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THE WORK OF THE NATIONAL RESEARCH COUNCIL IN 1948

(A summary of the Council's work in 1948 issued by its Public Relations Branch)

It has been an effective and highly productive year in the activities of the National Research Council at Ottawa. With a staff of more than 2600 persons, many of whom have won wide recognition in their respective fields, the Council now occupies a very creditable place in the scientific world. In 1948, for the first time, the Council awarded 19 post-doctorate fellowships each tenable for one year in the Division of Chemistry of which Dr. E.W.R. Steacie, F.R.S., is the Director. Holders of these fellowships include men trained in English and Scottish universities and institutions in Holland and Denmark.

Heretofore, the trend in post-graduate research has always been from Canada to other countries, mostly the United States and Europe. It is a mark of progress that the flow of scientists is now moving in both directions and it is a notable achievement for Canadian scientific workers to be selected as the guides and mentors of mature investigators who have been trained in the older and famous European centres of learning.

Award of these fellowships indicates also a movement in Canadian research towards a greater concentration of effort in the field of pure science than was possible during the war years. The Council's programme of investigations now more nearly represents the nice balance between pure and applied research, which is considered essential to continued productive effort. Freshness of approach to industrial research problems, can only be maintained through intensive studies which have for their object the discovery of new knowledge. Gone is the day when "pure" research was pursued only in the universities; progressive scientific institutions everywhere now recognize the fundamental value and importance of carrying on research in pure science within their own organizations as an essential means of promoting the successful prosecution of industrial problems.

The National Research Council's Atomic Energy Project at Chalk River has enjoyed a successful year of operation of its heavy water pile or nuclear reactor. This has afforded the highest flux of neutrons available anywhere for experiments and for the production of radioisotopes. Radioisotopes have been supplied to 19 approved laboratories across Canada. Highlights of research include a new approach to the measurement of the mass of the neutron made possible by the high flux of neutrons in the pile. This indicated that the hitherto accepted value might be significantly low. Much knowledge has been gained of the effects of radiations on various substances. The instrumentation for the measurement of radiations has been

considerably advanced. In the field of biology interesting results have been obtained on the effect of radiation in producing chromosome breaks.

In December a highly successful conference on the use of isotopes in industry was held in Ottawa to acquaint Canadian industrialists with possible uses of radioactive isotopes now being produced at Chalk River. Representatives were present from all major industries including pulp and paper, mining, chemical companies, milling, yeast manufacturers, textile companies, the rubber industry, manufacturers of pharmaceuticals, chief railways, electrical companies, manufacturers of cement, oil refineries, and the automobile and farm implement industries. About 120 leaders from Canadian industry were present at the Conference. The group included directors of research and other executive officers who came to discuss the technical use of isotopes with N.R.C. scientists.

Programme for the Conference included a demonstration lecture by Dr. D.A. Keys, Vice-President of the Council and Manager of the Atomic Energy Project.

Group discussions followed in which the industrial representatives were shown how the radioactive materials produced at Chalk River could be used in the control of industrial processes. For example, the amount of wear on a bearing can be determined easily and accurately; the thickness of gold plating on jewellery can be measured and controlled; what happens to the sulphur in coke used in iron blast furnace smelting operations, can be followed. Hundreds of peacetime applications exist for radioactive materials including the possible use of atomic energy for heat and power purposes.

In the pure chemistry branch, of the Division of Chemistry, work is continuing on various problems connected with the structure of alkaloids, and an investigation using radioactive tracers has been started on the synthesis of alkaloids in plants. One project employs radioactive atoms to trace the mechanisms of chemical reactions. First observations are being made using radioactive carbon in a study of some controversial aspects of the photochemical decomposition of acetone. Radioactive tracers are also being employed in investigations on the transition from the gaseous to the liquid state. A variety of physical chemistry problems are under investigation, including photochemistry, surface chemistry, spectroscopy, and calorimetry.

Work has started on the construction of new laboratories for the applied chemistry branch of the Division of Chemistry at the Montreal Road site. The new building, when completed, will provide badly needed additional laboratory facilities and will relieve the present congestion in the Sussex Street laboratories.

An appreciable fraction of the work carried out in the applied chemistry branch consists of tests and service work for Government departments and industry and the development of testing procedures or analytical methods in connection with the drafting of Government specifications. The major activities of the branch, however, are concerned with many long-term research projects in the applied chemistry field, some of which may be mentioned.

A study is being made of the factors which affect corrosion rates in the high-temperature corrosion of alloy

steels. It is anticipated that this investigation may lead to results of great industrial value. Work is also proceeding on the mechanism of corrosion inhibitor action. This is a problem of every-day interest; for example in the prevention of corrosion in automobile cooling systems.

Improvement of visibility through aircraft windscreens by the use of a bonded rain repellent is of great significance in flying. Flight tests up to 600 m.p.h. through all sorts of rain conditions have been carried out on the rain repellent developed last year. These tests have demonstrated the effectiveness of the repellent in maintaining visibility when flying through rain. The material is meeting general acceptance by the aircraft industry and is now being manufactured commercially.

Catalytic reactions of acetylene with aldehyde under pressure, an industrial investigation sponsored by Shawinigan Chemicals Limited, has for its object the preparation of acetylenic alcohols and glycols. Chemistry of unsaturated fatty acids is being studied in an attempt to prepare them by the dehydrogenation of saturated acids.

Further work is being done on the use of silver-calcium alloys as catalysts in the direct oxidation of ethylene to ethylene oxide. Work is also being done on the design of a reactor to provide optimum heat-transfer rates from the catalyst bed to the cooling medium. Attempts to employ the catalyst in the fluidized condition were not successful.

In collaboration with other laboratories, an attempt is being made to correlate the results of laboratory tests of natural and synthetic rubber stocks with road tests of tires containing the same stocks.

A new method for the recovery of oil from Athabasca tar sands by flash distillation in a fluidized bed of sand is meeting with considerable success in the laboratory stage. The data obtained in the course of laboratory experiments have been used to design a pilot plant on which construction has now been started.

In detergency research measurements have been made of the adsorption of soap, such as sodium stearate, and of the free fatty acids and free alkali on carbon black. Further work is being done on the adsorption of soaps on cotton.

Synthesis of organic compounds containing tracer elements is proceeding. The laboratory engaged in this work has prepared on request a large number of compounds containing stable tracers such as deuterium, nitrogen 15 and carbon 13. Facilities are being provided for the preparation of organic compounds containing active tracers such as carbon 14 and iodine 125.

The newly formed Division of Building Research commenced its active work during the year. Because the construction industry of Canada is operating at a higher volume than ever before in its history, recruitment of suitable staff is proving to be difficult but some progress has been made. A new Associate Committee of the Council has been authorized to deal with the National Building Code; the Division is assembling all available information on municipal and other codes for the use of this body.

In the field of housing research, the Division continues its co-operation with Central Mortgage and Housing Corporation; joint studies have been made of field problems such as paint deterioration and basementless houses. A soil mechanics laboratory is in operation and a number of soil studies have been made in the field including an extensive investigation at Steep Rock Lake. Initial tests have been run on the heat performance of existing buildings, preliminary to this winter's programme of similar tests. A long-term study of mortar deterioration is being planned. To assist those interested in the testing of building materials, a directory of commercial testing laboratories in Canada has been prepared as the first of a series of technical reports designed to assist the building industry.

Brief reference may also be made to the work of the Canadian Government Specifications Board formerly known as the Canadian Government Purchasing Standards Committee. Very satisfactory agreement regarding mutual fields of activity have been reached between this Board and the Canadian Standards Association.

The Division of Mechanical Engineering has been engaged during the past year on work in aeronautics, hydrodynamics, and certain phases of mechanical engineering. This Division serves as the research organization of the Royal Canadian Air Force and also provides the Canadian aviation industry with research, development and testing facilities. In performing this two-fold service, the icing and low-temperature operation of jet engines have been investigated and the supercooling of water and the atomization of water have been studied.

In co-operation with the Department of National Defence, the Division has studied the behaviour of fuels and lubricants at low temperatures. Related problems have been investigated in the gasoline and oil laboratory. In the wind tunnels, models of new aircraft have been tested for Canadian aircraft firms. The study of the control and stability of tailless aircraft was continued, with flight trials of the tailless glider at Namao, Alberta. In the autumn the glider was towed, via Winnipeg, Chicago and Toronto to Arnprior where trials will continue this winter at the Flight Research Station. Special automatic instrumentation for the tailless glider and instruments, including a cloud-droplet camera, for the measurement in flight of the meteorological conditions associated with aircraft icing, have been developed in the instrument laboratory.

In the low-temperature laboratory, opened early in the year, the cold chambers are now in full operation and tests on the behaviour of aircraft components, engines, vehicles, etc., at low temperatures are proceeding. Facilities for the static testing of full-scale components in the structures laboratory have been brought into operation and certain wings tested. Work has begun on the design of a laboratory to be equipped with supersonic wind tunnels and equipment for work on combustion, compressors and turbines.

In the hydraulics laboratory, several projects have been undertaken on open-water structures including log chutes, spillways, and river channels. The fire hazard laboratory has continued the testing of domestic oil-burning equipment for the Canadian Standards Association.

In the Division of Physics a new spectroscopy laboratory has been established under the direction of Dr. G. Herzberg who joined the staff of the Division during the year. Continuous recording of cosmic-ray intensities has been started to study the effects of geomagnetic and other geophysical phenomena on the intensity, in order to learn more about the nature of the primary rays. The study of cosmic rays by exposing nuclear photographic plates at high altitudes has yielded results showing the interaction of mesons, protons, neutrons, and nuclei that are of high scientific value.

A special Geiger-counter equipment developed during the year as an aid in prospecting for radioactive ores in diamond drill holes, was given field tests. An absolute magnetometer using the fluxgate principle has been almost completed. Interesting work has been done on measuring the efficiency of hydroelectric turbines by the temperature drop in the water as it passes through the turbine.

Results of some observations on the adsorption of water vapour by wheat have been published. This subject is important because of the effect of moisture on the quality of wheat during storage. Some preliminary experiments were made during the year to determine the usefulness of the velocity of sound as a control in oil refining. A high-speed motion-picture camera designed to take pictures at 200,000 frames per second was completed. It has been operated successfully at 120,000 frames per second. No difficulty is anticipated at higher taking rates when special electrical equipment required for this purpose becomes available.

There has been a continued demand for development of both civil and defence radar equipment, and during the past year the Division of Radio and Electrical Engineering has co-operated with Canadian industry to put into production a modern marine radar set, which promises to have wide application. During the same period the development of radar equipment to facilitate navigation in and out of harbours has been pursued actively, as well as a study of the most suitable type of navigational marker for use in conjunction with radar equipment. Gratifying progress has been made in the application of Shoran radar to both topographic and geodetic surveying procedure.

Considerable time has been devoted to more fundamental radar studies, particularly in connection with propagation and antenna design. Preparations have been completed for an exhaustive study of propagation in the microwave region over various types of snow surfaces. A continual demand exists for shorter and shorter wavelengths and the Division's tube laboratory is devoting its time to the development of tubes to operate at wavelengths shorter than one centimetre.

Radar equipment (32-5 megacycle) has been set up to study meteors in collaboration with the Dominion Observatory; the records obtained have led to very interesting speculations, and it is believed that these studies, co-ordinated with visual observations, will result in a much better understanding of meteor phenomena.

In the radio field, the ratio of signal-to-noise strength is a most important factor and depending upon the frequency of the equipment, the noise which becomes a predominant problem may originate within the equipment itself or externally. To study this latter source of noise a new station has been established near Ottawa to obtain further solar-

noise records in the ten-centimetre region.

A five-million-volt van de Graaff generator has been completed for the Atomic Energy Project to assist in nuclear studies and a one-half million volt unit has been completed for the Division of Chemistry. A third accelerator of the cavity-type, employing excitation at a frequency of 3,000 megacycles, has been built experimentally and an eight-million-volt output has been realized.

Various electronic devices have been completed, including: a pH monitor, which measures and controls the pH of biological culture media to a high degree of precision; an infra-red detector for locating hot joints on power transmission lines; and a panoramic ionosphere recorder which sweeps through a frequency range of 1 to 20 megacycles for determining the character of the ionosphere. The Division has embarked on a fundamental study of dielectric theory and a laboratory for this purpose is now being set up.

Both fundamental and applied investigations on food preservation, utilization of agricultural crops and residues, fats and oils, plant science, animal science, and statistics are being carried on in the Ottawa laboratories of the Division of Applied Biology.

Studies have been continued on food bacteriology, especially microbiological content of butter and assessment of various organisms as a measure of fecal contamination in egg products. Most of the previous chemical studies on egg products have been completed, with the exception of fundamental work on the browning reaction in dried egg powder. After many difficulties, butter containing 16% moisture (the legal maximum) was consistently produced from the Fritz continuous butter-making machine. Work on seaweed extracts has been resumed. From rape and mustard oils, edible shortenings were produced that could not be distinguished by flavour and odour ratings from commercial shortenings prepared from other oils.

In non-food uses of agricultural products, many moulds and bacteria are being examined, both in laboratory and pilot-plant operations, with a view to the production of industrial chemicals. Work on the fermentation of grains has been carried to a stage of completion and similar studies are now devoted to other products such as molasses. Improvements were made in the pilot-plant separation of starch and gluten from wheat flour. Dry undenatured gluten was prepared in the laboratory and these findings are now being translated to pilot-plant operations.

Some expansion of research facilities occurred during 1948. Work on fundamental aspects of photosynthesis was continued on a larger scale, and a new project was begun on animal physiology. The Prairie Regional Laboratory was opened in Saskatoon on June 6th. Plans are under way for a Maritime Regional Laboratory in Halifax.

Since the opening of the Prairie Regional Laboratory most of the time of the staff has been spent on equipping the laboratories. During the closing months of the year, work was started on several projects in two main fields: fermentations and microbiology, and crop utilization.

In the first group work is proceeding on: (a) the production of fungal amylase for the conversion of starch to sugars; (b) production of butanediol, glycerol and lactic

acid by bacterial fermentations; and (c) solvent recovery of the products of fermentation.

Under crop utilization there are two investigations: (a) oil seeds project on the separation of fatty acids by distillation, low-temperature crystallization, or solvent extraction; (b) agricultural residues project on pressures and temperatures required for briquetting straw.

In medical research, the extra-mural programme of awarding grants-in-aid of research and for medical research fellowships has been continued. During the year 118 grants-in-aid were given mostly to members of the staffs of Canadian medical schools. Thirty-one fellowships were awarded, seven for a second year, and four for a third year of tenure. Two of the grantees are holding their fellowships abroad, one in England and one in Switzerland. The other fellowships are held in Canadian medical schools and hospitals.

The Advisory Committee on Medical Research, as well as making recommendations in respect of applications for grants and fellowships, has acted again as the Scientific Advisory Committee to the National Cancer Institute of Canada, and has given the Director of the Division of Medical Research valuable advice on matters of policy and other business.

There has been a marked expansion in the work of the Division of Information Services. Several years ago, Technical Information Service was organized to provide without charge technical information which could be used by industrial and other workers to improve the efficiency of Canadian industry. The volume of inquiries has been expanding steadily, and one of the most encouraging features has been the increased percentage of requests for information from people who have used the service before, and who have found it useful.

Similarly, the library of the National Research Council has been asked to provide a much greater service to outside organizations. With its large collection of scientific and technical material, it is being called on increasingly to supply copies of articles which cannot readily be obtained elsewhere in Canada. During the past eight years, loans to people or libraries outside the Council's own staff have increased about seven-fold.

Both the number of subscribers to and the number of articles published by the Canadian Journal of Research have shown a substantial increase this year. An indication of the wide interest in Canadian scientific research is that nearly three-quarters of the Journal's circulation is to organizations outside Canada.

Work of the liaison offices has not shown the expected post-war decrease in activity. The presence of Canadian scientific liaison officers in London and in Washington has proved to be of great help in linking Canadian scientific work with that being done in other countries.

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