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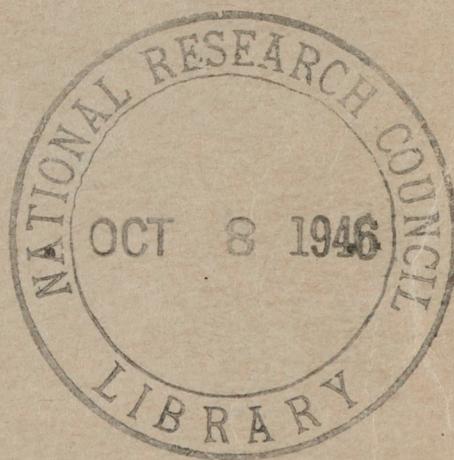
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TWENTY-NINTH  
ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL  
OF CANADA

1945-1946



Published by authority of the RT. HON. C. D. HOWE, M.P.

*Chairman of the Committee of the Privy Council on  
Scientific and Industrial Research*

OTTAWA, CANADA

*N.R.C. No. 1411*

**TWENTY-NINTH  
ANNUAL REPORT**

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**NATIONAL RESEARCH COUNCIL  
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**OTTAWA, CANADA**



THE RT. HON. C. D. HOWE,  
*Chairman, Committee of the Privy Council on  
Scientific and Industrial Research,*  
Ottawa, Ontario.

SIR:

I have the honour to present to you herewith the Twenty-ninth Annual Report of the National Research Council, for the fiscal year 1945-46.

In accordance with the requirements of the Research Council Act, this report contains the report of the President and a statement of the receipts and expenditures of the Council during the year under review.

Your obedient servant,

C. J. MACKENZIE,  
*President, National Research Council.*



THE COMMITTEE OF THE PRIVY COUNCIL ON SCIENTIFIC  
AND INDUSTRIAL RESEARCH

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THE MINISTER OF TRADE AND COMMERCE  
THE MINISTER OF MINES AND RESOURCES  
THE MINISTER OF NATIONAL DEFENCE  
THE MINISTER OF NATIONAL HEALTH AND WELFARE  
THE MINISTER OF FINANCE  
THE MINISTER OF AGRICULTURE  
THE MINISTER OF LABOUR

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NATIONAL RESEARCH COUNCIL  
1945-46

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- G. M. SHRUM, M.M., M.A., Ph.D., F.R.S.C., Professor and Head of the Department of Physics, University of British Columbia, Vancouver, B.C.
- ARTHUR SURVEYER, B.A., B.Ap.Sc., C.E., D.Eng., Consulting Engineer, 1010 St. Catherine Street, West, Montreal, Que.

**TWENTY-NINTH ANNUAL REPORT**  
**OF THE**  
**NATIONAL RESEARCH COUNCIL**  
**1945-46**

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**REPORT OF THE PRESIDENT**

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The National Research Council of Canada met the impact of war in 1939 with one central laboratory and a small but efficient and very keen laboratory staff. Growth throughout the war years was substantial and during this first year of peace, the attention of Council has been directed chiefly towards the orderly conversion to peacetime applications of the new and enlarged facilities developed to meet war needs. (1)

In addition to its central laboratory, the Council established 21 other laboratories during the war, each for a specific requirement in connection with the war effort. Some of these were small and temporary, others larger and of a permanent nature. These laboratories were located all across Canada from Halifax to Vancouver. Temporary laboratories for cold weather work were set up at Lake Louise, Jasper, Edmonton, Saskatoon and Winnipeg.

An explosives experimental establishment at Valcartier has become part of a large Service organization. In connection with the work on atomic energy, laboratories were equipped in Montreal and later extensive and permanent facilities for these investigations were constructed at Chalk River, Ontario. Naval research stations were located on both east and west coasts, Sizable radar laboratories were built near Ottawa, and on a site just outside the city, additional permanent laboratories were constructed with new and larger wind tunnels for aeronautical research and to provide more extensive facilities for hydrodynamic studies. Space is available on this new site for further expansion and plans include provision for the construction of high voltage laboratories, and a chemical engineering pilot plant.

At the outbreak of war, practically every laboratory in Canada offered its facilities to the Government, and the story of how these laboratories and staffs were welded into an informal but highly effective cooperative association for war, reflects the genius Canada displayed in many fields of her war effort for genuine and unselfish collaboration. The war history of the Council is in preparation, but the work is not yet sufficiently advanced to permit of a comprehensive review being given at this time. Some references, however, are included further on in this report.

The Associate Committee structure, a distinctly Canadian mechanism of proven effectiveness, has been extended and strengthened. Grants in aid of postgraduate research, and the award of scholarships were continued during the war and are now being augmented. Provision of trained personnel (2)

is sound insurance for commercial progress and industrial development. Canada's riches in natural resources stand as a challenge to the ingenuity of her scientists, but industry and capital must do their part by seeing to it that the remuneration of Canadian scientists is maintained at an attractive level in order that there may not be too much wastage through migration of trained personnel to other lands where better opportunities are offered.

3 | Outstanding developments were reported by the National Research Council of Canada in 1945-46. Among these were the investigations relating to atomic energy, the release of information on radar research, the design and construction of a plywood tailless aircraft which was ready for flight trials at the end of the year, and the development to the pilot-plant stage of a process for the production of butylene glycol from wheat.

Reconversion to peacetime practice was carried forward during the year as the war's end became a certainty. Gauge inspection work that had been a major activity in cooperation with the Inspection Board of the United Kingdom and Canada, was brought to a close in September 1945. Work on the Prairie Regional Laboratory at Saskatoon was pushed forward as quickly as possible but was retarded by material shortages that impeded building operations generally throughout the Dominion.

A building research conference reviewed the situation in the housing and construction field and laid plans for the coordination of studies and the initiation of practical schemes for the improvement of housing in all its branches, including construction, plumbing, heating, lighting, ventilation, and perhaps as important as any, the proper planning of housing projects with regard to their economic and social aspects. This work is being closely integrated with the activities of the Department of Reconstruction and Supply, through the Research and Development Branch of which the President of the National Research Council is Director.

Research work for the three Services—Navy, Army, and Air—continued throughout the year but on a gradually slackening basis towards the end of the war. Much of the work undertaken for the Services as a war measure, will be continued in peacetime but with industrial and commercial applications to civilian rather than military requirements.

Such activities will include applications of radar as aids to air and sea navigation, the continuance of many medical researches on the control of infectious diseases, studies in shock and blood substitutes, continued investigation of medical problems affecting the rehabilitation of wounded Service personnel including the development of plastic prostheses for artificial limbs, studies in heat-retaining values of textiles used in clothing, shrink resistance of woollens, particularly socks, wearing qualities of leathers and leather substitutes used in boots, and a host of other items.

4 | Aeronautical investigations include work on aircraft performance, engines and fuels, instrument design and testing, and a multitude of other problems. Electrical engineering, acoustics, heat and light, X-ray analyses, electrical measurements and standards are fields of physics that have seen wide application during the war and that will now be turned to the improvement of apparatus, equipment and devices for the betterment of housing conditions or the improvement of commercial industrial products.

Increased attention is now being given to fundamental scientific studies, many of which can be carried on to best advantage as parts of a well integrated programme in cooperation with the universities. During the war great

progress was made by the National Research Council in the coordination of research looking to the greatest possible use of all available laboratory facilities throughout the Dominion. One of the major studies in the development of new and extremely powerful explosives, was a co-operative project in which almost one hundred investigators working in university and industrial laboratories scattered across Canada, carried out researches on specific parts of a single programme in which the National Research Council had both a contributing and a coordinating function.

Similar applications in peacetime will ensure sound progress in research and yield high returns on each dollar invested. In addition to the tangible results to be secured, there is the incalculable value of the lift to morale that comes from working on a problem that is known to be part of an important national undertaking. The influx of veterans in large numbers into the universities imposes a very heavy teaching load on the science departments and reduces the time available for research, but on the other hand, veterans who are graduates are also returning to the universities for further training in research and will thus form the nucleus of new research teams that can be put to work wherever adequate facilities are available.

As soon as security measures permitted, an exhibition of military radar equipment designed in Canada, was assembled and shown at the National Research Laboratories to many hundreds of scientific personnel. Some of the principal items on which work was done may be mentioned.

Naval radar equipment was designed for installation on escort vessels for the detection of other ships or surfaced submarines. A microwave radar was developed to give accurate range to targets and improved performance in bearing measurement for use on frigates, algerines and corvettes. Another type was made for use on small ships of the motor torpedo boat or Fairmile class for the detection of other surface targets.

Army radar included the 9L IIIC which was designed to operate with an anti-aircraft battery. It consisted of an early-warning radar and an accurate position-finding radar operating together. This equipment by the National Research Council was the first microwave anti-aircraft fire-control radar in the world to go into quantity production.

The CDX Mark I is a microwave coast-defence gun-control unit for fixed-site installation. Equipment of this type will form the basis for the design of peacetime harbour-control radars.

Air Force radar included long-range early-warning devices produced for coastal defence against surface vessels and low-flying aircraft. Some of the early sets made in Canada were sent to the Panama Canal zone where they were used successfully to guard that vital area.

Demonstrations have been made of a distance indicator which shows the pilot of an aircraft his distance from one or more selected ground points. This is but the first in a large number of possible applications of radar techniques to problems of aerial and marine navigation.

Canada was one of three countries, whose governments and scientists embarked together on the gigantic, years-long gamble, the best kept secret of the war, which resulted in the manufacture of the atomic bomb from materials mined in Canada and made available to the United States for the purpose.

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An official statement on Canada's role in the atomic bomb drama, released by the Rt. Hon. C. D. Howe, Minister of Reconstruction and Supply, stated that Canada had been associated with scientific developments in atomic research since 1899 when Sir Ernest Rutherford began his work on radioactivity at McGill University. But it was the discovery, reported in 1939, of "fission" of the uranium atom that gave the first hope that it might be possible to release atomic energy on a large scale, capable of military and industrial applications.

From that time scientists in Great Britain, the United States, Canada and France directed their energies towards the possibility of finding a war application for this research. On the fall of France, French scientists were sent to join the British scientists. In October 1940 information was exchanged among the countries concerned and in 1942 Great Britain proposed that an important section of the work should be carried on in Canada as a joint enterprise.

A laboratory was established in Montreal under the administration of the National Research Council of Canada. This laboratory had a staff of 340 and was by far the largest organization ever created in this country to carry out a single research project.

Work of the laboratory was closely coordinated with the tremendous activity in this field in the United States. Its work led to the design and construction of a pilot plant for the production of atomic bomb materials. The plant is located at Chalk River, Ontario, about 120 miles west of Ottawa. A branch of the National Research Council has been established there in association with the pilot plant to carry out research on the application of atomic energy in war and in industry and on the use of its products in research and medicine.

In the laboratories at Ottawa the work of reconversion to peacetime applications of war research and the initiation of new problems are being pushed forward rapidly. Staff now number about 1,400 persons of whom one-half are of professional grade. This represents considerable growth during the war, and is commensurate with the record of industrial progress in Canada. Research activities must be maintained on a steadily increasing scale if Canada is to go forward and hold the place she has gained during the war, as an industrial nation.

Research staff of the highest calibre are required, for first class work cannot be done by second rate personnel. Selection is therefore of prime importance and the National Research Council through a special committee carefully weighs the qualifications of all candidates for appointment.

Many skilled scientists who have had some years of intensive research as members of the Council staff, have found suitable avenues of advancement in the service of Canadian industries. In this way the influence of the National Research Council in the promotion of industrial research in Canada has been extended far beyond its own laboratories.

Aeronautical facilities at the laboratories may now be used for work on problems of interest to industry and to the civilian population. During the war they were reserved almost wholly for work required by the Armed Services. Most of the apparatus and equipment provided are of a character and capacity which would not otherwise be available in the Dominion. Care has been taken to avoid, as much as possible, duplication of facilities existing elsewhere in the country.

While present aerodynamic theory is essentially based on the findings of previous research and the experience gained from the study of successful aeroplanes, no designer would today undertake the building of a new type aeroplane without first checking its performance through wind-tunnel tests.

The Council has three wind tunnels—two horizontal to measure forces acting on aircraft (pitch, roll and yaw), and a vertical tunnel in which problems associated with dangerous spins can be safely and inexpensively solved.

The giant strides made by modern aircraft in terms of power and performance have, in a structural sense, placed new emphasis not only on the elastic and dynamic properties of any given airframe but also on the strength it might exhibit. The National Research Council's structures laboratory has therefore been equipped to conduct tests and experiments relative to this important phase of aeronautics.

Perhaps one of the most interesting projects undertaken in recent years has been that concerning the tailless aircraft. The original feeling was that, in view of the intensive research being done in other countries, efforts to gain experience with such aircraft should be made in Canada. It was agreed that a one-third-scale flying model of a large "flying wing" transport aeroplane should be designed and constructed primarily to investigate the control and stability of the type.

Wing span of the model designed by the laboratory staff is 47 feet; the maximum weight on test will be approximately 4,000 pounds. In the glider type chosen, a pilot and observer will be carried. Dual controls are provided. Primary structure of the glider is entirely of wood, embodying a single laminated spar and a relatively thick moulded plywood skin over conventional ribs. The model was completed and ready for flight trials at the end of the year. (Successful trials have since been reported).

Through pilot-plant operations, the structures laboratory has gained much valuable experience in the use of synthetic resin adhesives and impregnants, plywood moulding techniques, the application of glueing pressures to complicated assemblies, and on the advantages and deficiencies of various glue-line heating methods and numerous similar problems. Members of the staff have frequently been called upon by the Services and industry to assist in drafting specifications as well as for consultation work. Many Canadian firms have sent personnel to the laboratory for varying periods to study methods in use.

The hydrodynamics laboratory comprises model-testing basins for the measurement of forces acting on hulls of ships, seaplane floats and other craft, and a hydraulics laboratory for work on structures such as canal locks, dams, spillways, and power-plant details.

A recent inquiry concerns the Kingsville harbour on Lake Erie. Under certain storm and current conditions a sandbar forms directly across the navigation channel between two parallel piers by which the harbour is protected. Annual dredging is necessary to maintain the channel.

In order to deal with this problem and offer a possible solution, it was necessary for the laboratory to construct a miniature replica of the harbour and then to simulate as closely as possible conditions affecting the formation of the sandbar. Continuous experimentation was necessary before satisfactory duplication was achieved, the results of which compared favourably with the soundings obtained at Kingsville. This done, proposed extensions

of the longer pier were tested to determine the most efficient location and design.

Work is in progress on two other models; one dealing with the problem of sandbar formations in the Fraser River, the other to investigate the forces acting upon an emergency gate for canals.

6 In the physics laboratories, one of the main objectives of work in radiology is to develop new and better instruments for the radium industry to assist in the location of radioactive ores and the measurement of these ores and their products. New techniques have been developed for X-ray and radium radiography, and research has been directed into the use of X-ray diffraction and electron microscopy to determine the properties of catalysts, pigments, rubber-compounding materials and many other products of interest to industry.

Special emphasis has been placed on photographic research with special reference to mapping Canada from the air. A small percentage increase in the amount of information which can be obtained from a photograph very considerably increases its value and has a direct bearing on the economics of the whole undertaking.

The importance of hydro-electric power in Canada demands that a vigorous national research programme in the electrical field be maintained. High-voltage research is being continued and studies are being made of recently developed insulating materials. Work is being done on electric control and protection, electrical heating, and electrochemistry. Research is proceeding on improved safety codes, new methods of house wiring and problems of rural electrification. The war disclosed serious faults in certain lines of electrical machinery. Studies to overcome these were undertaken, and will be continued because of important peacetime applications. Special electrical problems for the Chalk River project will command considerable attention of some of the staff of this laboratory during the coming year.

Some of the techniques used in acoustics during the war are being developed into peacetime applications. For example, the echo method of submarine detection is being investigated for its possible use in prospecting and in the detection of flaws in solid structures. Possible industrial uses for high-intensity and high-frequency sound are being considered. Other investigations include acoustic measurements on gases at very high temperatures, fundamental studies of matter, sound-deadening investigations in connection with housing research, and new investigations into the realm of physiological acoustics including studies on the development and standardization of hearing aids. As a result of the anti-submarine work for the war, special Canadian researches in physical oceanography were initiated and in collaboration with other Government departments and Canadian marine industry these investigations are being continued.

Because of the cold winter weather encountered in most parts of Canada the problem of house heating is of universal interest. Staff employed on this project are engaged in developing a new method of heating houses by floor or ceiling radiant-heat panels, and are endeavouring to ascertain the effect of window ventilation in severe weather if floors are heated. Part of this project concerns itself with the measurement of moisture in wheat and the speed with which this moisture moves from one part of the stored wheat to another. This problem is of considerable importance in connection with the preservation of stored wheat from mites. Work is continuing in

developing suitable thermostatic control for refrigerator cars. Modernizing of heat standardization equipment which was interrupted by the war has been resumed.

The transition from war to peace has afforded a welcome opportunity in the chemistry division for the discontinuance of a large amount of routine testing that had to be done during the war for the Armed Services and has enabled the staff to turn their attention once again to more fundamental research. Progress is being made in the organization of chemical engineering facilities on a greater scale and a new building to house this work is projected. Much work has already been done in the design of the water-treatment plant, the steam plant and the chemical laboratories for the Chalk River establishment. When the new chemical engineering building has been completed, there will be provision for at least three pilot plants so that laboratory investigations may be carried forward through a semi-industrial stage and results secured that can be applied directly to industry.

Studies in distillation, evaporation, heat transfer, hydraulics and other similar subjects, carried out on large scale, are essential to industrial chemical research. Space must be provided for installation of the heavy machinery required for this purpose.

Industrial researches in progress include work on laundering and cleaning, fundamental and applied research on fibres—cotton, silk, rayon and nylon, as well as wool. Interesting results have been secured on the use and action of detergents and on soil-removal problems. Preservation of fabrics is another large and important study.

Investigations on lubricating greases have been carried on in co-operation with industry. Plastics and colloids represent a growing field of study.

New sources of alkaloids have been found in Canadian plants and methods for their extraction have been worked out. In a few cases alkaloids have been synthesized.

An interesting item in applied chemical research was the development during the war of a surface treatment for aircraft windows to prevent blurring during a rainstorm. A simple and very effective method of keeping the pilot's window clear was found and it has been adopted. Unfortunately the slower speed of motor cars renders the method inapplicable in its present form but development work is being continued.

While a large part of the work in the Division of Chemistry has been of direct application to industry—paints, rubber, textiles, petroleum, explosives, etc.—about one-third of the research work in the division is of fundamental significance. Progress in the industrial application of science depends on the advancement of basic scientific knowledge.

Activities in applied biology continue in two main fields: (i) utilization of agricultural surpluses and wastes, and (ii) food investigations.

Fermentations work has involved the study and test of hundreds of bacteria to ascertain whether and to what extent they would break down such industrial waste materials as sulphite liquor from pulp mills into products of commercial value. Similar studies have been made on wheat starch and such good results have been secured that the laboratory investigation has been carried forward to the pilot-plant stage. Butanediol has been produced and this material has been found to be an excellent anti-freeze. Moreover

it can be used as the basis for the production of a long line of other chemical products whose combined value is far in excess of that of wheat, the primary raw material used.

In the utilization of starch a workable method of separating starch from gluten has been developed. A simple process has been designed which gives a high yield of pure starch. The demand during the war for starch has led to the use of this method in a British Columbia plant which is now making several hundred tons of glucose per month. Manufacturers of cornstarch are also interested in the process. Starch is used for the manufacture of syrup on an important commercial scale and investigations have therefore been started on the manufacture of wheat syrup.

Work has been projected on a modification of wheat starch with a view to the replacement of cornstarch and other starches in commercial use, by prepared wheat starch. Success in the project depends on the utilization of gluten other than as feed, perhaps by its conversion to glutamic acid for food flavours and other uses. Pure glutamic acid is not a commercial product but a crude acid might find a ready sale. Some work has been done on the utilization of agricultural residues such as straw, bran and hulls. Furfural derivatives and their uses have been studied. Tetrahydrofurfuryl alcohol has been found to be promising as antifreeze.

The rubber shortage gave rise to investigations having for their object the recovery from Canadian plants of materials that could be used as rubber substitutes. The resin fraction from milkweed leaves was found partially satisfactory for this purpose but further study revealed that the product might find a more acceptable use as a substitute for chicle in the manufacture of chewing gum.

Establishment of the Council's Prairie Regional Laboratory, now under construction at Saskatoon, will enable work in this field to be pursued more vigorously than heretofore. Situated on the campus of the University of Saskatchewan, the laboratory will be staffed by experienced and well trained personnel who will be in close touch at all times with the University staff on the one hand and the farming and manufacturing community on the other.

Food investigations during the war were directed almost entirely to the problems involved in the transport of perishables to Great Britain. The longer period of transport occasioned by the circuitous routing of freighters because of submarines, gave rise to numerous problems for which solutions had to be found. A simple and effective method of refrigerating the holds of ordinary cargo vessels was developed and applied. Modifications in bacon cure were suggested to the packers.

Work was done on the preparation, packaging, preservation and shipment of dried egg and dehydrated pork. Methods for the preservation of shell eggs by oiling were developed as soon as it became apparent that their shipment would be feasible. The contract for shell eggs for Great Britain from Canada in 1945 was 600,000 cases. Specifications for the oiling of eggs were drawn and applied. It was found that oils of higher viscosity than ordinarily used were better and that application could be made at room temperature. It is important in the oiling of eggs that the coating be applied as soon as possible after the egg is laid in order to retain its natural carbon dioxide content, as an aid in preserving the quality. The egg contains about 10 per cent carbon dioxide when it is laid but in five days most of this is replaced by air.

Dehydration studies have been carried out on milk, eggs, and mixtures of these two. Of a dried sugar-egg mixture some twenty million pounds were used in Great Britain in the baking trade last year. Dried sugar-egg retains its whipping power in sponge.

Milk and egg mixtures have been used with success as high protein foods in the treatment of amputation patients. About 90,000 pounds of such preparations were shipped last year for use in overseas military hospitals for this purpose.

Packaging of foods especially for shipment overseas and, in the latter part of the war, to the Pacific, presented many problems in which satisfactory results were obtained.

Among the Associate Committees operating under the authority of the National Research Council, those dealing with medical research have come to occupy a prominent place. The Associate Committee on Aviation Medical Research having completed its work was disbanded in September 1945. Preparation of the history of the Committee's activities was completed later in the year, and the record was accepted as a substantial and very creditable contribution to knowledge in this new field. Research on some subjects undertaken during the war is being continued at Toronto in the Institute of Aviation Medicine under the auspices of the Royal Canadian Air Force.

The Associate Committee on Army Medical Research is being continued for the time being in order to provide for certain medical research studies of military significance. Action in regard to the Associate Committee on Naval Medical Research has been deferred pending a decision regarding the Navy's post-war requirements for medical investigations of a research character.

The general subject of medical research was sponsored by the National Research Council just before the war at the request of the Canadian Medical Association and the Royal College of Physicians and Surgeons. Since then the scope of the investigations undertaken has developed very extensively, and towards the close of the year under review, the National Research Council approved a recommendation from the Associate Committee on Medical Research that provision be made for the continuance of medical research on a permanent basis. A Division of Medical Research under the National Research Council has accordingly been authorized and will be established early next year. It is not contemplated that this new Division will set up laboratories of its own immediately, but rather that it will continue for the present to make use of the facilities provided in the university medical schools and hospitals. Research grants will be made for the support of investigations in the medical sciences, and funds will be provided for the establishment of a limited number of medical research fellowships to aid in the postgraduate training in research of selected personnel.

On the industrial side, Associate Committees have continued to provide the Council with helpful advice and informed opinion in respect of many problems. Members of these Committees serve without pay and their contribution to the planning and direction of research studies in varied fields is an important element in the success of the Council in dealing with the broad subjects represented by Committee activities. It is a pleasure to place on record here a well deserved tribute to the hundreds of Committee members who so patriotically give of their time and effort in the promotion of the research activities entrusted to them by the Council each year.

Part of the peacetime reconversion effort has resulted in necessary changes in the organization of the laboratories to cope with the growing volume of work. In chemistry for example, an Assistant Director has been appointed to be directly responsible for the chemical engineering and industrial sections of the Division's work, including colloids and plastics, paints, rubber, and textiles. Similarly in the Division of Physics and Electrical Engineering, an Assistant Director has been given charge of the radio and electrical engineering activities. In Applied Biology, staff expansion includes provision for the Prairie Regional Laboratory, which is under construction at Saskatoon for the study of problems related to the utilization of agricultural surpluses and wastes.

Under the terms of the Research Council Act, the membership of the Council consists of not more than 15 persons appointed by the Governor in Council on the recommendation of the Committee of the Privy Council on Scientific and Industrial Research. During the year ended March 1945, five members completed their terms of office as members of the National Research Council. The retiring members were: Dean Armand Circé, Dr. J. A. Gray, Dr. O. Maass, Mr. F. Molineux, and Dr. A. Surveyer. Two of these were reappointed for a further term of three years: Dr. J. A. Gray, O.B.E., B.Sc., D.Sc., F.R.S., F.R.S.C., Chown Science Research Professor, Queen's University, Kingston, Ontario, and Dr. Arthur Surveyer, B.A., B.Ap.Sc., C.E., D. Eng., Consulting Engineer, 1010 St. Catherine Street, West, Montreal, Quebec. Three new members, each of whom will serve for a term of three years from 1 April, 1945, were appointed: Mr. Percy Bengough, President, Trades and Labour Congress of Canada, 172 MacLaren Street, Ottawa, Ontario; Dr. David A. Keys, M.A., Ph.D., F.R.S.C., Macdonald Professor of Physics, McGill University, Montreal, Quebec; and Dr. Paul E. Gagnon, B.A., B.Ap.Sc., D.I.C., Ph.D., D.Sc., F.R.S.C., Director of the Department of Chemistry and Chemical Engineering, and Director of the Graduate School, Laval University, Quebec, Quebec.

The Council derives its funds largely from a Parliamentary appropriation. Supplementary revenues come through contributions from industry for special work, fees for other services, income from trust funds, royalties and sale of patents. During the war, the Council's normal revenues were supplemented by special allotments from the Government War Appropriation, to enable research to be done on assigned projects for the Armed Forces.

The "Sir Frederick Banting Fund" contributed early in the war by a number of Canadian public spirited corporations and citizens, continued to be administered by the War Technical and Scientific Development Committee of which the President of the National Research Council is Chairman. Grants were made from this fund to the Council for the conduct of investigations and the development of new equipment that might be useful in the war. This money, in addition to regular Government grants gave great flexibility to the Council's programme and proved to be of great value in the war effort. Much of the money advanced in grants was subsequently repaid when the projects thus assisted became self-supporting. Consequently, the Fund has been maintained and can be used in peacetime for research and development, as it was in war.

The work of the several laboratory divisions of the Council has been reported upon by the respective Directors, in the following sections of this report.

The financial statement of the Council for the fiscal year ended 31 March 1946, is also included.

## FINANCIAL STATEMENT FOR THE FISCAL YEAR 1945-46

## Receipts

On Hand in Trust Fund March 31, 1945:

Cash.....	\$ 251,643 14	
Bonds.....	162,000 00	
		\$ 413,643 14
Parliamentary Appropriation.....		1,188,596 33
Royalties and Sale of Patents.....		32,833 38
Laboratory Fees.....		273,646 56
Sale of Publications.....		8,758 41
Interest on Bonds.....		6,035 00
Contributions from Industries, etc.....		63,815 83
Miscellaneous.....		38,425 06
		\$ 2,025,753 71

## Expenditures

Salaries.....	\$ 644,883 82	
*Less Wages of Shop Staff.....	84,784 88	
		\$ 560,098 94
Scholarships.....		52,185 00
Library.....		6,300 02
Publications Issued.....		17,557 38
Travel.....		13,431 20
Patents.....		7,036 25
Western Laboratory—Building and Equipment.....		86,511 37
Laboratories—Equipment, Supplies, etc.....		563,604 79
General Expenses.....		19,680 38
On work of the following Associate Committees:.....		190,341 57
Aeronautical Research Committee.....	38,250 23	
Canadian Committee on Food Preservation.....	213 64	
Canadian Standards Association.....	10,000 00	
Canadian Government Purchasing Standards.....	787 87	
Conference on Utilization of Agricultural Wastes and Surpluses.....	1,689 86	
Dental Research Committee.....	5,870 08	
Electrical Committee.....	61 65	
Field Crop Diseases Committee.....	6,589 68	
Forestry Research Committee.....	6,780 04	
Geophysics Committee.....	520 16	
Grain Research Committee.....	27,424 80	
High Voltage Committee.....	-175 40	
Industrial Radiology Committee.....	9,342 95	
Laundry Research Committee.....	1,444 16	
Medical Research Committee.....	55,752 52	
National Building Code.....	92 70	
National Committee on Fish Culture.....	4,718 24	
Parasitology Committee.....	13,087 93	
Weeds Research Committee.....	6,500 00	
Wool Research Committee.....	1,390 46	

\*Wages of the staff of the Instrument and Model Shops are a part of the cost of work performed in the Shops, for which charges are made. These charges are included under other items of expenditure.

**Expenditures—Concluded**

Research Grants to Individuals.....		51,441 42
**Research on Problems Sponsored by Government Departments, Industry, etc.....		9,609 51
International Affiliations.....		4,313 75
		<hr/>
		\$ 1,582,111 58
Balance on hand March 31, 1946:		
Cash.....	234,142 13	
Bonds.....	209,500 00	
	<hr/>	443,642 13
		<hr/>
		\$ 2,025,753 71

**Special War Expenditures**

Funds allotted to the Council from the War Vote.....	\$ 3,724,829 96
Funds provided by other Departments for work performed on their request..	1,478,526 76
	<hr/>
	\$ 5,203,356 72

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\*\* *The National Research Council is fully repaid for this work.*

19 July, 1946.

# REPORTS OF THE DIRECTORS

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## DIVISION OF APPLIED BIOLOGY

W. H. COOK, *Director*

The majority of the investigations in this Division fall into two main classes: industrial utilization of agricultural wastes and surpluses, and preservation of food. Until August, 1945 the volume and direction of these activities were wholly dictated by war needs. When peace came, a number of readjustments were made: war projects unrelated to peacetime requirements were abandoned; others, because of the nature of the work, were continued but with a change in emphasis; important pre-war researches laid aside during the war years were resumed, and several new projects were undertaken.

At the request of the various Services, tropicalization tests were made of all types of Service equipment, including the mould-proofing of radios, electrical cables, plastics, leathers, woods, cements, waxes, paints, and medical stores. This work is now confined to the rot-proofing of fabrics. Three new fungicides were evolved during the year. These are copper complexes of organic compounds and are all superior to copper dimethylglyoximate for the mould-proofing of textiles. A large collection of fungi has been built up from these studies and their ability to ferment starch to useful products is now being assessed.

Similarly, wartime package research was done on practically all Service items intended for use in tropical, temperate, and Arctic climates, including a wide range of instruments, spare parts, and ammunition. This work was largely abandoned and is now confined to the packaging of food. During the year, considerable assistance was given to the Canadian Packaging Committee in the preparation of various packaging codes.

Recent expansion of the work on industrial utilization of agricultural wastes and surpluses includes the erection of a modern laboratory on the campus of the University of Saskatchewan in Saskatoon. During the year considerable progress was made and it is expected that the building will be completed toward the end of 1946. Considerable laboratory and pilot plant equipment has been ordered, and a small group is actively at work in space borrowed from the University of Saskatchewan. With the completion of the building it will be possible to expand the work with the object of making important post-war contributions to both agriculture and industry.

The large-scale investigation on the production of new chemicals from farm crops was continued. Emphasis was shifted from the production of war chemicals to products useful in a peacetime economy. Two new fermentations were studied in the laboratory: *Bacillus subtilis* and *Serratia marcescens*, capable of producing butanediol in high yields, with glycerol or formic acid as secondary products. These fermentations are now ready for pilot-plant study. Improvements were made in the method of recovering butanediol from wheat mashes fermented in the pilot plant with *Aerobacillus polymyxa*.

Cyclic methyl ethyl ketal, derived from butanediol, shows promise as a possible blending agent with motor fuels. Many other ketals derived from butanediol are also being studied. A large number of esters, many of them new, were prepared from butanediol and various fatty acids, and are of interest for possible use as solvents, drying agents and plasticizers.

A thorough investigation has been made of antifreeze mixtures, particularly of components obtained by fermentation. From laboratory studies and practical driving tests it was found that aqueous solutions of *levo*-butanediol were a satisfactory permanent-type antifreeze. A testing device for these mixtures was developed for use in service stations. Work on anhydrous coolants with antifreeze properties, particularly tetrahydrofurfuryl alcohol, was extended to include binary solutions.

During the war period, the production of resins and rubber-like polymers from various plant materials was studied on a pilot-plant scale. It has now been found that the same methods, namely pebble-milling followed by froth flotation, can be applied to the separation of oil from waste seed screenings.

Because of shortages of sugars and syrups, particularly corn syrup, wheat syrup was investigated on a semi-pilot-plant scale under the conditions necessary for starch hydrolysis. The Division's pilot plant previously described was used for separating starch and gluten from wheat, and first quality syrups were prepared from this starch. The quality of wheat syrups from new commercial enterprises was tested frequently and advice given on technical details.

Prior to the war, the Division was active in several fields of plant science. The specialists involved were transferred to other duties during the war period, except for an investigation on forest-tree breeding. It seems probable that the laboratory studies in forest-tree breeding will be taken over by the Dominion Forest Service, or the Department of Agriculture which departments have to assume responsibility for developing new trees. As suitable staff become available, work in other fields of plant science will be resumed.

Many requests are received for investigations in the general field of animal science. The number of *ad hoc* problems referred to this Division is now on a level that demands considerable time from investigators assigned to other projects. Hitherto the amount of space available has precluded studies in this field but it is hoped that it may become possible to initiate a group which will concern itself with general problems in the field of animal science.

In the food field, the work on egg products has been particularly valuable. The scientific work on dried eggs helped to produce an excellent Canadian product during the war; but the British housewife prefers shell eggs as a symbol of peace, and it appeared that the large wartime dehydration industry might have to be abandoned. However, it was found that the addition of sugar before drying yielded a product equal to liquid or frozen eggs in baking properties, and bakers became interested, since sponge goods require the addition of sugar in any event. Also the new product keeps better than ordinary dried eggs. As a result, this product is now an important item of Canadian export, and the British Ministry of Food has ordered 20 million pounds for 1946. The greatly enlarged egg production developed during the war is continuing at a high level during the peace, and the entire Canadian surplus is being sold to Britain.

Now that the war is over, other egg products are also assuming importance. Methods of assessing quality have been adapted to use on liquid and frozen egg, and their storage characteristics are being determined. The storage life of shell eggs is improved by holding them in dilute carbon dioxide overnight, or in high concentrations for one to two hours, previous to oiling. Equipment for gassing eggs prior to oiling has been developed and Division's investigators are assisting industry to put this development into operation. A substantial volume of eggs will be gassed and oiled this year for overseas test shipments. One commercial fungicide is showing promise for application to oiled shell eggs. Bacteriological studies on the *Salmonella* group of organisms were continued.

Quality-testing methods for use on canned poultry were revised at the request of the Department of Agriculture. Several commercial concerns expressed interest in the studies on Irish moss (a sea-weed) as a substitute for the agar used in canned meats, and it is expected that a plant based on these investigations will shortly come into operation. This new industry should benefit the Maritimes.

Extensive investigations on Canadian Wiltshire bacon were carried on before the war, and consumer surveys had shown that the British consumer preferred a milder cure. The war intervened before the necessary adjustments could be made, and the convoy system and other war conditions then demanded a still harder cure. A standard cure was adopted which met these requirements, but the bacon is much too salty for the peacetime trade. Efforts are now being made to produce a milder bacon. The ideal salt concentration is being determined subjectively, and possible changes in apparent saltiness during storage and cooking are being studied. Attention is being given to taste panels generally, with the object of improving their precision and the value of the results.

During the war a great many nutritional problems were studied at the request of the Armed Services. This work has been completed and nutritional investigations are now under way on problems held in abeyance during the war. Efforts are being made to improve the versatility of chemical methods of assay for riboflavin, thiamin, and niacin, since the present methods are limited in their application. Improved methods will be applied to an extensive study of cured pork at all stages of processing. A study on the storage life of dried milk powders was continued.

Co-operative studies with the Ontario Research Foundation and the Associate Committee on Grain Research were continued on the processing and treatment of domestic oils for edible purposes. During the year it was found by workers at the Ontario Research Foundation that iso-linoleic acid is not the only cause of flavour reversion in linseed oil shortenings. These studies are being continued in an effort to find means of preventing flavour reversion. In view of the current world shortage of edible fats, surveys were made of wartime shortenings and lards, and considerable variation in quality and storage life was found in both. Recommendations were made for the improvement of these products, and the work is continuing. More satisfactory methods of measuring rancidity have been developed. A war problem on the storage life of butter was completed, and it was found that canned butter kept twice as long as butter stored in parchment.

The secret war project known as "Habbakuk", concerned with the construction of floating-ice airfields, was disclosed during the year under review.

Members of the staff designed the refrigerating system used on the model constructed at Pyramid Lake, Jasper, and made other contributions.

During 1945, the Director and a senior member of the staff visited Europe to examine German science and industry in company with British scientists. Several Canadian applications of the resulting information may be possible. One of the most important is a continuous butter-making process based on the Fritz butter machine, and this possibility is now under study. The refrigerating system used on German submarines may have possibilities as an air-conditioning unit, or for use as an efficient heat pump. In the field of microbiology, an examination was made of German utilization of wood sugars and waste sulphite liquors from pulp mills for the production of high protein feeds by micro-organisms. Other fermentation industries were examined, particularly those producing citric, lactic, and gluconic acids.

Members of the engineering staff contributed advice and assistance to Canadian army engineers in the design of refrigerated trucks (thermocars) in which the temperature can be controlled from 120° F. to -40° F. regardless of weather conditions. These trucks are intended for use by the Indian army. A simple apparatus for measuring humidity in cold stores was devised and is now under test. A specially refrigerated test-room has been completed and was successfully operated at -80° F. Cheap absorption refrigeration units are being evolved for use on farms where electric power is not available.

The great increase in the use of fast frozen foods has brought up problems of refrigerated transport. The overhead-bunker type of railway car used in Canada, while better than the types used in most other modern countries, is still unable to provide a temperature of 0° F., which is necessary for transporting these goods. Studies are under way on this problem, including various eutectic ices with salts other than sodium chloride.

With the return of Dr. J. W. Hopkins from the Royal Canadian Air Force the statistical services carried on a maintenance level during the war were resumed in full, and new studies were initiated in connection with problems of quality control.

In addition to the major projects of the Division, many problems of a relatively minor character were undertaken at the request of various Government institutions and commercial firms, e.g., the design of constant-temperature, seed-testing rooms for the Department of Agriculture; analyses of meat products intended for U.N.R.R.A.; investigation of alleged smoke damage to vegetation in the vicinity of St. Catharines, Ontario; and advice on weed killers for use on the railways.

During the war, the Division published 175 scientific papers, 32 trade journal articles, and 11 popular articles on work of the Division. During 1945-46 the figures were 44, 12, and 5 respectively. More than 500 unpublished war reports were prepared.

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## DIVISION OF CHEMISTRY

E. W. R. STEACIE, *Director*

The past year has involved considerable change in the Division from two points of view: (a) reorganization necessitated by the end of the war and the transition to post-war problems, and (b) the reorganization of the

Division necessitated by its greatly increased size as compared with the pre-war establishment.

The reorganization necessitated by the end of the war has now been mainly completed. The post-war staff have largely been recruited with the exception of junior positions.

The Chemistry Division is now much larger than it was before the war and it was felt that the time had come for a more or less complete reorganization. The work of the Division falls naturally into two classes. First, there are those sections which deal with basic branches of chemistry, i.e. organic, inorganic, colloid, etc. The work in these sections may be either pure chemistry or applied chemistry, but is essentially purely chemical in outlook. In the past, this side of the Council's activities has been relatively weak and it is felt that it should be very considerably strengthened. The other type of work is that concerned with engineering or pilot-plant operations and technical services related to specific industries such as textiles, rubber, paint, etc. The Division has therefore been organized in two branches: (1) Fundamental Chemistry Branch which is headed by the Director and includes sections devoted to organic, inorganic and colloid chemistry and to a number of different aspects of physical chemistry, (2) Applied Chemistry Branch. Since the last report, Dr. A. Cambron has been appointed Assistant Director of the Division and is taking charge of the Applied Chemistry Branch. It will include as main sections chemical engineering, industrial organic chemistry, textiles, rubber and other similar topics.

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## FUNDAMENTAL CHEMISTRY BRANCH

E. W. R. STEACIE, *Director*

### Organic Chemistry

With the end of the war, the work on alkaloids has been pushed more vigorously. The investigation of the alkaloids of the *Lycopodium* species has been carried further and the alkaloids have been isolated from two new species. Considerable work has also been done in connection with the determination of the structure of annotinine which is one of the *Lycopodium* alkaloids. The study of the structure of the alkaloid gelsemine has also been resumed. Other alkaloids which have been either isolated or which have been subjected to structural studies are: lycoctonine,  $\alpha$ - and  $\beta$ -pseudaconitine, the alkaloids of *Lupinus macounii*, those of *Delphinium consolida* and of *Secum acre*.

*Miscellaneous.*—Numerous organic syntheses have been carried out. All the possible mono-methyl- and di-methyl-indoles have been synthesized.

*Chemical Warfare.*—The investigations which were being carried out for the Chemical Warfare Establishment have been completed.

*Synthetic Rubber Research.*—Research subsidized by the Associate Committee on Synthetic Rubber Research has been undertaken. It consists of, (a) an investigation of alkali metal-catalyzed polymerizations as well as the study of the kinetics of such reactions, and (b) the synthesis of methoxybutadiene and the study of the oxidative degradation of the polymers prepared from it.

*Publications*

- Manske, R. H. F. and Marion, L. The alkaloids of *Lycopodium sabinaefolium* Willd. Can. J. Research, B, 24: 63-65. 1946.
- Marion, L. The alkaloids of *Sedum acre* L. Can. J. Research, B, 23: 165-166. 1945.
- Marion, L. and Manske, R. H. F. Identity of the hydrolytic base obtained from *Delphinium Brownii* Rydb. with Lycoctonine. Can. J. Research, B, 24: 1-4. 1946.
- Marion, L. and Manske, R. H. F. The alkaloids of *Lycopodium lucidulum* Michx. Can. J. Research, B, 24: 57-62. 1946.

**Photochemistry**

A number of investigations have been made of mercury photosensitized and other reactions of unsaturated compounds. These include propylene, isoprene, butene-1, butene-2, isobutene. These compounds are of interest in connection with the general mechanism of polymerization which is a subject of major scientific and industrial importance at the moment. In most cases, previous photochemical information has been very scanty, and the results obtained in this work have made it possible for the first time to outline a specific mechanism for the reactions. Investigations of mercury photosensitized reactions of propane have been made since this work is of fundamental importance to the photochemistry of the paraffins. Work has also been done on diethyl ether.

Investigations have been made of the reactions of atomic hydrogen produced by a discharge with mercury dimethyl and with acetone. These reactions have a considerable importance in photochemical mechanisms and this constitutes the first direct determination of their rate.

*Publications*

- Darwent, B. deB. and Steacie, E. W. R. The mercury photosensitized reactions of propane at low pressures. J. Chem Phys. 13: 563. 1945.
- Gunning, H. E. and Steacie, E. W. R. The mercury photosensitized reactions of propylene and isoprene. J. Chem. Phys. 14: 57. 1946.
- Harris, G. M. and Steacie, E. W. R. The reaction of hydrogen atoms with acetone. J. Chem. Phys. 13: 554. 1945.
- Harris, G. M. and Steacie, E. W. R. The reaction of hydrogen atoms with dimethyl mercury. J. Chem. Phys. 13: 559. 1945.
- Steacie, E. W. R. Atomic and free radical reactions. Reinhold Publishing Corporation, New York. pp. vii + 548. 1946.

**Inorganic Chemistry**

The work of this section during the past year has been devoted entirely to investigations connected with the atomic energy project.

**Surface Chemistry**

The electrical resistance and length changes of activated carbon rods have been studied for two reasons: (a) to determine why adsorption causes the electrical resistance to change, and (b) as an indirect method of studying the fundamental mechanism of adsorption from the gas phase. To study

this phenomenon an assembly for measuring the adsorption on and resistance of the rods was required. This involved the construction of a sensitive d.c. bridge system and a standard type of apparatus for the adsorption measurements. In addition a knowledge of the dimensional changes in the adsorbent was desirable, and this involved the construction of a precise Schering bridge and variable condensers whose change in capacitance was dependent upon the extension of the rods. About 40 adsorption curves measured on four rods have been completed. The data are not yet sufficient to warrant publication.

*Studies on Macromolecules.*—An attempt is being made to determine the molecular weight of macromolecules by measuring the limiting value of the force-area product at zero force when the materials are spread as monofilms on water substrate. To check these determinations an osmometer is required to give an absolute value of the molecular weight. A precise osmometer has been constructed and a Wilhemy balance has been assembled. Preliminary measurements have been made with both assemblies, but satisfactory results have not yet been obtained.

### Chemical Spectroscopy

Arrangements have been made to secure staff and equipment for work on ultra-violet and infra-red absorption spectroscopy and for investigations connected with Raman spectroscopy.

### Thermodynamic Properties of Gases at High Temperatures

In view of the very great interest in the properties of gases at high temperatures in connection with the development of jet propulsion and also the intrinsic scientific and industrial importance of this field, an extensive investigation has been commenced. At present, equipment is being assembled and constructed.

### Radioactivity

The work of this section has been entirely connected with the Chalk River atomic energy project. It is hoped in the coming year to make investigations of reaction mechanisms by tracer technique.

### Colloid Chemistry

A new and simple film balance has been developed which makes the measurement of small changes in surface tension easily possible. This instrument is being used to re-investigate the properties of gaseous films of fatty acids and it is hoped to extend this work to large molecules shortly.

During the year two problems of industrial interest have been undertaken. Laboratory work on the first of these—the production of a panel from wood fibres, with impact strength approaching that of plywood,—has been completed. The second problem, which concerns the activation of bleaching clays, is continuing.

Twenty reports involving routine and special tests have been issued.

Changes in the physical properties of phenolic coating resins during polymerization have been followed in an attempt to find a physical meaning for the term “cure”. A publication on this subject is in preparation.

Work on lubricating grease, under an agreement with Imperial Oil Ltd. is to be undertaken in the near future.

#### *Publications*

Puddington, I. E. A constant volume pump for circulating gases. *Ind. Eng. Chem., Anal. Ed.* 17: 592. 1945.

Puddington, I. E. Some properties of metal soap-mineral oil systems. *Inst. Spokesman*, 9, (9):1-4. 1945.

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## APPLIED CHEMISTRY BRANCH

A. CAMBRON, *Officer-in-Charge*

As already mentioned, the sections in the Division of Chemistry whose activities are mainly in the applied chemical field have been organized as a separate group in the Division under the name of Applied Chemistry Branch.

In view of the proposed expansion of the Fundamental Chemistry Branch, it is planned to transfer the staff of the Applied Chemistry Branch to new laboratories at the Montreal Road site. Plans for this new laboratory are now being drawn and it is expected that construction will begin when the present ban on new buildings is lifted.

During the first part of the past fiscal year the activities of the Applied Chemistry Branch were largely concerned with the solution of specific problems submitted by the war supply departments and by the Armed Services. The volume of work has not decreased since the war ended and it is expected that the adaptation of wartime developments and research to peacetime economy will provide active fields of investigation for several years.

The Applied Chemistry Branch is composed of ten sections and the following is a brief outline of the activities of each section during the past year.

### **Chemical Engineering Section**

The major project undertaken by this section during the past year has been the chemical process development and the chemical plant design for the Chalk River atomic energy plant. Specific duties in connection with this project were assigned to each of three groups in the section.

#### **(i) Heat Transfer and Water Treatment Group**

The operation of the Chalk River plant requires large volumes of cooling water and it was the responsibility of this group to investigate suitable treatment of the water and to assist with the design of the water-treatment plant. Heat exchange units were designed and built to determine heat transfer coefficients under pile operating conditions. Under a wide range of heat fluxes and water rates the rate of deposition of film in heat exchangers was measured for treated and untreated water and the effect of the film on heat transfer determined. The effect of inhibitors was also studied.

Before the Chalk River plant was completed this group was able to report that a suitable supply of cooling water was available, and that conditions had been established under which heat transfer coefficients considerably higher than required for successful operation of the pile could be obtained.

**(ii) Pilot Plant Group**

Suitable methods for the extraction of fissile materials produced in a chain reacting pile have been investigated in Montreal and Chalk River laboratories of the National Research Council. The function of the pilot-plant group during the year has been to obtain the engineering data required for converting laboratory-scale studies to pilot-plant and to full-scale operation. The unusual problems encountered required novel solutions and the work was rendered more difficult by the absence of basic data. Details of this work cannot be released at this time but it may be stated that the processes which will be used in the Chalk River chemical processing plant have been successfully operated on a pilot-plant scale by this group.

**(iii) Design Group**

The function of this group has been to design the chemical processing units at Chalk River from the engineering data obtained by the pilot-plant group. The successful completion of this phase of the work is largely due to the experience of Mr. Mills and of Mr. Simpkinson whose services have been kindly loaned to the National Research Council by Consolidated Mining and Smelting Co., Ltd., and to the close co-operation between the design and pilot-plant groups.

**(iv) Sulphur Recovery Group**

An important project under investigation in this section is in connection with sulphur recovery from sulphur-bearing ores. This project is sponsored by Noranda Mines Ltd.

During the year work was started on the recovery of small amounts of selenium and tellurium by distillation. Effective removal of tellurium has been shown to be possible and experiments on the removal of selenium are continuing. The pilot plant at Noranda for the recovery of selenium has been operating for two months. Results show that satisfactory selenium recovery may be obtained.

**Textile Laboratory****(i) Laundry, Dry Cleaning and Cellulosic Textiles Section**

Research work in the field of laundering and cleaning has included a study of the laundry application of a film of oil to cotton and wool hospital fabrics for the purpose of decreasing the release of infection-bearing dust during use; also studies on the launderability of cotton-linen towelling made in Canada, of cotton twill cloths used in Army clothing and of cotton shirtings printed with pigment-resin mixtures. A study on the detergency of tallow soap containing bentonite has been completed. A study on some of the fundamental principles of detergency has been begun and an investigation of the soiling characteristics of a number of carbons differing in properties and structure, and also of the redeposition characteristics in detergent solutions of these carbons, is under way.

Test-bundle and referee-report services have been maintained to members of the Canadian Research Institute of Launderers and Cleaners. Advice on laundering and cleaning problems has been given to a number of Government departments.

Research in the field of cellulosic textiles has been confined chiefly to studies in the field of rot-proofing. The work has included studies on the action of water on the efficacy of copper naphthenate, the critical examination

of a number of compounds including copper hydroxynaphthenate, ammonium humate, copper 8-hydroxyquinoline, mixtures of copper naphthenate and organic mercury compounds. The permanence to weathering and the rot-proofing efficacy of a number of inorganic and organic rot-proofing compounds have been studied. Recommendations have been made in regard to fabric treatments for use on cotton textiles for tropical areas. A number of rot-proofing treatments for sewing thread have been investigated and a suitable method recommended for commercial use. Co-operative work has been carried out in the field of rot-proofing in conjunction with the British Ministry of Supply and the American Association of Textile Chemists and Colorists.

The laboratory has co-operated in the work of the National Research Council Co-ordinating Committee on Protective Equipment (Research) and has completed studies on raincoat fabric, tentage and numerous types of cotton and rayon clothing fabrics. Technical requirements have been set up for a considerable number of textile specifications issued by the Directorate of Inter-Service Research and Development.

Many miscellaneous investigations and analyses have been carried out for Canadian textile manufacturers and various Government departments.

#### (ii) Wool and Non-Cellulosic Textile Section

A study has been made of the impact strength of parachute cord and comparison has been made with results given by the regular breaking-strength test, which test fails to give a true indication of the shock-absorbing properties of the cord. A special tester had to be built and high-speed pictures taken to study the behaviour of the cord during the test.

The analysis of wool samples from experimental flocks was continued and 575 samples were tested for clean wool yield and 280 for fibre diameters.

Thermal transmission tests were conducted with a hot cylinder instead of the flat plate previously used for such tests. It was found that both methods give identical results provided appropriate corrections are made for the varying angle of the wind striking the cylinder.

Apart from the regular routine testing of a large number of items for specification purposes a complete study was made of the general service sock to determine its shrinking propensity and ways of overcoming the undesirable shrinkage. New testing methods were developed and although the work was not completed it was possible to make definite recommendations for the improvement of the sock.

Dr. Larose went to Germany as one of a textile team to investigate some of the technological advances made in that country during the war. Twenty-one "targets" were visited, and a number of reports written on the information gathered during the trip. Advantage was taken of the passage through England to pay a short visit to the textile research institutions at Leeds and Manchester.

A study has been started of the air permeability of fabrics and its variation with pressure. A number of tests were carried out for outside firms.

#### *Publications*

Bayley, C. H. The effect of light and air on the accuracy of cuprammonium fluidity measurements on textile cotton. *Can. Textile J.* 62: 36-38, 50. 1945.

- Bayley, C. H. and Tweedie, A. S. Report on AATCC co-operative tests for determining mildew and rot-resistance. *Am. Dyestuff Repr.* 34: 128-135, 139-140. 1945.
- Bayley, C. H. and Weatherburn, M. W. Observations on the growth of some copper-tolerant fungi on cotton fabrics. *Can. Textile J.* 62: 34-36, 46. 1945. *Am. Dyestuff Repr.* 34: 247-248. 1945.
- Bayley, C. H. and Weatherburn, M. W. A study of the effect of leaching on the rot-proofing efficacy of copper naphthenate. *Am. Dyestuff Repr.* 34: 457-460, 471-473. 1945.
- Bayley, C. H. and Weatherburn, A. S. Chemical aspects of the application of dust-laying oils to wool. *Can. J. Research, F*, 23: 402-412. 1945.
- Larose, P. Textile research. 1946 Manual of the Textile Industry of Canada.

### Protective Coatings Section

The year under review saw the conclusion of most of the war projects which had been carried out in this section. One of the last to be completed was the development of a temporary camouflage paint for army vehicles; it is easily applied and readily removable in the field or elsewhere.

Other problems which were under study during the war will provide information equally useful for peacetime purposes. These include the formulation of strippable coatings for metal objects, anti-fouling paints for ships, rot-proofing coatings for wood, anti-condensation coatings for humid enclosures, varnishes for special electrical use, and sealers for plaster wall board.

A comprehensive investigation was commenced to determine whether organic rust inhibitors could be used to advantage in metal-priming paints.

Fundamental work on unsaturated long-chain acids was extended to include a study of the reactions of certain dihydroxy and chlorohydroxy derivatives.

A considerable volume of co-operative work was carried out with the Canadian Government Purchasing Standards Committee and the American Society for Testing Materials.

#### *Publications*

- Hopkins, C. Y. and Chisholm, M. J.  $\alpha$ -Cyano- $\beta$ -phenylglyceric acid. *Can. J. Research.* In press.
- Michael, T. H. G. Magnetic easel for use in spraying test panels. *Ind. Eng. Chem., Anal. Ed.* 17: 464-465. 1945.
- Michael, T. H. G. and Hopkins, C. Y. Laboratory schedule for the examination of paints. *Can. Chem. Process Ind.* 29: 455-457. 1945.
- Michael, T. H. G. and Hopkins, C. Y. Some physical properties of aqueous solutions of 1, 3-butanediol. *Can. J. Research.* In press.

### Industrial Organic Section

The investigation of the catalytic air oxidation of ethylene to ethylene oxide was continued, most of the work being on methods of preparing silver catalysts and the action of promoters. A paper was prepared for publication.

During the year work was undertaken on the synthesis of organic compounds containing heavy hydrogen (deuterium). As a preliminary step in

this project an apparatus was designed to effect the conversion of acetylene to acetaldehyde in a closed system, dideutero acetylene being obtained by the action of deuterium oxide on specially prepared calcium carbide. An alternative method under investigation for the preparation of organic deuterio compounds is the use of carbon suboxide as a starting material.

Another project under investigation is one sponsored by Shawinigan Chemicals Ltd. This project is concerned with the chemistry of acetylene and the preparation of acetylene derivatives and is under the immediate direction of Dr. R. H. J. Creighton from the staff of Shawinigan Chemicals Ltd.

#### (i) Rubber Laboratory

A specification for tire-recapping compounds was drafted, in collaboration with the Army, after considerable testing work. A modification of the laboratory procedure for determining the abrasion resistance of synthetic rubber, resulting in greatly improved correlation with road tests of pneumatic tires, was developed. Bogie wheels, amongst other items, were the subject of a report.

Other investigations carried out toward the end of the war period included non-skid deck coverings, automatically inflatable life jackets, cable insulation, and other items for the Navy, as well as aircraft hose and hydraulic aircraft glands for the Air Force.

Work on electrically conducting rubber was continued in collaboration with Shawinigan Chemicals Ltd. A patent was obtained, jointly with J. L. Orr of the National Research Council de-icing laboratory, on an electrically conducting rubber heater shoe for de-icing aircraft propellers.

There was co-operation with other National Research Council laboratories and outside organizations and in the preparation of specially designed rubber parts.

Researches now in progress include a joint research with Polymer Corporation Ltd. on the standardization of rubber-testing procedures and on the low-temperature behaviour of synthetic rubber, including friction on ice.

As mentioned above, one of the projects under investigation in this laboratory during the year was concerned with the possible use of acetylene black in rubber compounding particularly with the object of obtaining electrically conducting rubber. This project was sponsored by Shawinigan Chemicals Ltd. who loaned one of their staff, Dr. B. P. Buckley, to assist in the work.

#### *Publication*

Hall, R. H., Buckley, B. P., and Griffith, T. R. Acetylene black and conductivity. *Can. Chem. Process Ind.* 29: 587-590. 1945.

#### Corrosion Section

Test work for the Department of National Defence and the Inspection Board is now practically ended. This work was mainly on protective oils, greases and waxes and on tropicalization.

Work has been continued on improved inhibitors for anti-freeze solutions, but without definite results.

A series of tests for corrosion-resistant materials for refrigeration cars of the Canadian National Railways were made and recommendations forwarded. Numerous other outside inquiries were answered.

Tests of various metal-spray coatings in hot water under line pressure are continuing. Lead-spray coatings appear to last the longest, while zinc deteriorates quite quickly at 65°C.

A study of anodic protection in sea water has been started and is continuing.

Work on the reproducibility and accuracy of the salt-spray test has been started and preliminary work has been undertaken on the use of humidity effects in corrosion testing.

#### *Publication*

Cohen, M. An apparatus for measuring corrosion. *Trans. Electrochem. Soc.* 87: 221-226. 1945.

The study of the effect of inhibitors in water corrosion has been continued and will be kept up as a major project of the laboratory. The work to date has touched on the glassy phosphates and sodium nitrite and is being extended to include a study of the inhibiting effect of silicates and soluble oils, and of pH adjustment. This study is being made in conjunction with electrochemical measurements, and will include work on ordinary waters.

There has been a constant use of the laboratory for work on the Atomic Energy Project at Chalk River during the year, and it is expected that some of this work will be continued.

### **Colloids and Plastics Testing Laboratory**

Work for the Services continued throughout most of the year and most of the reports were for the Services directly or through the Inspection Board of the United Kingdom and Canada.

Leather products were foremost in materials tested and included vegetable tanned sole and insole leathers, chrome and chrome re-tan upper leathers, chrome horsehide and cowhide garment leathers, hydraulic leathers and leather washers of various types used in fuzes, torpedoes, etc. Some materials associated with leather were also tested such as straight and sulphonated fish oils for use in boot-reconditioning plants and shoe polishes.

Various tests were investigated to find one most suitable for evaluating waterproofing of mitt leathers. The use of a Mullen test and a test involving water-penetration time during flexing gave the most information.

Considerable testing was carried out on plastic products including mess trays,  $\alpha$ -cellulose-filled melamine tableware (Naval), phenolics for smoke-boxes and hand grenades, battery-box materials, phenolic-surfaced lignin laminates, Service combs and toothbrushes. Various materials were compared for use as cores with rolls of asdic recording paper; hard rubber and phenolic-laminated paper were found to be preferable to the cellulose acetate butyrate which was being used.

There was some further examination of Service buttons in plastic and information for specification purposes was finalized.

Some charts were coated for the Hydrographic Service using the map-coating solution developed here. No report has yet been received on performance.

Qualification testing of silica gel dessicants used in Service "packaging" continued during the year.

Some testing was carried out for civilian interests. Materials included substitute insole materials for children's shoes, reconstructed leather, safety-shoes, defective concrete ("cinder") block. Flex tests at 0° F. were carried out to evaluate the cold-cracking resistance of a series of vinylite soleing materials.

There was considerable impact testing of hardened glass goggle lenses and impact and optical testing of plastic goggles. This work resulted at the close of the year in the formation of a Canadian Code for Head and Eye Protection.

Some preliminary work was carried out to develop a viscosimeter suitable for measuring viscosity in surface films (on water) of plastic plasticiser mixtures.

### Applied Physical Chemistry Section

Dr. Stedman has been active during the year in dealing with a wide variety of special problems submitted by the Armed Services. Most important of these problems were: the control of frost on standing aircraft; propeller de-icing; rain repellent for aircraft windows. As a result of the work on rain repellents a wax type of repellent has now been successfully developed, and after extensive service tests at all air speeds, has been adopted by the Royal Canadian Air Force.

The main investigation undertaken by Dr. Katz during the war was a study of methods for determining carbon monoxide in low concentrations, of detecting this gas, or of reducing the hazard due to its presence. Part of this work was done in co-operation with the Chemical Warfare Laboratories in Ottawa. In connection with this work, a survey was made to determine the possible carbon monoxide hazards in army workshops, tank hangars, and in the interior of tanks and aircraft.

*Investigation of Atmospheric Pollution.*—Another important investigation undertaken by Dr. Katz since the war ended has been the collection of data required to determine the amount of damage to plant life resulting from air pollution by gaseous effluents, mainly sulphur dioxide, in the vicinity of an Ontario metallurgical plant, and in the Sudbury area.

### Analytical Laboratory

During the year ended 31 March, 1946 there were received in the laboratory 1011 samples involving several thousand determinations. Many of these were of a comparatively simple, routine nature, but many were difficult and complex and required special technique for their solution. Semi-micro and micro techniques were developed and found to be useful tools for many determinations, especially where the amount of sample was very small.

Considerable progress was made with the work of re-designing and remodelling the laboratory, and when complete, it is hoped that this will add to the efficiency of its operation.

Among the more important and difficult analyses carried out were the following: various catalysts, chicken blood and tissue; phthalic anhydride in paint vehicles; BeO in beryllium fluoride; beryllium-copper alloys; styrene in

G.R.S.; fire foam liquids;  $P_2O_5$  in polyphosphates; aluminium in aluminium pigments; zirconium-beryllium alloys; titanium-beryllium alloys; special fillers for rubber; metallic impurities in calcium metal.

### Explosives Testing Laboratory

The explosives testing laboratory which is located on the Montreal Road site, and is operated jointly by the Department of Mines and Resources and the National Research Council, has continued to function in its statutory capacity for the inspection of explosives. Most of the work in this field, was concerned with the examination and testing of military explosives or pyrotechnics for the Armed Services or for the Board of Transport Commissioners.

In addition to the routine inspection work the staff of the laboratory carried out a number of research projects sponsored by the Associate Committee on Explosives, in part, a study of detonation rates in cast explosives under various conditions and of the geometry of shaped charges. Another investigation was concerned with a new method for determining the impact sensitivity of explosives.

### Customs and Excise Laboratory

Operated jointly by the Department of National Revenue and the National Research Council, this laboratory has continued to function in its statutory capacity for the examination of commercial products for customs and excise purposes.

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## DIVISION OF MECHANICAL ENGINEERING

J. H. PARKIN, *Director*

With the cessation of hostilities, the laboratories entered upon a period of transition. War work for the Armed Services rapidly declined, work for industry and Government departments began to increase.

For the post-war period the emphasis will be on research rather than test and development, although the laboratory facilities will be available to industry for such testing and other work as may be required.

Much consideration has been devoted to post-war research programmes, assistance to industry and staff reorganization.

In keeping with trends elsewhere, organization of work on gas dynamics, combustion and heat transmission was begun and provision of facilities for work in the supersonic field of aerodynamics is planned.

Approval was given for the establishment, with the assistance and co-operation of the Royal Canadian Air Force, of a Flight Research Section. The organization has been planned and negotiations are proceeding for the transfer of an R.C.A.F. Air Station to the Council.

With the relaxation of security restrictions the facilities available in the laboratories are being brought to the attention of industry. A booklet describing the facilities has been prepared by the National Film Board and distributed to industry. A quarterly report on the work of the laboratories, and a monthly list of publications are planned.

The addition to the structures laboratory, the addition to the engine laboratory housing the 15 ft. hangar stand, and the storage building were completed.

A low-temperature laboratory, engineering laboratory, and additions to the storage building and garage were designed and construction started.

An order was placed for a 600,000 lb. testing machine for the structures laboratory.

Three members of the staff spent some months in Germany investigating enemy science and technology and a member of the aerodynamics staff spent some time with the British team investigating the aeronautical facilities of the Hermann Goering Institute at Volkenrode.

Following are brief descriptions of the work of the different laboratories and sections of the Division.

## Aerodynamics

### *Facilities*

Laboratory facilities of this section include two horizontal wind tunnels and a vertical spinning tunnel. All three tunnels have been in operation for a good proportion of the year, especially the new horizontal tunnel (2000 hp.) for which there is always a back-log of work despite the speed with which tests can be made.

Through the effective assistance and co-operation of the Royal Canadian Air Force, flight test facilities, including personnel and services, are available at the Test and Development Establishment, Rockcliffe.

### *Aerodynamic Balancing of Aircraft Controls*

Work on this long-term fundamental research project has been continued and expanded. A great deal of experimental data on the effect of small changes in control surface profile on hinge moments is being obtained from wind-tunnel model tests and flight tests on full-scale aircraft. Good agreement has been successfully demonstrated between results obtained on full-scale Harvard ailerons and on a 0.4 scale wind-tunnel model, if readily calculable allowances are made for the deflection under load of the full-scale aircraft surfaces, and for the flow-constraint effects of the wind-tunnel walls on the model. The dependence of hinge moments on velocity and pressure conditions at the control surface trailing edge is being studied. Work is continuing on the effects of aspect ratio and of control span on hinge moments.

### *Tailless Aircraft*

A large amount of work on the aerodynamic design of a tailless glider, which has recently been completed in the structures laboratory, has been performed in the horizontal and spinning tunnels.

A comprehensive test-flight procedure has been developed to determine the flying characteristics of the glider. The necessary flight-test instruments have been designed, built, installed and calibrated.

Much useful information should be obtained from a comparison of wind-tunnel, theoretical and flight results.

### *Tests for the Armed Forces, Government Departments and Industry*

In addition to wind-tunnel tests on equipment for the Royal Canadian Air Force, the Royal Canadian Navy and the Canadian Army, an increasing amount of work is being undertaken for other Government departments and

for industry. This work includes tests on rain, snow and wind gauges, tests on axial flow compressor-blade sections, and tests on new aircraft of Canadian design.

#### *Equipment*

The development of new equipment and measuring instruments, such as a hot-wire anemometer for measuring air turbulence, slipstream motors for wind-tunnel models, a multiple manometer for pressure measurements, etc. is being continued.

#### *Work Projected for Coming Year*

In addition to the above mentioned work, all of which is expected to continue, a study of the correlation, model and full-scale, of the longitudinal stability of an aircraft is planned. Such correlation work increases the usefulness of wind-tunnel tests for aircraft designers. It is hoped also to be able to undertake some fundamental research in the study of air moving at supersonic velocities.

### **Hydrodynamics**

#### *Facilities*

The small testing basin has continued in use for tests of hulls. The control of the carriage of the new large basin has been revised and calibrations tests of the basin will now proceed.

The facilities of the hydraulic laboratory have been used throughout the year for hydraulic model tests.

The staff was increased during the year to cope with the large projects on hand.

#### *Hydraulic Model Studies*

(i) A model of Kingsville harbour, a small port on the north shore of Lake Erie, was constructed during the previous year at the request of the Department of Public Works to determine the effect of proposed pier extensions upon the formation of sandbars in the harbour entrance.

The model was built to a scale of 1:240 horizontally and 1:60 vertically and occupies an area approximately 20-feet square. Verification tests were completed during the year and numerous pier extensions tested. While no satisfactory means of preventing the formation of sandbars was found, it was shown that their formation could be delayed by suitable design of the pier extension.

(ii) The design of a model of a section of the Fraser River in the vicinity of New Westminster, B.C. was begun during the previous year at the request of the Department of Public Works to investigate means of maintaining the ship channel.

The model which is approximately seventy feet long and made to a scale of 1:400 horizontally and 1:100 vertically, was built during the year. Designs for the tide- and flow-control mechanisms, water-level recorders, and movable-bed profile-marking and recording machine were prepared by the laboratory staff.

(iii) A model of a new type of emergency canal gate, designed by the Department of Transport to close a canal in event of failure of the navigation locks, was tested to determine the direction and magnitude of the forces acting upon the structure.

(iv) During the preparation of designs for a power development project it was desired to determine the discharge capacity of a proposed spillway structure. A model test showed unfavourable flow conditions. Modifications were made which simplified construction and improved the flow without reducing the capacity of the structure.

(v) Hull Tests. Resistance tests were made on a model of a cargo ship and directional stability tests were performed on five barges and one dredge. Modifications were made to the barges which improved towing and in two cases marked reductions were made in resistance.

All of the test work in the model-testing basins was undertaken at the request of industry.

### Engine Laboratory

#### *Facilities*

The installation of a 150 hp. motoring, 300 hp. absorbing, electric dynamometer has been completed.

The 15-foot hanger stand, has been taken over from the contractor. Instrumentation will be completed by the laboratories staff.

Preliminary layout drawings for a north wing addition to the laboratory to house single-cylinder and traction dynamometer equipment were designed. Installation and modification of laboratory equipment continued.

The rapid staff turnover in the laboratory, which has adversely affected productive output, has been arrested.

#### *Detonation Projects*

Considerable progress has been made in full-scale single-cylinder technique, and satisfactory indication of detonation has been obtained on fuels up to 100 O.N. on both Peregrine and Perseus engines. Use of engine exhaust for heating carburettor air has been abandoned, and steam and electric carburettor-air heaters have been designed and installed. An improved method of fuel and air mixing has been fitted on both engines. Other improvements in instrumentation and technique have been made.

#### *Vibration Investigation*

Vibration encountered in the test stands has been studied, using a pickup developed in the laboratories. New equipment has been ordered.

#### *Single-Cylinder Oil-Test Engine*

A single-cylinder modification of a Jacobs engine, under construction in the laboratory for some time, has been completed. As the problem of ring sticking, for which the engine was designed, has been abandoned, the engine is being used for other test work.

#### *Glow Plug Ignition*

The relative effects on detonation, of glow-plug and high-tension-spark ignition is being investigated.

#### *Oil De-aeration*

The investigation of foaming in aircraft oil systems has been continued. Mockups of oil systems have been built, and an apparatus set up to test a centrifugal de-aerator from a Junkers engine.

### *Cold Weather Operation*

A questionnaire on cold weather operation of aircraft has been distributed. The replies are being edited and a report thereon is being prepared.

### *Tests*

Endurance tests on four N.R.C. hub generators have been made using a Pratt and Whitney R1830, 1200 hp. engine.

Propeller endurance tests to Civil Aeronautics Administration and Department of Transport specifications have been made for a manufacturer.

Sea-level power curves have been obtained for a Pratt and Whitney R985 AN-1 engine for the Royal Canadian Air Force.

Miscellaneous tests have been made, such as calibration of flowmeters, cold tests on valves, etc.

## **Gasoline and Oil Laboratory**

During the past year, as in the previous war years, the main work of the laboratory consisted of investigations and tests of petroleum products undertaken at the direct request of the Department of National Defence.

Work of an investigational nature covered a wide variety of problems and types of petroleum products. In general such problems included the development of improved products, new test methods, the investigation and correction of service difficulties, and participation in essential co-operative research programmes. An indication of the type and scope of this work is given in the following summary:

### *Hydraulic Fluids*

A shear-breakdown apparatus was constructed and test conditions established for determining the rate of viscosity breakdown of mineral oil type hydraulic fluids for aircraft. This was correlated with flight-test results on these fluids. A hydraulic pump test stand was also designed and constructed for use in the testing and development of improved hydraulic fluids. A new method for determining and standardizing the rubber-swelling characteristics of petroleum-oil-type aircraft hydraulic fluids was investigated. An investigation was made of corrosion of magnesium alloy aircraft hydraulic system tanks by blown-castor-oil-base hydraulic fluids. In addition, work was done on a number of minor problems such as miscibility of hydraulic fluids, and various difficulties experienced with these fluids in aircraft.

### *Lubricating Oils and Lubricating Greases*

The laboratory assisted in a programme of performance tests of heavy duty oils in military equipment under high temperature conditions, by undertaking analyses of the new and used oils, filter cartridges, sludges, and in the interpretation of the data obtained. Other work on lubricating oils included comparison of oil-filter efficiencies for naval engines, application of oxidation tests for turbine oils, development of a method for determining oil dilution in the field and the examination of a large number of used oils, sludges, and engine deposits to determine causes of operating troubles. An extensive review of the problem of oil deterioration was made with a view to outlining a programme of future research.

A pressure viscometer for greases was designed and constructed for determining the viscosity of greases over a wide range of temperatures and

rates of shear. This instrument is being used in the study of grease lubrication problems, and in the study of flow characteristics of greases as related to their practical performance.

### *Fuels*

During the war the laboratory installed a supercharged knock-test engine developed by the Coordinating Fuels Research Committee for evaluating the detonation characteristics of high octane fuels under rich mixture conditions. Previous mention of this equipment could not be made because of secrecy restrictions in force at the time. In addition to routine tests of aviation fuel for the Royal Canadian Air Force and oil companies, this unit was also used in connection with a number of problems such as a correlation of laboratory tests of fuels with their full-scale performance in aircraft engines. Examinations are being made of possible fuels under development from fermentation processes by the Applied Biology Division of the National Research Council. Work is in progress on certain alcohol and other non-hydrocarbon fuels. The laboratory is also participating in an investigation by the Coordinating Fuels Research Committee directed toward the development of methods for determining knock ratings of very small samples, and in other Committee activities.

### *Miscellaneous*

In connection with the Ontario Provincial Government's project for spraying by aircraft to check damage by the spruce bud worm, the laboratory investigated the effect of D.D.T. solutions on aircraft fuels and fuel tank linings of Canso aircraft provided by the Royal Canadian Air Force for this work. Suitable gasket materials for northern fuel pipe lines were also investigated. A gland lubrication problem in a parachute dropping device used on Exercise Musk-Ox was solved and several hundred glands were specially prepared in the laboratory for installation in the parachutes.

The laboratory actively participated in the work of the Canadian Government Purchasing Standards Wartime Subcommittee on Petroleum Products, the Associate Committee on Petroleum, the Subcommittee on Low Temperature Greases and Hydraulic Fluids, the Subcommittee on Performance Tests of Heavy Duty Oils, and other committees which were set up to correlate the work of the laboratories with industry and the requirements of the Defence Services.

With the closing of hostilities, and the cancellation of contracts there has been a decrease in the number of samples received for tests of a routine nature, such as tests for compliance with purchasing specifications for petroleum products. This decrease in routine work of the laboratory which was necessarily undertaken during the war is reflected in a decrease in the number of reports issued and samples tested. However, with the return of the laboratory to a peacetime basis it will become possible to devote a much greater proportion of time and funds to peacetime problems and more fundamental research projects which have long been held in abeyance.

During the year the laboratory issued 459 reports covering work done on 802 samples of petroleum products. These figures include both reports of work of an investigational or research nature, and reports of tests of petroleum products against Defence Department purchase specifications. The distribution of this work is indicated in the following table:

SUMMARY OF SAMPLES TESTED

For	Fuels	Lubricants, greases, and hydraulic fluids	Miscellaneous	Total
Government Departments.....	199	260	18	477
Internal.....	146	83	5	234
External.....	68	19	4	91
	413	362	27	280

**Aircraft and Allied Instruments**

The close of the war brought about a sharp reduction in the amount of instrument type-approval test work required by the Royal Canadian Air Force. Only 12 instruments of two types were tested during the year.

Routine tests of 375 aircraft and allied instruments were completed including 225 which were first overhauled. Less than 40 per cent of this work was for the Royal Canadian Air Force as against 70 per cent during the previous year.

Instrumentation required for the flight-testing of the tailless glider was the major project undertaken and completed during the year. All quantities to be measured were arranged to rotate mirrors, the record being given by light traces on a photographic film.

A number of instruments required for the study of the meteorology of ice formation, and which were under development at the beginning of the year, were advanced through the experimental stages during the year and had reached the final design stage at its close. These included a cloud-droplet camera, light-transmission meter and air thermometer. These instruments are to be installed on an aircraft engaged in de-icing research. Development of a dewpoint hygrometer was also continued. A further effort is to be made to reduce vibration effects and to simplify the controls of this instrument.

A stall-warning indicator was developed and successfully tested in flight on a transport type of aircraft. A number of units are being made for more extensive tests, under all weather conditions, on airline operations.

The laboratory collaborated with the Royal Canadian Air Force in the development and production of a directional reference unit to be used as an aid to north-country flying. It also continued to collaborate with the Royal Canadian Navy in aiding the commercial production of units of the anti-submarine weapon stabilizer previously developed.

Various instruments and devices developed for other research groups in the laboratories, included an amplifier for drop-test work and a stroboviewer for propeller de-icing research.

**Structures Laboratory**

*Facilities*

The addition to the laboratory to house the shop, stores and autoclaves was completed, equipped and occupied. This released the main laboratory for use as structures laboratory. The space formerly occupied by veneer

stores and glue room, is being converted into offices and computing room. A 600,000-lb. testing machine has been ordered. Some attention was given to the design of a large hydraulic wing-testing apparatus and a large under-carriage drop-test gear.

#### *Tailless Aircraft*

The construction of a tailless glider was carried to completion during this period. The moulded skin was assembled to the structural framework and all operational components were made and installed.

A detailed stress analysis of the glider was submitted to the Royal Canadian Air Force for approval and a service manual prepared. Numerous castings and fittings were proof tested, including a drop test of the under-carriage.

During the latter part of February the aircraft was crated and shipped to Edmonton for flight trials.

#### *Wing Flutter*

The effect of wing stiffness and deflection form on the critical flutter speed of a uniform rectangular wing is being studied.

The model which has been made for experimental observation, includes controllable variability of stiffness and/or deflected form in bending and/or torsion. A short preliminary qualitative study was made in the wind tunnel but before continuing, it was necessary to obtain a comprehensive picture of the model's range at variables so that the experimental work could be planned to yield a maximum of useful data.

In part, it has been found that the stiffness may be varied to give ratios of torsion to bending natural frequencies up to about 5, with structural damping from 5 to 13 per cent. This covers the range in which most aircraft wings appear to fall. The preliminary trials were made at a Reynolds number of 500,000, with an estimated limit of about 1,000,000.

The quantitative factors required for comparison of theory and experiment, for which indicating or recording apparatus has been provided, include (for each degree of freedom) structural stiffness, deflected form (static and dynamic), natural vibration frequency, structural damping (by vibration and hysteresis), structural inertias and coupling, together with such characteristics as wing mass, mass radius of gyration, c.g. and elastic axis position, etc.

With technique and sequence for these observations now in hand, preparations are under way to make a full series of wind-tunnel observations.

#### *Prosthetics*

The prosthetics work continued with experimental work in low-pressure moulding of plastic limbs. Forty-eight forearm sections, a knee splint and several Syme's prostheses are undergoing service tests. Experimental work on the Syme's prosthesis is aimed at a lighter limb and improved ankle joint. Design work is in progress on complete limbs for above-the-knee and elbow amputations, including attempts to improve mechanical action. Experimental work has been done and is in progress on such details as a hollow plastic foot, a rubber ankle joint, lifelike latex hand, and wrist and elbow joints. It is planned to give attention to a hydraulic action for arms to give muscular control.

### *Vibrations*

Vibration characteristics of the empennage of a commercial aircraft were examined in flight during this period. It is planned to supplement existing two-channel recording oscillograph detection apparatus with a twelve-channel oscillograph and associated amplifiers. Vibrators were built to excite airframes during ground-resonance tests.

### *Moulded Plywood*

A moulded plywood dinghy is being constructed in the laboratory to demonstrate the moulding technique as applied to small sailboats. Samples of furniture constructed of moulded plywood and impregnated fabric are being made to illustrate the possibilities of these materials in this field.

Tests were continued on resin adhesives, impregnants and other bonding materials.

### *Work for Industry*

Drop tests were carried out on two prototype undercarriage struts in co-operation with industry.

Upon a request from industry, the laboratory's radio-frequency unit (normally used for the polymerization of phenolic glues) was used to determine the feasibility of using radio-frequency currents for biscuit baking. A satisfactory cooking cycle was established and power consumption estimates were made.

## **Aircraft De-Icing**

### *Electro-thermal Propeller De-Icing*

The electro-thermal propeller de-icing system originated in the laboratories of the National Research Council. Subsequently suitable equipment was developed for full-scale installation on an aircraft, and flight tests under natural icing conditions were made in cooperation with the Royal Canadian Air Force.

At the request of the Royal Canadian Air Force and the British Ministry of Aircraft Production, specifications were prepared and arrangements made for the manufacture of approximately 150 sets of electro-thermal propeller de-icing equipment for service trials, under operational conditions, on a number of aircraft types.

During the year the section installed N.R.C. electro-thermal propeller de-icing equipment on approximately 30 aircraft of the Royal Canadian Air Force, the Royal Air Force and Trans-Canada Air Lines, including Lancasters, Liberators, Yorks, Mosquitoes, Cansos, Lodestars, etc. Two members of the staff spent some months in England supervising the installation of this equipment on Royal Air Force aircraft.

During the service trials a number of mechanical failures developed in the propeller-hub generators employed to supply power to the heating elements and accordingly a programme of endurance testing of these generators has been undertaken on the hangar test stand of the engine laboratory. Suitable modifications are being developed to overcome the failures experienced and this work is still proceeding.

No difficulties have been encountered with the conducting-rubber heater elements, of which one set has been in operation for over 1200 hours

without serious deterioration. The heater elements also successfully withstood the standard propeller overspeed test which was carried out at the Royal Aircraft Establishment in England.

Further flight tests of the electro-thermal propeller de-icing equipment in comparison with the standard alcohol de-icing system were carried out by the Royal Canadian Air Force De-icing Flight, from which it was concluded that the electro-thermal system was much superior. Confirmation of the results was obtained from reports by Trans-Canada Air Lines and operational reports of the Royal Canadian Air Force, one of which attributed the safe return of a Canso aircraft from Atlantic coastal patrol to the effectiveness of the National Research Council equipment.

More refined tests of the effects of ice formation on propeller performance and power required for both cyclic and continuous ice removal, as well as for ice prevention, are to be carried out under natural icing conditions on the experimental Consolidated RY3 aircraft provided for this purpose by the Ministry of Aircraft Production.

#### *Electro-thermal Wing De-icing*

A number of experimental electrical wing-heating elements have been produced and installed on the RY3 for tests of power requirements for ice prevention and cyclic ice removal under natural icing conditions. For this purpose, a special high-voltage high-output aircraft generator has been installed on the aircraft.

A design proposal prepared for the complete electro-thermal de-icing of wings and propellers of a Lancaster aircraft indicated that this system will compare favourably on a weight basis with the existing equipment comprising pneumatic overshoes on the wings and alcohol distribution system on the propellers, while the de-icing effectiveness will be greatly improved. This system also compares favourably on a weight basis with the proposed air-heating systems and has the further advantage that it can be installed on existing aircraft without major structural alterations.

A study of German de-icing technique, with particular regard to thermal de-icing systems for wings, windscreens and propellers, etc., was made by a member of the staff who visited Germany as part of the Canadian Enemy Science and Technology Investigation.

#### *Flight-Testing of Aircraft De-icing Equipment*

The British Ministry of Aircraft Production has provided a four-engined Consolidated RY3 aircraft with air-heated wings for de-icing tests. The National Research Council was asked to provide experimental equipment for this aircraft, including electro-thermal propeller de-icing, wake rake and recorder for propeller thrust measurement, photo-electric dew-point hygrometer for measurement of free water content, light-transmission meter and recorder for measurement of free water content and cloud-droplet camera.

Consequent upon the closing down of the Royal Air Force Transport Command at Dorval, the Royal Canadian Air Force undertook the operation and maintenance of the aircraft, and the Council, responsibility for the scientific instrumentation and observation. The aircraft is now based at Ottawa and flying operations will continue.

The scientific observations will be made jointly by observers from the Royal Aircraft Establishment, England, the Meteorological Service of Canada and the National Research Laboratories.

### *Low-Temperature Laboratory*

A low-temperature laboratory is under construction to provide facilities for testing the operation of engines, tanks and other mechanized equipment at low temperatures as well as for investigating heat-transfer problems generally. The facilities include one large chamber 50 ft. long by 15 ft. wide by 15 ft. high and two smaller chambers 10 ft. by 10 ft. by 8 ft. each of which can attain a temperature of  $-70^{\circ}\text{F}$ . The refrigeration plant is a three-stage ammonia system having a capacity of 250 tons with a 900 kw. electric drive.

### *Icing Tunnel*

In the design of the low-temperature laboratory, provision was made to use the large refrigeration plant to provide artificial refrigeration in the icing tunnel. The existing open-circuit tunnel will be converted into a closed-circuit tunnel. The icing tunnel has a working section of four feet square. A speed of 300 miles per hour will be attained with a 1,000 hp. electric motor drive. A working temperature of  $-44^{\circ}\text{F}$  will be obtained at a speed of 200 m.p.h.

## **Mechanical Engineering and Design**

The work of this section embraces a wide variety of mechanical engineering problems, many of which are non-aeronautical. In the past, laboratory equipment and apparatus of many types have been designed and developed. The section has acquired considerable experience in the field of snow mechanics and its relation to the design of aircraft skis and track-type over-snow motor vehicles. During the war, practically all of the work done was for the Armed Services, and included the design of fire-control instruments, fuse mechanisms, an automatic stabilizer for a naval weapon and tracks for an over-snow vehicle.

During the year the work of the section was confined largely to the engineering design of equipment for the Atomic Energy Division. This work is continuing.

A number of fire-control instruments whose construction had been started the previous year, were completed.

In connection with the work of the Associate Committee on Soil and Snow Mechanics, a number of special instruments were developed for measuring the characteristics of snow, including density, hardness, free water content, and grain shape and size. The Committee intends to collect data on snow conditions at a number of observation stations throughout Canada, and instruments of this type will be used. Two sets of the instruments were supplied to Exercise Musk-Ox.

A towing dynamometer, utilizing electric strain gauges, was designed and built for Exercise Musk-Ox. The dynamometer was temperature compensated and electrically damped. An electrical instrument mounted inside the snowmobile indicated the drawbar pull.

The design of a modification of the horizontal wind tunnel is in progress. The present elliptical working section of the tunnel is to be replaced with a 10 ft. by 7 ft. rectangular section. The modification is intended to facilitate certain types of tests, particularly those of large chord aerofoils spanning the working section.

The modification requires the redesign of the nozzle, working section and diffusor.

## Fire Hazard Laboratory

### *Reinstallation of Equipment*

Moving of the laboratory equipment from the John and Sussex St. site and reinstalling the equipment in the Montreal Road Laboratory was completed.

### *Fire Hazard Tests*

In connection with the fire hazard listing, labelling and inspection service of the Canadian Standards Association, the Fire Hazard Laboratory makes fire hazard tests on domestic oil-burning equipment, domestic gasoline-burning equipment, gasoline safety cans and degreasing solvents.

With industry reconverting to peacetime production, applications for fire hazard tests of domestic oil-burning equipment began to come in early in the year, and the testing of such equipment became once more the major work of the laboratory. This work is summarized in the following table.

SUMMARY OF FIRE HAZARD TESTS

	Domestic furnace oil burners, automatic, gun type	Domestic range oil burners, manual control	Domestic oil-burning space heaters, manual control	Other appliances	Total
Applications received.....	9	13	8	2	32
Tests completed.....	1	1	4	1	7
Appliances on test, 31 March, 1946.....	4	8	4	0	16
Application for test received but appliance or further data required before tests are undertaken.....	4	4	0	1	9

### *Other Work*

Other work included the provision of equipment for testing hose clamps and for investigating aircraft cabin heating; tests of unlined linen forestry hose and an oil cooler; and an investigation of the flow of water through a small orifice at high pressures.

## SHOPS AND SERVICES

J. H. PARKIN, *Officer-in-Charge*

The central shops of the laboratories comprise instrument, machine, woodworking, sheet metal, paint and electrical shops with tool crib, stores and gauge-inspection room. These shops serve the Sussex Street, John Street and Montreal Road Laboratories and also function as the shops of the Division of Mechanical Engineering.

The normal work of the shops comprises the construction, alteration and repair of instruments, apparatus and equipment and the installation of equipment, principally for the laboratories, but many instruments are made, adjusted and repaired for Government departments.

The maintenance, alteration and extension of mechanical and electrical services in all of the laboratories is a responsibility of the shops and services organization. Service shops and staffs are maintained for this purpose and function under two foremen.

The services include the operation of the hydro-electric power plant at the Rideau Falls, supplying power to the Sussex Street and John Street Laboratories, and the central heating plant, water, gas, electric, compressed air and sewer systems, and char service of the Montreal Road Laboratories.

War work for the Armed Services and the Department of Munitions and Supply has virtually ceased and has resulted in a considerable reduction in the staff of the central shops.

Some of the more important items of work done in the shops during the year were:

Instrumentation for flight trials of a tailless glider,  
Snow-testing equipment for Exercise Musk-Ox,  
Plottres and angulators for Department of Mines and Resources,  
Seed-testing equipment for Department of Agriculture,  
Equipment for Atomic Energy Division,  
Fourteen wind tunnel models and six ship models.  
The total orders for the year were 1448.

The staff of the shops and services numbered some 125 at the end of the year.

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## DIVISION OF PHYSICS AND ELECTRICAL ENGINEERING

R. W. BOYLE—*Director*

B. G. BALLARD—*Assistant Director*

After the war terminated it was possible to view the war activities of the Division in retrospect. At one period or another during the course of the war, there must have been engaged in war work under the auspices of the Division, a total scientific and technical personnel of upwards of six hundred men and women. As the war progressed, new establishments were formed to suit specific purposes and groups of our personnel split off to join them. Amongst the new war organizations were the Naval Experimental stations at Halifax, Sydney, N.S., and Vancouver, B.C., the Gauge Laboratory in Ottawa of the Inspection Board of the United Kingdom and Canada; the Montreal Laboratory for Atomic Physics Research; the Oceanographic Establishment, under the Navy and the National Research Council jointly, at both the western and eastern coasts; and the Canadian Army Research and Development Establishment at Valcartier, P.Q. The peak number of personnel, scientific and technical, in the Division proper was about two hundred in the years 1943 and 1944, which number diminished to about one hundred and twenty after the war terminated. It has become very evident that it will be an anxious effort, taking a much longer time than was expected, to re-staff with competent and satisfactory personnel.

Beginning after V-E Day and more markedly after V-J Day, the war work fell off, most of the projects having then been completed and others summarily stopped. By the end of the year (31 March, 1946), nearly all work initiated by the war had ceased; but there are certain important exceptions which will be continued, in co-operation with other organizations, because of their peacetime value. Amongst these may be mentioned:

- (a) The work on physical oceanography, on both the western and eastern coasts, will continue under a joint committee of the Fisheries Research Board, the Royal Canadian Navy and the National Research Council.
- (b) Special work on photography, particularly referring to aerial photography, in co-operation with the Aerial Photography of the British Ministry of Aircraft Production and under the auspices of the National Research Council Associate Committee on Photography.
- (c) Work on the standardization of screw-threads in co-operation with the Department of Mines and Resources, under a committee of the United Nations on "Unification of Engineering Standards".
- (d) Application of airborne magnetic detectors, in co-operation with the Dominion Observatory and the Department of Mines and Resources, in three projects, namely: (1) Location of mineral deposits; (2) Survey of earth's magnetism; (3) Automatic magnetic steering of aircraft. The automatic steering of sea-boats by magnetometers will also be continued.
- (e) Application of new infra-red detection apparatus to certain industrial and forestry problems.
- (f) Work on the new electrical insulants developed to replace natural rubber and to meet the exacting requirements of military and other equipment.

During the year, serious consideration has been given to the question of uniting all electrical work, including radio, under one immediate head, an arrangement which looks forward to the future when it is certain that electrical work of many kinds will be much increased. As from 1 January, 1946, Mr. B. G. Ballard, Head of the Electrical Engineering Laboratories, was appointed as Assistant Director, specially charged with the duty of immediate direction of electrical engineering including radio.

The details of work in various sections follows:

### Acoustics Laboratory

In the early part of the year, the effort of the acoustics laboratory was concentrated largely on various naval problems, but with the end of the war and the completion of almost all researches, the laboratory began other investigations. However, certain oceanographic work, started for the Navy on the east and west coasts, was continued, not only that particular researches might be completed but also because of the apparent peacetime value of the research facilities already established. Following a series of conferences between representatives of the Fisheries Research Board, the Royal Canadian Navy and the National Research Council, it was decided to continue the work under a joint committee of the three organizations, this committee to assume control on 1 April, 1946. A special salinometer for use in this activity was developed and built in the laboratory.

An attempt to utilize techniques employed during the war is being made by developing echo-ranging equipment for geophysical prospecting. A similar ultrasonic device was constructed to measure the thickness of ice but difficulties with many spurious echoes were encountered, and for the particular problem of ice measurement a very simple "hot-point" apparatus was substituted. A powerful sound-generating equipment to cover a wide frequency range is being constructed to carry out experiments with high-intensity sound. A small experimental "dead" (anechoic) room is being built. The reverberation chamber has again gone into operation with absorption tests on commercial materials and some experimental work on absorption in panels. Assistance has been given to other Government departments on acoustical matters, e.g. acoustics of the House of Commons. A theoretical study is being made of the structure of matter and the way in which sound waves may be used to elucidate some of its properties. Certain avenues of approach which have been opened up appear to have promising possibilities.

### Electrical Engineering Laboratory

The volume of work in the electrical engineering laboratory remained large throughout the year, although in the latter months the emphasis shifted to peacetime applications. During this period the laboratory suffered the loss of senior personnel who either returned to their former positions or were attracted to industrial concerns.

Further studies in plotting devices for the Army were carried out. Detailed consideration of the function of the proposed coastal defence plotter resulted in a reconsideration of the complete coastal defence fire-control system and a report was prepared at the request of the Directorate of Artillery indicating the amount of equipment involved in the various possible systems. Further work on this project has ceased pending a decision regarding the extent to which the Army will undertake its own development work.

The automatic illumination scheme for the Navy was demonstrated to Admiralty representatives and was considered sufficiently effective to warrant further experimental work. However, since there was no short term naval requirement for the scheme the work was discontinued.

The work on synthetic insulants was continued and an extensive report issued on the investigations on submarine cables for the Navy. Work has been temporarily suspended pending the setting up of a peacetime programme.

Construction of a Van de Graaff generator for the Chalk River Laboratory was undertaken and is well on the way to completion although failures of manufacturers to make deliveries are causing delays.

Redesign and construction of the one-million-volt surge generator and associated oscillographic measuring equipment has been undertaken and is nearing completion.

The laboratory continued to act in a consulting capacity for the Montreal Road Laboratories and the Prairie Regional Laboratory, and in the improvement of lighting and ventilation of parts of the main building.

The development of certain counter measures for new enemy torpedoes and the investigation of commutation on d.c. motors for Naval applications were two projects of a less extensive nature undertaken and completed for the Royal Canadian Navy.

A number of tests on tropicalized packaging were also carried out.

Other investigations, essentially of a peacetime nature, were undertaken and are continuing. These include an investigation into rural grounding problems, the design and construction of an automatic sorting machine for documents which is capable of considerably higher speeds than those available commercially, and the development of closely regulated alternating current supplies of several kilowatts capacity for use in the life-testing of incandescent lamps.

### **Electrical Measurements Laboratory**

With the termination of hostilities the Laboratory has resumed work on a long-term programme of improving and expanding facilities for electrical standardization. This programme includes additional standards of resistance and the provision of a precise bridge for inter-comparing decimal, multiple and sub-multiple values of the ohm between  $\cdot 0001$  ohm and 10,000 ohms to an accuracy not less than one part in a million. Owing to war developments stable reference standards of resistance up to 1,000,000 megohms are now desirable. The programme also includes the preparation of standards of capacity designed for mechanical stability and whose capacity can be determined by means of a Maxwell bridge. The work on a primary standard of mutual inductance, interrupted by the war, was again taken up during the year. The quartz primary of this inductance now has the elementary form of thread cut on it and lapping is in progress to bring it to its final dimension and form. The auxiliary apparatus, such as bridges, for the use of these primary standards is being studied. This work is gravely handicapped by the lack of personnel.

There has also been a sharp increase in work on "Approval of Type" of electric meters. Additional testing apparatus is under consideration. Vibration and humidity troubles have been encountered by the laboratory but it is expected that the humidity problems will be overcome in the coming summer.

### **General Physics Laboratory**

During the past year the general physics laboratory has effected modifications in the design of tropicalized photo-electric counter-chronograph equipment with the result that the first complete field units are now available. The magnetic steering device formerly developed in the laboratory was installed in a Fairmile craft and given extensive sea trials off the east coast. The fastax camera was widely used not only in investigations dealing with elongation and impact strengths of nylon and fortisan fibres but also as a means of obtaining basic information for the design of guns. One type of electronic instrument was designed and built to measure time delay in blasting caps, while another was designed to operate and automatically control the taking of single-frame pictures on a 16 mm. movie camera. Electronic devices to record pulses arriving simultaneously, or nearly so, and rejecting pulses arriving more than a few microseconds apart were constructed for the Chalk River project. Measurements of pressures along a 20 mm. gun barrel have been undertaken using quartz and tourmaline crystal gauges.

### **Heat**

During the period under review, Dr. Babbitt started work on thermal conductivity of metals at high temperatures, with Mr. Dauphinee and Mr. Armstrong added to the staff of the section to undertake this research. Dr. Babbitt has continued the investigation which he is personally conducting

on the diffusion of water vapour. In the early part of the year Dr. Niven was in England observing the methods used in applying panel heating to houses and investigating the possibilities of using it in prefabrication. The erection of two panel-heated buildings for test purposes has been started. Assistance on the heat-panel project was given by Mr. Michener who worked on the staff of the heat section during the winter. His work was largely concerned with the heat transmission of various types of flooring and with the practicability of the various types of flooring construction. Work on the thermostatic control of refrigerator cars, discontinued during the war, was resumed and a car was equipped in the winter. Work is in progress to equip two of the new steel cars with thermostats so that thorough trials can be made on the three cars before advocating its general use on all refrigerator cars. Investigation was begun on the possibility of using a calibrated wooden stick as an indicator of forest fire hazard. Dr. Katzman was employed to take charge of temperature standardization in the thermocouple range. Tests on thermal conductivity of building materials have increased throughout the year.

### Metrology

Work in the metrology section for the past year was marked by an increased number of measuring instruments received for verification. These included nearly 2000 gauges of the Johansson type, while the remainder covered a wide field of application. The section was represented at most of the sessions of the International Conference on Unification of Engineering Standards held in Ottawa in the fall of 1945 under the auspices of the combined Production and Resources Board. Senior officials of the metrology divisions of the National Physical Laboratory and of the National Bureau of Standards attended, thus presenting opportunity for informal discussion of matters of mutual interest. One session of the Conference was devoted to metrology, and at its conclusion hope was expressed that an international conference devoted to that subject alone might be arranged in the near future. As a result of the Conference, a new form of screw thread was recommended to the standardizing bodies of Great Britain, the United States and Canada for adoption as a unified standard.

Research, commenced last year, and carried out co-operatively by British, United States and Canadian laboratories to investigate the strength under fatigue conditions of the new thread and those it is intended to supersede, was continued. The relevant work at Ottawa is being conducted jointly by the Department of Mines and Resources and the National Research Council. As in past years, special design work was carried on and a torpedo-attack teacher of intricate construction was built at the coast to working drawings prepared in the section, and was subsequently handed over to the Navy upon completion. A special magnifying stereoscope for photogrammetric purposes was designed for the Department of Mines and Resources. Three of these instruments were built in the Instrument and Model Shop to specifications made in the section. Owing to the quantity of verification work sent in and the difficulty in recruiting a competent scientific staff, the section has not yet been able to verify its standards, sub-standards and associated calibrations, work which was held in abeyance during the war.

### Optics

The major research effort of the laboratory was in photography with particular emphasis on photographic optics. Extensive experiments were conducted in the field of night aerial photography. The work concerned

the accurate measurement of the photometric characteristics of various types of flash bombs when burst in the air. A large amount of special equipment was developed. Physical shape of the flash was determined by two high-speed motion picture cameras directed at the explosion of the flash bomb by radar equipment. The co-operation of the United States Office of Scientific Research and Development and the Canadian Army in these experiments is gratefully acknowledged.

The new criterion for determining speed of photographic emulsions mentioned in the report for 1944-1945 has been further investigated. Results show that speed determinations by the new criterion can be reliably made by different observers at different times.

High-speed motion-picture photography has been intensively studied. The laboratory mockup has yielded 60,000 to 80,000 frames per second with very satisfactory definition. An improved model which will attain 200,000 frames per second with a larger picture size and superior definition is being planned.

Careful studies have been made of the performance under service conditions of the tri-camera mounts designed for accurate tri-metrogon photography. The mechanical stability of the mount has been shown to be very satisfactory. Angular errors due to the method of processing employed on survey film have been shown to cause errors as large as 15 minutes. Steps are being taken to rectify the trouble.

A densitometer in accordance with the American Standards Association specification for measuring photographic density and a new lens-film resolving-power testing bench have been designed in the laboratory and built in the laboratory workshop. The mechanism of photographic imagery has been extensively studied. Reports of the photographic researches have been sent to some forty organizations within the Empire and in the United States. The usual number of routine optical tests and a limited amount of standardization have been carried out.

### **Radiology**

Investigations of the strength of materials were brought to a close because of the falling-off in demands for mechanical tests and the scarcity of staff for research in this field. Similarly, studies of the physics of rubber were suspended because of reductions in staff. The equipment required for this work as well as for X-ray intensity standardization has been retained in case it may be needed when personnel is again available. Radiographic tests have been reduced greatly in number, but some radiography was carried on at outside locations for the Nuclear Physics Division, and a few objects were radiographed for the Bureau of Mines and for the Radio Section. A radiographer was trained and accredited for radiographic inspection for the Royal Canadian Air Force.

X-ray diffraction studies have been hampered by losses in staff but a problem was undertaken for the Ontario Department of Health, on development of apparatus and techniques for the determination of free silica content of industrial dusts. Eighty such analyses have been made for that department. In connection with radioactivity research some residues and concentrates were analyzed and a start was made on classifying diffraction patterns of a group of uranium compounds. A high-temperature camera was designed but its construction was not carried through.

A commercial electron microscope was installed early in 1945. Much work was done on the instrument here and visits were made to other microscope laboratories to acquire familiarity with the special techniques of specimen preparation and instrument operation. Several problems were undertaken, largely in the field of catalyst studies for the Chemistry Division, but also including investigations of bacteria, rubber latex, asphalt, crystal morphology and surface structures in stainless steel.

The 600-kilovolt constant-potential generator, previously used for high-voltage X-ray work has been used to provide accelerated positive ions for research carried on in conjunction with the Nuclear Physics Division. Considerable work has been done toward developing improved ion sources, and the extensive auxiliary apparatus required for the observation of nuclear reactions initiated by accelerated ions has been put in operation.

The routine standardization of radium has continued to increase in volume and in the variety of preparations measured in spite of inadequacy of equipment and shortage of trained personnel. In view of the great strength of some radium capsules being measured, efforts have been made to reduce the radiation hazard for those making the measurements. Since the Government expropriation of Eldorado Mining and Refining Company, this laboratory has served to a great extent as a new research department for the reorganized company. A chemistry laboratory was set up to investigate some problems in the refining and analysis of radioactive materials. Improved filling techniques were developed for medical and industrial radium containers. Methods of ore analyses by means of Geiger counters were improved, and apparatus for this work was made available to the refinery and the mine. Portable Geiger counters of several types were developed and produced here when they were unavailable elsewhere, and satisfactory designs were recently released to Canadian manufacturers for commercial production. Apparatus and techniques were developed for the rapid filling and testing of Geiger-Mueller tubes. The Ontario Department of Health was supplied with apparatus for detecting radon in the breath of workers in radium plants. Much work of a consultative nature was also done in this field.

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## ELECTRICAL ENGINEERING AND RADIO BRANCH

B. G. BALLARD, *Officer in Charge*

Throughout the year, the Branch has continued to devote the major part of its effort to radar development or to projects employing radar technique. As the war drew to a close, there occurred only a minor change in the character of work due primarily to the fact that the Armed Services wished to complete most of the projects on which the Branch had been engaged, and also due to the fact that air and marine navigational aids, to which considerable attention had been devoted, have important post-war applications.

On 1 January, 1946, the Electrical Engineering Laboratory of the Division of Physics and Electrical Engineering was amalgamated with the Radio Laboratory to form the Electrical Engineering and Radio Branch.

At about the same time, Brigadier F. C. Wallace, under whose guidance the Radio Laboratory had functioned so successfully and to whom much of the credit for its accomplishments is due, resigned.

Several members of the staff who had been on loan from other organizations returned to their original duties. Others resumed their university careers and still others sought their fortunes in commercial or industrial enterprises. It would be impossible in a brief report to mention these men individually but they deserve credit for their untiring efforts and their magnificent contribution to the National Research Council's war work.

During the closing months of the year, plans were prepared for re-organization to enable the Branch to meet most effectively the problems of the post-war period. The strength of post-war staff will be approximately the same as that prevailing throughout the war. The end of the war has brought no relaxation in work, and the requests for projects to be undertaken is well in excess of the capacity of the Branch.

A brief review of the Branch activities follows:

### **Radio Aids to Air Navigation**

Early in the year, the first meter presentation distance indicator was built and flight tested. Previously cathode ray tube presentations were used. The equipment is airborne and operates on secondary radar principles, showing the pilot his distance continuously from one or more selected ground points. The decision to adopt the National Research Council distance indicator within the British Empire was reached after a successful demonstration in the United States in January, 1946 where its superiority over equipment developed in the United States was established convincingly. The United States equipment employed a frequency of 1000 mc. whereas the National Research Council equipment operates on 200 mc. As a result of these trials, the British Empire has obtained a frequency allocation for 200 mc. distance indicators until January, 1949 at least.

The laboratory is now engaged on the development of these units to a point where they may be turned over to industry for production to meet civil aviation and Air Force requirements.

The Research Council assisted with the installation of two microwave early warning sets (MEW), one at Dorval, Quebec, under the auspices of the Department of Transport, and the other at Winnipeg under the control of Trans-Canada Airlines. Both stations were intended for analyzing the problem of air traffic control by means of ground radar surveillance, and the detection of approaching storms. In addition, the National Research Council developed a radio-link system for transmitting MEW information to remote observation points.

A prototype microwave height finder previously developed at the National Research Council was turned over to the Royal Canadian Air Force who in turn co-operated with the Canadian Army Operational Research Group in connection with their stormy weather project. It is found to be a very useful instrument in analyzing heights and precipitation layers, and from the data collected has come valuable confirmation of some meteorological theories.

### **Radio Aids to Marine Navigation**

During the war, the Branch had developed a 3 cm. surface search radar for marine service to British Admiralty requirements. The set was known as the Type 268 and was manufactured in quantity by Research Enterprises Limited. Adjustment of the Naval programme at the close of the war resulted in a surplus of these units which has been taken over by Canadian

Arsenals Limited. The National Research Council is undertaking to install and service these type 268 sets on Canadian ships for Canadian Arsenals Limited. This arrangement will expire on 31 December, 1946, at which time it is hoped that private organizations will have acquired the technique of installation and servicing and will be in a position to assume that responsibility in 1947 and thereafter.

It is contemplated that Canadian Arsenals Limited will ultimately withdraw these sets from service, and in the meantime, the National Research Council will co-operate with Canadian industry to develop a suitable replacement unit.

### **Developments for the Armed Services**

During the year, the Branch completed an extensive programme in connection with the development and construction of some high definition radar units for the British Admiralty. The initial sets delivered to England are now installed and operating successfully.

A very close liaison with Research Enterprises Limited in connection with the production of microwave early warning radar sets has continued throughout the year and most of the production problems have been solved. The development of a Remote Plan Position Indicator (PPI) display for the above sets was undertaken and engineering information for the construction of modification kits to be used in conjunction with existing sets has been forwarded to Research Enterprises Limited.

Early in the year, the Branch was engaged on the development of a counter-mortar radar (CB) but the work has continued at a much lower priority since V-J Day.

The original coastal defence radar (CDX) equipment provided a rough means of determining range and bearing error by observation of the fall of shot. However, it was found that in service it was impossible for the operators to achieve sufficient skill to obtain useful readings of these errors. To overcome this difficulty a special cathode-ray tube with a long delay screen as a special shell-spotting indicator to be used in conjunction with the present CDX equipment was proposed. A prototype, delivered to the Army for trials, proved entirely successful.

Work in conjunction with proximity fuse fitted shells to determine the exact instant of shell burst and thereby permit an appraisal of premature bursts under different weather conditions particularly under conditions of heavy snow was undertaken. With the arrival of spring this work was abandoned.

A special long delay screen for cathode-ray tubes has been developed in connection with the coastal defence fall-of-shot indicators.

Radar methods were employed to assess false performance of shell fuses under different weather conditions.

### **Troposphere Studies**

The Branch co-operated in the study of propagation over land in the 3- and 10-centimetre bands at a station in Suffield, Alberta. Many valuable data were obtained which will be useful in radio link systems and radar coverage problems. It appears that future radio transmission conditions can not be predicted accurately from present meteorological data but considerable quantitative information was obtained which will be applicable in establishing general theories of propagation.

### **Ionosphere Studies**

A programme was undertaken to replace vertical incidence ionospheric recorders with modern automatic equipment. The new equipment was used at the Victoria Beach site, Manitoba, to obtain ionospheric measurements during the eclipse of 9 July, 1945, and subsequently, it was used as a mobile observatory to obtain records between Winnipeg and Churchill.

The Branch developed a modification of the panoramic ionosphere recorder previously introduced by the Carnegie Institute of Washington, D.C., with the view of improving the original equipment. It is too soon as yet to predict how successful the performance will be.

### **Radio Communication**

At the request of the Deputy Minister for Air, the Radio Branch undertook a survey of radio communication problems along the Alaska Highway.

During the summer of 1945, the National Research Council was approached by the Canadian Pacific and the Canadian National Railways to undertake propagation tests at wavelengths of 10 centimetres over sites between Montreal and Toronto. This project has been carried on in co-operation with the railway communication engineers, the National Research Council assisting in the survey and selection of sites, and undertaking the design and construction of antenna, transmitters, monitors, receivers and signal generators. Most of the field testing has been undertaken by railway personnel.

### **Miscellaneous**

During the spring and early summer of 1945 a 10-centimetre noise source was designed and constructed for use in testing receiver sensitivity in radars operating on that frequency.

A more accurate means of receiver calibration was considered, and it appeared that a thermal noise source would be ideal as a standard of S-band power. This led to the construction of a modulator for the amplification and detection of thermal noise. The equipment is now complete, and it is in the form of a radiometer to investigate the 10-centimetre power arriving at the earth's surface from the sun, earth's atmosphere, etc.

A K-band test set to indicate the operating efficiency of radar units operating on this band was designed in the spring of 1945, and twelve of these sets have since been constructed and calibrated. Considerable effort was expended in studying the waveguide feed-line and the ageing of K-band magnetrons to ensure that the tubes would operate properly and without frequency splitting.

About 60 K-band tubes were constructed in the tube laboratory to meet the requirements of radar sets constructed by the Research Council operating at this frequency. The project was completed in November, 1945, and since that time the tube laboratory has devoted its efforts to the construction of oscillator tubes operating over the 0.5 to 2.0 centimetre region.

The laboratory has continued to provide a standard frequency service to a precision of better than one part in a million.

To meet a requirement of the Department of Transport a high-frequency cathode-ray direction finder originally designed by the National Research

Council was modified to operate on low-frequency marine direction-finding bands. Previously, there had been no equipment of comparable accuracy operating on these frequencies.

A wide variety of minor projects was undertaken including the development and construction of some pH control sets, the determination of dielectric constant and dielectric strength of materials such as bread dough, investigation of the performance of radio receivers, construction of special impedance bridges, investigation of suitable plating technique for different atmospheric conditions, etc.

The traffic in documents and reports through the Technical Information Section continues to be heavy.

The Branch represented the National Research Council on several committees including the Committee on Acclimatization of Signals, Radar, Electrical and Optical Equipment, the Navigation Subcommittee of the Associate Committee on Aeronautical Research, the Working Subcommittee of the Associate Committee on Survey Research, the Canadian Radio Technical Planning Board, and several subcommittees of the Canadian Standards Association and the Canadian Electrical Association.

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## CODES, PUBLIC RELATIONS AND PUBLICATIONS

S. J. COOK, *Officer-in-Charge*

Under this heading are grouped the continuing activities heretofore reported in separate sections under "Codes and Specifications" and "Research Plans and Publications".

In the field of codes and specifications, the National Research Council serves as a medium for the co-ordination of ideas on standards for industrial materials and through its Committees is able to offer a service to Government departments and to industry in the preparation of acceptable specifications. The Canadian Government Purchasing Standards Committee comprises representatives of all Government departments that are interested in the purchase of supplies. In the preparation of desired specifications, it is usual to appoint a panel of experts to study the problem and to bring in a draft specification for consideration by those concerned. When approved with any revisions that may have been made and accepted, the specification is issued as a tentative standard. As such, it is accepted by all Government departments as a basis for the purchase of the product described.

Considerable interest in these specifications has been aroused not only throughout the industries that supply materials to the Government, but also by other large buyers who often adopt the Canadian Government Purchasing Standard specifications as a guide in their own buying. The specifications drawn up by the Committee have no legal force except as indicated by the user firms; but they are being given wide circulation and it is believed they are serving a very useful purpose in promoting high standards of quality.

Another activity in standardization has been the preparation of the National Building Code, including ancillary documents such as the Standard Plumbing By-law and the Model Zoning By-law.

Each of these subjects is dealt with separately below in more detail.

*Canadian Government Purchasing Standards Committee.*—Demand for specifications issued by the Committee is showing continual increase, as evidenced by the following figures, corresponding figures for the previous year being given in brackets:—

Departments of National Defence and Munitions and Supply 28,000 (15,800); other Dominion departments 6,500 (4,000); Industrial firms and others 18,500 (16,300), making totals of 53,000 (36,100).

Twenty-five new specifications were issued during the year and thirty-two existing specifications were completely revised and re-issued. Amendment sheets were issued for twenty-five specifications. Eleven specifications were cancelled, so that the total number of specifications on issue at the end of the fiscal year was 229, as compared with 215 at the end of the previous fiscal year.

The preparation and distribution of these specifications and the correspondence involved, required the stencilling of 1,370 (1,590) pages; mimeographing of 190,000 (330,000) pages; the distribution of 3,300 (7,700) notification cards; and 9,360 (8,000) letters.

During the year there were sixteen meetings of Subcommittees, and thirty-four meetings of the Panels.

*Canadian Co-operative Aviation Fuel Exchange.*—The Aviation Fuel Exchange has now been in operation for five years. Seven oil companies have distributed in rotation three samples to each of the 24 participating laboratories. The results of tests were compiled and detailed reports were sent to the participating laboratories and fifteen others interested.

The Exchange affords the various laboratories an opportunity of comparing the performance of their octane-rating engines, and of estimating the accuracy of their other test work on aviation fuel. Tests on the reproducibility of tetraethyl lead determinations and sulphur determinations were also included. Since October, 1945, the Exchange has been operated on a quarterly basis.

*Canadian Co-operative Lubricant Exchange.*—The Lubricant Exchange, organized in September, 1944 to fulfil a somewhat similar function in the testing of petroleum lubricating products, has continued to operate on a monthly basis. A monthly sample is distributed to the 13 participating laboratories, who report their results to the secretary. Copies of a monthly report based on these results were sent to the participating laboratories and 14 others interested.

*Committee on Chemical Water Standards.*—Sponsored by the Chemical Institute of Canada and the Canadian Public Health Association, this Committee co-operates with the Joint Editorial Committee on Standard Methods for the Examination of Water and Sewage, which in turn is sponsored by the American Public Health Association and the American Water Works Association. The Committee on Chemical Water Standards held one meeting during the year.

*National Building Code.*—Distribution of the National Building Code (N.R.C. No. 1068, Price, \$1.00) has been continued and no major changes in the Code have yet been made. It has been extensively used by Canadian municipalities as an authoritative guide in the preparation or revision of local building by-laws and regulations.

The Standard Plumbing By-law, issued separately, and later included as an Appendix to the National Building Code, was discussed at a meeting of the Canadian Institute on Sewage and Sanitation and a resolution was passed: "commending the said By-law to the consideration of authorities—municipal, provincial and others, as the case may be—having jurisdiction over plumbing regulations throughout Canada, as a guide, with a view to its adoption when plumbing regulations are being prepared, or when amendments of existing regulations may be contemplated."

During the year under review, the Standard Plumbing By-law was translated and issued in a French edition. The National Association of Master Plumbers and Heating Contractors of Canada at once approved the French edition of the Plumbing By-law and recommended that the Quebec Department of Labour support its use. In accordance with this recommendation, the Quebec Department of Labour subsequently purchased copies of the French edition for distribution to municipalities within the Province.

The Model Zoning By-law (N.R.C. No. 659) has been reviewed but no changes have been made in it as yet.

Following a conference on building research held under the auspices of the National Research Council in September, 1945, further progress was made in the preparation of "A Building Code for Smaller Municipalities", based on the National Building Code and the Model Zoning By-law. This shorter Code consists principally of minimum requirements for safety and health in one- and two-family dwellings. Regulations for buildings used for other purposes have been included by reference to the National Building Code. Thus, the proposed abridged Code is complete, even though only the regulations for one- and two-family dwellings are given *in extenso*. With this arrangement it is hoped that the shorter Code will be acceptable not only to the very small municipality where nearly all construction is of one- and two-family dwellings, but also to the somewhat larger town or city in which there is an appreciable amount of other construction. For very large cities the use of the National Building Code is still recommended.

Towards the close of the year "A Building Code for Smaller Municipalities", was nearing final draft form and it was expected that it would be published early in the summer of 1946.

*Public Relations.*—Among the general duties of this branch, one of the more important functions lies in the field of public relations. This activity includes the maintenance of international affiliations through memberships held by the Council in scientific organizations throughout the world, for the purpose of securing reference publications or for the promotion of the work of certain organizations such as the Imperial Agricultural Bureaux which are jointly supported by various member countries of the British Commonwealth of Nations. Exchange of the Council's publications for selected scientific material of interest, published by universities and societies in other lands, is also arranged.

Distinguished visitors from foreign lands and Empire countries are being received in greater numbers as national barriers to the interchange of scientific knowledge are removed and it is a pleasure to record that Belgium, Brazil, China, France, Sweden and the Netherlands have been among the countries represented by visitors to the National Research Laboratories during the past year. From the United States, Great Britain and the other

British Dominions visitors arrive with growing frequency, and Canadian scientists return these visits as opportunity permits. This interchange of visits is a great source of benefit in the general planning and organization of research investigations.

*Scientific Secretariat.*—Closely allied to public relations, is the work of the scientific secretariat. Secretarial services for committees are provided as required and in some instances, the work is extensive. In recent years, for example, executive-secretarial service has been provided for the several medical committees of the Council, the Associate Committee on Dental Research, the Associate Committee on Forestry, and the Inventions Board, as well as for the Review Committee of Council and others as required.

Editorial services include work on the Annual Report of the Council and on the preparation and publication of the *Canadian Journal of Research*. Special articles are prepared as required and information on the work of the Council is supplied to the Press, as occasion demands.

Translations are for the most part restricted to special articles and the preparation of the French edition of the Annual Report.

*Inventions Board.*—Secretarial service has been continued throughout the year for the Civilian Consulting Committee of the Inventions Board. This work was carried on in co-operation with the three Service Consulting Committees—Navy, Army and Air—as in previous years. With the end of the war the work of the Inventions Board has steadily decreased and it is expected that the Board and its several committees will be disbanded early in the new year. In the meantime the review of proposals submitted is being continued as there are numerous projects under investigation on which final reports have not yet been made.

### Publications

National Research Council publications, other than the *Canadian Journal of Research* are issued in a single series in which each paper is given a "N.R.C. No." Included in this series are the Annual Reports of the Council, reprints of scientific papers written by members of the staff and published in various technical journals, mimeographed collections of abstracts and patents from the scientific literature, translations of articles from foreign language journals, special publications such as the National Building Code and other documents arising from Committee activities as for example, "Treatment of Thermal Burns", "Amputations" and "Low Back Pain and Sciatica", prepared by the Medical Committees, as well as addresses and certain other papers on the work of the Council.

During the year 107 papers were added to the Council's list of publications (N.R.C. No. 808) bringing the year-end total to 1,379 titles. A supplement to the list of publications was issued in December, 1945, completing the listing to the end of that year. A bi-monthly list of additions is published and widely distributed.

A Clip-Sheet containing abstracts of all papers appearing in the *Canadian Journal of Research* is published every second month and circulated to abstract journals and to prospective subscribers.

*Canadian Journal of Research.*—The *Canadian Journal of Research* is edited by a Joint Editorial Board consisting of members of the National Research Council, the Royal Society of Canada, and the Chemical Institute

of Canada. It is published by the National Research Council under authority of the Chairman of the Committee of the Privy Council on Scientific and Industrial Research.

Since January 1944 the *Canadian Journal of Research* has been published in six sections, each of which is issued bi-monthly as follows: Sections A, Physical Sciences, B. Chemical Sciences, and F. Technology appear in January, March, May, July, September and November; Sections C. Botanical Sciences, D. Zoological Sciences and E. Medical Sciences appear in February, April, June, August, October, and December. Annual indexes are printed in the November and December issues respectively. The scheduled date of publication is the first of each month.

All submitted manuscripts are critically examined by competent reviewers working in co-operation with the Editor in Chief and the several Section Editors, and the Editor in Chief reports that in spite of considerable pressure from other duties on the academic and scientific personnel responsible for refereeing papers, there was a considerable improvement in the average time required for reviewing in 1945. This whole-hearted co-operation from Section Editors and reviewers is gratefully acknowledged and highly appreciated by the National Research Council and particularly by the Editor in Chief.

During the year under review, the Chemical Institute of Canada elected to use Sections B and F of the *Canadian Journal of Research* as their official medium of publication for research papers. As part of this arrangement the Editorial Board has been expanded by the addition of Dr. R. V. V. Nicholls, representing the Chemical Institute of Canada.

Editorial preparation and the publication of accepted papers are carried out under the supervision of the Managing Editor by the editorial staff: Dr. W. W. Thomson, Associate Editor; Dr. Pauline Snure, Assistant Editor; and Miss D. A. C. Keating, B.A., Editorial Assistant.

Volume 23 of the *Canadian Journal of Research* for the year ended December 1945 contained 140 papers (1461 pages). The number of papers by Sections, and the number of pages, in brackets, were as follows: Section A, Physical Sciences, 9 (85); Section B. Chemical Sciences, 35 (296); Section C. Botanical Sciences, 19 (222); Section D. Zoological Sciences, 7 (183); Section E. Medical Sciences, 26 (256); Section F. Technology, 44 (419). The totals for 1945 were 140 (1461) as compared with 98 (1121) in 1944.

Of the 140 published papers, 51 originated in the National Research Laboratories; 3 were done co-operatively between the National Research Council and other institutions; 23, submitted from universities and other institutions, were based on work done with financial assistance from the Council; 14 originated in Provincial and Dominion Government departments; and 49 were received from other sources including universities.

Subscription rates for the *Canadian Journal of Research* are as follows:

Any one section, \$2.00; two sections, \$3.00; three sections, \$4.00; four sections, \$5.00; five or all six sections, \$6.00.

There has been a substantial growth in the number of pages published in the Journal and in the number of copies distributed during the past year. The following tabulation shows the distribution for November-December 1945:

DISTRIBUTION OF *Canadian Journal of Research*, NOVEMBER-DECEMBER, 1945

Section	Number of Paid Subscriptions	Total Distribution, including Subscriptions, Free and Exchange Copies				
		Canada	Great Britain	United States	Other Foreign	Total
A.	577	247	98	389	99	833
B.	841	487	105	406	102	1100
C.	482	220	81	305	102	708
D.	456	208	85	297	99	689
E.	426	222	69	273	78	642
F.	730	472	96	322	86	976

SCHOLARSHIPS AWARDED—1945-46

(a) GRANTEES BY UNIVERSITIES AND CLASSES OF SCHOLARSHIPS

By University of graduation	University	By Classes of Scholarships and Institutions Where Held			
		B.* \$450	S.* \$750	F.* \$900	Total
1	Acadia.....	—	—	—	—
12	Alberta.....	1	—	—	1
6	British Columbia.....	—	—	—	—
1	Dalhousie.....	—	—	—	—
1	Ecole Polytechnique.....	1	—	—	1
2	Laval.....	—	2	—	2
6	Manitoba.....	2	—	—	2
3	Montreal.....	1	1	1	3
1	Mt. Allison.....	—	—	—	—
10	McGill.....	5	22	10	37
2	McMaster.....	2	—	—	2
1	New Brunswick.....	—	—	—	—
1	Oka Agricultural College.....	—	—	—	—
1	Prince of Wales College.....	—	—	—	—
8	Queen's.....	6	1	—	7
7	Saskatchewan.....	1	1	—	2
2	Sir George Williams.....	—	—	—	—
2	Toronto.....	2	7	2	11
1	Western Ontario.....	—	—	—	—
68	Total.....	21	34	13	68

\* B.—Bursary. \* S.—Studentship. \* F.—Fellowship.

(b) DISTRIBUTION OF SCHOLARSHIPS BY FIELDS OF RESEARCH AND UNIVERSITIES

Field of Research	Post-graduate work done at:										
	McGill	Toronto	Queen's	Montreal	Laval	Saskatchewan	Alberta	Polytech.	Manitoba	McMaster	TOTAL
Biochemistry.....	1	3	—	—	1	—	—	—	—	—	5
Biology.....	—	—	1	—	—	—	—	—	—	—	1
Chemical Engineering.....	—	—	1	—	—	—	—	—	—	—	1
Chemistry.....	7	—	1	—	—	—	—	—	—	2	10
Economic Geology.....	—	—	1	—	—	—	—	—	—	—	1
Electrochemistry.....	—	—	1	—	—	—	—	—	—	—	1
Genetics.....	1	—	—	—	—	—	—	—	—	—	1
Ind. and Cell. Chemistry.....	2	—	—	—	—	—	—	—	—	—	2
Industrial Chemistry.....	—	—	—	—	—	—	—	1	—	—	1
Metallurgical Engineering.....	—	1	—	—	—	—	—	—	—	—	1
Organic Chemistry.....	9	2	—	2	—	—	1	—	—	—	14
Physical Chemistry.....	14	2	1	—	—	2	—	—	2	—	21
Physics.....	3	1	1	—	—	—	—	—	—	—	5
Physiology.....	—	1	—	1	1	—	—	—	—	—	3
Zoology.....	—	1	—	—	—	—	—	—	—	—	1
Total.....	37	11	7	3	2	2	1	1	2	2	68

## REPORT OF THE DIRECTORS

## (c) SUMMARY OF SCHOLARSHIP GRANTS

Date	Fellowships		Studentships		Bursaries		Amount Actually Expended by Council
	Number	Value	Number	Value	Number	Value	
		\$		\$		\$	\$ cts.
1917-18.....	3	1,000	4	750	—	—	5,550.00
1918-19.....	2	1,200	5	750	—	—	7,150.00
	1	1,000					
1919-20.....	1	1,500	18	750	6	500	20,850.00
	3	1,200					
	1	1,000					
1920-21.....	1	1,500	10	750	8	500	17,700.00
	1	1,200					
	3	1,000					
1921-22.....	1	1,500	8	1,000	27	750	38,575.00
	6	1,200					
1922-23.....	3	1,200	22	1,000	13	750	35,725.00
1923-24.....	1	1,500	8	1,000	25	750	37,830.00
	11	1,200					
1924-25.....	1	1,500	12	1,000	30	750	40,101.66
	3	1,200					
1925-26.....	1	1,500	17	1,000	22	750	40,082.75
	3	1,200					
1926-27.....	1	1,500	17	1,000	20	750	41,105.00
	5	1,200					
1927-28.....	1	1,750	16	1,000	27	750	41,855.00
	4	1,200					
1928-29.....	1	1,750	17	1,000	29	750	43,720.00
	3	1,200					
1929-30.....	1	1,750	18	1,000	26	750	49,990.00
	3	1,500					
	6	1,200					
1930-31.....	1	1,750	22	750	35	600	59,535.00
	1	1,500					
	5	1,000					
1931-32.....	5	1,000	22	750	25	600	38,490.00
1932-33.....	4	1,000	9	750	8	600	17,605.00
1933-34.....	5	550	6	500	6	450	9,160.00
1934-35.....	2	550	6	500	18	450	11,825.00
1935-36.....	2	550	9	500	18	450	13,205.00
1936-37.....	2	700	11	600	16	500	15,675.00
1937-38.....	3	1,000	12	600	25	500	22,813.20
	2	750					
	3	700					
1938-39.....	2	1,000	17	650	27	550	28,309.96
	3	750					
1939-40.....	2	1,000	34	650	28	250	31,561.68
	5	750					
1940-41.....	2	1,000	37	650	23	250	33,355.03
	4	750					
1941-42.....	1	1,000	30	650	21	250	31,438.28
	12	750					
1942-43.....	8	750	37	650	19	250	32,300.00
1943-44.....	14	750	29	650	22	250	33,256.25
1944-45.....	9	750	30	650	18	250	29,025.00
1945-46.....	13	900	34	750	21	450	52,110.00
	481		517		563		879,898.81

## APPENDIX

### 14-15 GEORGE V.

#### CHAPTER 64.

##### The Research Council Act.

(Revised Statutes of Canada, 1927, Chapter 177)

[Assented to 19th July, 1924.]

HIS MAJESTY, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:—

1. This Act may be cited as *The Research Council Act, 1924*.
2. In this Act, unless the context otherwise requires,—
  - (a) “Committee” shall mean the Committee of the Privy Council on Scientific and Industrial Research;
  - (b) “Chairman” shall mean the Chairman of the Committee of the Privy Council on Scientific and Industrial Research;
  - (c) “Council” shall mean the Honorary Advisory Council for Scientific and Industrial Research;
  - (d) “President” shall mean the President of the Honorary Advisory Council for Scientific and Industrial Research.
3. There shall be a Council to be called “The Honorary Advisory Council for Scientific and Industrial Research.”
4. (1) The Council shall consist of not more than fifteen 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 each 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 each be appointed for a period of one year.  
(3) Any retiring member shall be eligible for reappointment.
5. There shall be a President of the Council who shall be appointed by the Governor in Council on the recommendation of the Committee. The President shall be the chief 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 moneys provided for the work of the Council.

6. The Council shall have charge of all matters affecting scientific and industrial research in Canada which may 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.

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.

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.

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.

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 the 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 waste 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.

**11.** (1) All discoveries, inventions and improvements in processes, apparatus or machines, made by a member or any number of members of the technical staff of the Council shall be vested in the Council and shall be made available to the public under such conditions and payment of fees or royalties or otherwise as the Council may determine, subject to the approval of the Governor in Council.

(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.

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

**13.** (1) The President shall report annually to the Council upon the progress and efficiency of the work of the Council and as to its requirements, and shall make such recommendations therein as he may deem necessary.

(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.

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