scientists should be selected to form the Department, under the presidency of the C.N.S., New Zealand Naval Board. A scientist of wide experience should be appointed as vice-president.

APPENDIX B.

Diagram of Scheme of Organization.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.



The secretaries and executive officers of the laboratories, services, and institutes will be members of the executive staff of the Department, under the Permanent Secretary.

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