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Organization and Activities
of the
National Research Council

Ottawa
November, 1935.

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SCIENTIFIC AND INDUSTRIAL RESEARCH

CHAIRMAN

NATIONAL RESEARCH COUNCIL

PRESIDENT

DIVISION OF
RESEARCH INFORMATION

ADMINISTRATIVE
DIVISION

NATIONAL RESEARCH LABORATORIES

EXTRAMURAL ACTIVITIES

DIVISION OF
BIOLOGY AND AGRICULTURE

ASSOCIATE COMMITTEES

DIVISION OF
CHEMISTRY

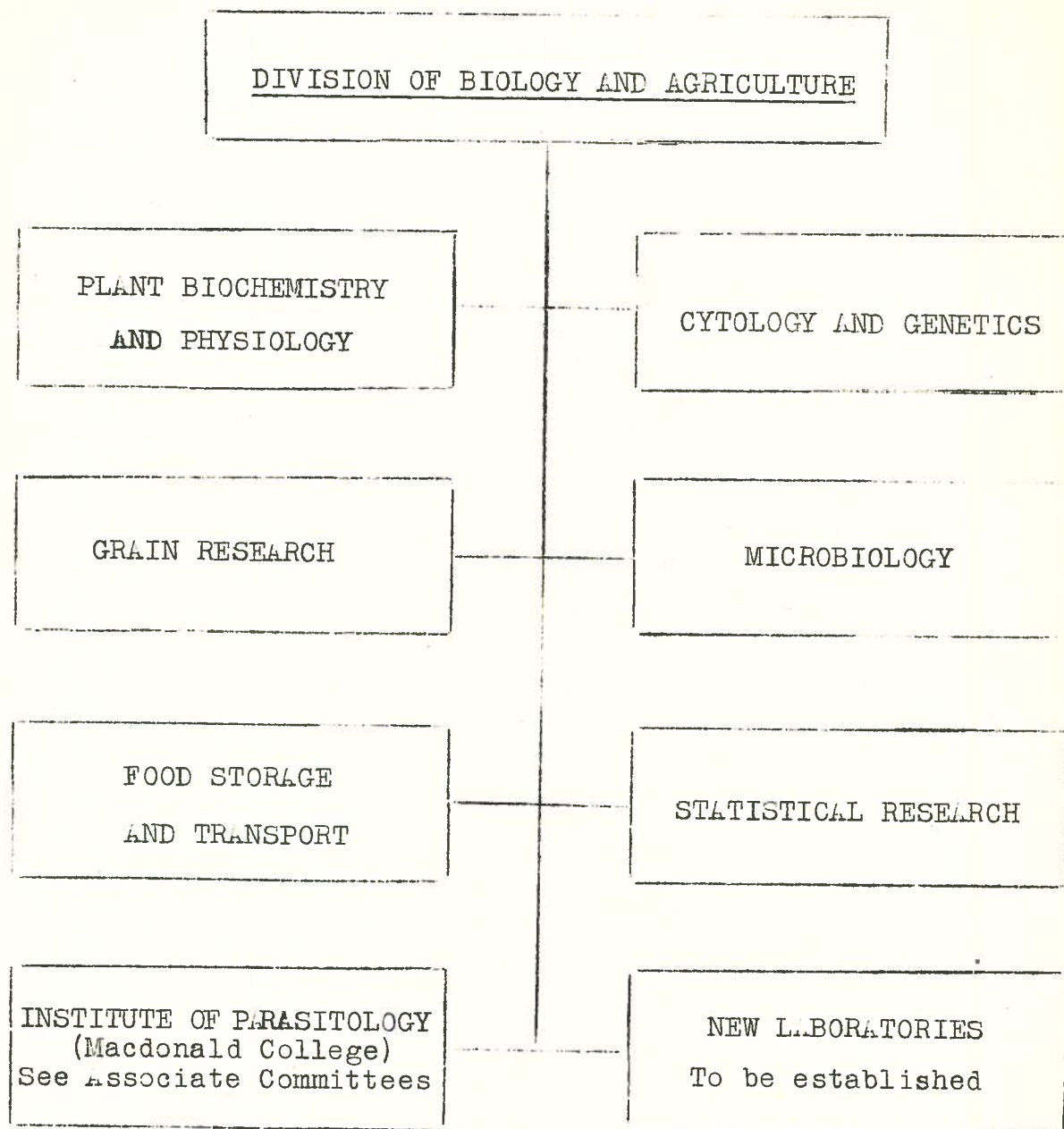
CONFERENCES
WITH INDUSTRY

DIVISION OF
PHYSICS AND ENGINEERING

ASSISTED RESEARCHES

OTHER DIVISIONS
TO BE ESTABLISHED

POSTGRADUATE
SCHOLARSHIPS



For explanatory notes see next page

Explanatory Notes to Accompany Chart of Division of
Biology and Agriculture

Plant Biochemistry and Physiology

- Rust resistance in cereals
- Organic constituents of wheat leaves
- Chemical weed killers
- Plant growth studies

Grain Research

- Wheat and wheat flour
 - Standardization and mechanization of baking tests
 - Gluten proteins
- Barley for malting
 - Cleaning and handling
 - Experimental malting methods
 - Proteins
 - Diastase

Food Storage and Transport

- Celery cold storage
- Poultry cold storage
 - Dechilling and defrosting
- Freezer burn
- Taints

Cytology and Genetics

- Effect of temperature on mutation in cereals
- Hybridization of wheats and wheat grasses

Microbiology

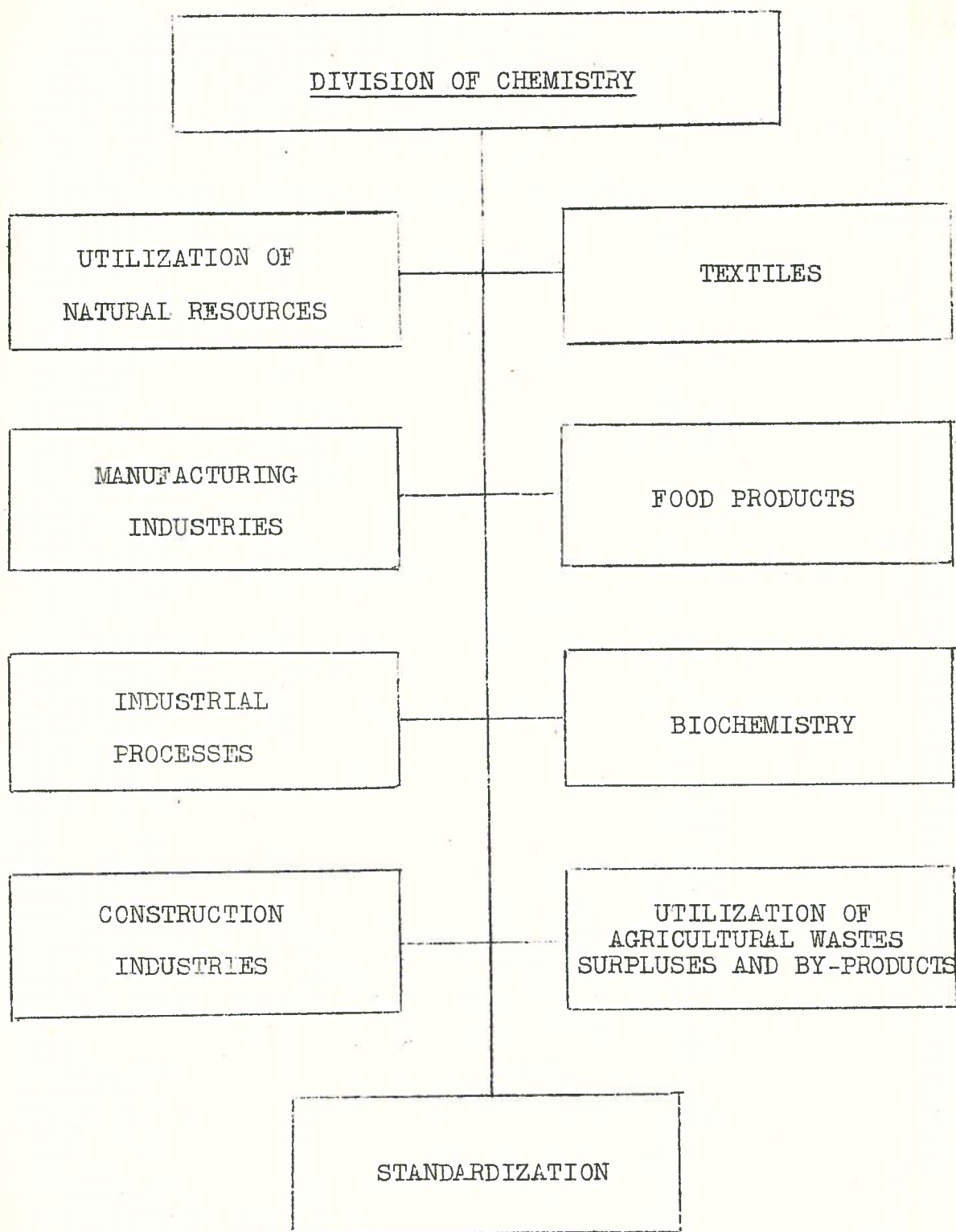
- Root parasites of agricultural plants
- Straw-rotting organisms
- Moulds of foods in cold storage

Statistical Research

- Influence of weather conditions
 - On growth and yield of wheat
 - On protein content of wheat
 - On yield and composition of sugar beets
 - On effect of crop rotation and manuring
- Evaporation measurements
- Accuracy of experimental baking tests
- Effect of fertilizer on yield and composition of barley
- Advisory and collaborative service

New Laboratories to be Established

- Fermentations
- Vitamins and animal nutrition
- Others as required.



For explanatory notes see next page

Explanatory Notes to Accompany Chart of Division of Chemistry

Utilization of Natural Resources

Bitumen
Bentonite
China clay

Diatomaceous earth
Natural gas
Silica

Manufacturing Industries

Adhesives
Leather and furs
Metallurgical refractories

Printing, inks and papers
Rubber
Storage batteries

Industrial Processes

Bleaching and decolorization
Boiler water treatment and
water softening
Corrosion

Distillation
Filtration
Grinding

Construction Industries

Asbestos
Cement
Lime

Composition flooring
Road surfacing

Textiles

Dry cleaning
Dyeing
Laundering

Textile finishing
Mothproofing
Wool manufacture

Food Products

Dehydrated apples
Dehydrated vegetables
Honey

Maple products
Poultry dressing
Sugar refining problems

Biochemistry

Animal and plant sterols
Chemical principles of
plants
Insecticides

Plant alkaloids
Plant hormones
Vitamins, chemistry of

Utilization of Agricultural Wastes, Surpluses and By-Products

Cereal straw
Grain alcohol
Milkweed

Potatoes and potato starch
Refuse screenings

Standardization

Chemicals
Chemical apparatus

Products involving chemistry
Textiles.

DIVISION OF PHYSICS AND ENGINEERING

ELECTRICAL
ENGINEERING

HEAT

GENERAL PHYSICS

OPTICS

ACOUSTICS

METROLOGY

ELECTRICAL MEASUREMENTS
AND
PRECISION STANDARDIZATION

RADIO

AERONAUTICS, HYDRAULICS
AND
MISCELLANEOUS ENGINEERING
(See next page)

MEDICAL RADIOLOGY
Radium
X-rays

DIVISION OF PHYSICS AND ENGINEERING
(Continued)

AERONAUTICS, HYDRAULICS AND
MISCELLANEOUS ENGINEERING

AERONAUTICS GENERAL
Strength-testing of
Aircraft Ribs and Skis

MODEL TESTING BASIN
Aircraft Floats and Hulls
Boats and Vessels
Current Meters

AIRCRAFT AND
ALLIED INSTRUMENTS

GENERAL
HYDRAULIC LABORATORY
to be established

WIND TUNNEL

OTHER LABORATORIES
to be established
as required

AIRCRAFT
ENGINE LABORATORY
Engines, Accessories
Gasoline and Oil

FIRE HAZARDS
Oil Burners
Accessories and Fuel Oil
Miscellaneous Devices

INSTRUMENT AND MODEL SHOPS
(Serving all laboratories)

Blueprinting and Photostating
Cabinet Shop
Electrical Shop

Fine Instrument Shop
Machine Shop
Sheet Metal and Welding Shop

DIVISION OF RESEARCH INFORMATION

PUBLICATIONS

Canadian Journal
of Research

Annual Report

Technical Reports
and Bulletins

Miscellaneous Reports,
Statements for the Press

RESEARCH INFORMATION
SERVICE

Technical Inquiries

Literature Searches

Bibliographies

Translations

EXTERNAL RESEARCH

ACTIVITIES

NATIONAL RESEARCH

LIBRARY

PATENTS

COMMODITY STANDARD

SPECIFICATIONS

ADMINISTRATIVE DIVISION

SECRETARY-TREASURER

UNDER DIRECTION OF THE PRESIDENT: -

GENERAL
ADMINISTRATION

Administration of the staff of the National Research Council; the record of decisions reached by the Council and the issue of instructions required to bring them into effect.

FINANCE

Collaboration with the Representative of the Treasury; expenditures by the National Research Council, including grants in aid of research, postgraduate scholarships, trust funds, etc.

CENTRAL
REGISTRY

Receipt, registration and custody of all correspondence, documents, etc.

PURCHASING

Purchase of all supplies and equipment of whatever nature required in the laboratories, etc.

INVENTORIES
STORE AUDIT AND
COST ACCOUNTING

CENTRAL
STENOGRAPHIC
SERVICE

NOTE: The organization
above set forth is that now
in process of development.

ORGANIZATION AND ACTIVITIES
of the
NATIONAL RESEARCH COUNCIL

ORGANIZATION

The National Research Council was organized late in 1916 as a result of a suggestion of the British Government, which had previously established the Department of Scientific and Industrial Research to advise it in all matters pertaining to science and technology. The Council was at first known as the Honorary Advisory Council for Scientific and Industrial Research, but later authority was given for the use of the short title, National Research Council.

While the National Research Council is thus nearly 20 years old, its activities during the greater part of that period were of necessity through existing research agencies, as laboratory facilities had not been provided. The first small laboratory was secured in 1927 and the present main building was opened in 1932.

The Council operates under the Research Council Act of 1924, a copy of which is attached as Appendix "A". Under that act the Council was established as an incorporated body, responsible to a Committee of the Privy Council on Scientific and Industrial Research. The Minister of Trade and Commerce is Chairman of the Committee. The Council itself consists of 15 members appointed by the Governor-in-Council for a period of three years. Of these, not less than four retire annually.

Members of Council serve without remuneration, with the exception of the President, who is the chief executive officer. The present membership of the Council is given in Appendix "B". The personnel of the Council indicates that while the Government is in no wise limited by the act in its appointments to Council, the members have in practice been chosen with some regard to representation by provinces, sciences, technical departments of the Government service, and industry.

As prescribed by the Research Council Act, appointments to the staff of the National Research Council are made by the Council itself upon nomination by the President, and subject to approval by the Committee. Professional members of the staff are selected by special committees appointed by Council for that purpose. In the case of associate committees established by the Council for the purpose of carrying out specific tasks or undertaking research in special fields of science and technology, persons are engaged by the committee on the authority of the President. Such appointments are, however, of a purely temporary character and are always reported to Council, which reviews at each meeting the activities of its various committees.

All members of the permanent staff of the Council have the privileges of the Superannuation Act and are permitted to take out civil service insurance.

As will be seen by the accompanying charts, the internal work of the Council is organized in a number of divisions, each under a director. The Council has in addition a large number of associate committees, through which co-operation is

effected with other Government departments, scientific departments of the universities, and industry. The work of the Council is also related to that of the universities through a system of assisted researches and through postgraduate scholarships.

The laboratory divisions established to date include Biology and Agriculture, Chemistry, and Physics and Engineering. These are responsible for laboratory researches carried on in the fields of science and technology indicated by the titles. The work of each of these divisions will be described below. To serve these divisions, and to serve also research workers throughout Canada, the Council has created the Division of Research Information. This division has been charged with the maintenance of a bibliographic and literature service, including translations, responsibility for the National Research Library and the Council's publications, and duties relating to patents and specifications. The Administrative Division is responsible for accounting, purchasing, filing and general clerical work, not only for the professional divisions of the Council but also for the administration of the assisted research and scholarship systems.

The associate committees owe their origin to the desire of the Council to enlist the co-operation of the scientific workers of the country in a systematic attack upon national problems. Through these committees the advice and active support of some hundreds of research workers and technologists in Government departments, the universities and industry has been secured, and through their united efforts results of

national importance have in some cases been achieved. **References** to the work of these committees will be **made** later.

"Assisted researches" were established early in the Council's history to provide special apparatus or technical assistants for specialists in the universities who wished to investigate problems deemed by the Council to be worthy of financial support, and who were unable to secure the necessary help from their own institutions. Many contributions have thus been made in the field of pure science, and a number of investigations have had considerable practical assistance. In all, about 250 researches have been carried out under this system, which has been productive of results at a minimum of cost to the Council. Nevertheless, in recent years it has been necessary greatly to restrict this type of work, owing to the radical reduction in the Government vote to the Council and, to the Council's increasing responsibilities in the maintenance of the National Research Laboratories.

The establishment of scholarships grew out of a survey of the scientific man-power of the country, which was made by the Council shortly after its creation and which revealed a serious shortage of scientifically trained men. At that time many of the most brilliant graduates of Canadian universities were going to the United States for post-graduate study and were eventually absorbed into industry there, thus, in many cases, being permanently lost to Canada. In an effort to remedy this serious situation, the Council initiated a scholarship system for outstanding graduates of Canadian universities to permit them to

take post-graduate work in science leading to M.Sc. and Ph.D. degrees. To date some 400 of the most brilliant graduates of Canadian universities have thus been trained, and it is gratifying to know that nearly all have remained in Canada, where many occupy important positions in universities, Government service and industry. In recent years, owing to the shortage of funds, it has been found necessary to reduce the value of individual scholarships by 50 to 65% and some reduction has also been made in the number of awards.

OUTLINE OF WORK BY INDUSTRIES

Agriculture

In researches in this field the Council has worked jointly with the Dominion Department of Agriculture and the agricultural colleges. At present the Associate Committees on Field Crop Diseases, Grain Research, Storage and Transport of Food, Weed Research and Wool are established as joint committees of the Department and the Council, which share in the assignment of, and responsibility for, specific problems and give financial assistance to researches undertaken in the agricultural colleges and universities when such assistance is necessary. Under this co-operative plan, agricultural research is co-ordinated to the best possible advantage, as is evidenced by the results being obtained. For example, in 1925 the Council formed, with the co-operation of the Dominion Department of Agriculture, the Associate Committee on Cercal Rust, since expanded into the Associate Committee on Field Crop Diseases. The researches undertaken in this joint effort have been completely successful

in solving the problem of black stem rust of wheat, estimated to have caused damage to the extent of \$100,000,000 in 1935 alone. It is now mainly a question of multiplying the new rust-resistant varieties until they are available in sufficient quantity for seed, when the rust menace of the prairies will be a thing of the past. It is expected that the distribution of seed to farmers will begin in 1937. Almost equally useful but less spectacular work has been done by the Associate Committee on Grain Research, while the newer committees are also making excellent progress with the problems in their own particular fields.

Special assisted researches, in agriculture, as distinct from those under committees, have likewise been very productive. Their nature is indicated by typical examples, such as the effect of soil acidity on the activity of beneficial bacteria, the destruction of wireworms on the Canadian prairies, fungi, factors affecting the milling and baking quality of wheat, and the relation of bacteria to the quality of butter.

In co-operation with the Empire Marketing Board and other organizations, the Council established the Institute of Parasitology at Macdonald College, and since the dissolution of the Board has assumed its financial support. Such an institute investigating the very destructive parasites of animals, is Empire wide in its significance and in this respect it is comparable with the great agricultural research institutes of Great Britain.

Since the establishment of the National Research Laboratories the Division of Biology and Agriculture has devoted its

whole energies to work in the field indicated by this title, in which also it has co-operated closely with the Dominion Department of Agriculture. In general, the Council assumes responsibility for research of a more fundamental character, as distinguished from the field experiments of the department. The investigations under way will be described in the report of the division. The Division of Chemistry has carried out a number of agricultural researches, including work on potato products, maple sugar, honey, dehydrated apples, the utilization of cereal straw, the wax plucking of poultry, wool, and refuse screenings. The Division of Physics and Engineering has co-operated in a study of physical problems associated with the storage and transport of food.

Forestry

The Council has been less active in this important field on account of the fact that the Dominion Forest Service has undertaken research on a large scale. In several cases the Council has made provision for work which the Forest Service was unable to finance, for example, at Petawawa, Ontario, and in New Brunswick. Part of this work has now been taken over by the Forest Service. Under the system of assisted researches, investigations have been made of the gas and water content of trees in relation to the sinkage of logs, of the very serious bark disease of the beech, and of a number of other forestry problems. The most comprehensive study ever made of the effect of smelter gases on forest trees has been carried out by the Council for the Dominion Government in the Northport district of Washington,

where forests are affected by fumes from the smelter at Trail, B.C.

Recently, at the request of the Canadian Pulp and Paper Association and the Canadian Society of Forest Engineers, and in co-operation with the Dominion Forest Service and the Dominion Department of Agriculture, the Council has arranged to call a Conference on Forestry Research. At this conference it is proposed to consider the major problems in forest growth and maintenance, and an effort will be made to allocate these problems to the institutions most competent to investigate them. It is expected that this will lead to a re-organization of the Council's Associate Committee on Forestry Research and to considerable activity in this field.

Mining

In view of the fact that the Dominion Department of Mines has been organized for work in geology and the principal branches of ore dressing and metallurgy, the Council has confined its efforts to supplementing the work of that department and to financing a few investigations in the universities. Associate Committees on Mining and Metallurgy, Iron Ores, Helium, Asbestos, and Magnesian Products have been organized. The possible utilization of Canadian iron ores has been studied and an estimate has been made of the conditions under which they could be developed. The possibility of helium production in Canada has been investigated. The Asbestos Committee has been actively at work in co-operation with the producers and manufacturers and a number of researches are being carried out in

the laboratories of the Division of Chemistry. The work of the Associate Committee on Magnesians Products has resulted in the greatly increased development of one Canadian ore deposit and in the re-establishment of this industry on a sound basis. The co-operating companies have been successful in greatly increasing sales in both domestic and foreign markets. This work is at present being actively prosecuted in the laboratories of the Division of Chemistry. All radium produced in Canada is standardized in the Physics Division of the National Research Laboratories. Under the system of assisted researches, the operation of ball milling has been studied with an ultra-speed camera, an investigation has been carried out on the possibility of recovering oil from the large deposits of Nova Scotia shales, and studies have been made of rock crushing and screening, the reduction of titaniferous iron ores and other problems.

Fisheries

Several researches of practical value have been carried out on behalf of this important industry. A simple remedy was discovered for the discoloration of canned lobster, which formerly resulted in large losses. The cause of the discoloration of codfish was determined and a method of prevention indicated. The Associate Committee on Oceanography is actively at work on marine problems of the Pacific coast. A Conference on Fresh Water Fisheries is contemplated for the near future. In all this work the Council enjoys the co-operation of the Department of Fisheries and the Biological Board.

Power

The development of power is in general in the hands of large companies not urgently in need of technical assistance, but considerable electrical work is being done in the laboratories of the Division of Physics, and provision has been made there for a high voltage laboratory, which it has not yet been found possible to equip. The Associate Committee on Electrical Measuring Instruments, working in co-operation with the Electricity and Gas Inspection Service of the Department of Trade and Commerce, has been active in matters relating to the metering of electricity. Responsibility for the approval of type of electric meters has been placed by law on the Council. Under an assisted research a study has been made of the possibility of developing power by means of windmills and an investigation has been carried out on power losses in dielectrics.

Furs

Work was carried out some years ago on the influence of diet upon the health and quality of fur of foxes in captivity. This has now been taken over by the Department of Agriculture. A number of requests have been received for the Council to organize research in the fur-growing industry, but it has not yet been possible to take any steps in this direction.

Manufacture

In researches on behalf of the primary industries, already discussed, studies of many manufacturing problems have also been involved. This has been particularly true in the case of researches on asbestos, magnesian products and power

industries. Since the establishment of the National Research Laboratories the increase in manufacturing problems studied by the Council has been very considerable. References to these will be found in the reports of the laboratory divisions.

The plan followed in undertaking research on manufacturing problems varies according to conditions. When the work to be done is for the benefit of a whole industry, it may be started at the expense of the Council, but in such cases it is understood that when results of value are obtained, financial support from the industry will be forthcoming. This course has been followed in several instances. In some cases, the cost of the work has been shared by the Council and the industry from the beginning and the Council has then retained an interest in the patents secured. It is hoped to have an income from this source in the near future. A third alternative follows closely the plan of the Mellon Institute for Industrial Research at Pittsburgh, under which an industry or company pays for the total cost of an investigation and receives in return the sole rights to the results obtained.

The standardizing activities of the National Research Council are of particular interest and importance to manufacturing industries. Through the Canadian Engineering Standards Association, the main Committee of which operates as an associate committee of the Council, much work has been done in the field of engineering standards. The appreciation of this work by manufacturers has resulted in the extension of material support from the industry. An Associate Committee on Chemical

Standards has been formed and it is planned to expand its activities as soon as feasible. In the last few years some 15 miscellaneous specifications have also been prepared by the Council's staff, usually in response to definite requests from industry. Recently a Canadian Government Purchasing Standards Committee has been formed by the Council and a large number of specifications are being prepared by it. While these are being issued primarily for the use of Government departments, many requests for them are being received from manufacturers of the products treated.

Construction Industries

Owing to the severe climatic conditions prevailing in Canada the problems of construction are of special importance. An Associate Committee on Heating and Insulation has undertaken a study of some of the fundamental problems involved and investigations have been carried out at three different centres. This work^{is} now being concentrated in the laboratories of the Division of Physics.

Much damage has been done to concrete structures in many parts of the west by alkali waters. The problem has been very thoroughly investigated under an assisted research and the chief causes of deterioration have been established. This work has pointed the way to a solution of the problem by the manufacture of an alkali-resistant cement which has recently been placed on the market by one of the large cement manufacturers. Investigations have also been carried out on the corrosion of iron and steel in the soil, and on the relative rigidity of

welded and riveted structures. A careful survey was made of the damage done to wood piling by marine borers, and the conditions under which such damage may occur have been determined.

One laboratory in the Division of Physics has recently been equipped for studying the transmission of sound in buildings. This will be of material value in determining the relative advantages of different types of construction.

In the last few years a number of requests have been received from responsible bodies urging that the Council organize research on behalf of the construction industries, and undertake a systematic study of their principal problems. Owing to the limitation of funds, however, it has not been possible to proceed with this work.

Service Industries

When radio broadcasting was first introduced much trouble was experienced with inductive interference. The means for locating and correcting this trouble were worked out under an assisted research of the Council, and the routine task of performing this service has been taken over by the Radio Branch of the Department of Marine. Radio research was provided for in the construction of the National Research Laboratories and has for several years been carried out continuously in close co-operation with the Canadian Radio Broadcasting Commission. Some years ago the Council formed an Associate Committee on Laundry Research and at the same time opened a laboratory for studying laundry problems. As a result of the work done in this laboratory, laundry practice in Canada has been materially

improved. There has been an increasing number of problems submitted for solution as the work of the laboratory has become better known, and the interest of the industry has increased to such an extent that a Laundry Research Institute has been formed, through which the work is being co-ordinated and financial support is being extended to the investigations. Work on behalf of the service industries has also been carried out under several assisted researches, principally in connection with specific problems in radio broadcasting.

ASSOCIATE COMMITTEES

The National Research Council has established several classes of committees, each fulfilling a fairly definite function.

"Research" committees have been formed for the specific purpose of undertaking the organization and prosecution of research on some major problem or group of problems. Their normal procedure is to make a survey of the whole field in which they are to operate, prepare a list of research problems which in their opinion should be attacked and then assign these to the organizations or institutions best qualified and equipped to undertake their solution. Reports of work done are presented at meetings of the committees, usually held annually, and the fullest opportunity is afforded for criticism and suggestions. Future work is then planned in the light of the results secured by the group as a whole. In view of the nature of their work, such committees are normally composed in the main of technical representatives of industry, the universities and the Government service.

"Advisory" committees do not undertake research, but advise the Council in respect to matters assigned to them for study. In general they are rather broader in their scope than are the research committees and have as members executive and administrative officers as well as specialists. Advisory committees may at any time have specific research problems assigned to them and then become research committees.

"Special" committees are established as may be required to deal with such questions as standards and specifications,

patents, etc.

A "conference" is often called as a preliminary step to the formation of a committee, or may be organized to make recommendations in regard to the problems of a large field of science, as chemistry or physics. In general, a conference does not meet at frequent intervals, and between meetings retains only a chairman and secretary as the nucleus of the larger group, other members being selected ad hoc when a conference is to be called.

Those committees which include in their membership representatives of industry or other organizations than the National Research Council are usually called "associate committees" to distinguish them from internal committees of the Council. In some cases, joint associate committees are established in co-operation with other organizations. To any of these committees grants may be voted by the Council for the purpose of carrying out tasks to which the Council has given approval. Such committees as receive grants are responsible to the Council and to the Auditor General for the proper expenditure of such funds.

Through the establishment of associate committees the Council has enjoyed the advice and co-operation of some hundreds of specialists and executives and such success as has been obtained by the committees has been to a large extent due to the contribution which they have made.

There follows a list of the Committees of the Council, together with the chief organizations co-operating in their work.

Joint Associate Committees of the National Research Council
and the Dominion Department of Agriculture

Associate Committee on Field Crop Diseases

Co-operating organizations:

Board of Grain Commissioners for Canada
 University of Alberta
 University of Manitoba
 University of Saskatchewan

Associate Committee on Grain Research

Co-operating organizations:

Board of Grain Commissioners for Canada
 University of Alberta
 University of Manitoba
 University of Saskatchewan

Associate Committee on Market Poultry

Associate Committee on Potato Research

Co-operating organization:.

Canadian starch manufacturers

Associate Committee on Storage and Transport of Food

Associate Committee on Wood Research

Co-operating organizations:

Alberta Department of Agriculture
 Manitoba Department of Agriculture
 Saskatchewan Department of Agriculture
 University of Alberta
 University of Manitoba
 University of Saskatchewan

Associate Committee on Wool

Co-operating organizations:

Canadian Co-operative Wool Growers
 Canadian Woollen and Knit Goods Manufacturers' Association
 University of Alberta
 University of Saskatchewan
 Wool Industries' Research Association (Great Britain)

Research Committees

Associate Committee on Asbestos

Co-operating organizations:

Canadian asbestos producers and manufacturers
 Dominion Department of Mines
 Quebec Bureau of Mines
 Quebec Committee on Asbestos Standardization

Associate Committee on Coal Classification and Analysis

Co-operating organizations:

Alberta Department of Mines
 Alberta Research Council
 American Society for Testing Materials, Sectional
 Committee on the Classification of Coal
 Dominion Department of Mines

Associate Committee on Fire Hazard Testing

Associate Committee on Gas Research

Co-operating organizations:

Alberta Research Council
 Dominion Department of Mines
 University of Alberta

Associate Committee on Laundry Research

Co-operating organization:

Eastern Canadian Laundryowners' Association

Associate Committee on Leather Research

Co-operating organizations:

British Leather Manufacturers' Research Association
 Tanners Association of Canada
 Tanners Section, Toronto Board of Trade
 Technical Association of Canadian Leather Belting Manufacturers

Associate Committee on Magnesians Products

Co-operating organizations:

Canadian Refractories, Limited
 Dominion Department of Mines

Associate Committee on Oceanography

Co-operating organizations:

Biological Board of Canada
 Meteorological Service of Canada
 Pacific Committee on Oceanography (U.S.A.)
 University of British Columbia

Associate Committee on Parasitology

Co-operating organizations:

Dominion Department of Agriculture
 Imperial Bureau of Agricultural Parasitology
 McGill University
 Quebec Department of Mines

Associate Committee on Radio Research

Co-operating organizations:

Canadian Marconi Company
 Canadian Radio Broadcasting Commission
 McGill University
 Northern Electric Company
 Radio Branch, Department of Marine
 University of Montreal

Associate Committee on Radiology

Co-operating organizations:

Canadian Medical Association
 Canadian universities
 Hospitals and cancer clinics
 Provincial departments of health
 Radiological societies

Associate Committee on Survey Research

Co-operating organizations:

Department of the Interior
 Department of Marine
 Department of Mines
 Department of National Defence

Associate Committee on Trail Smelter Smoke

Co-operating organizations:

Consolidated Mining and Smelting Company of Canada, Limited
 Department of External Affairs

Associate Committee on Tuberculosis

Co-operating organizations:

Dominion Department of Agriculture
 Fort Qu'Appelle Indian Health Unit
 Queen Alexandra Sanatorium
 Queen 's University
 University of Alberta
 University of Montreal
 University of Toronto

Advisory Committees

Associate Committee on Agriculture

Co-operating organizations:

Canadian Society of Technical Agriculturists
 Dominion Bureau of Statistics
 Dominion Department of Agriculture
 Macdonald College
 Nova Scotia Agricultural College
 Oka Agricultural Institute
 Ontario Agricultural College
 University of Alberta
 University of British Columbia
 University of Manitoba
 University of Saskatchewan

Associate Committee on Electrical Measuring Instruments

Co-operating organization:

Electricity and Gas Inspection Service, Department of
 Trade and Commerce

Associate Committee on Forestry

Co-operating organizations:

Canadian Pulp and Paper Association
Dominion Forest Service
Forestry Departments, Canadian universities
Provincial Departments of Forestry

Associate Committee on Helium

Co-operating organization:

Dominion Department of Mines

Associate Committee on Iron Ores

Special Committees

Canadian Government Purchasing Standards Committee

Co-operating organizations:

Dominion Government Departments

Associate Committee on Chemical Standards

Associate Committee on Engineering Standards

Co-operating organization:

Canadian Engineering Standards Association

Special Committee on Electrical Units and Regulations

Co-operating organization:

Electricity and Gas Inspection Service, Department of
Trade and Commerce.

Special Committee on Gas Meters

Co-operating organization:

Electricity and Gas Inspection Service, Department
of Trade and Commerce.

Associate Committee on Patents and Awards.

DIVISION OF BIOLOGY AND AGRICULTURE

This division was established mainly to undertake and promote researches on problems of the agricultural industry. From the outset an endeavor has been made to co-ordinate the work with that of all other agencies concerned in this field, notably the Department of Agriculture and the provincial colleges of agriculture. The object has been, not to duplicate, but to support the work of these other institutions, by attacking fundamental aspects of problems which were beyond their scope. It has usually been possible to arrive at a satisfactory division of responsibility by mutual agreement. Most of the present program has been undertaken at the request of committees representative of these various institutions. For convenience, these notes on the work will be grouped under the headings of the various laboratories which have already been established by the Division.

Plant Biochemistry Physiology

Rust Resistance in Wheat. In 1924, a comprehensive attack on the rust problem was launched under the joint auspices of the National Research Council and the Department of Agriculture. Breeding for rust resistance has been pursued so energetically and successfully by the Department of Agriculture and the western universities (the latter subsidized by the Council) that seed of satisfactory new varieties should begin to be available to farmers by the spring of 1937.

In these circumstances, the biochemical studies on the fundamental nature of rust resistance, which have been carried on latterly in the Council's laboratories, are being temporarily set aside in favor of more pressing problems. Though still incomplete, they have contributed substantially to our knowledge of plant chemistry, lack of which has always been a stumbling block to progress towards the solution of many practical problems.

Chemical Weed Killers. In response to requests from organizations in the prairie provinces, a committee representing the federal and provincial departments of agriculture and the three universities was set up in 1929 to promote and co-ordinate weed control investigations in that area. Besides subsidizing researches in the universities, the Council itself conducted and published a survey of the weed situation during two seasons, and carried on laboratory investigations of the relative effectiveness of some 80 chemicals as weed killers, and the fire hazards involved in the use of certain of these. The experiments have now been completed, but many of the results are still under study in preparation for publication. There is also in preparation a comprehensive review of the world literature on the use of chemicals as weed killers. The Council is still supporting at the University of Saskatchewan studies of the growth habits of weeds, which have thrown a great deal of new light on the problem of control by cultivation. Because of the financial situation, support to the

Universities of Alberta and Manitoba was withdrawn at the end of the first three years. The latter institution for the succeeding three years (ending March 31, 1936) obtained support from the North West Grain Dealers Association, but has renewed its application for help next year from the Associate Committee on Weeds. This is now a joint committee with the Department of Agriculture. Weeds cause greater losses to agriculture than insects, plant and animal diseases combined. It would seem that support for all worth-while weed research now in progress should be obtained from some source if possible.

Plant Growth Studies. Plant physiologists have long cherished the ideal of constructing equipment for growing plants under conditions controlled with respect to the chief factors of the environment, in which it would be possible to study the effect of a given factor (e.g., a particular fertilizer, or a disease attack) while holding the others constant, as well as to determine the threshold values and complex interactions of temperature, humidity and light. The development of such apparatus, which would be of use not only to ourselves but also to many other investigators throughout the country, was undertaken as soon as the laboratories were established, and the first two chambers of a projected series have been constructed and thoroughly tested by growing several crops in them. Their use in investigational work has had to be suspended temporarily because of lack of staff to take care of other pressing work, but should be renewed as soon as possible,

since they represent a fundamental type of work which other institutions quite rightly look to the Council to do.

Grain Research.

Wheat and Wheat Flour. The work being carried on in this field represents part of the program of the Associate Committee on Grain Research, now a joint committee with the Department of Agriculture and representing also the prairie universities and the Board of Grain Commissioners. Since its inception the work of this committee has been concerned chiefly with the maintenance of the high quality of Canada's export wheat. Many important projects have been carried out with the various co-operating laboratories acting as a single unit, working to a common plan with parts of the same samples of wheat. One of the recent projects, the testing of new, disease-resistant varieties for the plant breeders of the Associate Committee on Field Crop Diseases, is a part of what is perhaps the most comprehensive scheme of co-operative scientific effort which has so far been applied to an agricultural problem in Canada.

The estimation of the quality of wheat depends upon experimental milling and baking tests. It soon became apparent that to get reproducible results in different laboratories it would be necessary to rule out the personal factor which entered into many of the operations carried out by hand. The Council, therefore, undertook a study looking to the standardization and mechanization of the test. This has now been almost completely achieved.

The Council also undertook a special study of the gluten proteins, the substances which form the framework of the loaf and therefore determine its size, shape and fineness of texture. Good progress has been made in elucidating their physical and chemical properties which are so important in determining the quality of any particular variety of wheat.

In co-operation with the Board of Grain Commissioners, the Council a few years ago established a durum wheat laboratory in Winnipeg. This year for the first time the Grain Standards Board had before it as an aid in establishing the grade standards some real information as to the macaroni-making value of the different varieties and types of durum wheat coming forward.

Barley for Malting. In view of the critical situation in the wheat market, the improvement of the quality and marketability of possible substitute crops has become a problem of the first importance, and the Grain Research Committee has turned its attention to barley and flax. In regard to malting barley, the Council first made a survey of threshing, cleaning and handling methods, to trace the causes of damage which made so much of our barley unfit for malting. The second year's work, done with the help of the Seed Branch of the Department of Agriculture, is nearing completion and promises to show how most of the trouble can be avoided. At the same time the Council investigated the British requirements in malting barley, and undertook jointly with the Department of Agriculture, the Board of Grain Commissioners and the universities, investi-

gations as to the suitability of our barleys for various uses. The Council has taken the responsibility for developing in its own laboratories standard methods and equipment for experimental malting tests (analogous to experimental milling and baking tests of wheat), and is also sharing with the Department of Agriculture the cost of upkeep of a laboratory at the University of Manitoba, where all the plant breeders of the country may send samples of their new barley varieties for malting test. Chemical and biochemical studies of protein and diastase, two elements in barley which greatly affect its value for particular purposes, are also under way in the Council's laboratories.

Food Storage and Transport.

Celery Cold Storage. At the request of the Quebec-Federal Committee on Cold Storage, which initiated an extensive investigation into the causes of celery spoilage in storage, the Council made a study last fall and again this fall of the temperature, relative humidity and air movement in certain commercial cold storage warehouses in Montreal. The variability of temperature in different parts of the rooms this year was somewhat greater than last year and emphasizes the recommendation made in last year's report, that a more positive system of air circulation is desirable.

Poultry Storage and Transport. A great many problems in the field of poultry storage and transport have been referred to the Council by the Department of Agriculture, and these are being attacked in order of urgency. For this purpose, laboratory

equipment and facilities are excellent, but the staff is too small for rapid progress. In co-operation with the Department of Agriculture studies have already been made on the safe holding period for chilled poultry, and on methods of dechilling and defrosting poultry taken out of storage, to avoid condensation of moisture on the carcasses. Investigation is now being made chiefly of the problem of "freezer burn", one of the most frequent and serious defects liable to develop in poultry in cold storage.

Taints. Problems of taint in stored or transported foodstuffs have been referred to the Council by the Department of Agriculture, and by transportation and insurance companies. A program of research was prepared as a result of a conference with the interested bodies. A beginning was made with apple and wood taints, since these seem to be the chief ones, but shortage of staff has made progress slow.

Cytology and Genetics.

Effect of Temperature on Mutation Rates in Cereals.

Occasionally mutations or "sports" appearing in cultivated plant species give rise to new and useful varieties, but their appearance is so comparatively rare as to have only restricted importance in plant breeding work. By heat treatment of the seed or plants of barley it has been found possible greatly to increase the number of mutations. Again it has been demonstrated that some of these changes are of such a nature as might confer fertility on the progeny of crosses between distantly related

plants which are usually sterile. Thus the plant breeder is provided with a new method which may prove of considerable importance.

Hybridization of Wheats and Wheat Grasses. There is need in western Canada of a forage crop which possesses drought resistance, soil-binding properties and large seeds. In co-operation with the Department of Agriculture the crossing of wheat with wheat grasses has been started. It is proposed to use the new method referred to in the foregoing section in an attempt to induce fertility in the hybrids.

Microbiology.

Root Parasites of Agricultural Plants. Root rots of wheat, club root of cabbage, and powdery scab of potatoes are three diseases in connection with which some important points, hitherto obscure, have been cleared up during the past year in the Council's laboratories.

Straw-fermenting Organisms. Wheat straw is possibly the most important agricultural waste product in Canada. In its natural state it has a very limited use in industry, but there are some possibilities of converting it into other useful compounds. Since the process of disintegration in nature is carried out by micro-organisms, a preliminary survey of these has been carried out in preparation for fermentation studies.

Moulds of Food Products in Cold Storage. One of the problems in the cold storage of food products is the development of moulds which are capable of growing even at such low temperatures. A study of these organisms has been initiated in connection with the food storage experiments reported earlier.

Statistical Research.

Influence of Weather on Crops. One cannot hope to influence the weather, but one may by the study of long-time trends in various districts learn how better to adjust methods and types of agriculture to the average conditions prevailing in such districts. One may also hope in time to be in a better position to make long-range forecasts of both weather and crops. For studies of this kind use has been made of the weather records of the Dominion Meteorological Service and the crop records of the Department of Agriculture and the colleges of agriculture. By this means the influence of weather on the growth, yield and protein content of wheat has already been elucidated to a considerable extent, and studies on its influence on the yield and composition of sugar beets and on farm practices such as crop rotation and manuring are in hand.

Long time evaporation records are not yet available in Canada, and since the evaporating power of the air has an important influence on the use of water by crops, some preliminary information was obtained by a study of American data.

Accuracy of Experimental Baking Tests. As a service to the four laboratories co-operating with the Grain Research Committee, statistical analyses are being made of the results of their baking tests, to determine the chief sources of error and help them improve their methods. This study is now in its third year, and improvements in accuracy are already evident.

Effect of Fertilizers on Yield and Composition of Barley. At the request of the National Barley Committee, studies have recently been made of the experimental results obtained at the Manitoba Agricultural College, on the effect of fertilizers on the yield and composition of barley. The effects are of a nature having an important relation to malting quality.

Miscellaneous. As specialists in the application of statistical methods to biological problems are rare, our laboratory is called upon to do a great deal of advisory work, and occasionally to collaborate with other laboratories. Examples of collaboration are: a study of variation in the weight of internal organs of domestic fowl, with the University of British Columbia; determination of feeding standards for hogs, with Macdonald College.

Institute of Parasitology.

The Institute of Parasitology is the most important extra-mural laboratory of the Council. It was located at Macdonald College (McGill University) because of the interest in, and work on, parasitology which had already developed there, and also because of the superior facilities for work with large

animals which an agricultural college having a livestock farm naturally possessed. The Institute is under the general direction of the Associate Committee on Parasitology, on which representatives of McGill University, the Dominion and Quebec Departments of Agriculture, and the Imperial Bureau of Agricultural Parasitology are associated with the Council. The Empire Marketing Board at first carried half the cost of upkeep, but this support ceased when the Board was dissolved.

One estimate of the normal annual loss due to animal parasites in Canada is \$20,000,000. Though only in its fourth year of operation, the Institute has already justified itself by its substantial contributions to methods of farm sanitation, for example, in controlling the parasites of sheep and pigs, two sources of great loss. Other special features of its program include a survey of the parasites of Canada, a long-time project of which however the progressive results are immediately useful, and the training of post-graduate students, which can be done to advantage because of its association with McGill University. At the outset it was necessary to go abroad to find a qualified man for the position of director, but the lack of a trained Canadian personnel is being rapidly corrected by the educational work of the Institute itself.

New Laboratories to be Established.

Fermentations. Reference has already been made to the enormous wastage of straw going on in the West; millions of tons are burned up every year. Fermentation seems one possible

method of converting it to useful products. As soon as possible research should be made in the field of fermentations, not only of straw, but of other products, a major project.

Vitamins and Animal Nutrition. From time to time requests have been received to investigate problems which require the making of vitamin assays. Routine assays required in connection with the administration of the Food and Drugs Act and the Feeding Stuffs Act should be made by the Department of Health and the Department of Agriculture respectively. However, it is the responsibility of the Council to carry on the investigations necessary to develop methods and establish standards. There are also referred to the Council occasionally problems in animal nutrition, particularly connected with mineral deficiencies, the preliminary investigation of which could best be done in a laboratory with small animals. Excellent accommodation for this work is to be found in the animal house on the roof, but so far it has not been possible to use it.

Other Laboratories as Required. Various other lines of biological work have been proposed from time to time, some of which should be taken up in due course, but the two foregoing seem to be the most important gaps at present.

DIVISION OF CHEMISTRYAsbestos

In 1930 a commission appointed by the Legislature of the Province of Quebec requested the National Research Council to undertake the study and standardization of the Quebec Standard Asbestos Testing Machine, used by both producers and buyers, on which the grading of asbestos is based. Shortly afterwards, in order to provide close contact with the industry, not only in this matter, but in a more extensive programme of research on asbestos, an associate committee of the Council was organized on which are represented all the producers of asbestos in Canada together with the Federal Department of Mines and the Quebec Bureau of Mines.

Uncertainties concerning the Quebec Standard Testing Machine were costing the producers large sums each year. After time-consuming studies carried out both in the laboratories and the mills, the machine was satisfactorily standardized and standard specifications for it were adopted by the producers.

The studies just mentioned made clear that in addition to the properties of asbestos fibres on which the standard grading test depends there are many other properties of significance in regard to the commercial utilization of asbestos, and extended studies of a rather fundamental character have been made of the properties of asbestos. These studies are being actively pursued and are being found to have important practical bearings.

A systematic study has been made of the short fibre asbestos used in asbestos cements, and new facts of practical significance concerning these grades have been brought to light. The asbestos from most of the mines in Canada is unfortunately relatively high in magnetic iron, and work has been undertaken in the laboratories on the possibility of removing this iron so as to render the asbestos better fitted for purposes of electrical insulation. Extensive studies have been carried out on the long grades of asbestos fibres used for spinning textile yarn and in this connection some fifty batches each one ton in size have been actually processed in asbestos textile mills in the United States. The average content of recoverable fibre in the rock is only a few per cent. of the latter's weight and hence the industry produces a vast quantity of waste or tailings. Considerable attention has been given to the possibility of utilizing such tailings. Several processes have been worked out, of which particular mention may be made of (a) a process by which molded asbestos products can be produced from it and (b) a process by which, as a result of chemical decomposition, it can be made to yield magnesium sulphate (Epsom salts) and active silica, that is silica in a porous form. Commercial interests now have under serious consideration the possibility of undertaking manufacture under the latter process. It is believed that magnesium sulphate could be made by means of it at a price competitive with that of the imported material now brought into Canada to the extent of about 2,500 tons a year. The active silica which the process also yields can be used for drying gases in industry or in the

air-conditioning of buildings (plants in Montreal and Toronto have tried it out on a commercial scale with satisfaction), as an admixture in Portland cement to render the latter resistant to alkaline soil conditions such as are found in many parts of western Canada, and for other purposes.

Some of the studies in progress in the laboratory hold out the promise of improving the milling process by which asbestos fibre is secured from the rock and of increasing notably the yield of fibre obtained.

Close contact with the industry is being maintained not only by occasional meetings of the associate committee, but by arrangements under which one of the laboratory workers attends the regular monthly meetings of the Quebec Asbestos Producers Association on the one hand, and on the other hand a technical representative of one of the producing companies attends on occasion the meetings in Ottawa of an internal committee of the laboratories on the subject of asbestos.

Paint and Varnish.

The annual consumption of paint and varnish in Canada is about \$20,000,000. Of this quantity about \$17,500,000 is manufactured in Canada, and the rest is imported.

A laboratory for the study of paint and varnish was established last year by the National Research Council and is fairly completely equipped. The first purpose for which the laboratory was established was to study the technical features necessary for the preparation of standard specifications covering paints and varnishes and the raw materials employed in their preparation, for use by the departments of Government in making

purchases. This work now being under way, the laboratory is engaging on a more extended program of research, in which special attention is being devoted to the newer materials, such as synthetic resins, which are now being offered with increasing frequency for use as protective coatings. Additional staff could be advantageously used in this field of work.

The laboratory has developed a new test for determining in a direct manner the hiding power of paints. A study is being made of an accelerated method of determining the resistance of paints, varnishes and enamels to weathering, the results being compared with the behavior of painted panels exposed to the weather on the roof of the building.

Collaboration in the sphere of paint and varnish research has been arranged with the Ontario Research Foundation, and the question of developing facilities to meet the needs of the industry is being explored.

Bleaching Clays.

Practically all the \$300,000 worth of bleaching clays (bentonites) used in Canada is imported from the United States. The chief use for such clays is in the refining of gasoline and lubricating oils, but considerable amounts are also used in the refining of vegetable and animal oils and fats, in foundry work and in the reclaiming of used crankcase oil and dry cleaning solvent.

Certain results obtained with a domestic sample in the National Research Laboratories led the Council to make a serious effort to locate a domestic deposit of clay with good bleaching properties. A variety of samples from deposits in each of the four western provinces has been examined as regards their effectiveness, both in the raw state and after processing (acid treatment), in refining gasoline, lubricating oil and vegetable oils. One clay in particular has been found to be of excellent quality and to be equal after processing to the most efficient and expensive Californian product. A visit has recently been paid to this deposit, which is in western Canada, and discussions have taken place with the owners who are planning to exploit it. There seems good ground for hoping that in the not distant future it will be possible to supply the Canadian market with this domestic material.

In the search for suitable bentonite deposits assistance was rendered by the Saskatchewan Development Board, the Federal Department of Mines and the Development Bureau of the C.P.R.

Carbon Black.

Carbon black, which is essentially soot obtained by burning natural gas, is the most important material used for mixing with rubber in the manufacture of tires and other rubber goods. A smaller tonnage is used in printing ink and for other purposes. In the peak year of 1929, 15 million pounds of carbon black, worth about one million dollars, was imported into Canada.

The carbon black used in Canadian industry is entirely imported. At the same time there is going to waste in the Turner Valley field, Alberta, natural gas far in excess of that which would be necessary to produce carbon black sufficient for all Canadian requirements. The manufacture of carbon black from this waste gas is, however, under two handicaps, namely, (a) an unfavorable freight differential to Eastern Canadian markets of about $\frac{3}{4}$ cents a pound as compared with carbon black from Texas, (b) the presence, in this case, of sulphur compounds, apparently necessitating preliminary purification at a cost equivalent to about 1 cent per pound of carbon black.

Having in mind these two factors, work in the National Research Laboratories on the production of carbon black from waste Alberta gas has been directed to studies referring to the influence of the sulphur content of the gas and more particularly to the development of such improvements in the process for the manufacture of carbon black as would increase the yield (which by the process now practised in the United States is only about 5% of the total carbon in the gas) to such an extent as to outweigh the handicaps just mentioned. The work has met with considerable success and a combination process has been developed by which it is possible to secure both motor fuel (see section on natural gas) and carbon black - the latter in yields two or three times as great as those now obtained in the United States. The process is now ready for consideration by commercial interests.

Another process for the manufacture of carbon black on novel lines has been worked out in the laboratory. It gives yields some ten times those now secured in commercial practice in the United States, but the quality of the black, for both rubber and paint uses, is not quite so high as that of the regular black now on the market. There would seem, however, to be room for this special process, which is so much more economical of natural gas than present processes; and a full account of the extensive experimental work that has been carried out in connection with it has just been prepared and will be brought to the attention of commercial firms.

Alberta Bitumen.

With many authorities of the opinion that the known oil fields of the world will be approaching depletion in from twenty to thirty years, the importance of the potential oil supply represented by the vast tar sand deposits at Fort McMurray need not be emphasized. These deposits are known to cover an area of about 1000 square miles to an average depth of 100-200 feet. Bitumen can be extracted from the sands at a cost of about six dollars per ton of bitumen.

Development of this deposit as a source of gasoline is not in immediate prospect on account of the low price of petroleum, and the work carried out in the National Research Laboratories in regard to the bitumen has been directed to (a) securing fundamental scientific information on the material, (b) developing from the crude bitumen (which is semi-fluid) solid bitumens of considerably enhanced value for use in the

paint and rubber industry and for roofs, shingles and floorings. While road-making bitumens may be as low in price as \$15.00 per ton, the varieties for paint, varnish and rubber may sell up to \$150.00 per ton and can easily meet the high freight costs to eastern markets. Several large batches of suitable bitumens have been made in the laboratories following small-scale preliminary investigations and are now in the hands of interested parties for commercial testing.

In the course of preparing solid bitumens from the crude material, heavy oils have been secured and are being studied as regards their possible value as lubricants.

The Council has provided financial support for researches initiated at the University of Alberta, and carried out in conjunction with the Research Council of Alberta, on the production of gasoline by treatment of the bitumen with hydrogen under high pressure.

Potato Products.

In view of the low price of potatoes last season and the existence of a surplus, a conference of interested parties, including growers and marketers, the Potato Marketing Board, the Department of Trade and Commerce and the Department of Agriculture, was held towards the close of last year, and following this, there was set up a Joint Committee on Potatoes of the Department of Agriculture and the National Research Council.

The part of the National Research Laboratories in the program of work planned by this committee is a study of the industrial utilization of potatoes and especially of the possibility of replacing corn starch by potato starch for various industrial purposes. Many special problems arise in regard to the industrial utilization of starch products. Starches from different plants are not identical, nor are the needs of different consuming industries. Active investigation of potato starch is in progress - (a) for laundering, (b) as an adhesive in plywood manufacture, (c) for paper finishing, (d) in baking powder, (e) for the production of jelly candies, (f) for textile finishing, (g) for the production of dextrines and their use as adhesives and in the finishing of textiles. Promising results are being secured along several of these lines.

In connection with this work plant trials have been carried out in three power laundries, one plywood manufacturing plant and one confectionery manufacturing plant. Valuable co-operation is also being given by a number of other firms, and, in regard to plywood, by the Forest Products Laboratory.

Attention is also being given to such possible outlets for surplus potatoes as the manufacture of power alcohol, dehydrated potatoes, potato flakes, etc., the economic aspects of the matter always being kept fully in mind.

Maple Products.

The value of the Canadian crop of maple products reached a peak of \$6,188,656 in 1929, with exports (mostly to tobacco manufacturers in the United States) of \$2,500,318.

The increased U.S. tariff of 1930 against maple products seriously affected the export business, and shortly afterwards laboratory investigations were started on maple products in the National Research Laboratories. An enlarged market is the present need of the industry. Increased sales of maple products can be attained by an all year round market, by introduction of new products and by finding use for low grade sugars and syrups.

For the first case there has been developed a new type of maple sugar block, easily broken up for eating and keeping its colour and consistency indefinitely, and a maple icing sugar which can be utilized as easily as the common icing sugar. A process for the making of a concentrate of true maple flavor has been developed and manufacture carried out on a small scale. Such a product should prove of value to confectioners, ice cream makers and others who are unable to make the fullest use of existing maple products due to manufacturing difficulties in their use. A method of processing maple sap to yield a syrup up to ten times normal intensity of flavor has also been developed, and in this connection interesting studies have been made with the object of elucidating and controlling the factors concerned in the development of maple flavor from the flavorless sap. Some advances have been made in improvements of lower grade syrups and sugar.

Contact with the plants engaged in processing maple products at Plessisville, Lennoxville, Granby and Montreal, P.Q. has been maintained by personal visits and by submission of samples of products developed in the laboratories.

Honey.

Next to maple products, honey ranks as the most important "luxury" sugar produced in Canada, the value of the annual crop being about \$2,500,000.

Canada's exports of honey would seem to be capable of considerable expansion. At present they are a very small percentage of the total production.

In order to produce honey of uniform consistency and free from danger of spoilage by fermentation, it is essential that the moisture content shall be carefully controlled. Hence one of the chief subjects of work in regard to honey in the National Research Laboratories has been the study of various methods of determining this quantity and the development of a convenient and reliable method for practical use. The good quality of this work has been widely recognized. As a result of the work a special honey hydrometer is now being manufactured for use by honey producers.

In collaboration with the Department of Agriculture, specifications have been drawn up for a series of standard colors to enable the producers and inspectors to follow the new grading provisions of the Fruit and Honey Act.

Work has also been done on improving the color and flavor of buckwheat honey, use of honey in candy and as a source of fruit sugar for diabetics, bleaching of beeswax, etc.

The program of work in the laboratories on honey was decided on after discussions at meetings of the Associate Committee on Honey on which are represented the Department of

Agriculture, the Ontario Agricultural College, the Ontario Honey Producers Co-operative, Ltd., honey interests in Manitoba, Quebec, etc.

Magnesian Products.

Co-operative research on magnesian products was the first laboratory project undertaken by the National Research Council. Briefly, the results are that Canada has been changed from an importing to an exporting country in respect to these materials. The major development has been that of refractory linings for metallurgical furnaces. These are being extensively used both in Canada and abroad. Magnesite composition flooring, developed in this investigation, has been installed in the National Research Laboratories and is proving eminently satisfactory. Refractory brick are now being manufactured in England from Canadian raw material. Recent activities have been mainly in the production of chemically bonded refractories, plastics, cements and brick. These new products are meeting with a most gratifying reception from the industries in which they are used. The manufacture of chemically bonded refractory brick is of particular interest in a country like Canada, where the market is relatively small, since no expenditure for kilns is necessary and the product can be made available at a relatively low cost, thus benefiting both producer and consumer.

Dehydrated apples.

Considerable work has been carried out to determine the procedure necessary to produce dried apples of high quality - of good appearance and closely similar to fresh apples in flavor. A plant for the production of a superior type of dehydrated apples has been erected in Nova Scotia based in part on the result of this work. Technical advice on difficulties attending commercial operation has been given since the starting up of the plant. Heretofore the Canadian dried apples have not reached the high quality of the American production and the latter country has almost monopolized the European market.

Utilization of Cereal Straw.

In view of the vast tonnage of straw wasted in Canada annually an investigation has been initiated with the object of ultimately developing technically and commercially feasible processes for the utilization of straw. This problem because of its difficulty will require long intensive work even when an increase of staff makes it possible to devote more effort to it than has been possible to date. As a start, study has been made of the various components - cellulose, lignin, fats, resins etc.-and a good background of fundamental knowledge set up. The study of the use of lignin in making synthetic resins, of rendering the cellulose suitable for artificial silk manufacture, the dry distillation of the straw to yield tar, gas and carbonized residue, etc., have been commenced.

Milkweed.

Milkweed, which grows so rankly in most parts of Canada, offers numerous points for investigation. The estimated yield of the floss per acre, for example, is actually equal to, or greater than, that of cotton. In addition, the plant carries in the stalk bast fibres with some resemblances to flax; and the seed carries an oil similar to cottonseed oil. The floss or seed fibre was tried out initially in its natural condition in a textile plant as an admixture with cotton; the results were not encouraging owing to the slippery and brittle nature of the fibre. Further work has been done towards modifying these objectionable features but this investigation has not yet advanced to the point where a second mill trial can be made. The fibres are also being investigated as a substitute for kapok in stuffing cushions, etc. Retting trials with the stalks have not been as encouraging to date as was hoped. The seed yields an oil which is to be further investigated. Practically all vegetable oils used in Canada are imported. The milky exudations from the stalks and the roots, which are said to contain a medicinal principle, are also to be investigated.

Leather.

Laboratory work on leather was started five years ago following the formation of an associate committee on which are represented all or almost all the large tanners of the country. The field of leather research is so wide and the problems which it presents so varied that it could be hoped that the lone worker who is now engaged in it in the National Research

Laboratories could be given assistance, so that more rapid progress could be made with the outstanding problems which face the industry. Matters to which the laboratory has already devoted its attention are as follows:

Problems of the leather tanners have received first consideration. These problems included the hardening and cracking of chrome-tanned shoe uppers due to perspiration, the cracking of heavily-finished upholstery leathers, cracking of grain on bag leathers, analytical methods, etc.

Utilization of waste products such as the making of glue from waste chrome leather and the recovery of wool from scrap of sheepskins tanned in the wool, have been investigated.

The use of Canadian fish oils and tanning extracts made from Canadian materials has received attention.

An apparatus has been built to test the wearing qualities of shoe leather and equipment installed and used for measuring the permeability of leathers to air and to moisture.

A survey of the damage caused cattle hides by the warble fly indicated an annual loss of nearly one million dollars.

Abstracts of technical advances in the industry are compiled and sent to tanners. Bulletins on "Small Scale Manufacture of Leather" and "Home Tanning" have been prepared and are sent on request to interested parties.

At the request of the National Parks Branch a procedure was developed for tanning buffalo hides, about 2000 of which are now available annually. Satisfactory procedures for dyeing the

skins for use in making coats and robes have been worked out.

Experimental work has been done on the preparation of tanning extract from hemlock bark - one of the few domestic sources of tanning material. This was done in conjunction with a firm which is considering starting the manufacture of hemlock extract in Canada. Other domestic sources of tanning material to which attention is being given by the laboratories are sumac and black spruce.

A program of research on the production of acceptable tanning material from the waste liquor of sulphite pulp mills has been planned, but shortness of staff has made it impossible to pursue it hitherto.

A problem of great importance which will be taken up when staff permits is to determine how tanning can be speeded up without sacrifice of leather quality - a problem which at least one large tanner in Europe has apparently solved.

Laundrying and Dry Cleaning.

The importance of the laundrying and dry cleaning industry in the life of the country can be appreciated when it is remarked that the yearly expenditure in Canada for this service is over twenty million dollars. Investigation into the problems of the laundry industry was undertaken in 1930 at the request of the Eastern Canadian Laundryowners Association and an associate committee was set up on which this Association was represented. Both the scope of the work and the extent of contact with the industry have since then steadily enlarged. The launderers of western Canada were brought into

association with the work and a Dominion-wide laundry research fund was established. Still more recently the dry cleaning industry has been brought in and there has been established the Canadian Research Institute of Launderers and Cleaners, admission to which has been made dependent on the achievement and maintenance of a minimum standard of quality in the work done by member firms. The object of this Institute, which is national in scope, is to make the work of the laboratory fully available, to guide the laboratory in directing its work in such a way as to be most fruitful, and to afford financial support to the laboratory's work.

A method of measuring in quantitative terms the efficiency of washing processes in the removal of dirt, which was developed in the laboratory, is of first-rate importance as affording a basis for the exact study of washing operations. Many of the factors involved in power laundry practice, such as concentration and kind of soap, temperature, concentration and kind of alkali, have been studied with the object of determining the optimum procedure for washing different classes of goods. Systematic work of this kind will be extended still further in the future.

A "test bundle" system has been developed which enables the efficiency of laundries to be checked regularly and recommendations made for the improvement of their procedure where indicated. The bundle of selected materials (including cloth dyed with fast and with fugitive colors) is sent to

laundries, washed a number of times with their regular work and then returned to the laboratory for a test report and advisory comment.

Other features of the work of the laboratory relate to the use of bleaches and sours, the latter term indicating the acidic materials added at a certain stage of the washing process in order to neutralize residual alkali derived from the soap solution. Much study is given to the influence of the weave of fabrics, the materials from which they are made, manufacturing flaws, the nature of dyes used, etc. on launderability, and in this connection plans are being developed for a closer contact and the development of a better understanding between the manufacturing end of the textile industry and what may be called the maintenance end as represented by the laundering and cleaning industry.

Systematic work on dry cleaning was started only recently but has made a very satisfactory beginning. A program of research on the efficiency of the various dry cleaning solvents (including the newer, non-inflammable solvents) and dry cleaning soaps, together with a study of the fundamentals of the dry cleaning process, is being followed. A study of the new synthetic detergents, which differ from soaps in yielding a lather in hard water, and in regard to their solubility in dry cleaning solvents, promises to give interesting results. Good progress is being made towards the development of a special test bundle system for controlling the efficiency of dry cleaning operations.

Mention may be made of an extended investigation conducted two years ago to ascertain whether the sulphur dioxide present in the air of industrial cities is, as had been alleged, a serious factor in the deterioration of clothes put out to dry in it. No serious damage was found.

The laboratory is also working on the development of a new water softener prepared from Canadian raw materials.

Wool.

The effect on wool growth and quality of the environmental conditions under which sheep are kept and the composition of the ration fed to them has been a subject of study since 1929 under the auspices of the Associate Committee on Wool. The sheep-raising end of the investigation has been carried on at the University of Alberta and the detailed examination of wool samples from each individual sheep in the investigation has been carried out in the National Research Laboratories. The examination of the wool samples has involved much time-consuming work on the measurement of staple length, fibre length, fibre diameter, crimp, tensile strength, and the content of grease, suint, dirt and clean wool. This investigation has now been brought to a close and a full report on it will shortly be issued.

Considerable attention has also been given to the development of methods suited for determining the quality of wool, yarn and cloth in respects other than those just mentioned; one purpose of such work being to make it possible to compare fully and exactly the quality and value of Canadian

wool with wools from elsewhere. In view of opinion held by some that Canadian wool is "harsh", a method for measuring the resiliency of wool has been devised and used for comparing Canadian and Australian wools and also in studying the effect of dyeing on softness. (This apparatus was also found useful and was used for measuring the resiliency of kapok, milkweed floss and asbestos fibre.) An apparatus for testing the resistance of cloth to wear has been developed. This apparatus was employed in testing several batches of cloth made from Canadian wool under the auspices of the associate committee and for comparison with cloth made from Australian wool of similar fineness. The Canadian wool showed up very satisfactorily. The prevailing humidity has been observed to affect resistance to abrasive wear very markedly and a systematic study of this feature is now in hand. Other testing apparatus installed in the laboratory includes a cloth tester, yarn tester, twist tester, reel, and an apparatus known as a "flexometer" designed to compare the relative harshness and softness of cloths. The behavior of wool fibres is known to be greatly influenced by the prevailing humidity, and, in view of the marked difference in average humidity between Canada and Great Britain, both in the textile mills themselves and out of doors, it was decided to undertake a systematic study of the influence of humidity on the properties of raw wool and cloth. This is now in hand and studies have already been made of the relation of wool grease and suint to the matter.

Rubber.

The rubber laboratory is the only one in Canada outside of those maintained in the manufacturing plants. It is therefore in a particularly advantageous position to render service to the country as a whole.

A most outstanding contribution to the industry came from McGill University where a research grant enabled work to be done prior to the establishment of these laboratories, the vulcanizing and testing equipment used being later transferred to the National Research Laboratories. An intensive study of the resin present in raw rubber revealed that fatty acids are a normal constituent of rubber resins and that in most rubber mixtures it is advisable to add a further supply. This discovery completely reversed views held previously and as a result the consumption of fatty acid by the rubber industry on this continent reached more than 12,000,000 lb. in 1928. While the major benefit has accrued to the rubber industry and consumer in lowering costs and extending life of goods, the market for tallow and slaughter-house grease from which stearic acid is made has been substantially increased.

In conjunction with the Biological Board of Canada, an investigation has been carried out in the National Research Laboratories into the possibility of making fatty acids suitable for use by the rubber industry from the pilchard oil of British Columbia. The results are so favorable that it may be hoped that this line of manufacture will be taken up in Canada.

Apart from the raw rubber many other compounds enter into the manufacture of the final product. To date very few of these have been produced in Canada but in recent years the laboratory has examined for such purposes carbon black made in the laboratories from Turner Valley gas, mineral rubber made from Alberta tar sand bitumen, clays from the western provinces, silica, kaolin and talc from the central provinces and diatomaceous earth from the maritimes. All of these investigations have been of decided assistance to those working on the materials thus tested.

The manufacture and applications of synthetic rubber have received attention. An article on Synthetic Rubber contributed to the leading American industrial chemical journal has been received with interest throughout the world, requests for reprints having come from Japan, Soviet Russia, Germany, France, Italy, etc. A chapter on the physical properties of raw rubber is now being prepared for a co-operative work on the subject of rubber.

A new process for the production of an adhesive capable of bonding rubber to metal has been developed in the laboratories and is now being studied particularly in regard to its use in automobile construction.

A study of behavior at winter temperatures of rubber cord for use in absorbing shock on aeroplanes has been initiated and will be pursued during the coming winter.

Chemical Investigation of Plants.

An investigation of wide scope to isolate the chemical principles present in plants, especially plants indigenous to Canada, to determine the chemical nature of these principles, and to discover any practical uses which they might have, was started in 1930. Attention was first given to those plants, many of them poisonous to live stock, which were known or suspected to contain substances of physiological activity. As was to be expected in this field of work, new avenues of investigation are continually opening up and unexpected discoveries are being made of matters of practical interest. Among the latter special mention may be made of the discovery of new and powerful insecticides, which offer the promise of practical possibilities, and the preparation of synthetic substances which when applied in minute amounts stimulate plant growth to an amazing degree and offer vast potentialities of practical usefulness.

In the course of the work very substantial contributions, which have met with recognition from all parts of the world, have been made to our knowledge of the chemical principles of plants and especially to the alkaloidal constituents. The magnitude of the field of work may be realized when it is remarked that of the 130,000 species of flowering plants (phanerogams) known only about 4,500 or $3\frac{1}{2}\%$ have been investigated chemically and many of these have been investigated only in a very cursory way. It is interesting to note that the U.S.S.R. has engaged on an extensive programme relative to the

chemical examination of plants with the object of disclosing materials of practical usefulness, has had a number of expeditions in the field during recent years collecting sufficient material of different plant species for chemical examination, and in a preliminary report last year on the alkaloid content of the medicinal and poisonous plants of the U.S.S.R. reported on the examination of 377 species.

Referring more particularly to the aspects of the work on plants in the National Research Laboratories in which features of practical interest are clearly apparent, the following may be mentioned:

1. A number of the new alkaloids isolated from Canadian plants are being tested pharmacologically by the medical schools of the University of Toronto, the University of Western Ontario and a firm of pharmaceutical manufacturers, to determine their possible usefulness as drugs.

2. The alkaloids from several species growing wild in profusion in western Canada have been tested with regard to their insecticidal power by the Entomological Station of the Department of Agriculture at Annapolis Royal, N.S., and one at least of these shows practical promise, as it was found to be more toxic to insects than nicotine sulphate. Larger quantities of the plant have been collected during the present season, and more extensive testing of the alkaloids from them will be made in due course.

3. Hormones (chemical messengers) and vitamins, are now well known to perform functions of the highest significance

in animal organisms and to be effective in extremely minute concentrations. A few years ago certain substances representing what may be considered as the analogues of hormones and vitamins in the vegetable kingdom were isolated from natural sources. When administered in minute amounts, they stimulate growth in a remarkable way and have other profound effects on plants. In the National Research Laboratories a number of synthetic substances were prepared (originally in connection with the work on alkaloids mentioned above) which tests carried out at the Boyce Thompson Institute of Plant Research, Yonkers, N.Y., showed to have similar effects to the materials just mentioned. This line of investigation may issue in profound practical results, and samples of the synthetic products prepared in Ottawa are now being made available for experimentation by botanical laboratories in various parts of the continent. When prepared by the methods originally used, the synthetic products were all very expensive, but recently a new and cheaper method of preparing the most important one of them has been developed in the National Research Laboratories and should contribute to bringing synthetic plant hormones within the realm of practical use. As an example of the effect of the hormones it may be mentioned that the introduction of a few drops (0.3 ccs.) of a solution of one part in 100,000 of water into a tomato plant causes the formation along the whole stem of roots which can be replanted and will grow to mature plants.

Wax Plucking of Poultry.

Some twelve months ago at the request of the Department of Agriculture and other interested parties work was undertaken to develop if possible a "wax" which would enable poultry to be dressed speedily and well; would obviate the tedious removal of pin feathers by hand and produce a bird of good appearance and marketability. The work, which involved the testing of about 140 different mixtures, has been brought to a successful conclusion. About eight tons of the "wax" mixture finally decided upon has been supplied in trial lots to poultry dressers throughout the country and the method is now rapidly becoming well established. Manufacture on a large scale and distribution by a commercial organization has now been started under a license issued by the National Research Council which fully protects the public both as regards price and quality of the product.

Little loss of wax is involved in its use, since, after it has been used, the wax can be melted and, after straining out feathers, made available for re-use. The wax has properties such that it will grip the pin feathers and remove them without tearing the skin away from the carcass. The bird, after having had the large feathers roughly removed by hand, is dipped in the molten wax; the latter is allowed to set and is then stripped off.

In this work close and active co-operation was afforded by the Poultry Division of the Department of Agriculture; and from now on the dissemination of the method will be largely in its hands. A descriptive bulletin on the method has been

issued by the Department of Agriculture and the National Research Council jointly.

The method is being employed by all classes of poultry dressers - the large packers, wholesale dealers and individual farmers.

Power Alcohol.

The use of alcohol as a supplementary motor fuel has been advocated by many in Canada, especially in the west, as a means of dealing with agricultural surpluses. Owing to this interest a comprehensive investigation was made about two years ago into the cost of production of alcohol under Canadian conditions and into the performance of alcohol blended fuels; and since that time the subject has been followed up closely. Possible sources of alcohol to which consideration has been given are cereal grains (especially wheat), potatoes and sugar beets.

In addition to an analysis of the economic phases of the matter, actual tests were made with alcohol-gasoline blends, the behavior of such blends in engines being studied in the engine laboratory and their stability in the chemical laboratory.

The reports issued in connection with the studies have been well received and widely circulated.

Refuse Screenings.

Refuse elevator screenings are more favorably placed for industrial utilization than most agricultural waste products in that they are collected in large amounts at central points. At the head of the lakes, for example, some 50,000 tons is available yearly. About 60% of the screenings is made up of weed seeds, from which oil similar to rapeseed oil can be extracted. The screenings have been separated into their various components, broken grain, weed seeds etc. and have been examined for such purposes as oil production (from weed seeds), power alcohol, fuel briquettes etc. A comprehensive report has been prepared on the subject.

In connection with the laboratory studies an interesting machine was developed by which seeds, which, on account of their similarity of size, cannot be separated satisfactorily by screening, can be separated by taking advantage of their difference in shape.

Construction Industries.

The need of co-ordinated investigation of the problems of the construction industries has long been realized by the National Research Council, since the results of investigations carried out in other countries are not necessarily applicable in Canada owing to the difference in climatic conditions. A number of requests have been received from industry for research on problems of construction, but in view of the shortage of staff no comprehensive investigation has yet been possible.

Research has nevertheless been carried out on a number of individual problems. For example, a study has recently been made of the corrosion of the aluminium hull of a cruiser belonging to the Royal Canadian Mounted Police. Advice has also been given on many other corrosion problems.

The nucleus of equipment required for a real attack on problems in this field is now available. Further, it will be possible to utilize to a considerable extent present work on other projects, such as paints, oxychloride cement, bitumen, plaster and asbestos. It is hoped that all of these can be related to a general program of value to the construction industry.

Diatomaceous Earth.

Numerous deposits of diatomaceous earth are found in Canada but to date industrial development has been slow. The Canadian materials differ appreciably from those of foreign origin. In many deposits the diatom structure has been partially broken down. Before development can take place, therefore, it is essential to make full investigation into their inherent qualities and the special uses to which, after suitable processing, they can be most advantageously used. Such investigation was begun over two years ago and is giving encouraging results. In particular their use in the paint and rubber industries and to assist filtration in sugar refining is being followed up. The Department of Mines, which has already done extensive mapping of the deposits, has greatly facilitated the work by procuring samples and information.

Industrial Uses of Minerals.

Apart from the minerals specifically mentioned elsewhere, assistance has been rendered on request, to parties desirous of evaluating the industrial importance of various mineral deposits. Materials considered in this connection include silica, paint pigments and marl.

Distillation.

A new type of distilling column, greatly superior to the columns now used in industry, has been invented in the laboratories. It was originally developed to facilitate the examination in the laboratory of Turner Valley gasoline by determining its constituent compounds, but, in view of its probable value to the many industries, such as oil refining, wood alcohol distillation, etc., in which distillation plays an important part, attention is now being concentrated on its development as an industrial tool. Several columns of semi-commercial size will be produced in the near future for trial by an industrial firm.

The value of these columns has been well demonstrated by showing that they are capable of effecting some separation from ordinary water of the "heavy water" which is present therein to the extent of only one part in six thousand and which differs from ordinary water in boiling point by less than 1°C.

Natural Gas.

The daily wastage of gas in the Turner Valley, Alberta, at one time exceeded 600 million cubic feet and even to-day, after conservation measures have been put into effect, exceeds 200 million cubic feet (about 4,000 tons of gas). This wastage is a challenge to all interested in the conservation of our natural wealth. Work in the laboratories has been concerned with the production from natural gas of ethylene (a starting material for the manufacture of industrial alcohol, antifreeze, etc.), of carbon black(see section on this subject) and of benzol. The work has resulted in definite advances in regard to these matters; it has shown, for example, how it is possible to produce from Turner Valley "stabilizer" gas, now wasted, a benzol suitable for motor fuel to the extent of nearly three gallons per thousand cubic feet of gas. The process depends essentially on the heat treatment of the gas, and the work appears to solve satisfactorily some of the technical difficulties involved in the use of alloy steel at the high temperatures presented.

Printing and Paper.

Some time ago two Canadian organizations connected with the printing trades requested the National Research Council to undertake research work on problems of printing and the graphic arts generally. Owing to shortness of staff, it has not been possible to undertake systematic work in this field, but a few isolated pieces of work have been carried out.

At the suggestion of a newspaper publisher, work was conducted with the object of developing a preparation, cheaper than the very expensive imported preparation now used, for removing carbon deposits from the brass matrices used in linotype machines. The work was successful.

Assistance has recently been rendered in connection with the problems which present themselves when printing is performed by rapid-drying spirit-aniline dye inks, using a rubber fount.

Consideration was given to problems connected with photogelatine engraving, and it was possible to make recommendations which markedly improved the quality of the reproductions.

At the request of Government departments studies have been made on the probable permanence of record and other papers used for Government documents and of the inks used. These studies are now being taken into consideration by a subcommittee engaged on the preparation of standard specifications for the purchase of paper by Government departments. Work has also been done on safety paper for Government cheques and on the quality of paper used in printing Dominion of Canada bonds.

Tests were made and advice given in regard to the choice of ink and other materials in connection with the preparation of the Book of Remembrance.

In connection with certain of the paper investigations the Pulp and Paper Division of the Forest Products Laboratories, Montreal, has collaborated and given advice.

Textiles and Dyeing.

Our equipment and services for testing textiles of all types are available to Government departments and other parties. Numerous samples have been received of such materials as woollen goods, ducks, flannels, silks, rayons, etc. and of garments. Many of these tests have been requested as a guide to purchasing large quantities of material or garments.

Standards of fastness to light are in course of investigation by the exposure of selected dyed samples to sunlight and to accelerated fading tests in the fugitometer. Comparison is being made between the sunlight and accelerated fading tests.

A specially equipped laboratory for experiments on dyeing has not yet been set up, but it is hoped to establish one in the near future. A good start has been made in the field of textile research with the very limited staff available. It would, however, be advantageous, not only to intensify the work on the subjects already embarked upon, namely laundering and wool, but to extend the work to include other textile subjects, such as the manufacture of cotton goods.

Industrial Surveys.

Surveys have been made of Canadian chemical imports, which amount to approximately \$40,000,000 yearly, with the object of indicating where our own resources might be used in their manufacture and the extent to which the solution of associated technical problems would assist in that direction.

It is highly desirable that a much broader and more intensive survey should be made as soon as staff permits, with the object of determining in a fully rational manner, by means of an analysis of Canadian resources, existing industries and other factors, to what subjects the national research effort can be more fruitfully directed.

A survey of fruit and vegetable processing, including canning, was made to determine where research could be most profitably employed. The Food Canners Association of Canada has requested the Council to undertake researches in canning, but, owing to shortness of staff, it has not yet been possible to start such researches.

A study was made of the possibility of developing a lithopone industry, since Canadian imports amount to about 8,000 tons annually and as all raw materials used are native.

Miscellaneous Investigations.

A great many investigations of importance although of more limited application than the major research projects have been and are being carried out in the laboratories. A few representative illustrations are given below.

Battery Separators.

The standard wood used for separating the lead plates in automobile and other storage batteries is Port Orford cedar, imported from Oregon. It seemed possible that a domestic wood, namely British Columbia yellow cypress or cedar, would work satisfactorily, and an extended investigation of the behavior of separators made from this wood in comparison with separators

made from Port Orford cedar has been carried out. The domestic wood was found to be comparable in its behavior with the imported material and it is gratifying to note that its use appears to be growing in Canada. Different batches of the domestic wood were, however, found to be more erratic in their behavior than the imported wood and this aspect of the matter has been taken up with the manufacturers of the domestic separators in Vancouver, and at the present time a new batch of test batteries is being built and will be subjected to investigation.

Salt-Clay Mixtures on Roadways. Following road trials in Nova Scotia, where stretches of road were surfaced, with good results, with a mixture of clay and salt, an investigation of the effect of salt was undertaken in the laboratories. It was shown that the salt greatly reduces the tendency of the clay to shrink, crack and dust. The manner in which the salt acts to produce these effects was elucidated. As a result, in part, of this study, practical interest in the matter has grown; there has been an increase in the use of Nova Scotia salt for road treatment, and road trials have been carried out in Ontario, using salt from Sandwich.

Spontaneous Combustion, Etc. At the request of the Department of Insurance investigations have been made on the liability to spontaneous combustion of binder twine and oil-impregnated mops.

Following a fatal fire in a match factory in Canada, representatives of the National Research Council held conferences with the Department of Insurance and all the match manufacturers of Canada, and as a result standard tests on matches were drawn up. Since then a considerable number of batches of matches have been tested in the laboratories according to these tests.

Bitumenized Cement. A special form of Portland cement, in which the particles are partially coated with bitumen, has recently come into use to some extent in Europe, and was claimed to resist temperature changes when used for road construction better than the regular cement. On account of this claim, the material seemed worthy of investigation in view of Canadian climatic conditions. An investigation of the properties of the material in comparison with ordinary Portland cement has been made in conjunction with the Testing Laboratory of the Department of Public Works.

Tree Stump Destruction. At the request of parties in British Columbia some investigation was devoted to the possibility of destroying tree stumps economically by the application of chemicals. The possibility was not realized, but experiments were conducted in British Columbia with the object of developing an apparatus for burning tree stumps, and a report was issued on the subject.

Cleansing Compounds. With the object in part of drawing up specifications for the purchase of cleansing compounds by Government departments, an investigation was carried out on the various abrasives and other components which may be used in such compounds.

Cleaning Corroded Monuments. A method of cleaning corroded and stained, out-door bronze monuments and statues, which, while efficacious, does not attack the metal, was worked out. It was employed by the Department of Public Works in cleaning several statues on Parliament Hill. Information concerning it has been supplied to several cities in Canada.

Beet Sugar Syrup. Various methods suggested for the preparation by a simple procedure from sugar beets of a syrup suitable for table use were examined and an improved procedure developed.

Vitamins. A number of products have been assayed for vitamins C and D by chemical means. The laboratories however are not at present equipped to carry out biological assays for vitamins.

Hops. A number of samples of Empire hops have been examined with the co-operation of one of the breweries. Certain samples were found to be particularly rich in some of the desired constituents.

Standardization. Members of the division have taken an active part in the work of various subcommittees entrusted with the preparation of specifications for purchases by Government departments.

During the recent Price Spreads investigation the laboratories were called on to examine numerous articles of common use sold at retail. The work included a survey of silks, cotton goods, soaps, paints, rubber goods, etc.

Close contact has been maintained with the British Standards Institution in regard to the specifications for chemical products on the preparation of which the Institution is actively engaged. All such specifications have been received while in draft form and have then been submitted for comment to interested parties in Canada.

Carbon Monoxide. Experiments were made to determine whether carbon monoxide is present in the cockpit of aeroplanes in flight. Silica and China Clay. A useful and simple method of determining the distribution of particle size in these materials was developed and, among other purposes, has served as a useful guide in directing the operations of a plant engaged in the production of the materials in question.

It was conclusively demonstrated for the first time that the reinforcing effect of china clay in rubber stocks is directly dependent on the particle size of the material. The question of locating a deposit in Canada of china clay equal to imported clays now used in rubber compounding is receiving consideration.

The possibility of using a domestic clay, either in its original or in a processed condition, for paper finishing is also receiving attention.

Refined Sugar Syrup. A procedure was worked out for the production of refined syrup from raw cane sugar without following all the stages (including vacuum evaporation and centrifugation) involved in production of refined crystalline sugar. Since the jam maker and canner need their sugar in syrup form, this simplified, economical procedure should be of distinct value to them.

Decolorizing Carbon. Extended tests were made to compare the relative efficiencies of a considerable variety of decolorizing carbon for use in the refining of sugar and of vegetable oils and fats, and in the treatment of drinking water. Certain significant factors were brought to light.

Experiments which it is hoped to continue have been made on the production of decolorizing carbons from domestic raw materials.

Enquiries. Enquiries on technical matters from industrial firms, Government departments and individuals are dealt with by the Division at the rate of about 100 a month. Many of these can be answered directly but a not inconsiderable number involve the conduct of a greater or smaller amount of experimental work.

DIVISION OF PHYSICS AND ENGINEERINGA. MAIN BUILDINGElectrical Engineering

Much of the early work of the electrical engineering branch was devoted to the arrangement of electrical services and equipment for the new laboratory building, first, in co-operation with the consulting engineer retained by the architects, and later in the installation of equipment and services which were essentially separate from the contract for the building itself. This latter work included the installation of battery systems, with the associated distribution boards and charging systems, machinery for the electrical engineering laboratories with the necessary control switchboards and distribution boards, and various smaller installations such as electric drives for airplane engine testing equipment, asbestos testing equipment, and mills of various kinds.

Considerable time has been devoted to committee work. The special Committee on Electrical Units and Regulations prepared specifications for approval of type of the various meters used in measuring electrical energy and power for revenue purposes. These specifications also included auxiliaries, such as transformers, which are associated with the above meters. The committee prepared definitions covering the various units employed in the measurement of electric energy and power, and made recommendations for the establishment of primary legal electric standards for the Dominion of Canada.

A large amount of work has been done in connection with the panel on specifications of the Canadian Engineering Standards Association. During the laboratories' contact with this panel, the following specifications have been prepared and reviewed:

- Transformers for oil burners and luminous tube signs.
- Enclosed safety switches.
- Industrial control equipment.
- Fractional horse power motors.
- Gasoline measuring and discharge devices.
- Electrical equipment on oil burners.
- Appliance cord sets.
- Motor operated blowers and stokers.
- Cable for oil burners and luminous tube signs.
- Oil circuit breakers.
- Wiring devices (wireways, busways, junction boxes, etc.)
- Switchboards and panel boards.
- Hair dressing appliances.
- Soldering lugs, etc.

The electrical engineering laboratory has been associated either directly or indirectly with the work of the Associate Committee on Radio Research, the Associate Committee on Electrical Measuring Instruments, and the Associate Committee on Radiology.

The main problem of research has been the design of a precision voltage regulator for the output of either alternating current or direct current machines. The characteristics of various types of regulators have been studied and in several instances investigated experimentally in an effort to arrive at

the most satisfactory type of equipment, and to overcome the disadvantages common to the various types. At the present time a regulator developed here is in continuous operation which holds voltage within 0.1% and so far has proved to be completely reliable. Demands on the use of this regulator for other purposes has to a considerable extent hampered the progress of the investigation. Work is continuing to determine the most satisfactory type of reference standard and to reduce to a minimum the time of response without introducing oscillations.

Following the Council's agreement to give approval listing to oil burners a number of machines were submitted to the electrical engineering laboratory for inspection and test of the electrical features. This work was carried out in accordance with the specifications of the Canadian Engineering Standards Association, although in some instances problems arose which were not covered by the specifications and it became necessary to undertake special investigations to determine the fitness of the equipment for its application.

In addition to the above, a large number of minor problems were presented to the laboratory from other divisions of the Council, other branches of the Government service, and from industry. These include:

Investigation and elimination of undesirable static charges.

Tests on water heaters.

Measurement of losses in electric rotating machines.

Measurement of the ignitability of heat insulation from

electric causes,

Measurement of carburetor temperatures in aircraft engines during flight.

Overhauling and repairing various types of electric instruments and equipment (for Government departments only.)

Development of photoelectric cell equipment for recording flashes of short duration.

Electrical Measurements and Precise Standardization

The work in the electrical measurements laboratory may be divided into three parts:-

1. Testing in connection with approval of meters or other equipment used for determining a charge for electric power.
2. Precision standardization.
3. Consultation and experimental investigations.

The approval of a meter involves a great deal of testing to determine if the meter meets the Council's "Specification for Type Approval".

Standardization involves intercomparison of the Council's standards with one another and with the standards of Great Britain and of the United States, and also the comparison of equipment sent to the laboratory for standardization by Canadian firms or Government departments with the standards maintained here.

The laboratory is consulted frequently on measurement or control questions by other Government departments.

At present an investigation of the effects of temperature on the performance of watthour meters, especially as it affects

lubrication, is proceeding.

The Associate Committee on Electrical Measuring Instruments is actively working on methods and standards of electrical measurements. It is attempting to correlate closely the theoretical measurement with what can be attained by the measuring equipment available.

General Physics

Grain Grading In Artificial Light. Before the development of an optics laboratory, the general physics laboratory undertook a problem in connection with the development of artificial illumination for the grading of grain. Numerous artificial light sources were tried in both the filtered incandescent and discharge tube type. The possibility of using photoelectric cell methods was also investigated and shown to be impracticable. The lights were put to practical trial in Winnipeg and Vancouver by grain inspectors and it was shown that grading by artificial light, 24 hours in the day, was quite feasible.

Static Discharge in Aerial Photographic Cameras. The electrostatic properties of photographic films used in aerial photography were investigated with a view to the elimination of static markings on the films. The investigation led to several suggestions for minor alterations in existing cameras which would reduce static and in the design of new cameras which should be practically free from this trouble. A number of flights were made to study the physical properties of the atmosphere under weather conditions of the type when photography could ordinarily be carried out. During these flights the variation of some of the

electrical properties of the atmosphere with altitude were also studied.

Ballistics. A new method of measuring the velocity of projectiles has been developed. The velocity was measured by the interruption of beams of light by the projectile as it moves along the trajectory, the times of interruption being recorded electrically by photoelectric cells and suitable recording apparatus. The method was first used with rifles in a short range in the sub-basement of the laboratories but has since been developed further for artillery and was used successfully at Petawawa in 1935.

Atmospheric Electricity. During the greater part of the past year continuous records of the atmospheric potential gradient have been taken on the northeast side of the National Research Council building with a view to study the relation, if any, between potential gradient and local meteorological conditions. It was found that deviations from the mean diurnal variation occur much more often and are of greater magnitude when the barometer is falling or before it is about to fall than with a rising barometer. A preliminary examination of some of the early results compared with the movement of air masses recorded by the Dominion Meteorological Office indicates that masses of polar air moving across the continent may have an electrical identity as well as that defined by other physical properties. A more thorough comparison of the potential gradient records with meteorological records is being made as rapidly as possible.

Metrology

In the metrology laboratories much work of the same type is carried out year by year. A general idea is conveyed by the following -

1. Special WorkFor

a. Completed during year 1934-35:

Design and construction of plotting instrument for high oblique photographs.	Associate Committee on Survey Research.
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Investigation of effect of air temperature on principal distance of aerial camera.	R.C.A.F.
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Comparison of Dominion platinum-iridium avoirdupois pound and troy ounce weights.	Department of Trade and Commerce.
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Investigation of lengths of 4 24-metre invar wires in conjunction with Government Laboratories at Sevres, London, Charlottenburg, Warsaw and Washington.

b. In progress since April 1, 1935:

Design and construction of stereo-plotting instrument for vertical air photographs.	Associate Committee on Survey Research.
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Changes in design of high oblique plotter	do
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Design and construction of instrument-recording camera for air photography.	R.C.A.F.
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Installation of apparatus for testing gas meters.	N.R.C.
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Consideration of specifications for standard sieves.	Subcommittee on Sieves of Government Purchasing Standards Committee.
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Investigation of discrepancies in lengths of 24-metre invar tapes when tested at Washington and Ottawa (subsidiary to tests on 24-metre invar wires in section (a))	N.R.C. and Bureau of Standards, Washington.
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c. Work not yet started:

For

Investigation of possibility of development of an air camera for oblique air photography in which the depression angle is recorded for each exposure.

Department of National Defence.

II. Routine TestingFor

Standardization of:

Clinical thermometers	Government departments and commercial firms.
Chemical "	do
Thermocouples	R.C.A.F.
Miscellaneous thermometers	Government departments and commercial firms.
Hydrometers	do
Watches and chronometers	do
Weights	do
Surveying instruments comprising: transits, levels, alidades, compasses, clinometers, binoculars, etc.	do
Measures of length comprising:	
Line standard rules	do
End standard gauges	do
Surveyors' and engineers' tapes	do
Aerial cameras.	R.C.A.F.
Strength of materials	Government departments and commercial firms.

Medical Radiology

Radium and the Radium Industry. Tests of the purity of Canadian radium prepared from the extensive ore deposits at Labine Point, Great Bear Lake, were carried out and showed that this material is practically free from the objectionable impurity mesothorium. This investigation was undertaken and published to disprove unfounded rumours regarding the Canadian product.

Standards and equipment were set up for measuring the omission of radiation from radium preparations and testing them for possible leakage. This service is required by the purchasers of radium products. Five hundred radium needles, tubes and plaques were measured and certified up to the end of the fiscal year

1935 and over 100 since that date.

A bulletin "Health Hazards in the Radium Industries", by Mr. J. D. Leitch was published under the auspices of the Council on the recommendation of the Associate Research Committee on Radiology.

Radiology. An Associate Committee on Radiology was established in 1933 following the recommendation of a meeting of prominent Canadian radiologists and physicists to promote research in this field, and otherwise assist in overcoming the technical problems of the radiation treatment of cancer. It consists of physicians, physiologists and physicists engaged in this work and is representative of several universities, clinics, provincial health departments, and medical societies, and works in co-operation with these organizations. On the advice of this committee, the National Research Council has established standards and apparatus for testing radium and X-ray equipment in its laboratories, and has developed and is constructing testing equipment to be placed in suitable centres to assist the cancer clinics, is publishing a series of technical bulletins for the information of radiologists, has assisted research in other institutions, and has drawn up an extensive research program of urgent problems in the radium and X-ray treatment of disease. A start has been made on certain of these research projects and two of them have been completed.

Heat

Heat Insulation. The measurement of the thermal conductivity of building materials, started several years ago at the formal request of the Tariff Advisory Board, is still in progress. The results to date have been published in three papers in the Canadian Journal of Research. These measurements were carried out on the hot plate apparatus built after the design of the apparatus used by the Bureau of Standards, Washington. On account of the demand, however, for measurements on the heat transmission of built-up walls instead of small samples, a hot-box apparatus was constructed during the year 1934; this type of apparatus has been found at other laboratories to operate in a very unsatisfactory manner, and while the newly built hot-box has already been used for carrying out certain tests, the effort of the laboratory is being directed rather towards ascertaining the causes of these operational difficulties and overcoming them, before starting a series of routine tests.

The laboratory, when requested carries out measurements on the thermal conductivity of diatomite and other soft furnace bricks; the mean temperature of sample attainable is 1450°F. This work was originally undertaken at the request of the Department of Mines, in order to assist in the development of the Canadian deposits; the results have been published in the Canadian Journal of Research.

Temperature Standardization. The laboratory is now equipped to standardize platinum thermometers at three fixed points, namely, the melting point of ice, the boiling point of water and

the boiling point of sulphur. Some work dealing with the calibration in boiling sulphur has been written up and will be published in the near future.

The equipping of the laboratory for the standardization of thermocouples to a great accuracy is still in progress. There is already equipment to undertake the standardization of pyrometers of commercial accuracy, and recently some calibrations have been made.

Air Conditioning. In view of the present interest by the public in the field of air conditioning some observations have been made during the past year on an instrument developed in Great Britain and known as the eupathoscope, designed to estimate comfort conditions in rooms. The object of these investigations was to ascertain whether the apparatus gave a fair indication of atmospheric comfort conditions in Canadian houses. Closely allied to the house heating problem is the problem of heat loss from the human body, and in this connection some apparatus was constructed to estimate the heat transmission of fabrics.

Refrigeration. In reply to a request from the Department of Agriculture, the problem of heating refrigerator railway cars during the winter season has been under investigation during the last two years; after some preliminary testing of the efficiency of the insulation on the cars, it was concluded that the insulation was good, and that improvement along these lines would not avoid the occasional use of heat in the cars during long hauls in severe weather. The work was followed by experimenting on a method to introduce heat into the cars near the floor instead of at the ends as present practice necessitates, and thanks to the

co-operation of the Canadian National Railways, a heater and pipe system was successfully developed. The railway requested that it should be protected by a patent and an application has been recently filed. At the present time a new heater is being constructed at the C.N.R. workshops in Montreal in which there are embodied several improvements both in regard to operation and ease of construction. The new heater will this winter be thoroughly tried out under operating conditions with a view to equipping a fleet of refrigerator cars next year.

At the request of the Quebec Federal-Provincial Committee on the cold storage of celery and in co-operation with Macdonald College, an investigation has recently been made in order to decide whether conditions in the Harbour Commission's cold storage at Montreal were the best possible for the preservation of celery.

Optics

The optics laboratory has provided for lamp standardization. An integrating sphere and a bar photometer enable measurements to be made on both flux and horizontal candle power. The primary standards for Canada of candle power and of flux are maintained here together with secondary standards calibrated from them. Lamp tests were carried out for the Price Spreads Committee of Parliament. Life testing equipment is being installed.

Apparatus for spectroscopic tests is also available. Tests undertaken usually involve the detection of small impurities in a sample. Such work was done for the investigation on the corrosion of the S. S. Interceptor.

The spectrophotometric equipment is being built up at the

present time of both the visual and photometric type. Experience has shown that this equipment is essential. Many tests require spectrophotometric measurements directly or indirectly. Work has been performed on welders, goggles, filters, sugar testers, asbestos testers and in sensitometry involving such tests.

Photoclectric photometry and colorimetry are also developed here. Such work has been done for the chemistry laboratories of the Customs Department and for the Associate Committee on Asbestos.

Tests on photographic materials have been undertaken and improvement of the apparatus used is proceeding. A great deal of this sort of work has been done for the Topographical Surveys.

Radio

Atmospherics. The direction of arrival of atmospherics was investigated for about three months during the summer of 1933. The purpose of these preliminary experiments was to establish a correlation between atmospherics and weather phenomena if possible, and to determine the wisdom of establishing two such observing stations in Canada. As a result of the work it is considered essential to have two companion stations in this country in order to obtain the experimental data required. Owing to lack of funds, however, it was impossible to proceed with the construction of the necessary apparatus required until the autumn of 1935. The observational work will be started again as soon as the new equipment now under construction is completed.

The two stations will provide a real test of the utility of the methods employed and their applicability to Canadian meteorological conditions. It is hoped that a useful tool for long

range weather forecasting may be evolved and prove of permanent value to the meteorological and aeronautical services. The work will be carried out in co-operation with the Department of National Defence in Canada and with the Radio Research Board of Great Britain and the U.S. Naval Laboratories.

Ionosphere. Since 1932 a programme of investigation on the properties of the ionosphere has been undertaken by the radio laboratories co-operating with the Department of Physics at McGill University. Following the work at the time of the total eclipse of the sun in 1932 a series of routine measurements of the heights and ionization contents of the ionized regions has been carried out, particularly at McGill University. At these laboratories the equipment is being developed to take the records automatically, thus minimizing the time and effort involved.

Primary Standards. In conjunction with the electrical standards laboratory considerable work has been done on a primary standard of mutual inductance of the Campbell type. When completed this will serve as an ultimate standard of reference to many alternating current measurements. At present a preliminary model is under construction in the workshops.

Testing and Measurement. Work on the performance of radio receivers, (particularly those intended for reception of broadcast programmes by the general public)/^{was} started in the autumn of 1934 at the request of the Canadian Radio Broadcasting Commission. Actual testing was finished in May and since then the apparatus has been improved so that some of the records may be taken automatically.

Precise measurement of inductance and capacity at commercial power frequencies and the lower audio frequencies are possible. As yet most of this work has been calibration of equipment for other sections of the Council. Certain measurements were made for the Canadian Radio Broadcasting Commission.

Measurement of current is possible, by the addition of recent equipment, up to very high frequencies, as is calibration of wave meters and frequency meters for both audio and radio frequencies.

Acoustics and Allied Subjects

Acoustic Testing Laboratory. During the past year a "reverberation chamber" was built on the Annex property. In this chamber a number of measurements have been made for commercial firms and other Government departments on the sound absorptive properties of various kinds of building materials. Experiments are under way to determine the best method of using certain of the materials. The laboratory is also equipped to make measurements on the sound-insulation value of partitions.

Acoustics - General. Apparatus has been set up and work is under way on the calibration of microphones. In co-operation with the Canadian Radio Broadcasting Commission, apparatus has been built to measure the acoustic output of radio receivers. This enables a much more complete test of receivers to be undertaken than is usually attempted. Acoustic tests have been made recently on a new aeroplane engine exhaust silencer invented in this country. On several occasions advice on acoustic problems has been given to other Government departments.

Vibrations in Solids. Vibrations in rods and disks, which are so important from the point of view of radio-frequency standards, have been and are being studied in order to elucidate certain anomalies which are known to occur. Papers on this subject are published from time to time.

Ultrasonics. Recent developments in the study of the behavior of sonic and ultrasonic waves in liquids have shown that these phenomena are very useful in the determination of the physical characteristics of liquids and the consequent determination of their value for various industrial and technical purposes. In particular, the manner in which liquids subjected to a high-frequency ultrasonic disturbance produce scattering of light passing through them, provides a ready means of investigating their various characteristics. An investigation to determine the relation between the ultrasonic energy transmitted by a liquid and the degree of light scattering, the effect of frequency, optical wave-length and reflecting surfaces has been completed. An investigation of the sound absorption coefficients of various liquids has been started and will be continued as time permits.

Electrical Units and Regulations.

The specifications for approval of type of the various electricity measuring devices proposed by the Committee on Electrical Units and Regulations and officially adopted by the Council have been very favorably accepted by the manufacturers and utilities. In the case of the specification covering instrument transformers and phase shifters, some minor revisions were recommended by the committee and approved by the Council early in

1935. It is hoped that it will be possible in the very near future to have the various specifications printed in final form. Requests for copies of these specifications have been received from Great Britain, Italy, Argentina, Japan, China and other countries.

Gas Units and Regulations.

The Committee on Gas Units and Regulations has drawn up three reports, accepted by the Council, to define the units which are used in gas measurements and to set out the regulations for the submission of meters to the laboratory for approval of type tests. Specifications have also been drawn up to govern the approval of type. These specifications cover positive displacement gas meters and arrange for a procedure for the testing of very large meters of other types in situ. The specifications thus far have been favorably accepted by the manufacturers and public utilities.

B ANNEX

Aeronautical Laboratories

The provision of aeronautical laboratories was authorized in 1929 and construction commenced, about Dec. 1, 1929, on the wind tunnel and model-testing basin. Trials were run in October, 1931, of both tunnel and basin. The installation of the engine laboratory commenced about Jan. 1, 1931, and trials were run early in December of that year.

With the transfer of the Physical Testing Laboratory of the Department of the Interior to the Council in 1932, the work

on aircraft and allied instruments was assigned to the aeronautical laboratories. The equipment was moved from Cliff Street to the Annex in the fall of 1932.

The Council co-operated closely with the Dept. of National Defence in the provision of the aeronautical laboratories. The Department bore the cost of the construction of the model-testing basin and of the rehabilitation of the building to house it (about \$25,000) and contributed \$5,000 toward the cost of the rehabilitation of the building to house the engine laboratory.

Research was begun with a large proportion of improvised equipment, owing to the pressure of the demands for work to be undertaken. The design and construction of permanent equipment were proceeded with as opportunity offered, and the laboratories are to-day reasonably well equipped.

The work of the aeronautical laboratories has consisted of tests, calibrations and investigations directed toward the solution of specific problems submitted. The urgency of this work and existing staff limitations have up to the present precluded any possibility of carrying on researches of a more general character. Most of the work done has been for departments of the Dominion Government, particularly for the Department of National Defence.

The equipment of these laboratories, while installed primarily for aeronautical work, is also useful for much work in the general engineering field, and it is estimated that approximately half of the work done to date has been of this character.

The aeronautical laboratories comprise the following:-

1. Aerodynamic Laboratory equipped with a wind tunnel in which speeds up to 160 miles per hour may be secured in a jet 9 ft. in diameter. This laboratory is devoted to investigations, tests and calibrations involving the flow of air.

2. Hydrodynamic Laboratory. This is equipped with a model-testing basin, 400 ft. long, 9 ft. wide and 6 ft. deep, having a carriage capable of speeds up to 30 miles per hour. The work of the laboratory includes investigations, tests and calibrations in connection with aircraft floats and hulls, boats and vessels, current meters, etc.

3. Engine Laboratory.

(a) Dynamometer laboratory, equipped with a dynamometer capable of testing engines developing up to 1000 h.p., at speeds up to 2,500 r.p.m., for investigations and tests of prime movers and accessories.

(b). Detonation laboratory, provided with testing units and equipment for investigations and tests of gasolines and lubricating oils.

4. Aircraft and Allied Laboratory. This laboratory is provided with a refrigerating chamber and other necessary apparatus for the testing and calibration of all types of aircraft and similar instruments such as barometers, tachometers, hygrometers, altimeters, etc.

Examples of Work Completed in the Aeronautical Laboratories

1. Locomotive. At the request of the Canadian National Railways, an investigation was made resulting in the development

of an exterior form, applicable to the existing 6100 type C.N.R. locomotives, having a much reduced air resistance (about 25% reduction for the locomotives alone) and overcoming the hazard due to the "blinding" of the locomotive driver by smoke.

Locomotives embodying the recommendations resulting from the study are understood to be now under construction by the Canadian National and Canadian Pacific Railways, and locomotives of very similar design have since been built in Great Britain, the United States, Germany, and France.

2. Aircraft Skis. At the request of the Department of National Defence, tests to determine the pitching moment of a number of full-sized aircraft skis were made in the wind tunnel, and more recently a comprehensive investigation was made of the aerodynamic characteristics of a large number of skis as used in Canada, followed by the development in the laboratories of a ski of improved design having a very low resistance and pitching moment. The new ski is such that aircraft should have a better performance on skis than on wheels, whereas with present skis the performance is inferior on skis.

The report on this study has been in large demand by aircraft constructors and operators in Canada, as well as in England and foreign countries. The Royal Canadian Air Force is testing these skis in service.

The work is being continued this winter with an investigation of the snow performance of skis, in an effort to secure information on which to base the design of skis.

3. Aircraft Floats. At the request of the Department of National Defence, tests were conducted in the basin on aircraft floats having unsatisfactory characteristics. The tests resulted in the recommendation of a modification which satisfactorily corrected the trouble.

4. Development of New Freight Aircraft. Development tests were made, for a Canadian^{firm}/in connection with the design of a new aircraft for freight carrying in the north country. The effects on performance of many alterations in the design were investigated.

One aircraft embodying the results of these investigations is now in operation and two are under construction for the Department of National Defence. In connection with the latter machines, further wind tunnel tests to determine the effect of different cockpit arrangements were made.

5. Patrol Cruisers. Several models of patrol cruisers to be built for the Royal Canadian Mounted Police have been comprehensively tested at different times.

In connection with the 60-foot "Interceptor", now in service, basin tests were made to determine the better of two alternative designs and further tests of the better design were made, resulting in modifications being embodied to improve its performance. In the case of the "Improved Acadian" hull, basin tests for resistance were made and the required horsepower was calculated. More recently extensive tests were made and are still in progress in connection with a 120 ft. patrol cruiser for which a contract for two has been let. The basin tests indicated that the desired speed with the proposed engines would

not be obtained with the original design and several variations have been tested in an effort to secure improved results. A hull is being designed in the laboratories.

6. Aircraft Engine Type Tests. A type test, to Air Ministry specifications has been conducted, on an engine assembled in Canada, on which the Department of National Defence issued a certificate of airworthiness as required by the International Convention for Air Navigation to which Canada subscribed. Type tests of two other engines are to be made this year for the same purpose.

7. Alcohol Gasoline Blends. In co-operation with the Division of Chemistry, a study of the characteristics, as a motor fuel, of blends of alcohol and gasoline has been made.

8. Cameras in Photographic Aircraft. At the request of the Department of National Defence, a study was made in the wind tunnel in an effort to reduce the drag of the three cameras as used by the Royal Canadian Air Force in photographic work for aerial surveying. A reduction in drag of 80% was finally achieved.

9. Current Meter Rating. Several current meters have been rated and re-rated in the basin, for the Interdepartmental Water Levels Board, for use in the gauging of the flow of the St. Lawrence River. In addition to the routine rating, studies have been made of a number of factors influencing the operation of the meters.

10. Barges. Basin tests of models of barges to determine resistance and study stability have been made for naval architects.

11. Pumping Cold Oil in Starting Aircraft Engines at Low Temperatures. At the request of the Department of National Defence, a study was undertaken in an effort to overcome difficulties encountered in circulating the oil in engines, when starting aircraft engines in low temperatures, as in winter operation in the north country. Useful information was obtained.

12. Gasoline. At the request of several provinces which have established standard grades and control of the sale of gasoline, tests of samples have been and are being made in the laboratories. Aircraft gasoline is regularly tested for the Department of National Defence and the Department has issued a circular recommending that aircraft operators have the gasoline they are using tested in the laboratories. There were some 90 samples of gasoline in the laboratories for test at one time in the past summer.

A number of investigations in connection with gasoline have also been conducted, including the effect of sunlight on doped gasoline, seasonal variation in gasoline, deterioration of gasoline after long periods in storage, etc.

13. Carbon Monoxide in Aircraft Cockpits. At the request of the Department of National Defence, tests were made in flight to determine the amount of carbon monoxide present in the cockpits or cabins of a number of aircraft.

14. Altigraph for Aerial Survey Use. A sensitive, limited range altigraph has been developed in the laboratories under the auspices of the Associate Committee on Survey Research.

Recent service tests at Great Bear Lake indicate that the instrument has a very satisfactory performance and should prove valuable in connection with aerial survey work.

15. Tests of Aircraft and Allied Instruments. All of the instruments submitted by the Royal Canadian Air Force are calibrated in the laboratories as well as the reconditioning and repair of aircraft instruments. Instruments are also calibrated for provincial governments,

16. Weather Bureau Anemometer. At the request of the Meteorological Service of Canada wind tunnel tests have been made of a number of types of head for the anemometer used for recording wind velocity, in an effort to develop an improved instrument.

17. Exhaust Tail Pipe for Aircraft Engines. An exhaust tail pipe of improved design, developed in the laboratories, has been used commercially with success.

18. Aircraft Stability. At the request of the Department of National Defence, a wind tunnel study was made in an effort to determine the cause and correct unsatisfactory longitudinal stability in an aircraft used for aerial photography. The aircraft was found difficult to fly level and level flight is an essential in aerial photographic operations. The cause of the trouble was determined and a remedy recommended.

Work Now in Hand in the Aeronautical Laboratories

1. Farm Windmill. An investigation is being conducted in an effort to develop an improved windmill for the generation of electric current for farm use. The particular objective is a windmill capable of operating in light winds, thereby reducing

the size and cost of the necessary storage battery.

2. Stop Logs for Emergency Dams. At the request of the Chief Engineer, St. Lawrence Waterways, an investigation is being made to determine the magnitude and nature of the forces on the stop logs used as emergency dams in the case of failure of lock gates in ship canals. As the proposed "logs" are some 8 ft. dia. x 80 ft. long, the forces involved are large.

3. Data-recording Camera. Under the auspices of the Associate Committee on Survey Research, a camera for recording the readings of different instruments at the instant of taking an aerial photograph is being developed and made in the laboratories.

4. Canoes on Aircraft. Tests have just been completed in the wind tunnel to determine the effect on aeroplane performance of carrying a canoe and the best position for the canoe. Canoes are commonly transported in the north country by aeroplane. The results of the study should be useful to air transport companies.

5. Stalling of Tapered Wings. At the request of the Department of National Defence, an investigation is being commenced of the stalling of heavily tapered wings as used in modern aircraft. The question is one of great importance from the standpoint of the lateral control of such aircraft.

Tests Completed or in Progress.

Aircraft wing ribs
Windmill
Rotor propeller
Water meter
Humidifier
Gasoline dispenser
Aerial sign
Calibration of gallon measures

Gasoline engine moisture device
Lubricating oil
Roof ventilators
Mechanical transmission
Motor car models
Aircraft windmill
Spark plug

Fire Hazard Laboratory

On November 5, 1931, the Privy Council Committee for Scientific and Industrial Research "unanimously agreed that the National Research Council should immediately install the equipment required to establish a laboratory for testing oil burners, fire extinguishers, etc., etc. -----", and also "unanimously agreed that facilities should be provided in Canada which would make it unnecessary for equipment of this nature of Canadian manufacture to be sent to a foreign laboratory for approval before being placed on sale in Canada".

In accordance with the foregoing, provision of a laboratory for testing domestic oil burners commenced in January 1932. Tests were begun in September of that year. Since then work has continued steadily on the testing of domestic oil burners for fire hazard.

Of 12 automatic oil burners submitted for test, seven have been listed, three have failed to meet requirements and two are under test.

Fourteen manufacturers have submitted 19 models of atmospheric oil burners, of which 14 have been listed, three failed to meet requirements and two are under test.

Modifications in several of the burners have been tested from time to time, and revised listings issued. Tests have been conducted on different components and accessories of oil burners, such as shells and oil pumps.

As a necessary preliminary to the testing, specifications were drafted, and those now prepared, forming parts of a Safety Code for Oil Burning Equipment (NRC-11-1935) include:-

Part I. Section 1(a) - Design and Construction of Domestic Atmospheric Oil Burners

Part I. Section 1(b) - Design and Construction of Domestic Automatic Oil Burners.

Part III. Fuel Oil

In connection with the "listing" of oil burners, to ensure that manufacturers produce oil burners identical with those tested in the laboratories and to facilitate provincial officials in checking sale and installation, a Factory Inspection and Labelling Service has been established. All oil burners, or other devices, tested and listed by the Council carry labels indicating this fact. This service is self-supporting financially. A total of 9780 labels have been issued and 39 factory inspections made.

Certain provinces - British Columbia and Manitoba - now require that oil burners installed in these provinces shall carry Council listing. There has been close co-operation with these provinces.

Several other devices have been tested and listed at the request of manufacturers, including:-

Gasoline engine for fire pump drive.
Inhalator

Tests are in progress on the following:-

Gasoline vaporizing machine (including flash arrester)
Gasoline safety can
Gasoline stove
Automatic draft regulator

Preparations have been made and tests are about to commence on:-

Fire extinguishers
Valves for sprinkler systems

In connection with the foregoing, the following specifications have been drafted or are in preparation:-

N.R.C.-7-1934 - Safety Standard for Gasoline Engines for Fire Pump Drive.

N.R.C.-10-1935- Safety Standard for Dry Cleaning Solvent

N.R.C.-12-1935- Safety Standard for Gasoline Vapor Machine for Domestic Heating and Cooking

N.R.C.-13-1935- Safety Standard for Gasoline Safety Cans

N.R.C.-14-1935- Safety Standard for the Design and Construction of Automatic Draft Regulators

N.R.C.-15-1935- Safety Standard for the Design and Construction of Gate Valves of the Inside Screw Type.

Work is in progress on parts of the Safety Code for Oil Burning Equipment dealing with Installation and Operation of Domestic Oil Burners.

Miscellaneous work done or in progress in the laboratory includes tests on the following:

Refrigeration units for domestic refrigerators
Air blower
Fuel oil
Dry cleaning solvent

To provide a liaison between the laboratory and outside practice, and to act in an advisory capacity in connection with the drafting of specifications and the operation of the fire hazard testing laboratory, an Associate Committee on Fire Hazard Testing has been created by the Council.

Instrument and Model Shops

The functioning of the National Research Laboratories necessitates the provision of properly equipped and staffed instrument shops, in which the special precision scientific instruments and apparatus, designed and developed in the laboratories for use in the different investigations, can be made under close supervision. Many such instruments and apparatus cannot be obtained on the market and experience has demonstrated that it is not feasible to have them made in outside shops. The character of such instruments and apparatus, their variety and precision, require for their production, accurate, resourceful and skilled mechanics and high-grade tools.

In addition to instrument work, the shops undertake the construction of the accurate scale models required for wind tunnel and testing basin work.

The shops are also responsible for the modification, repair, installation and maintenance of the mechanical and electrical equipment of the laboratories. Owing to the nature and extent of the equipment and the character of the work done in the laboratories, the servicing and maintenance of the equipment is extensive, exacting and important.

The unique facilities available in the shops for fine instrument work and the construction and repair of special and unusual apparatus are being increasingly used by other Government departments. Under the auspices of the Associate Committee on Survey Research, a high-angle plotter for preparing maps for aerial photographs and a sensitive limited range altigraph

for use in air survey were constructed recently. Other departments served by the shops include National Defence, Interior, Public Works, Mines, Marine, Canadian Radio Broadcasting Commission and Canadian Government Motion Picture Bureau.

Typical examples of apparatus constructed for the laboratories, in the shops, are as follows:-

X-ray spectrometer	Photometric bench
Optical micrometer	Leather wear testing machine
Integrating photometer sphere	Dough modifying machine
Aerodynamic balances	Valve testing apparatus
Windmill dynamometer	Model aircraft

The shops include machine shop, fine instrument shop, forge and welding shop, cabinet shop, electrical shop, tool crib and stores, together with drafting, blueprinting and photostating facilities.

The shops function under the direction of a Workshop Committee composed of members of the laboratories' staff, under the chairmanship of the President, through a technical officer in charge of the shops. An accurate cost recording system is in operation.

The shops as at present established have proved to be inadequate to cope with the volume of work required, and following a comprehensive investigation by the Civil Service Commission proposals for re-organization have been made.

DIVISION OF RESEARCH INFORMATION

The Division of Research Information is one of the four professional divisions in which the work of the National Research Council has been organized. To it is assigned responsibility for the collection and distribution of information on scientific and technical subjects, principally for the Council's own laboratory staff but also for those working with financial assistance from the Council in outside laboratories and for independent research workers throughout Canada. In fulfilment of this purpose the work of the division has been organized in the following main branches:-

- (1) National Research Library
- (2) Research Information Service
- (3) Publications
- (4) External Research Activities

The collection of information is made chiefly through the National Research Library, which now subscribes to a large number of the most important research journals throughout the world. These journals, constituting as they do a permanent record of the results of scientific and industrial research, are the foundation upon which new researches must be based. Only by constantly keeping in touch with such sources of information can duplication of effort be avoided and advantage be taken of the progress made elsewhere. In addition to the journals the Council purchases for the library a moderate number of scientific and technical books.

To supplement these major sources of information special inquiries are occasionally conducted for the purpose of securing data not available in published form. Contacts are thus made with government organizations and individual research workers in various parts of the world and valuable information is secured on subjects in which the Council has a special interest.

The information thus collected is made available to the Council's laboratory staff chiefly through the facilities of the library, which are in constant use. In addition, however, four or five members of the staff of the Research Information Service spend practically their whole time in reviewing the literature, for which work they are especially fitted by language study and thorough training in one or more branches of science.

While certain of the results of the Council's work, being of industrial importance and of interest to competitors in foreign countries, cannot be published in detail, the majority of the scientific advances made by the Council's staff are reported in the Canadian Journal of Research, which is now in its seventh year of publication and is already well established as one of the important scientific journals of the world. Certain information of interest to specific Canadian industries or agriculture is published in technical reports and bulletins, which appear at irregular intervals, but these are issued less frequently than before the establishment of a regular monthly journal. The publication of the annual report of the National Research is one of the responsibilities of this division.

It is also the duty of officials of the division to perform a large amount of secretarial work for research committees of the Council, which, previous to the establishment of the National Research Laboratories, were responsible for the Council's major activities, and which even now provide for effective contact and cooperation between the research staff of the Council, research workers elsewhere, and technical and other representatives of the industry.

National Research Library

Owing to the necessity for economy in recent years, the purchase of books has been limited to those most urgently required. There are now available in the library about 17,000 volumes, in addition to a large number of pamphlets. In the selection of this material, consideration has been given to the need of supplementing the facilities of Ottawa libraries and also those in other parts of Canada, since, in a scientific library service, loans are frequently necessary and it is considerably more difficult to borrow from libraries outside the country.

An indication of the inadequacy of the present library is seen in the fact that during an average year it has been necessary to borrow books or periodicals from about 20 Canadian and six or eight United States libraries. While the necessity for occasional loans can never be entirely eliminated, the number of such loans should be greatly reduced, as the delay in obtaining information frequently involves serious inconvenience. It may be noted further that those members of the staff of the division who give most of their time to the study of the

literature frequently have to spend long periods in other libraries in Ottawa, otherwise the number of loans from those libraries would be greatly increased. In return the National Research Library is able to render considerable assistance by loans. A photostat service is also available, through an arrangement with the Division of Physics and Engineering.

The total number of regular and irregular publications received is about 850, of which approximately 150 are obtained in exchange for the Canadian Journal of Research.

Arrangements have been made whereby the Library of Parliament has transferred a number of sets of scientific periodicals to the National Research Library. The Library of the Royal Society of Canada is also housed in the library stacks and is thus made available to the staff of the National Research Council.

Research Information Service

The services rendered by this branch vary widely in character. A large number of the inquiries received involve only minor questions in science and technology and are readily answered without any special study of the literature. Frequently, however, an inquiry concerns a research problem of some member of the Council's own staff or a research committee, a university worker or an industrial investigator, and involves a thorough study of the scientific and technical literature of all important countries. In such cases exhaustive studies are made involving subsequently the preparation of comprehensive reports. The largest of these reports as a rule contain extensive bibliographies.

In doing this work, however, care is taken not to encroach upon the field of consulting chemists or engineers, and many requests for routine tests and information are referred to consulting firms or to some other branch of the government service.

Further, while inquiries regarding research always receive careful attention, many inquiries refer to matters upon which the Council does not attempt to prepare reports. Of such a character are requests from individuals for full information regarding the technical processes of a whole industry, or letters from students desiring information regarding historical and other events as assistance in the preparation of essays. In such cases nothing more is done than to refer inquirers to sources of general information such as technical books and encyclopaedias.

The following list of reports is typical of the large number prepared in recent years for the staff of the National Research Council, research workers elsewhere in Canada, or Canadian industries:

Agricultural Surpluses and Wastes.

Alcohol Fuel in Internal Combustion Engines.

Analyses of Canadian Public Water Supplies.

Apparatus for Determining the Resistance of Materials to
Abrasion.

The Decay of Bark and Its Use as a Fertilizer.

The Electrolytic Manufacture of Chlorates.

Evaporation from Gasoline Storage Tanks under the Influence
of the Sun's Radiation.
Flexible Steel for Belting.
Jerusalem Artichoke.
Knock Inhibitors.
Malt.
Patents on the Manufacture of Pectin.
Physical Constants of Saturated Hydrocarbons.
Recent Work on Lithium and Its Uses, 1927-1933.
Selenium.
The Service Testing of Power Cables.
Soybeans.
Steam-pipe Coverings.
Sulphurized Oils.
Sumac as a Tanning Material.
The Use of Iodine as a Preventive of Goitre.
Utilization of Tobacco Waste.
Utilization of Waste Leather.

A large proportion of the technical and scientific literature which must be consulted by research workers is in foreign languages. For this reason, provision has been made for a technical translation and abstracting service, through which information published in almost any of the European languages can be made available. Such work cannot be handled by **an** ordinary translating staff since for accurate translation or abstracting familiarity with the subject matter is essential. This service is available not only to the Council's own staff but also at cost to industry.

Publications

The National Research Council issues an annual report, the Canadian Journal of Research, technical reports and bulletins and various miscellaneous publications in printed or mimeographed form. The editing of these and all matters relating to their publication are handled by this branch.

The primary function of the Canadian Journal of Research is to act as a medium of publication for the work of the National Research Council, whether done in the National Research Laboratories or in the universities with financial assistance from the Council. The Journal is, however, open to suitable papers from any Canadian research worker.

In its first six years of publication the Canadian Journal of Research contained 656 scientific papers, comprising a total of 7,963 pages. In the last few years the volume of material available for publication has increased to such an extent that the Council decided to issue the Journal in four sections, dealing, respectively, with the physical, chemical, botanical and zoological sciences. This change was made effective in July, 1935, since which time the issues have averaged about 15 articles and 175 pages each.

Previous to the establishment of the Journal it was necessary to send a great many Canadian scientific papers to the United States and Great Britain for publication and, as a result, Canada lost much of the credit which should have been hers. At present a large proportion of this material is being published in Canada.

External Research Activities

The National Research Council has nearly 30 research and advisory committees and many assisted researches under way in laboratories outside Ottawa. Members of the staff of the Division of Research Information have been assigned technical responsibilities and secretarial duties in connection with the majority of these activities, including assistance to the President of the Council in the organization of research, responsibility in seeing that the work is carried out as planned, and a study of the reports submitted.

Specifications

A very considerable expansion of the Council's activities in the field of standards and specifications has led to the assignment of additional duties to the Division of Research Information. These cover the preparation of specifications for both the Canadian Government Purchasing Standards Committee and the Council itself. As it is essential in each case to consult all the interests concerned, this necessitates a large number of committee meetings and extensive correspondence.

In work on specifications it is desirable to proceed with considerable caution and on this account specifications are usually issued in tentative form and fully accepted only when they have met the test of time and experience. Further, none of the specifications issued by the National Research Council are in any way compulsory unless made so by bodies with authority to take such action. Since the specifications in general represent the practically unanimous view of the parties most

concerned, they are being widely adopted.

Patents

The Council has established an Associate Committee on Patents and Awards to advise it in the administration of that section of the Research Council Act dealing with discoveries, inventions and patents. Acting on the recommendation of this committee, a Subcommittee on Patents has been set up in each of the laboratory divisions.

With the development of the Council's researches, particularly in the manufacturing field, many inventions are being made, involving new processes and products. In order to make these available in Canada and foreign countries on conditions fair to producers, consumers and the Council, patents are usually secured, these being assigned to the Council.

Application for patents necessitates a previous thorough search of the patent and technical literature, which is carried out by the staff of the division. This staff is also responsible for seeing that applications placed are supported as may be necessary until patents are granted.

ADMINISTRATIVE DIVISION

Financial Summary

1916-17 to 1934-35

Revenue

1916 - 1935

Year	Government Vote	From In- dustry etc.	For Special Scholarships	Refunds	Sundries	Total
1916-17	\$	\$	\$	\$	\$	\$
1917-18	91,600.00					91,600.00
1918-19	120,000.00			21.62		120,021.62
1919-20	120,000.00			5,337.61	27.58	125,365.19
1920-21	120,000.00			5,827.13	2.00	125,829.13
1921-22	120,000.00			2,789.82		122,789.82
1922-23	120,000.00			783.69		120,783.69
1923-24	120,000.00	3,000.00		2,506.16		125,506.16
1924-25	120,000.00		900.00	3,897.10		124,797.10
1925-26	135,000.00		1,191.25	1,742.49	640.00	138,573.74
1926-27	150,000.00	10,000.00		3,332.37		163,332.37
1927-28	170,000.00	14,892.94		15,884.84	708.91	201,486.69
1928-29	300,000.00	20,961.47		1,422.84	982.25	323,366.56
1929-30	400,000.00	55,888.83		8,470.47	23.45	464,382.75
1930-31	500,000.00	41,986.62	3,600.00	3,892.25	894.56	550,373.43
1931-32	478,000.00	46,517.88		32,314.53		556,832.41
1932-33	410,000.00	40,426.55			4,091.45	454,518.00
1933-34	379,500.00	49,502.71		13,989.74	1,621.78	444,614.23
1934-35	392,000.00	78,890.08		8,266.81	278.83	479,435.72

NATIONAL RESEARCH COUNCIL

SUMMARY OF EXPENDITURES 1916-1935

Year	Research Grants & Scholarships	Library & Publications	Laboratory Equipment & Supplies	Travel & Other Administration	Salaries	Total	Remarks
1916-17	163.00			6,735.27	3,256.98	10,155.25	
1917-18	13,894.79	1,316.64		15,289.96	19,610.35	50,111.74	
1918-19	26,669.96	1,737.95		10,222.83	22,520.88	61,151.62	
1919-20	59,665.24	2,421.87		11,876.76	25,908.55	99,872.42	
1920-21	79,431.24	1,874.62		13,042.76	21,057.39	115,406.01	
1921-22	63,370.46	3,067.13		16,789.83	19,125.77	102,353.19	
1922-23	75,197.79	2,794.47		11,298.63	16,703.76	105,994.65	
1923-24	98,684.04	1,642.89		9,898.76	15,091.37	125,317.06	
1924-25	91,073.91	1,634.40		10,313.28	17,989.17	121,010.76	
1925-26	102,013.65	2,161.27		15,152.07	19,243.35	138,570.34	
1926-27	115,569.89	2,278.37	4,768.56	17,634.72	23,074.52	163,326.06	
1927-28	152,652.33	2,851.21		19,092.38	26,889.16	201,485.08	
1928-29	237,697.16	3,926.69	2,533.15	36,029.63	42,925.61	323,112.24	
1929-30	270,432.60	46,294.96	21,065.76	41,426.91	83,419.12	462,639.35	
1930-31	238,458.82	31,480.77	57,953.17	37,151.72	185,289.74	550,334.22	
1931-32	209,323.71	25,722.70	27,391.75	26,249.64	259,916.39	548,604.19	
1932-33	76,769.57	26,077.38	42,776.55	37,120.17	269,429.91	452,173.58	
1933-34	99,566.50	23,813.54	37,997.82	17,075.67	266,160.63	444,614.16	
1934-35	135,795.21	25,085.18	35,381.45	19,998.88	263,128.48	479,389.20	

SOURCES OF INFORMATION REGARDING
THE NATIONAL RESEARCH COUNCIL AND ITS WORK

1. Annual reports
2. Technical reports 1-28.
3. Bulletins 1-16.
4. Canadian Journal of Research.
5. Specifications issued by the Council and the Canadian Engineering Standards Association.
6. Proceedings of the associate committees of the Council.
7. National Research Council Scholarship Who's Who.
8. Mimeographed reports of the Council.
9. Scientific papers by assisted research grantees.
10. Scientific papers by holders of the Council's scholarships.

Technical Reports

1. The Briquetting of Lignites
2. The Recovering of Vapors from Gases
3. The De-tarring of Gas by Electrical Precipitation
(Out of print)
4. Nicotine and Tobacco Waste. (Out of print)
5. Canadian Waste Sulphite Liquor as a Source of Alcohol
6. An investigation into the Question of Early Putrefaction of
Eviscerated Fish in which the Gills have been Left.
7. Survey of General Conditions of Industrial Hygiene
in Toronto
8. A Method of Smelting Titaniferous Iron Ore
9. Food Requirements of the Ranch Fox
10. Fuel Saving Possibilities in House Heating
11. The Red Discoloration of Cured Codfish

12. The Discoloration, Smut or Blackening of Canned Lobster
13. Cultural Criteria for the Distinction of Wood-destroying Fungi
14. The Utilization of the Low Grade Iron Ores of Canada.
15. Marine Borers on the Atlantic Coast of Canada
16. The Relation of Bacteria to the Quality of Graded Butter
17. The Mosquitoes of the Lower Fraser Valley, British Columbia, and their Control
18. Investigations on the Treatment of Nova Scotia Oil Shales
19. Bacteriology of Certain Sea Fish
20. Consideration of the Relation between the Distribution of Teredo Navalis and Temperature and Salinity of its Environment.
21. The Life History of Exeristes Roborator Fab., a Parasite of the European Corn Borer.
22. An Experimental Study of Sieving
23. The Storage of Apples in Air-cooled Warehouses in Nova Scotia
24. The Drying of Wheat
25. The Drying of Wheat (Second report)
26. Weed Survey of the Prairie Provinces
27. Weeds and Their Control
28. Comparative Feeding Values for Livestock of Barley, Oats, Wheat, Rye and Corn

Bulletins

1. The Need of Industrial Research in Canada
2. Researches on Sound Measurement with Reference to the Testing of Fog Signal Machinery
3. How to handle Frozen Fish (Out of Print)
4. Hints on Frozen Fish (Out of Print)
5. Science and Industry

6. The Heating of Houses, Coal and Electricity Compared (Out of Print)
7. The Manufacture of Ethyl Alcohol from Wood Waste (Out of Print)
8. Some of the Problems of the Fox Raising Industry (Out of Print)
9. The Honorary Advisory Council for Scientific and Industrial Research and its Work. A Brief Résumé of the Activities of the Council up to 1921 (Out of Print)
10. A Plan for the Development of Industrial Research in Canada
11. Nitrogen Fixation (Out of Print)
12. Nitrogen in Industry
13. Interim Report on Protein Content as a Factor in Grading Wheat
14. Report of Inquiry in Europe Regarding the Feasibility of Using Protein Content as a Factor in Grading and Marketing Canadian Wheat.
15. Review of Literature Dealing with Health Hazards in Spray Painting
16. Health Hazards in the Radium Industry

Specifications

- NRC-1-1932. Specifications for Approval of Type of Electricity Demand Meters.
- NRC-2-1932. Specifications for Approval of Type of Curve Drawing Electricity Meters.
- NRC-3-1934. Specifications for Approval of Type of Instrument Transformers and Phase Shifters.
- NRC-4-1934. Specifications for Approval of Type of Watthour and Ampere Hour Meters.
- NRC-5-1934. Specification for Western Red Cedar Shingles.
- NRC-6-1934. Specifications for Approval of Type of Positive Displacement Gas Meters.
- NRC-7-1934. Safety Standard for Gasoline Engines for Fire Pump Drive.
- NRC-8-1935. Specification for Gasoline.

- NRC-9-1935. Specification for Fuel Oil.
- NRC-10-1935. Safety Standard for Dry Cleaning Solvents.
- NRC-11-1935. Safety Code for Oil Burning Equipment.
- NRC-12-1935. Safety Standard for Gasoline Vapour Machines for Domestic Heating and Cooking.
- NRC-13-1935. Safety Standard for Gasoline Safety Cans.
- NRC-14-1935. Safety Standard for Design and Construction of Automatic Draft Regulators.

Tentative Specifications of the Canadian Government Purchasing Standards Committee.

- No. 1-GP-1 Linseed Oil, Raw, Unrefined.
- " 1-GP-2 Linseed Oil, Boiled
- " 1-GP-3 Turpentine for Paint, Type I.
- " 1-GP-4 Paint Thinner, Petroleum Spirits, Type 1.
- " 1-GP-5 Paint Thinner, Petroleum Spirits, Type 2.
- " 1-GP-6 Putty for Glazing, Types I and 2.
- " 1-GP-7 Liquid Paint Drier, Types I and 2.
- No. 2-GP-1 Liquid Toilet Soap.
- " 2-GP-2 Household Bar Soap.
- " 2-GP-3 Laundry Chip and Powdered Soap.
- " 2-GP-4 Soft Soap.
- " 2-GP-5 Milled Toilet Soap.
- " 2-GP-6 White Floating Soap.
- " 2-GP-7 Liquid Household Soap.
- " 2-GP-8 Bar Toilet Soap.
- No. 3-GP-1 Gasoline.
- " 3-GP-2 Fuel Oil.
- " 3-GP-3 Illuminating Oils.
- No. 6-GP-1 Standard Mailing Envelopes.
- " 6-GP-2 Standard Letterhead Paper.
- " 6-GP-3 Standard Dimensions of Letterhead and Report Paper.
- " 6-GP-4 Attendance Register (Form)
- " 6-GP-5 Absence Record "
- " 6-GP-6 Summary of Absence Record "
- No. 10-GP-1 Burned Fireclay Brick for Stationary Boiler Service, (With memorandum).
- " 10-GP-2 Standard Questionnaire re Stationary Boiler Installations.

Publications of the Canadian Engineering Standards Association
 (the main committee of which acts as the Associate Committee
 on Engineering Standards of the National Research Council)

- No. A 1 - 1928 Standard Specification for Steel Railway Bridges
 (third edition).
- A 1a - 1928 Material Specifications, Steel Railway Bridges
 (second reprint).
- C 2 - 1929 Standards for Single-phase Distribution Trans-
 formers (second edition).
- C 3 -- 1924 Standard Specification for Galvanized Telegraph
 and Telephone Wire (reprint).
- B 4 - 1921 Standard Specifications for Wire Rope for Mining,
 Dredging and Steam Shovel Purposes.
- A 5 - 1927 Standard Specification for Portland Cement
 (second edition).
- A 6 - 1929 Standard Specification for Steel Highway Bridges
 (second edition).
- D 7 - 1922 Standard Specification for Flexible Steel Wire
 Rope and Flexible Strand for Aircraft Purposes.
- C10 - 1923 Standard Specification for Tungsten Incandescent
 Lamps.
- D11 - 1924 Interim Report on the Manufacture, Testing and
 Use of Gasoline.
- B12 - 1924 Standard General Specification for Galvanized
 Steel Wire Strand.
- E13 - 1924 Standard Specification for Railway Wire-Fencing
 and Gates.
- C14 -- 1924 Standard Specification for Reinforced Concrete
 Poles.
- C15 - 1924 Standard Specification for Eastern Cedar Poles.
- A16 - 1930 Standard Specification for Steel Structures for
 Buildings (second edition).
- C17 - 1925 Standard Requirements for A.C. Watthour Meters.
- B18 - 1930 Established List of Stove Bolts. (second edition).
- A19 - 1926 Standard Classification for Items of Highway
 Expenditure.
- A20 - 1927 Standard Specifications for Movable Bridges.
- C21 - 1927 Standard Specification for Control Cable for
 Electrical Power Plant Equipment.
- C22 - 1930 Canadian Electrical Code - Part I. (second
 edition). - Inside Wiring Rules.
- C22.2 - Canadian Electrical Code - Part II - Approval Speci-
 fications.
- No. 0-1932 Definitions and General Requirements.
- No. 1-1932 Power-operated Radio Devices.
- No. 2-1933 Electric Signs.
- No. 3-1933 Electrical Equipment for Oil-burning
 Apparatus.
- No. 5-1934 Service-entrance and Branch-circuit Breakers.
- No. 6-1933 Electric Clocks.
- No. 7-1933 Portable Electric Displays and Incandescent
 Lamp Signs.

- No. 9 - 1933 Electric Fixtures.
- No.10 - 1933 Electric Floor-surfacing and Cleaning Machines.
- No.11 - 1934 Fractional Horsepower Motors.
- No.12 - 1934 Electric Portable Lighting Devices (Portables).
- No. A23 -1929 Standard Specification for Concrete and Reinforced Concrete.
- G24 -1929 Standard Specification for Sampling for Check Analysis of Steel Billets, Bars and Shapes.
- G25 -1929 Standard Specification for Carbon Steel Billets and Bars of Forging Quality
- G26 -1929 Standard Specification for Commercial-Quality-Hot-Rolled Bar Steels.
- G27 -1929 Standard Specification for Commercial Cold-Finished Bar-Steels and Cold-Finished Shafting.
- G28 -1929 Standard Specification for Carbon Steel Castings.
- B29 -1932 Established List of Machine Screws and Nuts (second edition).
- G30 -1930 Standard Specification for Billet-steel Reinforcing Bars (second edition).
- G31 -1930 Standard Specification for Rail-steel Reinforcing Bars (second edition).
- G32 -1930 Standard Specification for Steel Wire for Concrete Reinforcement (second edition).
- B33 -1932 Established List of Cap Screws, Set Screws and Studs, Common and Semi-finished, Slotted and Castellated Hexagon Nuts.
- B34 -1934 Established List of Non-heat-treated Machine, Carriage and Plough Bolts, and Common Square and Hexagon Nuts.
- B35 -1933 Established List of Binder Head Screws.
- B37 -1932 Standard Blade Punching for Road Grading Machinery.
- C22.2 -No. 8 - Capacitors (Electrical Condensers).
- No.18 - Outlet Boxes.
- No.20 - Motor-operated Blowers and Stokers.
- No.22 - Electrical Equipment for Measuring and Discharge Devices for Explosive or Flammable Liquids.
- No.16-1935 Insulated Conductors for Power-operated Radio Devices.
- No.14-1935 Industrial Control Equipment in ordinary (i.e. Non-hazardous Locations.)
- No.17-1935 Cable for Luminous-tube Signs & for Oil-burner Ignition Equipment.
- No.21-1935 Cord sets.
- No.19-1935 Soldering Lugs
- A 36-1935 Standard Dimensions for Building Brick.
- G 38-1935 Standard Specification for Carbon-steel Forgings.
- C 22.2-No. 4-1935 Enclosed Switches.

APPENDIX "A"

14-15 GEORGE V.

CHAP. 64THE RESEARCH COUNCIL ACT

(Assented to 19th July, 1924.)

1917, His Majesty, by and with the advice and consent of the
c.20 Senate and House of Commons of Canada, enacts as follows:-

Short title 1. This Act may be cited as The Research Council Act,
1924.

Defini- 2. In this Act, unless the context otherwise requires,--
tions.

"Com- (a) "Committee" shall mean the Committee of the Privy
mittee." Council on Scientific and Industrial Research;

"Chair- (b) "Chairman" shall mean the Chairman of the Committee of
man." the Privy Council on Scientific and Industrial Research;

"Council." (c) "Council" shall mean the Honorary Advisory Council for
Scientific and Industrial Research;

"President." (d) "President" shall mean the President of the Honorary
Advisory Council for Scientific and Industrial Research.

Advisory 3. There shall be a Council to be called "The Honorary
Council Advisory Council for Scientific and Industrial Research."

Appoint-4. (1) The Council shall consist of not more than fifteen
ment of Council members who shall be appointed by the Governor in Council
on the recommendation of the Committee.

(2) The members of the Council with the exception of
the President, shall hold office for a period of three
years, and not less than four members shall retire each

year. Provided that of the members first appointed under this Act, not more than five shall be appointed for a period of three years, not more than five members shall each be appointed for a period of two years, and not more than five members shall be appointed for a period of one year.

Re-appoint- (3) Any retiring member shall be eligible for reappointment.
ment.

Presi- 5. There shall be a President of the Council who shall be
dent of appointed by the Governor in Council on the recommendation
the of the Committee. The President shall be the chief
Council. executive officer of the Council and shall have supervision over, and direction of the work of the Council and of the officers, technical and otherwise, appointed for the purpose of carrying on the work of the Council. He shall receive such salary and be employed for such term of office as the Governor in Council may prescribe, and such salary shall be paid out of the monies provided for the work of the Council.

Duties 6. The Council shall have charge of all matters affecting
of scientific and industrial research in Canada which may
Council be assigned to it by the Committee, and shall also have the duty of advising the Committee on questions of scientific and technological methods affecting the expansion of Canadian industries or the utilization of the natural resources of Canada.

Coun-
cil
incorp-
orated

7. The Council is hereby constituted a body corporate capable of suing and being sued and having the power to acquire money, securities, real estate or property by gift, grant, bequest, donation or otherwise, and of holding lands, tenements, hereditaments, goods, chattels and any other property, movable or immovable, for the purpose of, and subject to, this Act.

Meet-
ing of
Council

8. The Council shall meet at least four times a year in the city of Ottawa on such days as may be fixed by the Council, and may also meet at such other times and places as the Council may deem necessary.

Remuner-
ation

9. No member of the Council, with the exception of the President, shall receive any payment or emolument for his services, but each member shall receive such payments for travelling and other expenses in connection with the work of the Council as may be approved by the Governor in Council.

Powers
of
Coun-
cil.

10. Without thereby limiting the general powers of the Council conferred upon or vested in it by this Act, it is hereby declared that the Council may exercise the following powers namely:-

- (a) To make by-laws for the conduct of its business;
- (b) To control and direct the work of the Council through the President, and, in case of the illness, absence or suspension of the President, or in the case of vacancy in the office of President, through an Acting President temporarily appointed by the Council;

- (c) To undertake in such way as may be deemed advisable--
- (i) To promote the utilization of the natural resources of Canada;
 - (ii) Researches with the object of improving the technical processes and methods used in the industries of Canada, and of discovering processes and methods which may promote the expansion of existing or the development of new industries;
 - (iii) Researches with the view of utilizing the vast products of said industries;
 - (iv) The investigation and determination of standards and methods of measurements, including length, volume, weight, mass, capacity, time, heat, light, electricity, magnetism and other forms of energy; and the determination of physical constants and the fundamental properties of matter;
 - (v) The standardization and certification of the scientific and technical apparatus and instruments for the Government service and for use in the industries of Canada; and the determination of the standards of quality of the materials used in the construction of public works and of the supplies used in the various branches of the Government service;
 - (vi) The investigation and standardization, at the request of any of the industries of Canada, of the materials which are or may be used in, or of the products of the industries making such a request;

(vii) Researches, the object of which is to improve conditions in Agriculture;

- (d) To have charge of, and direction or supervision over, the researches which may be undertaken, under conditions to be determined in each case, by or for single industrial firms, or by such organizations or persons, as may desire to avail themselves of the facilities offered for this purpose;
- (e) To expend such sums of money as may be annually appropriated by Parliament for the work of the Council or which shall have been received by the Council through bequest, donation or otherwise;
- (f) With the approval of the Committee, to appoint such scientific, technical and other officers as shall be nominated by the President, and to fix the tenure of such appointments, to prescribe the several duties of such officers, and, subject to the approval of the Governor in Council, to fix their remuneration;
- (g) Subject to the approval of the Chairman, to publish, from time to time such scientific and technical information as the Council may deem necessary.

Dis- 11. (I) All discoveries, inventions and improvements in pro-
 cover- cesses, apparatus or machines, made by a member or any
 ies and number of members of the technical staff of the Council shall
 in- ven- tions, be vested in the Council and shall be made available to the
 Con- trol public under such conditions and payment of fees or royalties
 of. or otherwise as the Council may determine, subject to the

approval of the Governor in Council.

Pay-
ment
of
bonus-
es
and
royal-
ties.

(2) The Council, with the approval of the Governor in Council, may pay to its technical officers and to others working under its auspices who have made valuable discoveries, inventions or improvements in processes, apparatus and machines such bonuses or royalties as in its opinion may be warranted.

Audit of 12. All the receipts and expenditures of the Council shall be subject to examination and audit by the Auditor General.

Pres- 13. (1) The President shall report annually to the Council
ident's upon the progress and efficiency of the work of the Council
re-
port.

and as to its requirements, and shall make such recommendations therein as he may deem necessary.

Coun-
cil's
re-
port.

(2) The Council shall, after the conclusion of the fiscal year, make a report to the Committee containing the report of the President to the Council and also containing a statement of the receipts and expenditures of the Council during the preceding fiscal year. Such reports shall be printed and laid before Parliament within fifteen days of the making thereof, or, if Parliament is not then in session, within fifteen days after the commencement of the next session of Parliament.

Re-
peal.

14. Chapter twenty of the statutes of 1917 is repealed.

APPENDIX "B"NATIONAL RESEARCH COUNCIL

President: Major-General A.G.L. McNaughton, C.B., C.M.G.,
D.S.O., M.Sc., LL.D., Ottawa, Ont.

Secretary-Treasurer: S.P. Eagleson, Esq., Ottawa, Ont.

Members:

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Charles Camsell, B.Sc., LL.D., F.R.S.C., Deputy
Minister, Department of Mines, Ottawa, Ont.

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M. L'Abbé Alexandre Vachon, M.A., S.T.D., Lic. Ph., F.R.S.C.,
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