The National Research Council of Canada

Forty-fifth Annual Report for 1961-1962

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THE HON. GORDON CHURCHILL,
Chairman, Committee of the Privy Council on
Scientific and Industrial Research,
Ottawa, Ontario

SIR:

I have the honour to present to you herewith the Forty-fifth Annual Report of the National Research Council, for the fiscal year 1961–62.

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,

E. W. R. STEACIE,
President, National Research Council

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National Research Council 1961-62

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Changes in Council Membership

The Research Council Act provides that: (i) The Council shall consist of a President, a Vice-President (Administration), two Vice-Presidents (Scientific) and not more than seventeen other members, to be appointed by the Governor in Council; (ii) The members of the Council, with the exception of the President, the Vice-President (Administration) and the Vice-Presidents (Scientific) shall hold office for a period of three years; (iii) A retiring member shall be eligible for reappointment; (iv) There shall be an Executive Committee of the Council consisting of the President, the Vice-President (Administration), the Vice-Presidents (Scientific), and at least three other members selected by the Council.

During the year ending March, 1961, the National Research Council lost one member through the death of Dr. John Unrau, Professor of Plant Science at the University of Alberta.

Five other members completed their terms of office. Those retiring were: Mr. Claude Jodoin, President of the Canadian Labour Congress; Dr. C. J. Mackenzie of Ottawa; Dr. J. W. T. Spinks, President of the University of Saskatchewan; Dr. H. G. Thode, Vice-President of McMaster University; and Dr. J. T. Wilson, Professor of Geophysics at the University of Toronto.

Four of these were reappointed for a further term of three years, ending March 31, 1964. These were: Mr. Claude Jodoin; Dr. C. J. Mackenzie; Dr. J. W. T. Spinks; and Dr. J. T. Wilson.

Two new members, also appointed to March 31, 1964, were Dr. H. E. Duckworth, Professor and Chairman of the Department of Physics, McMaster University, and Dr. H. E. Gunning, Professor and Head of the Department of Chemistry, University of Alberta.

With these changes the National Research Council in 1961–62 consisted of the President, two Vice-Presidents (Scientific), a Vice-President (Administration), and seventeen other members.

Honours and Distinctions 1961-62

DR. B. G. BALLARD, Vice-President (Scientific), National Research Council, was awarded the honorary degree of D.Sc. by Assumption University of Windsor. Dr. Ballard was also elected President of the Canadian Standards Association.

DR. C. T. BISHOP, carbohydrate and lipid chemistry section, Division of Applied Biology, was elected a Fellow of the Chemical Institute of Canada.

MR. T. J. BLACHUT, head, photogrammetric research section, Division of Applied Physics, was elected President of the Canadian Institute of Surveying.

DR. E. P. COCKSHUTT, engine laboratory, Division of Mechanical Engineering, and MR. N. GALITZINE, were named recipients of the F. W. (Casey) Baldwin Award of the Canadian Aeronautical Institute, for their paper "The Fan-in-wing Powerplant System for VTOL Aircraft".

MR. C. B. CRAWFORD, head, soil mechanics section, Division of Building Research, was named recipient of the C. A. Hogentogler Award of the American Society for Testing Materials, for the best paper presented to the Society during the year 1960–61.

DR. A. M. EASTHAM, head, physical organic section, Division of Applied Chemistry, was elected a Fellow of the Chemical Institute of Canada.

DR. P. R. GORHAM, head, plant physiology section, Division of Applied Biology, was elected a Fellow of the Royal Society of Canada.

DR. G. HERZBERG, Director, Division of Pure Physics, was awarded the honorary degree of LL.D. by the University of Alberta. Dr. Herzberg was also named recipient of the Pittsburgh Spectroscopy Award of the Spectroscopy Society of Pittsburgh.

DR. R. F. LEGGET, Director, Division of Building Research, was awarded the honorary degree of LL.D. by McMaster University, Hamilton, Ont.

DR. LÉO MARION, Senior Director, National Research Council, was elected President of the Chemical Institute of Canada. Dr. Marion was also awarded the honorary degree of D.SC. by Queen's University, Kingston, Ont., and by the University of Montreal.

DR. A. S. PERLIN, head, chemistry of natural products section, Prairie Regional Laboratory, was named 1961 Merck Lecturer for the 44th Canadian Chemical Conference and Exhibition of the Chemical Institute of Canada.

MR. P. A. REDHEAD, microwave section, Radio and Electrical Engineering Division, was elected a Fellow of the Institute of Radio Engineers.

DR. R. E. ROBERTSON, organic chemistry section, Division of Pure Chemistry, was elected a Fellow of the Chemical Institute of Canada.

DR. W. G. SCHNEIDER, head, general physical chemistry section, Division of Pure Chemistry, was elected a Fellow of the Royal Society of London. Dr. Schneider was also awarded the 1961 Palladium Medal of the Chemical Institute of Canada.

DR. E. W. R. STEACIE, President, National Research Council, was elected President of the International Council of Scientific Unions. Dr. Steacie was also awarded the honorary degree of D.SC. by Memorial University of Newfoundland.

Forty-Fifth Annual Report of the National Research Council of Canada 1961-62

In the past year, the National Research Council:

- provided \$8.7 million to support pure research in the universities (including 975 grants; 675 scholarships and fellowships); an additional \$3.3 million was provided through the Medical Research Council;
- answered 17,000 technical enquiries from Canadian industries;
- operated five laboratory Divisions in the sciences: Applied Biology, Applied Chemistry, Pure Chemistry, Applied Physics, and Pure Physics; operated four engineering Divisions: Building Research, Mechanical Engineering, the National Aeronautical Establishment, and Radio and Electrical Engineering; operated two regional laboratories, one at Halifax and the other in Saskatoon;
- employed 733 scientific research staff (including 163 postdoctorate fellows), 997 technical personnel, and 890 general service and administrative staff;
- sponsored 40 Associate Committees, operating in such diverse fields of science as Aeronautical Structures and Materials, Dental Research, Forest Fire Protection, Geodesy and Geophysics, Oceanography, Plant Diseases, Radiation Biology, and Space Research.

The Role of NRC in Industrial Research

In this Report it seems timely to consider the nature of the contributions made by research to industry, and to express some views on the proper roles to be played by government and industrial laboratories.

One of the most encouraging developments of the past year has been the decision of the Government to give financial assistance for research and development in Canadian industry. My last two Annual Reports have expressed the concern of the National Research Council that insufficient research is being done in Canada by industrial firms. Last year figures were presented showing that industry performs in Canada only about a quarter as much research as in the United States or in the United Kingdom. And further, that neither the Government nor industry is financing research to be carried out in industry at anything like the same level as in the U.K. or the U.S.

During the fiscal year 1962–63, a special committee of the National Research Council will make awards totalling $1 million to support long-term applied research carried out by industrial firms in Canada. The system complements, in civilian areas of science and engineering, the program initiated last year for defence-oriented projects under the Defence Research Board. Assistance will be given on a shared-cost basis, with special consideration to studies expected to continue for a number of years. In this way it is hoped to strengthen existing research groups, and to encourage the establishment of new facilities.

The decision of the Government to make funds available to the National Research Council and the Defence Research Board for direct assistance to research and development carried out by industry is a response to industry's increasing recognition of the importance of research. It is also an acknowledgement of the Government's own responsibility to encourage this trend. The extension of corporate tax concessions during the past two years is further evidence of the Government's interest in building up industrial research, and indicates its determination to support industry fully.

In this Report it seems timely to consider the nature of the contributions made by research to industry, and to express some views on the proper roles to be played by government and industrial laboratories.

Such discussions are based on the fact that industrial research—meaning, here, industrial research and development—can flourish only in a favourable environment. Strong, technically-based industry is unthinkable in a country that is not imbued with the scientific outlook, or that does not possess a firm background of academic research and an active network of supporting laboratories.

The potential capacity of a nation to develop its industrial research competence therefore depends to a very large extent on the existence of well-developed university and government laboratories, together with private and semi-private organizations providing consulting and research services.

In pointing out the importance of research to industry, we must recognize that the advantages which a research laboratory brings to a firm are both direct and indirect. The direct benefits arise from the development of new products, or the improvement of existing products or processes. The less obvious benefits arise from the presence in the firm of an active group of scientists, familiar with modern scientific views and able to assimilate the latest technical developments. Such a group will bring to the company the progressive outlook that is associated with technical thinking. It will also ensure the continual presence in the company of an attitude receptive to scientific or technological change.

To obtain these advantages, industry must do its own research in its own laboratories. Only then can management be brought into close contact with a progressive research attitude. And only then can such an attitude exert its proper impact on executive thinking.

It is particularly important here in Canada to stress the indirect benefits arising from research, since the direct benefits can to a great extent be obtained from abroad. Canadian industry has access to technical knowledge and research results from the U.K. and the U.S., and Canadian subsidiaries can draw on parent companies for process development and technical innovation. As a matter of fact, Canada owes its degree of industrialization and its standard of living mainly to British and U.S. technical competence. We could, of course, continue to be dependent on these sources, if we were willing to accept permanently a secondary position. It is highly desirable that nothing be done to discourage the flow of technical information into the country. But at the same time, Canadian firms must build up their own capacity for industrial research so that they can develop new products and adapt existing processes to Canadian conditions. We must ensure that, by building up its research competence, Canadian industry becomes less dependent on external technological assistance, better able to assimilate technical advances from all sources, and better able to compete advantageously in the markets of the world.

The current situation in Canadian industry is largely the result of historical developments. Canada began as a primary producing country, and when industrialization took place it was mainly through branch companies dependent on parent organizations in either Britain or the U.S. The first Canadian research efforts were directed to the development of the country's natural resources, and were limited to essential surveys, agriculture, and mining. Only later was consideration given to the needs of secondary industry. Although certain companies have always recognized the importance of research, there has not been, until recently, any general acceptance by industry of this responsibility. It was, in fact, partly to offset this deficiency that the decision was taken to establish the National Research Council.

In deciding to build the laboratories of the National Research Council the Government of the day was influenced by two very immediate needs: the provision in Canada of a laboratory for the maintenance of fundamental standards—the counterpart of the National Physical Laboratory in the U.K., the Bureau of Standards in the U.S., and the Reichsanstalt in Germany—and a system of general research laboratories where supporting research for industry could be carried out, and to which industry could turn for advice and assistance.

From this beginning the National Research Council has developed in two directions. Firstly, as the matter of prime importance, it has supported and encouraged research in the universities. Secondly, it has built up a strong research organization which provides the objective basic research, the applied research, and the supporting scientific services needed in any country to sustain wide-spread, technologically-based industry. In doing this the Council has worked under the disadvantage that until recently industrial firms had not, to any extent, established research laboratories. Lacking research staffs, these firms were not in a favourable position to ask for scientific advice, or to apply the results of scientific investigations. Also, Canada has lacked the research associations and the semi-private foundations—functioning between government laboratories and industry—that have played so important a part in the U.K. and U.S. research scenes.

In a situation of this kind, the great danger facing a government laboratory is that it will allow itself to become preoccupied with secondary technical activities that should be carried out by industry itself or by independent research laboratories: namely the testing, trouble shooting, and minor product development that are ancillary to the research process. These secondary activities, if allowed to predominate, can stifle the research accomplishments of a national laboratory. The National Research Council, therefore, has seen it as its responsibility to make available in Canada a comprehensive general laboratory structure, where industry could be supported with a wide variety of research programs and with the supporting documentary and advisory services that are so important in the modern world.

It should be recognized that the laboratories of the National Research Council form by far the largest and most diversified industrial research complex in Canada. These laboratories have been in the past, and will be increasingly in the future, ready to assist and support industry in its own research efforts.

Apart from its general responsibility for the scientific and technical climate of the country and for the maintenance of academic research, the service of the National Research Council to industry has taken the form of five broad functions.

In the first place, the Council considers that it has a responsibility to undertake wide programs of objective basic research. That is, basic research in fields of potential technological significance. It is important, for instance, in developing advanced aircraft, that there be a broad background of fundamental aerodynamic knowledge. Similarly, before it is possible to design and operate a high-tension electrical transmission line, the properties of materials and the operation of equipment under various conditions must be studied. These are the sort of long-term investigation that the Council regards as one of its primary duties.

Secondly, the Council undertakes applied research under contract, or, at the request of an individual firm, will undertake investigations and tests for which no commercial or private laboratories are available. During the past year over 1500 jobs of this sort were carried out in the Council's laboratories, and more than 5000 representatives of industry visited the laboratories in connection with these investigations or on other enquiries. NRC scientists, in turn, made 3400 visits to industry.

Thirdly, as part of its supporting services for the nation's science and technology, the Council operates technical information and documentary services. NRC's Technical Information Service, with the cooperation of the Provincial research councils, maintains direct contact with industry through a system of field officers, and provides free advice on technological and industrial engineering problems. The NRC Library functions as the National Science Library, and ensures that there is in Canada, for use by Canadian scientists and engineers, the accumulated scientific and technical knowledge of the world. Through the Technical Information Service and the Library, NRC in the past year answered over 24,000 technical enquiries—close to 100 every working day. The Library alone, in the same period, provided more than 8500 scientific reports to 500 industrial firms.

Fourthly, from its intimate knowledge of the scientific community and of technical development in Canada, the Council is a source of advice to industry on problems such as salary levels for scientists, recruitment of staff, research expenditures, external sources of information, and scientific activity in the universities. Over the past year representatives of industry approached the Council with more than 9500 enquiries in these areas.

Fifthly, through its subsidiary Canadian Patents and Development Limited, the National Research Council makes available to industry the inventions arising in its laboratories, in other Government agencies and Departments, and in many Canadian universities and Provincial research organizations.

The totality of these services represents a considerable contribution to Canadian industry. More important, it is a measure of the degree of assistance which the Council can provide in the period ahead, when there must be a major effort by industry itself to build up its own research facilities.

It was noted earlier in this Report that industrial research and development can flourish only in a favourable environment. The major accomplishments of the National Research Council over the past forty-five years have been the fostering in Canada of first-rate academic research, and the creation of supporting government laboratories. Above all, the Council has been a major force in creating in Canada the scientific climate and the technical outlook that have carried the country into the research age as an advanced nation.

Now that Canadian industry has realized the need to accept industrial research as its own responsibility, the country is in the happy position that the necessary foundation has been well laid. Unlike many of the nations of the world, Canada does not suffer from educational deficiencies or from a lack of ancillary and supporting services.

The problem of industrial research in Canada is financial and economic. Once Canadian industry decides to make the necessary investments, the building up of its research facilities can proceed rapidly.

NRC Support for University Research

Our universities are the foundation of all scientific research in our country. They are the chief agents of research in basic science, and the only source of scientific manpower for our educational institutions, for research organizations, and for industry. Since 1916 one of the main functions of the National Research Council has been to foster science in Canadian universities through scholarships and grants-in-aid of research.

The past 45 years have seen a truly impressive development. At the end of the first world war there was little in the way of graduate schools or research. By 1939 large graduate schools existed in two universities, and considerable research efforts had developed in a number of others. Work on defence problems during World War II spread research into almost all the universities, and in the ten years following the war, scientific research became a major university activity. The most striking growth, both in quantity and quality, has taken place in the last five years.

Over the years, NRC expenditures for university support have roughly matched the growth of science in the universities. This support was \$14,000 in 1917; \$369,000 in 1939; \$3.6 million in 1957; followed by a four-fold increase to \$14.4 million in 1962.

Amazing though the rate of increase may seem, it has not permitted the Council to keep pace with the costs of modern research. Although the support budget has multiplied by a factor of four in the last five years, it has in each succeeding year proved more and more difficult to meet deserving requests. Rather than holding its own, the Council's support budget is actually falling behind the needs of the universities.

If allowed to continue, this situation will certainly be aggravated by the tremendous expansion now taking place in the universities. It is expected that in the ten years between 1960 and 1970 the university-age population (18–24 years) will rise by 44%. Higher and higher proportions of our young people are going, and will go, to university, so that full-time enrolment in the same period will nearly triple. Also, a steadily higher proportion of the student body is continuing on to advanced degrees. In 1960 there were about 9,000 full-time teachers and research workers in our universities and colleges; it is estimated that by 1970 there will be 25,000.

The growth of university science that has taken place in the last five years is the most striking thing in the history of Canadian science. The next five years can see another marked increase, because of expanded facilities and increased staff, because of increased graduate enrolment, and because our graduate schools are receiving larger and larger numbers of students from programs such as the Colombo Plan and the Commonwealth Scholarship Plan. The deciding factor, however, will be the question of financial resources.

Because of increased support from federal, provincial, and private sources, the financial position of the universities has improved greatly in the last few years. But if we are to avoid stifling the development of science in the universities at this stage, there is no doubt that far more support is needed from all sources. In particular, a major increase in National Research Council support for university research is urgently required.

Division of Applied Biology

This Division investigates applied problems related to the Canadian economy, and carries out fundamental studies in microbiology, biochemistry, and biophysics. A few brief examples of the work are given below.

Surveys have shown that most frozen food trucks allow the produce carried to rise to temperatures much higher than can be considered satisfactory. Tests were therefore undertaken to develop an improved cooling method. These tests, made with the cooperation of a truck manufacturer and the Department of Fisheries, showed that an adaptation of the jacket air circulation system originally developed for cold storage warehouses would solve the technical problem. The system can be installed in new trucks as they are built with little increase in cost or loss of load space. Existing trucks can be economically modified.

Further tests were made on the immersion freezing process for poultry, originally studied in the Division's laboratories and now used throughout the industry. The object of this work was to determine the immersion times and temperatures necessary under the conditions that have been adopted in practice. Related to this was a study of quality loss in poultry meat during freezing and refrigerated storage. The mechanisms causing off-flavours and texture changes in chicken meats stored at temperatures above freezing are being investigated.

Industrial companies successfully control the development of "body" and avoid coagulation in evaporated milk during sterilization, but very little is known about the chemical and physical reactions involved. Recent work in the Division has shown that the tendency for the milk to coagulate during heating is very sensitive to small changes in acidity, and that this sensitivity occurs only in the presence of a specific whey protein. The extent to which the stability of the milk varies with changing acidity is partially controlled by the concentration of the whey protein in the milk. It has also been found that milks, especially those collected from individual cows, differ in the acidity at which maximum stability occurs.

The competitive market value of Canadian wheat is determined in large part by its protein content. For some years now the Division has been engaged in long-term statistical studies of protein variability in wheat and wheat exports and the work has recently been expanded to include the effects of various weather conditions. Statistical relations between weather conditions and wheat protein content for numerous Prairie crop districts were characterized by a depressing effect on protein content of above-average rainfall during the growing season, maximal in mid-June; an elevating effect of above-average air temperature, maximal in mid-July, and a slightly depressing effect of preceding autumn rain. There have been, however, some statistically significant differences in the apparent relation of these factors in different years of a 25-year period, and these may be related to rainfall intensity.

In collaboration with the pulp and paper industry, a new structure was established for a material used for synthetic textile fibres. Investigations continued on the internal structure of ribosomes—particles responsible for manufacturing protein in cells. New interrelations between the effects of plant hormones and tissue pretreatment on cell growth were found. A new class of proteins containing a rare amino acid was studied in plant cell walls.

Atlantic Regional Laboratory/Halifax, N.S.

The general policy of the Atlantic Regional Laboratory is to carry on long-range studies of a fundamental nature which will be of value in developing the Canadian economy. Projects now underway include studies on the chemistry and physiology of plants and micro-organisms (with particular reference to marine organisms); animal nutrition; and chemical reactions at high temperatures. In this report, the work on high temperature chemistry will be reviewed as an example of how a long-term research program may help an important industry.

The program in high temperature chemistry was undertaken to study chemical reactions occurring in the manufacture of steel. Initially studies were made of the factors governing the distribution of phosphorus and manganese between slag and metal in the open-hearth furnace. On the basis of this work, a theory was developed which accounts for the distribution of oxygen and manganese between molten iron and simple slags under laboratory conditions. This theory has provided important information about the structure of molten silicates, and attempts are being made to extend it to more complex slags.

In the course of this work, improved methods have been devised for determining nitrogen in steel, and for preparing magnesia ware used to contain molten slags in laboratory studies. Most commercial magnesia ware is too porous to hold molten basic slags, but the Laboratory has perfected a simple slip-casting technique which permits fabrication of crucibles and other shapes. Relatively long thermocouple sheaths, made by the new method and used for continuously measuring temperatures in open hearth furnaces, are being tested under industrial conditions. Present measuring apparatus has given only intermittent values, due to disintegration of the sheaths when in contact with molten slags.

The electrochemistry of molten slags, about which very little is known, is also being investigated. Studies on the oxygen potentials have shown that extraneous potentials develop at metal-ceramic interfaces at high temperatures. Although these studies are mainly theoretical in nature, it is possible that some practical applications will develop, such as improved methods for measuring and controlling temperature and oxygen concentration during steel-making.

The Laboratory also carried out short-term studies undertaken for a specific purpose. The problem of automatically detecting methane in mine gases, by means of a portable detector, was recently investigated at the request of the Department of Mines of Nova Scotia. An inexpensive and compact new device was developed which can be operated by a miner's battery. The device samples the air continuously and automatically warns the user of dangerous concentrations of combustible gases.

Prairie Regional Laboratory/Saskatoon, Sask.

A major function of the Prairie Regional Laboratory is to study the chemistry and technology of crops presently grown in the prairie region and of those which might be adapted to production in Western Canada. Recent work on rapeseed offers a typical example. During World War II, limited amounts of rapeseed were grown to provide a source of marine engine oil. With the cessation of hostilities, this market disappeared. Over the past decade, large surpluses of wheat have made it imperative that alternative crops be developed. Coupled with these factors, Canadian dependence on imported vegetable oils underscored the need for an edible oil crop. The Laboratory therefore began determining the chemical constitution of the varieties of rapeseed which were adapted to the prairies, and university and federal government departments were encouraged to begin extensive breeding programs to improve crops. New methods for analyzing the oil and meal produced from rapeseed were developed with such success that oil from part of an individual seed can now be analyzed, and the remainder of the seed germinated and grown if desirable.

As with any new agricultural crop, some initial difficulties were experienced in processing the seed, but these are being overcome. Prejudice against using rape oil in edible products has largely disappeared, as a result of nutritional studies carried out in cooperation with the Food and Drug Directorate in Ottawa and various university departments on the prairies. Rapeseed meal has been accepted as a protein supplement in animal feeds. Studies are continuing an an undesirable factor of the seed which may make it difficult to process the oil for edible uses, or decrease the feed supplement value of the meal. The Laboratory's immediate objective is to discover a means of removing this factor during processing so that it does not appear in either the oil or the meal. The long range objective is to assist the plant breeders in developing nutritionally improved varieties free from any undesirable features.

Another project concerns the use of wheat as a source of starch and associated products. The raw material currently used by major Canadian producers is corn, most of which is imported. Establishment of an integrated Canadian industry using wheat to produce starches, gluten, syrup, dextrose, etc., seems to be quite feasible. It depends, however, on the development of a process utilizing low grade wheat flour, and making complete recovery of the starch and gluten (the protein fraction of wheat) in an undenatured form. A process has been developed in the Laboratory which allows a chemical dispersion of gluten directly from flour, without prior mechanical separation of the starch and gluten. This operation also allows recovery of the soluble flour components, which can amount to more than 10 per cent of the initial raw material. A vital gluten, which when mixed with water retains the physical properties of pure gum gluten, can easily be obtained from the dispersed protein and solubles.

The utilization research described above is a small part of the total chemical, biological and engineering development and research carried on in the Laboratory. Many interesting fermentation processes have been studied in detail, and it is hoped that some of these will lay the foundation for other new Canadian industries.

Division of Applied Chemistry

It has been the custom for this Division to pursue areas of natural science that lend themselves to continuing investigation and are of significance in the development of the chemical industry. This policy has resulted in the accumulation of specialized and basic knowledge on particular systems or techniques that would not have been possible had the work been limited in scope or too diversified. Illustrative examples of divisional activities are to be found in the chemical engineering group where work is conducted on a bench scale.

A number of years ago a study was initiated into the characteristics of fluid bed reactors, then becoming very popular for use in a number of industrial processes. In spite of their many advantages, these reactors possessed a number of limitations. For example, the solid particle size range for the successful conventional operation was quite closely defined; so also was the gas flow rate, while the depth of the solids bed was subject to similar restrictions. As a result of continuing investigation, the Division has found ways of widening these limits of operation. It was found that large and regular sized particles outside the conventional fluidizing range can be contacted effectively in the "spouted" bed. Scaling-up studies on reactors have resulted in a design for a multispout bed which operates from a single manifold, thus overcoming an earlier limitation to its use on any large scale application. More recently it has been discovered that by using a fixed perforated packing in conjunction with a fluidized bed, substantially improved operation may be realized, particularly in narrow tube reactors where, for example, bed depth may be increased many-fold. This construction permits a much greater range of contact times for reactants and flow rates of the fluidizing gas; smoother operation; and improved distribution of heat load. Limited industrial use has already been made of the spouted bed. It seems highly probable that because of the improvements effected by the Division, use of both spouted beds and fluidized reactors will be considerably expanded.

The separation of liquids from suspended or dissolved solids is a frequent industrial problem. For example, a great deal of effort has been devoted in various parts of the world to the removal of dissolved salts from water. In the past few years the Division has done considerable work on novel methods of separating suspended solids from their liquid carriers. This work has recently been extended to include dissolved solids. It has been found that virtually all dissolved salts can be removed from water by filtration through an appropriate medium, and extension of the principle to cover non-ionic materials is in progress. Preliminary estimates suggest the new approach to be both feasible and competitive with conventional methods.

Division of Pure Chemistry

The Division of Pure Chemistry is concerned with fundamental research in the fields of physical and organic chemistry. There are thirteen sections in the Division, twelve of which are concerned with problems of long-range nature, while the remaining one has for its function the preparation of substances that are needed by the other sections. The staff of research men is relatively small, but it is increased by a number of postdoctorate fellows who stay for a maximum of two years.

Although the research projects investigated have all produced some results, some of these are more immediately applicable than others. As illustrations of the work done, two examples have been selected which are typical of the more immediately practical kind of fundamental research:

(*a*) The electronic properties of a variety of organic crystals are being studied in order to obtain a basic understanding of their semiconduction behaviour. Several types of crystals have been found which exhibit semiconduction and photoconduction to a high degree. Of particular interest are single crystal specimens of so-called charge-transfer complexes. These are formed by combining an organic molecule, which readily donates electrons, with one which tends to accept electrons. In the resulting crystal there is a high degree of electron delocalization. The mode of electron transport in these and other crystals is being investigated, as well as their optical and magnetic properties. Because of the existence of "trapping centers" in many organic crystals, the nature of which is not yet understood, it is possible to store charge within the crystal in a controlled manner. This charge can be stored for indefinitely long periods at low temperatures (not unlike a memory effect), and can be released at will by warming the crystal. There now appears little doubt that a basic knowledge of the electronic properties of organic crystals generally will ultimately lead to the development of a variety of specialized electronic devices.

(*b*) In order to understand the behaviour and nature of molecules it is often necessary to investigate the properties of the atoms and bonds which they contain. Nuclear magnetic resonance techniques are employed therefore to study atomic properties of molecules in the gas phase and properties of the perturber molecules in the condensed phase. Bond properties are studied by means of spectroscopic techniques such as infrared absorption and Raman scattering to obtain bond moment and polarizability derivatives in the gas phase. The effect of the environment in the liquid phase is to change these properties so that the influence of intermolecular forces can be obtained from studies in the liquid phase. A theory of the effect of the environment has been developed which accounts for most of the solvent effects on chemical shifts, infrared and Raman intensities.

With the aid of the above instrumental techniques, the structure has been determined for several organic molecules of biochemical interest and of interest to the petroleum and perfume industries.

Division of Applied Physics

The various fields of physics investigated by this Division were chosen because they were considered likely to yield results useful to the Canadian economy in general, and to manufacturing industry particularly. At the same time these fields of research include all the physical standards fundamental to science and industry.

From the work of the Division have come a number of useful applications. One of the most spectacular has been the Helava plotter—a revolutionary device for making maps from aerial photographs. The instrument has already made a startling impact on the mapping world but its full possibilities are by no means known yet. The plotter is licensed under patent, and twenty-five instruments, in a very elaborate version for defense purposes, have been ordered by the U.S. government at a unit price of approximately a quarter of a million dollars. The first instrument was recently delivered and is living up to every expectation. A much simpler version for civilian use will be produced within a year at prices competitive with traditional plotters of infinitely less versatility. The Dauphinee six-figure potentiometer is now being sold by a Canadian firm in the United States at an approximate annual rate of $250,000. A five-figure version has been designed and will shortly go on the market. A direct reading resistance thermometer has reached initial commercial production in Canada. Tentative arrangements have been made for three Canadian firms to manufacture a novel temperature-depth recorder for use in oceanography. In time it should replace existing instrumentation for this purpose.

In order to maintain its ability to provide precision measurements to industry and other laboratories, the Division participates very actively in international standards work through the directing body in this field, Le Bureau International des Poids et Mesures. The respect that the Division has gained for its standards work is demonstrated by the number of its members that have been asked to assume leading roles in the Bureau's activities. This work is bearing more and more practical fruit in making it possible to meet the growing demands of industry for precision measurements and for guidance in establishing facilities in this field. One example of the keen industrial interest in this work was the attendance of 55 members of industry at a two-day symposium on electrical measurements held by the Division in November, 1961. A similar meeting on temperature measurement is planned for the near future because of the rapidly increasing industrial interest in this field.

Extensive experience in the measurement of cobalt-60 has led North American suppliers, both U.S. and Canadian, to ask the Division to devise an appropriate way acceptable to both supplier and user, of measuring the output of cobalt-60 therapy bombs. During the year the Division carried out 285 various kinds of calibration for 104 companies.

Division of Pure Physics

The Division of Pure Physics conducts basic research in five specialized branches of physics: cosmic rays and high energy particle physics; low temperature and solid state physics; spectroscopy, theoretical physics; and X-ray diffraction. The objectives of these programs are the advancement of fundamental knowledge.

The cosmic ray group studies cosmic rays coming from space and the physical nature and reaction of highly energetic particles generally. Continuous recording of the cosmic ray flux is carried out at four stations: Ottawa, Churchill, Resolute Bay, and Sulphur Mountain, the latter in cooperation with the University of Alberta at Calgary. Information is obtained about bursts of cosmic rays from the sun, and the modulating effect of the interplanetary plasma on the cosmic ray flux. Cosmic rays outside the earth's atmosphere are studied by means of rockets launched at Churchill, which is ideally situated in the latitude of maximum auroral activity. Highly energetic particles and their interaction with other nuclei are investigated using cosmic ray particles themselves, or through experiments carried out in laboratories where large particle accelerators are available.

The low temperature and solid state group is concerned with the electrical, thermal and mechanical properties of metals and semiconductors, especially at low temperatures. The study of the electrical properties of metals at very low temperatures, in particular below 1° K, has continued. Certain properties of alloys containing the transition metals, and of alloys of the heavier alkali metals, have been elucidated. Details of the crystal structure of various semiconductors have been determined by electron microscope studies.

The spectroscopy group studies the spectra of atoms and molecules in the microwave, visible and ultraviolet regions to obtain information about the structure of atoms, molecules and atomic nuclei. During the past year the magnetic moments of the nuclei of lutetium and thulium have been determined, and a number of diatomic and simple polyatomic molecules have been investigated. The spectra of several new free radicals have been obtained, thus establishing their existence in various chemical reactions, and their structures have been determined. The spectra of certain hydrogen-bonded molecules have also been obtained, and the structure of these molecules has been determined for the first time with high precision. A good deal of effort has been spent on developing optical masers for possible use as spectroscopic sources.

In the theoretical physics group, one of the main efforts during the past year has been the formulation of a basic equation describing the irreversible processes in ionized gases. On the basis of this theory, the transport and other properties of plasmas are being studied. Problems in nuclear structure and nuclear reactions have also been investigated.

The X-ray diffraction laboratory is engaged primarily in fundamental studies of molecular and crystal structures. Identification problems are occasionally undertaken for Government laboratories, as X-ray diffraction methods are non-destructive and only require very small amounts of material. Two of the major research projects concern narcotics and vanadium minerals. Other structures important in certain theoretical aspects of physical chemistry and physics are also being examined.

Division of Building Research

Construction constitutes Canada's major and yet most complex industry. The task of providing a research service to this industry, which is the function of the Division of Building Research, is therefore challenging. Construction is carried out in all parts of the country not only from east to west but now also from south to north. Building research must therefore be equally countrywide in its more practical aspects and in its application. The Division's laboratory work is centred in Ottawa, with some work carried out also in regional stations at Saskatoon and Halifax; field research work is carried out in all ten provinces, in the Yukon and in the three divisions of the Northwest Territories.

This field research work involves close cooperation with many parts of industry. An extensive survey of the performance of paper mill buildings in eastern Canada has been carried out in cooperation with the pulp and paper industry. The woodlands divisions of major pulp and paper companies have been helpful in connection with studies of the bearing capacity of ice sheets on rivers and lakes. Civil engineering contractors have facilitated the prosecution of research into the pressures exerted by Leda clay excavated for the new Ottawa sewage plant tunnel. Building contractors have assisted the Division in making studies of wind pressures on large building frames. Housing contractors across the country worked with the Division to produce a film on winter house building as a part of the national effort to reduce seasonal unemployment in the building trades.

This close association with industry is of vital importance to all phases of the Division's work, particularly in recognizing problems and selecting those upon which research should be done. Once the required information has been developed it must be disseminated and put to use. Here again, contacts with industry are maintained through the publications and mailing lists of the Division, through talks and contacts at meetings, through the inquiry and library services provided, as well as by papers presented and published through scientific and technical societies.

Cooperation between industry and the Division is also demonstrated by the expert voluntary assistance given by industry on many of the technical committees associated with the Division. Notable among these is the Associate Committee on the National Building Code, its Advisory Groups, and the many revision committees responsible for preparing the 1960 edition of the Code. Members from industry served on all these committees. Without their assistance, and the informed comments upon drafts submitted from all parts of the construction industry throughout the country, the 1960 edition of the Code would not have been as good a document as its wide acceptance indicates it to be.

New Housing Standards, to be used by Central Mortgage and Housing Corporation in connection with the National Housing Act, were published by the same Associate Committee at the end of 1961 as a Supplement to the Code. These came into legal use by the Corporation on April 2, 1962, as the only set of nationally recognized building standards in Canada. Keeping the Housing Standards up-to-date, to the direction of the Associate Committee on the National Building Code, and in the light its own and other research, will be another continuing task in which the Division will be aided by the great industry it serves.

Division of Mechanical Engineering

During the past year the nine laboratories of the Division have engaged in a large variety and record volume of industrial research projects. The year has also seen important progress in research work undertaken for its general value and as support for incoming projects.

On the industrial work, emphasis is placed on improving the operation of existing equipment and on devising new machinery appropriate to Canadian conditions. Extensive work has been done to improve the starting of gasoline and oil engines in cold weather, and to widen the range of fuels usable in diesel engines, especially those designed for railway service. Substantial effort is also being devoted to certain problems of gas turbine machinery for railway use and for transport aircraft capable of vertical take-off and landing.

In collaboration with the Defence Research Medical Laboratories, the Division is investigating the motor performance of human beings, especially as related to high performance servomechanisms such as the controls for new types of aircraft. This study is particularly related to the development of VTOL aircraft, where it is essential to fully exploit the capabilities of the pilot.

Broadly related to this there is a body of engineering work concerned with the design and development of apparatus for the rapid suturing of large and small blood vessels. The instruments designed have reached a point in experimental surgery where clinical use seems to be at hand. The experience gained in this work is being directed to an important type of operation requiring great speed of execution.

From the previous work of the Hydraulics Laboratory, there has emerged a new kind of "non-reflecting" breakwater, the first practical example of which is now being built at Baie Comeau. This type of installation entails problems of structural durability, but promises important advantages in appropriate locations.

In collaboration with the Fisheries Research Board, the Ship Laboratory has evolved new designs for draggers, trawlers and scallop draggers. One of these has been built: a general purpose trawler whose hull form incorporates a bulbous bow designed to economize in propulsion power and ride more comfortably in rough water. Such strong interest has developed in the rough water characteristics of many classes of ship that the laboratory wave-making apparatus is being enlarged to test the resistance models in head seas, and will shortly be capable of doing so for all directions of encounter. In conjunction with this development, design data and advice are being given on the propulsion aspects of hull forms and propellers and on the turning and stopping characteristics of alternative designs.

A research problem of long-term significance involves the behaviour of gases at temperatures much above those attainable by chemical reaction. The heat in these experiments is generated by electric discharges and by shock waves, and attempts are being made to control the subsequent gas flows by magnetic fields. Since the difficulties of observation and interpretation are severe, much of the effort is devoted to improving instrumental techniques, especially those of spectroscopy and high speed photography. A high-speed camera design resulting from this work has been licensed for production by a Canadian firm.

National Aeronautical Establishment

The increased national concern with industrial progress has been reflected in this Division by greatly expanded industrial support programs. As a result, the work of the Division is now divided approximately equally into four categories: defence projects, industrial support, applied research and basic research. The first two categories exist wholly in response to requests from the military services or from Canadian industry; the latter originate within the Division and represent its best assessment of national or scientific need.

Defence projects arose from a variety of requirements. A typical example is a continuing study of magnetic anomaly detection arising from anti-submarine warfare requirements. This work has been carried to the point of including a study of time-varying geomagnetism, and a detailed survey of the fine structure of the magnetic field over the continental shelf. In the course of the study, airborne detection equipment of greatly improved sensitivity has been developed.

In connection with military procurement policies and at the invitation of the Department of Defence Production, the Division was able to demonstrate the technical acceptability of a number of items of Canadian-built Air Force materiel. The object of this work was to procure for Canadian manufacturers the right to tender on hardware previously designed, built and qualified in other countries to specifications not standard in Canada. This problem, of foreign specifications and standards which stand in the way of Canadian suppliers, is a subject of continuing interest to the Division.

The most concentrated industrial support program was carried out by the low speed wind tunnels of the Aerodynamics Section. In the past two years a substantial investment has been made in these tunnels, and they have been developed to the stage where the rate of data gathering has quadrupled and the rate of use for industrial testing has risen to about 2000 hours per year. Scheduled use of the tunnels for industrial projects now extends well into 1963.

A more diversified program was pursued in the Structures Laboratory, where the volume of industrial work was very great. While it is not possible to describe in detail the full scope of the work, this included design; theoretical analysis; assistance with production problems; and product testing and field trials on such commodities as railway ore cars, naval ordnance, prototype light aircraft, road/rail trailers, power transmission towers, and a variety of aircraft components.

In the field of applied research, extensive flight operations proceeded for the third successive year on a long-term study of the physics and statistics of atmospheric precipitation. One of the purposes of this work is to obtain statistical information on the occurrence and distribution of atmospheric turbulence. A parallel study was made in a water tunnel of the character of the induced flow due to the topography of a highly irregular landscape.

More basic projects included studies of boundary layer stability, hypersonic aerodynamics, and cumulative fatigue damage.

Radio and Electrical Engineering Division

The program of this Division includes fundamental research in electrical science and engineering problems of interest to the Canadian electrical industry and the Armed Services. Sample projects are described below.

The Division maintains the best-equipped antenna laboratory in Canada, and is often called upon by industry for assistance in developing new antennas for which industrial laboratory facilities are not suitable. Antennas are also designed for the Armed Services, and manufactured by Canadian industry. In addition, the staff is frequently asked for advice on the development of antenna facilities in industry, on the manufacture and testing of antennas and radomes, and on antenna siting.

A radio remote-control system has been developed which permits a transmitter to control unattended apparatus at some distant, isolated site or sites. The transmitter which actuates the system may be hand-keyed or operated by a telephone dial. Communication transmitters normally fitted on ships or aircraft may be used in conjunction with this system to actuate unattended equipment, such as harbour or airport radio beacons, lighthouses, fog horns, or check-point beacons in the Arctic.

A transistorized transmitter, antennas, and coupling circuits have been developed for the 215–260 mc/s telemetry band. This has been part of a program for the development and manufacture of a scientific sounding-rocket. The project is mutually supported by an industrial firm in Western Canada, the Defence Research Board (CARDE), and the Department of Defence Production.

An electronic monitoring system has been built and installed at the Toronto General Hospital, for use in their cardiovascular operating rooms and intensive therapy ward—the first of its kind in a Canadian hospital. The monitor provides the anesthetist and surgeon with an oscillographic display of significant parameters, such as blood pressure and electrocardiogram, which indicate the condition of a patient undergoing surgery. The intensive therapy ward system enables the condition of a number of patients in the ward to be monitored at a central position. Industrial interest has been aroused in an electronic control system developed for the Ottawa General Hospital. The system synchronizes X-ray exposure with electrocardiogram, permitting X-ray photographs when the heart is quiescent, and so obtaining well-defined photographs for diagnosis.

A current ratio device, the "current comparator", has been developed for calibration purposes. It combines extreme accuracy with freedom from the effect of surrounding conditions, making it very attractive for precision measurements in industry.

Detection of objects having a surface temperature different from that of their surroundings is becoming increasingly important in industry, medicine, and military science. A portable transistorized infrared detector has been designed for this purpose. It is self-contained, tripod-mounted, and operates on flashlight batteries. Infrared scanning cameras are also being developed, particularly to further Canadian research in cancer detection and treatment.

A mobile mortar-locating radar, designed by the Division for the Army, is now being manufactured in Canada. Cooperation is being continued with the manufacturer.

Division of Administration and Awards

The purpose of the Division of Administration and Awards is to provide an administrative service for Canadian science, and to maintain in the National Research Council laboratories an atmosphere as conducive as possible to research creativity. The Division administers the grants and scholarships program supporting science in Canadian universities; it provides a scientific information service; and it provides centralized administrative serves for the Council's laboratories. In assisting the laboratories, the Division strives to interpret and apply the rules and regulations of the government service in a way that will not interfere with the maintenance of a research environment.

The grants and scholarships program has kept pace with the rapid expansion of the universities. Expenditures have been increased by an average of 35.8% per annum over the past three years, and in the fiscal year 1961–62 reached a total of $8.7 million. Publication of scientific papers in the research journals issued by the Council has increased as well, reflecting the spectacular growth of research work in Canada. Through its Information Services Branch, which is responsible for the National Science Library, the Division now provides 500,000 books, periodicals and reports for the use of Canadian scientists. This Branch also looks after Canada's interests in international scientific organizations, handles public relations for the scientific community and assists industry through its Technical Information Service.

The Technical Information Service has been answering technical inquiries from secondary manufacturing industries, particularly the smaller firms, for over sixteen years. TIS field engineers, in cooperation with provincial research organizations, personally visit factories across Canada and give technical assistance on the spot or refer problems to the TIS Ottawa staff. All personnel are graduate engineers or scientists with many years of industrial experience, and the staff is being expanded steadily to meet increasing demands from industry. Information is provided, free of charge, on the properties and processing of materials, layout and operation of plant machinery, and new ideas and techniques. The Service is now moving also into the broad field of industrial engineering as part of the national campaign to improve Canadian productivity. The information provided comes from the world's technical literature (available through the National Research Council Library), numerous Canadian laboratories and scientists, industrial firms and associations, and foreign technical and government sources. The Service also administers NRC's Industrial Research Assistance program.

Financial Statement for the year 1961-62

NATIONAL RESEARCH COUNCIL, INCLUDING THE MEDICAL RESEARCH COUNCIL

RECEIPTS

Parliamentary Appropriations			
Vote 270 (Operations of Laboratories)		$32,893,374.39	
Vote 125 (General Salaries—Dept. of Finance)		524,845.54	
Vote 271 and 647 (Capital)		5,431,059.41	
			$38,849,279.34
Special Funds			
On hand 1 April 1961			
Cash unallotted	$1,814,491.08		
Central Warehouse Account and Other Accounts	320,000.00		
		2,134,491.08	
Laboratory Services	541,812.69		
Sales of Publications	156,714.14		
Rental of Housing	3,147.76		
	701,674.59		
Less: Adjustment re Central Warehouse Inventory, Premium Discount and Exchange, Accounts Receivable and Refunds to Appropriation, etc.	6,219.01		
		695,455.58	
Contributions from Government Departments		3,170,546.75	
			6,000,493.41
Total Receipts			$44,849,772.75

EXPENDITURES

Salaries	$18,197,378.15	
*Less Salaries of Service Staff	577,275.61	
		$17,620,102.54
Allowances		50,309.34
Professional and Special Services		578,844.01
Travelling and Removal Expenses		414,968.98
Freight, Express and Cartage		80,821.91

Postage		37,218.16
Telephones and Telegrams		48,490.44
Printing of Annual Report, Scientific Journals and Other Material		468,871.32
Office Stationery, Supplies and Equipment		266,066.08
Library Books and Periodicals		165,536.53
Materials and Supplies		1,943,593.69
Expendable Research Equipment		2,224,501.54
Repairs and Upkeep of Buildings and Works		254,780.04
Repairs and Upkeep of Equipment		415,212.97
Municipal or Public Utility Services		474,387.80
Scholarships and Grants in Aid of Research—Science and Engineering		8,678,485.15
Scholarships and Grants in Aid of Research—Medical		3,300,000.00
Grant to the Royal Society of Canada		17,000.00
Sundries and Contingencies		202,586.42
Communications Building and Equipment		478,527.05
National Aeronautical Establishment High Speed Wind Tunnel and Equipment		574,953.03
Improvements to Aerodynamics Laboratory and Equipment		166,159.81
Algonquin Radio Laboratory and Equipment		494,919.11
Administration Building and Equipment		27,735.75
Applied Physics Building and Equipment		2,400,795.32
Alterations and Extensions		1,012,438.05
Acquisition of Equipment		275,531.29
Total Expenditures		$42,672,836.33
Balances on Hand March 31 1962		
Special Fund:		
Cash Unallotted	$1,843,280.61	
Central Warehouse Account and Other Accounts	333,655.81	
		2,176,936.42
Reconciliation to Receipts		$44,849,772.75

**This is the amount of salaries of staff of Plant Engineering and Workshop Services paid from charges made for services rendered which are included in other items of expenditure.*

In addition to the expenditures above the Council spent $901,907.56 on scholarships and grants administered on behalf of other organizations who provided the funds.

The Medical Research Council

Canadian Patents and Development Limited

Medical Research Council 1961-62

R. F. FARQUHARSON, M.B.E., M.B., F.R.C.P.(C), F.R.C.P., M.D.(HON.), D.SC.(HON.), F.A.C.P., F.R.S.C. Vice-President (Medical), National Research Council of Canada; Chairman, Medical Research Council.

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R. C. HARRISON, M.D., M.S., F.R.C.S.(C). Professor of Surgery and Director of Surgical Research, Department of Surgery, University of Alberta, Edmonton, Alberta.

F. C. MACINTOSH, M.A., PH.D., F.R.S. Professor and Chairman of the Department of Physiology, McGill University, Montreal, Quebec.

R. W. REED, M.A., M.D., C.M. Professor and Chairman of the Department of Bacteriology, McGill University, Montreal, Quebec.

Continued overleaf

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C. B. Stewart, B.SC., M.D., C.M., M.P.H., D.P.H., F.A.P.H.A. Dean of Medicine, and Head of the Department of Preventive Medicine, Dalhousie University, Halifax, Nova Scotia.

H. E. Taylor, M.D., C.M., F.R.C.P. Professor and Head of the Department of Pathology, University of British Columbia, Vancouver, British Columbia.

Medical Research Council 1961-62

Report of the Chairman

During the past year the Medical Research Council continued to support long-term studies carried out in the universities and their associated institutions and hospitals. The Council does not urge that funds be provided now for central laboratories and research hospitals of its own. It is felt that the universities and their teaching hospitals provide greater opportunities for medical research in its broadest aspects, and for its most effective application. The universities do not, however, have enough medical scientists with time for the intensive investigations which lead to better teaching and the advancement of knowledge. It is therefore important to build up in the universities a much larger pool of full-time medical scientists comparable to the research staff of the National Research Council. Increased expenditures for this purpose are already giving great returns. Growing numbers of competent young graduates in medicine and related sciences are now training for careers in medical research, but many more are needed.

The general area of medical research is continually becoming broader; this, in turn, means that its interrelationships with other sciences become closer. This process is well demonstrated by the development of cytobiology—the study of the individual cell in all its medical aspects—to which physical, biological, and medical scientists are all contributing. For research in this field the Council has provided, among other equipment, numerous electron miscroscopes, each costing $30,000–$40,000, for studying cell structure and function. These instruments are being used across the country in both pre-clinical and clinical departments. In the field of pathology their use has opened an important new approach to the problem of the structural changes that occur in many disorders. This work is being prosecuted vigorously and successfully in many Canadian centres.

Similarly, new knowledge and new tools are being used to examine clinical problems, and special facilities for clinical investigation are being developed in many of our teaching hospitals. These new clinical facilities are concerned with biochemical, physiological, and other methods of studying disease and treatment. Their development is costly, but the returns are great.

The instances cited above are examples of the continually changing opportunities for intensive research programs. Such opportunities arise when new tools provide an effective technological approach to old problems, and when new fundamental knowledge illumines old areas, creating new horizons and new obligations for research. New approaches extend into different fields, cutting across traditional areas of investigation and bringing research workers with apparently different goals into close collaboration. Studies of radiation injury, for instance, have brought different types of scientists into the broad area of radiobiology, a matter of national welfare demanding great development. Numerous other examples could be mentioned. It is the policy of the Medical Research Council to support these constantly changing areas and methods as they arise.

While the Council is interested in all fields of medical research there are certain subjects that receive support from other granting bodies, notably the Defence Research Board and the Department of National Health and Welfare. In allocating its budget the Council takes into consideration the amounts which applicants receive from other agencies.

During 1961–62, ninety-six programs directed by senior scientists were being supported on a term basis, meaning assurance of funds in specified amounts for a three-year period. Two hundred and twenty-four grants were made on an annual basis, renewable on application. Total value of these awards for the year was $2,289,555.

A further 50 grants totalling $385,279 were made for the purchase of special major equipment needed in the research programs.

In addition to its grants-in-aid of research, the Council continued to provide for the training in medical research of superior graduates through its Medical Research Fellowship program. Sixty Fellowships with a total value of $236,642 were held. Forty-nine of these awards were tenable in Canada, including four foreign investigators supported in Canadian laboratories, and eleven were provided to enable young Canadian doctors to take further research training abroad.

Twenty-four trained scientists competent to pursue independent research were supported as full-time Medical Research Associates in Canadian universities. Cost of this phase of the program was $238,172.

Canadian Patents and Development Limited

Annual Report for the year 1961-62

Officers:

President: F. T. Rosser
Vice-President: Marc Boyer
Secretary-Treasurer: F. R. Charles
Manager: J. R. Johnson

Directors:

Dr. E. R. Birchard
Dr. Marc Boyer
Dean R. E. Jamieson
Dr. C. J. Mackenzie
Mr. F. L. W. McKim
Dr. F. T. Rosser
Dr. E. W. R. Steacie
Brigadier F. C. Wallace
Dr. A. H. Zimmerman

Auditor: The Auditor General

Bankers: The Canadian Imperial Bank of Commerce

Head Office: National Research Building, Sussex Drive, Ottawa, Canada

Canadian Patents and Development Limited

THE HONOURABLE GORDON CHURCHILL,
Chairman of the Committee of the Privy Council on Scientific and Industrial Research, Ottawa

SIR:

In accordance with the provisions of Section 85(3) of the Financial Administration Act, I have the honour to submit to you, on behalf of the Directors of Canadian Patents and Development Limited, the Company's Annual Report for the fiscal year ended March 31, 1962. The Report of the Auditor General, following his examination of the Company's books, is attached, together with the Balance Sheet and Statement of Income and Expense covering the operations of the Company.

During the past year, Canadian Patents and Development Limited has investigated all patent matters for the National Research Council and, by virtue of the Public Servants Inventions Act, the Company has received a large number of inventions from other government agencies and departments. Under agreements with provincial research organizations and Canadian universities, the Company has also examined inventions received from the laboratories of these organizations. This year, 39 per cent of the cases originated within the laboratories of the National Research Council, 47 per cent resulted from work in other government agencies and departments, and the remaining 14 per cent came from universities and provincial research institutions.

During the year, officers in the Patent Section made the necessary investigations on all submissions and filed 107 patent applications; 150 patents were issued in thirteen countries.

Interest in the activities of the Company by both Canadian and foreign industry has increased. The Patents Handbook, which lists the inventions held by the Company, now has a distribution of over 2,000. Many more representatives from industry have found it advantageous to visit the Company's offices to examine inventions in detail and discuss licensing arrangements. Approximately 86 per cent of the visitors have been from Canadian companies, and the remaining 14 per cent have come from foreign countries, including the United States, England, Italy, South Africa and Argentina. The growing emphasis on good products of Canadian design has, no doubt, contributed to the increased interest of Canadian industry in the research results available through the Company.

It is the policy of the Company to offer all of its cases first to Canadian industry; 80 per cent of the licenses granted this year were entered into with Canadian firms for the production of goods in Canada.

From the Statement of Income and Expense it will be noted that the net profit for the year is $142,321, the highest in the Company's history. It is planned to expand development and promotional work.

In accordance with the Financial Administration Act, the budget for the next fiscal year has been approved by you and the Minister of Finance.

Yours very truly,

F. T. ROSSER, *President*

June 6, 1962

AUDITOR GENERAL OF CANADA
Ottawa

THE HONOURABLE GORDON CHURCHILL,
Chairman of the Committee of the Privy Council on Scientific and Industrial Research, Ottawa

SIR,

The accounts and financial statements of Canadian Patents and Development Limited have been examined for the year ended March 31, 1962. In compliance with the requirements of section 87 of the Financial Administration Act, I now report that, in my opinion:

(*a*) proper books of account have been kept by the Company;

(*b*) the financial statements of the Company

(i) were prepared on a basis consistent with that of the preceding year and are in agreement with the books of account,

(ii) in the case of the balance sheet, give a true and fair view of the state of the Company's affairs as at the end of the financial year, and

(iii) in the case of the statement of income and expense, give a true and fair view of the income and expense of the Company for the financial year; and

(*c*) the transactions of the Company that have come under my notice have been within the powers of the Company under the Financial Administration Act and any other Acts applicable to the Company.

Yours faithfully,

A. M. HENDERSON
Auditor General of Canada

May 23, 1962

CANADIAN PATENTS AND DEVELOPMENT LIMITED (*Incorporated under the Companies Act*)

BALANCE SHEET AS AT MARCH 31 1962 (with comparative figures as at March 31 1961)

ASSETS

		1962	1961
Cash		$ 18,209	$ 77,898
Short-term deposits		—	9,894
Accounts receivable	$108,131		84,706
Less: Provision for doubtful accounts	6,600		6,673
		101,531	78,033
Investments in bonds, of, or guaranteed by, the Government of Canada, at cost (market value, $386,013)	394,198		199,740
Add: Accrued interest	3,818		2,178
		398,016	201,918
		$517,756	$367,743

LIABILITIES

		1962	1961
Accounts payable		$ 59,459	$ 56,582
Royalties paid in advance		4,815	—
Capital:			
Capital stock:			
Authorized—10,000 shares of no par value			
Issued—5,000 shares, fully paid		296,199	296,199
Surplus			
Balance as at April 1 1961	$ 14,962		
Add: Net profit for the year, per Statement of Income and Expense	142,321		
Balance as at March 31 1962		157,283	14,962
		453,482	311,161
		$517,756	$367,743

Approved on behalf of the Board

F. T. ROSSER
Director

F. L. W. MCKIM
Director

The above Balance Sheet and the related Statement of Income and Expense have been examined and reported upon under date of May 23, 1962, to the Chairman of the Committee of the Privy Council on Scientific and Industrial Research as required by section 87 of the Financial Administration Act.

A. M. HENDERSON
Auditor General of Canada

CANADIAN PATENTS AND DEVELOPMENT LIMITED

STATEMENT OF INCOME AND EXPENSE FOR THE YEAR ENDED MARCH 31 1962

(with comparative figures for the year ended March 31 1961)

		1962		1961
Income				
Royalties, licensing fees, etc.	$277,329			$190,972
Less: costs of licensing rights and related technical assistance, etc.	12,168			29,238
		$265,161		$161,734
Income from agency agreements		3,457		3,092
Interest earned		10,081		5,875
Miscellaneous income		948		2,419
		279,647		173,120
Expense				
Services provided by National Research Council	$ 30,000			$ —
Salaries	26,879			26,313
Patent attorneys' fees and other patent expense	33,473			29,209
Awards to inventors	13,810			13,244
Provision for doubtful accounts	100			5,273
Promotion and development	28,903			5,258
Travel	2,846			827
Miscellaneous	1,315			1,291
		137,326		81,415
Net Profit		$142,321		$ 91,705

Note: Included in salaries for the year 1962 are directors' fees, $150 (1961—$50)

The Research Council Act / R.S.C. 1952 c. 239

As amended by 1953-54, c. 40 and 42

SHORT TITLE

1. This Act may be cited as the *Research Council Act*, R.S., c. 177, s. 1. Short title.

INTERPRETATION

2. In this Act, Definitions.

(*a*) "Chairman" means the Chairman of the Committee of the Privy Council on Scientific and Industrial Research; "Chairman."

(*b*) "Committee" means the Committee of the Privy Council on Scientific and Industrial Research; "Committee."

(*c*) "company" means a company incorporated pursuant to paragraph (*a*) of subsection (1) of section 17 and any company the direction and control of which is assumed by the Council pursuant to paragraph (*b*) of subsection (1) of section 17; "Company."

(*d*) "Council" means The Honorary Advisory Council for Scientific and Industrial Research; "Council."

(*e*) "President" means the President of The Honorary Advisory Council for Scientific and Industrial Research; "President."

(*f*) "Vice-President (Administration)" means the Vice-President (Administration) of The Honorary Advisory Council for Scientific and Industrial Research; and "Vice-President (Administration)."

(*g*) "Vice-President (Scientific)" means a Vice-President (Scientific) of The Honorary Advisory Council for Scientific and Industrial Research. R.S., c. 177, s. 2; 1946, c. 31, s. 1; 1950, c. 21, s. 1. "Vice-President (Scientific)."

3. There shall be a Council to be called "The Honorary Advisory Council for Scientific and Industrial Research." R.S., c. 177, s. 3. Advisory Council.

4. There shall be a committee to be called the Committee of the Privy Council on Scientific and Industrial Research consisting of such number of ministers belonging to the Queen's Privy Council for Canada as the Governor in Council may determine, to be nominated by the Governor in Council. 1946, c. 31, s. 2. Committee of the P.C. on Scientific and Industrial Research.

5. (1) The Council consists of a President, a Vice-President (Administration) and two Vice-Presidents (Scientific) and not more than seventeen other members, to be appointed by the Governor in Council. Appointment of Council.

(2) The members of the Council, with the exception of the President, the Vice-President (Administration), and the Vice-Presidents (Scientific) hold office for a period of three years. Tenure of office.

(3) A retiring member is eligible for re-appointment. Re-appointment.

(4) There shall be an Executive Committee of the Council consisting of the President, the Vice-President (Administration), the Vice-Presidents (Scientific), and at least three other members selected by the Council. 1950, c. 21, s. 2. Executive Committee.

President of the Council.

6. (1) The President is the chief executive officer of the Council and has 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.

Vice-President (Administration).

(2) Subject to the direction and control of the President, the Vice-President (Administration) has charge of all matters relating to administration and shall perform such other duties as the President may from time to time assign to him.

Vice-Presidents (Scientific).

(3) Subject to the direction and control of the President, each of the Vice-Presidents (Scientific) has supervision over such scientific matters and shall perform such other duties as the President may from time to time assign to him.

Salaries as prescribed by Governor in Council.

(4) The President, the Vice-President (Administration) and the Vice-Presidents (Scientific) shall receive such salaries and be employed for such terms of office as the Governor in Council may prescribe, and such salaries shall be paid out of moneys provided for the work of the Council. 1946, c. 31, s. 4; 1950, c. 21, s. 3.

Duties of Council.

7. The Council has charge of all matters affecting scientific and industrial research in Canada that may be assigned to it by the Committee, and also has 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. R.S., c. 177, s. 6.

Council incorporated Rep. and New. 1953-54, c. 42, s. 1.

8. (1) The Council is a body corporate, capable of suing and being sued and having power to acquire and hold real and personal property for the purposes of and subject to this Act.

National Research Council.

(2) The Council may be called the National Research Council. R.S., c. 177, s. 7; 1950, c. 21, s. 4.

Agent of Her Majesty.

9. (1) The Council is for all purposes of this Act an agent of Her Majesty and its powers under this Act may be exercised only as an agent of Her Majesty.

Proceedings by and against the Council.

(2) Actions, suits or other legal proceedings in respect of any right or obligation acquired or incurred by the Council on behalf of Her Majesty, whether in its name or in the name of Her Majesty, may be brought or taken by or against the Council in the name of the Council in any court that would have jurisdiction if the Council were not an agent of Her Majesty. 1950, c. 51, s. 3.

Meetings Rep. and New. 1953-54, c. 42, s. 2.

10. The Council shall meet at least three times a year in the City of Ottawa on such days as are fixed by the Council and at such other times and places as the Council deems necessary.

Powers of Executive Committee.

11. The Executive Committee of the Council may exercise the powers of the Council and shall submit at each meeting of the Council minutes of its proceedings since the last preceding meeting of the Council. 1946, c. 31, s. 5.

Travelling and other expenses.

12. No member of the Council, with the exception of the President, the Vice-President (Administration) and the Vice-Presidents (Scientific) shall receive any payment or emolument for his services, but each member shall receive such travelling and other expenses in connection with the work of the Council as may be approved by the Governor in Council. 1950, c. 21, s. 5.

Powers of Council.

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

(*a*) to make by-laws for the conduct of its business;

(*b*) to control and direct the work of the Council through the President, and, in case of the illness, absence or suspension of the President, or in the case of vacancy in the office of President, through an Acting President temporarily appointed by the Council;

Am. 1953-54. c. 42, s. 3 (1).

(*c*) to undertake, assist or promote scientific and industrial research, including, without restricting the generality of the foregoing,

Rep. and New. 1953-54. c. 42, s. 3 (1).

(i) 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 that may promote the expansion of existing or the development of new industries,

(iii) researches with the view of utilizing the waste products of the 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, and

(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;

Rep. and New. 1953-54, c. 42, s. (2).

(*e*) to expend, for the purposes of this Act, any money appropriated by Parliament for the work of the Council or received by the Council through the conduct of its operations, bequest, donation or otherwise;

Rep. and New. 1953–54, c. 42, s. 3 (2).

(*f*) with the approval of the Chairman, to appoint such scientific, technical and other officers as are 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;

Rep. and New. 1953–54. c. 42, s. 3 (2).

(*g*) subject to the approval of the Chairman, to publish and sell or otherwise distribute such scientific and technical information as the Council deems necessary;

(*h*) to carry on work and manufacturing of an experimental and development nature with respect to the matters referred to in paragraphs (*c*) and (*d*) so as to render the processes, methods or products to which the said matters relate more available and effective in useful arts and manufacturing and for scientific purposes and otherwise; and

(*i*) to license, sell or otherwise grant or make available to others, Canadian or other patent rights or any other rights, vested in or owned or controlled by the Council, to or in respect of any discovery, invention or improvement in any art, process, apparatus, machine, manufacture or composition of matter, and to receive royalties, fees and payments therefor. R.S., c. 177, s. 10; 1946, c. 31, s. 7; 1950, c. 21, s. 6.

14. Repealed. 1953–54, c. 40, s. 15.

Audit of expenditures.

15. All the receipts and expenditures of the Council are subject to examination and audit by the Auditor General. R.S., c. 177, s. 12.

President's report.

16. (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.

Council's report.

(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.

(3) 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. R.S., c. 177, s. 13.

*NOTE: "14. (1) Every discovery, invention or improvement in any art, process, apparatus, machine, manufacture or composition of matter made by a member of any number of members of the scientific and technical staff of the Council or a company and all rights with respect thereto are vested in the Council.

(2) The Council, with the approval of the Governor in Council, may pay to its scientific and technical officers and to others working under its auspices who have made any valuable discovery, invention or improvement in any art, process, apparatus, machine, manufacture or composition of matter, such bonuses or royalties as in its opinion may be warranted. 1950, c. 21, s. 7."

The Public Servants Inventions Act, chapter 40 of the Statutes of 1953–54, which was proclaimed in force as of the 1st day of June, 1955, repeals section 14. The Act, however, applies only to inventions that were made, or for which an application for a patent was made, after June 1st, 1954. Section 14, therefore, remains in force for all prior inventions.

17. (1) The Council may, with the approval of the Governor in Council,

(*a*) procure the incorporation by any one or more companies under the provisions of Part I of the *Companies Act*, for the objects and purposes of exercising and performing on behalf of the Council such of the power conferred upon the Council by paragraphs (*c*), (*d*), (*h*) and (*i*) of section 13 of this Act as the Council may from time to time direct and all the issued shares of the capital stock of each such company shall be owned or held in trust by the Council for Her Majesty in right of Canada except shares necessary to qualify other persons as directors; or

Council may procure incorporation of companies.

(*b*) assume, by transfer to the Council in trust for Her Majesty in right of Canada of all the issued share capital thereof except shares necessary to qualify other persons as directors, the direction and control of any one or more existing companies incorporated under the provisions of Part I of the *Companies Act* all the issued share capital of which is owned by or held in trust for Her Majesty in right of Canada except shares necessary to qualify other persons as directors and may delegate to any such company any of the powers conferred on the Council by paragraphs (*c*), (*d*), (*h*) and (*i*) of section 13 of this Act.

Assume control of existing companies.

(2) Every company shall keep and maintain such books and records, in addition to those required by the *Companies Act* as the Council may prescribe and shall make such reports and returns to the Council as the Council may require.

Books and records.

(3) The accounts of a company shall be audited by the Auditor General. 1946, c. 31, s. 9.

Accounts.

NRC Reports

ANNUAL REPORT

The Annual Report of the National Research Council, as required under the Research Council Act, contains the President's report and the financial statement of the Council for the fiscal year. It also outlines the main projects of the laboratory divisions.

NRC REVIEW

The "NRC Review" contains reports of the directors of divisions and heads of sections, accounts of work of the Council's committees, and a list of NRC personnel serving on outside organizations. A directory of scientific staff is included at the end of the book. It is distributed to scientists, research institutions and other persons or organizations who require such information.

REPORT ON UNIVERSITY SUPPORT

The Report on University Support provides detailed information about the Council's program of university support for science and engineering, and the research awards of the Medical Research Council. Published annually.

NRC RESEARCH NEWS

The "NRC Research News" is a bulletin intended to provide the scientific reader with a continuous record of activities of the National Research Council.

Design: Paul Arthur & Associates, Ottawa
Printer: University of Toronto Press, Toronto

NRC No. 6815