

Federal Science Expenditures and Personnel

Activities in the natural sciences and engineering

Guide to the collection of data in the natural sciences and engineering

Introduction

This introduction is intended to provide an overview of the process of collecting science expenditure data; definitions of and explanatory notes on natural sciences and engineering, social sciences and humanities, scientific and technological activities, performance sectors, and other terms used are given in subsequent sections.

The collection of science expenditure data is organized by the Business Special Surveys and Technology Statistics Division (BSSTSD) of Statistics Canada. This exercise was formerly conducted under the aegis of the Treasury Board Secretariat but is now solely a Statistics Canada survey.

Collection is undertaken to gather essential data describing the recent, current and proposed state of the federal resources allocated to science. Federal science expenditures data are provided to Industry Canada who in turn use the data in the development of advice to the Assistant Deputy Ministers' Steering Committee on the Management of S&T, their Minister and the Treasury Board Secretariat, as well as in policy development and in monitoring the implementation of science policies. Statistics Canada maintains historical expenditure series in natural sciences and engineering dating back to 1963 and to 1971 in the social sciences and humanities. These data are available through the Business Special Surveys and Technology Statistics Division (BSSTSD) or through special requests.

The basic reporting unit is the budgetary program of a department or agency. Each budgetary program forms the subject of separate scientific expenditure reports for the natural and for the social science activities within it. Both the program and the program activities within it may be scientific in whole or in part only. Only expenditures on the scientific components of a program or its activity are reported. In some programs it will be difficult to distinguish between the natural and social sciences. However, some allocation must be made and in determining this allocation, the dominant orientation of the projects and the area of expertise of the personnel involved must be considered. Detailed definitions are given on the following pages.

On the questionnaires, the identified expenditures are looked at from several different viewpoints and in various subdivisions. Expenditures on **research and development (R&D)** and **related scientific activities (RSA)** are subdivided to provide an indication of the "what" of a department's scientific effort. Expenditures in each category of scientific activity are further subdivided into "current" and "capital" segments. Current expenditures are additionally subdivided by sector, to indicate the "where" and "by whom" the activity is performed (e.g., in business enterprise, in higher education).

The human resources allocated to scientific activities are summarized in terms of the involved categories of personnel (scientific and professional, technical, etc.) and the principal focus of their efforts (R&D, RSA, administration of extramural programs).

When completed, checked for consistency with previous reports, entered into the database and totaled along the various dimensions, these data provide snapshots of the federal resources allocated to science, supporting not only the work of central agencies but also the submissions of departments and agencies requesting resources.

General

This guide consists of definitions/explanations for terms used in the questionnaire.

The **natural sciences and engineering** consist of disciplines concerned with understanding, exploring, developing or utilizing the natural world. Included are the engineering, mathematical, life and physical sciences.

The term **social sciences** is to be regarded as synonymous with social sciences and humanities and thus embraces all disciplines involving the study of human actions and conditions and the social, economic and institutional mechanisms affecting humans. Included are such disciplines as anthropology, business administration and commerce, information and knowledge management, criminology, demography, economics, geography, history, languages, literature and linguistics, law, library science, philosophy, political science, psychology, religious studies, social work, sociology, and urban and regional studies.

1. Expenditures by activity and performer

The questionnaire covers three consecutive fiscal years and the headings of all three are identical. One set of definitions/explanations therefore suffices.

Actual and planned expenditures on scientific and technological activities are to be classified according to the type of scientific activity and the performance sector in which the activities were or will be conducted.

Scientific and technological (S&T) activities are required for the generation, dissemination or initial application of the new S&T knowledge. The central activity is scientific **research and experimental development (R&D)**. In addition there are a number of activities closely related to R&D, and are termed **related scientific activities (RSA)**. Those identified as being appropriate for the federal government in the Natural sciences and engineering are: scientific data collection, information services, special services and studies and education support.

The performer is equivalent to the sector in which the scientific activity is conducted. The basic distinction is between intramural and extramural performance. Extramural payments are classified on the basis of the performance sectors to which they are made. The appropriate extramural performers are business enterprise, higher education, Canadian non-profit institutions, foreign performers, provincial and municipal governments, and other performers.

I. Research and experimental development

Research and experimental development – creative work undertaken on a systematic basis in order to increase the stock of scientific and technical knowledge and to use this knowledge in new applications.

The central characteristic of R&D is an appreciable element of novelty and of uncertainty. **New** knowledge, products or processes are sought. The work is normally performed by, or under the supervision of, persons with postgraduate degrees in the natural sciences or engineering.

An R&D project generally has three characteristics:

1. a substantial element of uncertainty, novelty and innovation;
2. a well-defined project design;
3. a report on the procedures and results of the projects.

Examples:

- Special investigation of a particular mortality in order to establish the side effects of certain medical treatments.
- The investigation of new methods of measuring temperature is research as is the study and development of new systems and techniques for interpreting the data.
- The development of new methods of identifying tree species and determining if they are diseased.
- The creation of a new transportation system as a prototype and the technical evaluation of its operations is R&D.

R&D is generally carried out by specialized R&D units. However, an R&D project may also involve the use of non R&D facilities (e.g., testing grounds), the purchase or construction of specialized equipment and materials, and the assistance of other units. Costs of such items, attributable to the project, are to be considered R&D costs.

R&D units may also be engaged in non R&D activities such as technical advisory services, testing, and construction of special equipment for other units. So far as is practical, the effort devoted to such operations should be excluded from R&D.

On the other hand, R&D may be carried out by units normally engaged in other functions (e.g. a marine survey ship used for hydrological research, a geological survey team may be directed to work in a certain area in order to provide data for a geophysical research project). Such effort is part of an R&D project and, again, so far as is practical, the costs should be assigned to R&D expenditures.

Item 1. In-house R&D – R&D performed by personnel of the reporting program. It may include R&D carried out on behalf of another program on a cost-recovery basis.

Item 2. Contracts – payments to organizations or individuals outside the federal government for the conduct of R&D by the recipient or to provide support for the federal government's in-house R&D programs.

a) R&D contracts – contracts to an outside institution or individual to fund R&D **performed** by the institution or individual. The criterion is: would the performer report the contract as intramural government-funded R&D if asked? If the answer is yes the activity would be an R&D contract, if no it would be a supporting contract. Contracts to other federal government departments should be reported as a transfer of funds on page 15 of the questionnaire.

b) Supporting contracts – contracts to an outside institution or individual to provide goods or services necessary to support the in-house R&D program. Examples are contracts with data processing firms for computing services, maintenance contracts for R&D facilities, or procurement contracts for specialized equipment which is not considered capital. The **total** amount reported for this activity should be reported under the

intramural column on pages 4 to 6.

Contracts for related scientific activities (RSA) should continue to be reported in the appropriate activity and performance sector spaces provided on the questionnaire.

Item 3. R&D grants and contributions – awards to organizations or individuals for the conduct of R&D and intended to benefit the recipients rather than provide the program with goods, services or information. These funds are normally identical to that portion of the budgetary “grants and contributions” line object of expenditure which is devoted to R&D activities.

Grants and contributions for related scientific activities (RSA) are to be reported in the appropriate activity and performance sector spaces provided on the questionnaire.

Item 4. Research fellowships – awards to individuals for advanced research training and experience. Awards intended primarily to support the education of the recipients should be reported as “education support”.

Item 5. Administration of extramural programs – the costs of identifiable units engaged in the administration of contracts and grants and contributions for scientific activities that are to be performed outside the federal government. These expenditures should be broken down by the type of scientific activity supported, i.e. R&D or RSA.

Item 6. Capital expenditures – expenditures on construction, acquisition or preparation of land, buildings, machinery and equipment are **capital expenditures**. All other expenditures are **current expenditures**.

II. Related scientific activities

Related scientific activities are concerned with the generation, dissemination and application of scientific and technological knowledge. The kinds of related scientific activities for the natural sciences and engineering are described below.

Item 7. Scientific data collection – the gathering, processing, collating and analyzing of data on natural phenomena. These data are normally the results of surveys, routine laboratory analyses or compilations of operating records.

Data collected as part of an existing or proposed research project are charged to research. Similarly, the costs of analyzing existing data as part of a research project are R&D costs, even when the data were originally collected for some other purpose. The development of new techniques for data collection is also to be considered a research activity. Examples of RSA scientific data collection are: routine geological, hydrographic, oceanographic and topographic surveys; routine astronomical observations; maintenance of meteorological records; and wildlife and fisheries surveys.

Item 8. Information services – all work directed to recording, classifying, translating and disseminating scientific and technological information as well as museum services. Included are the operations of scientific and technical libraries, S&T consulting and advisory services, the Patent Office, the publication of scientific journals and monographs, and the organizing of scientific conferences. Grants for the publication of scholarly works are also included.

General purpose information services or information services directed primarily towards the general public are excluded, as are general departmental and public libraries. When individual budgets exist, the costs of libraries which belong to institutions otherwise entirely classified to another activity, such as R&D, should be assigned to information services. The costs of printing and distributing reports from another activity, such as R&D, are normally attributable to that activity.

Sub category under Information services:

Museum services – the collecting, cataloguing and displaying of specimens of the natural world or of representations of natural phenomena. The activity involves a systematic attempt to preserve and display items from the natural world; in some ways it could be considered an extension of information services. The scientific activities of natural history museums, zoological and botanical gardens, aquaria, planetaria and nature reserves are included. Parks which are not primarily restricted reserves for certain fauna or flora are excluded. In all cases the costs of providing entertainment and recreation to visitors should be excluded (e.g. restaurants, children’s gardens and museums).

When a museum also covers not only natural history but also aspects of human cultural activities, the museum’s resources should be appropriated between the natural and social sciences. However, museums of science and technology, war, etc., which display synthetic or artificial objects and may also illustrate the operations of certain technologies, should be considered as engaged in museum services in social sciences.

Item 9. Special services and studies – work directed towards the establishment of national and provincial standards for materials, devices, products and processes; the calibration of secondary standards; non-routine quality testing; feasibility studies and demonstration projects.

Sub categories under Special services and studies include:

Testing and standardization – work directed towards the establishment of national and international standards for materials, devices, products and processes, the calibration of secondary standards and non-routine quality testing. The development of new measures for standards, or of new methods of measuring or testing, is R&D and should be reported as such. Exclude routine testing such as monitoring

radioactivity levels or soil tests before construction.

Feasibility studies – technical investigations of proposed engineering projects to provide additional information required to reach decisions on implementation. Besides feasibility studies per se, the related activity of demonstration projects are to be included. Demonstration projects involve the operation of scaled-up versions of a facility or process, or data on factors such as costs, operational characteristics, market demand and public acceptance. Projects called “demonstration projects” but which conform to the definition of R&D should be considered R&D. Once a facility or process is operated primarily to provide a service or to gain revenue, rather than as a demonstration, it should no longer be included with feasibility studies. In all demonstration projects, only the **net** costs should be considered.

Item 10. Education support – grants to individuals or institutions on behalf of individuals which are intended to support the post-secondary education of students in technology and the natural sciences. General operating or capital grants are excluded. The activity includes the support of foreign students in their studies of the natural sciences at Canadian or foreign institutions. Grants intended primarily to support the research of individuals at universities are either R&D grants or research fellowships.

Awards intended primarily to support the education of the recipients should be reported as “education support”.

Item 11. Administration of extramural programs – the costs of identifiable units engaged in the administration of contracts and grants and contributions for scientific activities that are to be performed outside the federal government. These expenditures should be broken down by the type of scientific activity supported, i.e. R&D or RSA.

Item 12. Capital expenditures – expenditures on construction, acquisition or preparation of land, buildings, machinery and equipment are **capital expenditures**. All other expenditures are **current expenditures**.

III. Performers

Intramural includes costs incurred for scientific activities carried out by in-house personnel of units assigned to the program; the related acquisition of land, buildings, machinery and equipment for scientific activities; the administration of scientific activities by program employees; and, the purchase of goods and services to support in-house scientific activities.

The intramural expenditures reported for scientific activities are those direct costs, including salaries, associated with scientific programs. The costs should include that portion of a program’s contribution to employee benefit plans (e.g., superannuation) which is applicable to the scientific personnel within the program.

Non-program (“indirect”) costs such as the value of services provided by other departments without charge and accommodation provided by the reporting program are to be excluded. Support services (i.e. administration, finance) provided by the reporting program, proportional to S&T expenditures should be included.

Extramural performers are groups being funded for S&T activities by the federal government sector. In this survey the extramural performers include:

Business enterprise – business and government enterprises including public utilities and government-owned firms. Incorporated consultants providing scientific and engineering services are also included. Industrial research institutes located at Canadian universities are considered to be in the higher education sector.

Higher education – composed of all universities, colleges of technology and other institutes of post-secondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with, the higher education establishments.

Canadian non-profit institutions – charitable foundations, voluntary health organizations, scientific and professional societies, and other organizations not established to earn profits. Non-profit institutions primarily serving or controlled by another sector should be included in the controlling sector.

Provincial and municipal governments – departments and agencies of these governments. Government enterprises, such as provincial utilities are included in the business enterprise sector, and hospitals in the Canadian non-profit institutions sector.

Foreign performers – all foreign government agencies, foreign companies (including foreign subsidiaries of Canadian firms), international organizations, non-resident foreign nationals and Canadians studying or teaching abroad.

Other performers – include provincial research councils, and individuals or organizations in Canada not belonging to any of the above sectors.

2. Personnel

Intramural expenditure data should be supported by data on the personnel devoted to scientific activities by all the employees engaged in these activities.

Full-time equivalent (FTE) – a measure of the time actually devoted to the conduct of scientific activities. An employee who is engaged in scientific activities for half a year has a full-time equivalence of 0.5. Personnel data reported should be consistent with expenditure data.

Scientific and professional – people in jobs that require at least one academic degree or nationally recognized professional qualification (e.g., Professional Engineer P.Eng.), as well as those with equivalent experience.

Technical – people in jobs that require specialized vocational or technical training beyond the secondary level (e.g., community colleges and technical institutes) as well as those with experience equivalent to this training.

Other – clerical, secretarial, administrative, operational and other support personnel.

In regard to personnel resources there are two caveats:

1. where the S&T activities are a part of the program being reported, only auxiliary staff relevant to the S&T activities are reported on a prorated basis;
2. whenever financial and administrative support is provided from another program, that support is allocated to the S&T resources for the program being reported.

3. Sources of funds for total scientific and technological activities

This question identifies the sources of funds for expenditures on scientific activities reported for all three years. It will help to ensure that work funded from outside the department is not overlooked.

Departmental S&T budget – that portion of the total departmental budget which was spent on natural science and engineering activities.

Revenues to / from other federal departments – money transferred from this program to another federal department or money transferred into this program from another federal department for activities in the natural sciences and engineering.

Provincial government departments – all funds from the provincial government used for natural science and engineering activities. The funds are referred to as payments, contributions, transfers, etc. Also include provincial portions of federal-provincial cost sharing programs performed by the department program.

Business enterprises – all funds from business enterprises used for natural science and engineering activities performed by the department.

Other – all funds for natural science and engineering activities from sources not specified above.

4. Scientific and technological expenditures by socio-economic objectives

Socio-economic objectives allow departments to classify their S&T resource allocations according to the purpose for which the expenditure is intended. The objectives are listed on the questionnaire at the highest level of aggregation with sub-levels given here for clarification of categories. In many cases, projects have multiple objectives and a department should assign its expenditures consistent with the stated objectives of the department. Care must be taken to avoid “double counting”.

The objectives are based on the Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NABS) produced by the Statistical Office of the European Communities (Eurostat).

1. Exploration and exploitation of the Earth – scientific activities with objectives related to the exploration of the Earth’s crust and mantle, seas, oceans and atmosphere, and scientific activities on their exploitation. It also includes climatic and meteorological research, polar exploration (under various headings, as appropriate) and hydrology.

Examples:

- General scientific activities
- Mineral, oil and natural gas prospecting
- Exploration and exploitation of the sea-bed
- Earth’s crust and mantle excluding sea-bed and studies of soil for agriculture (objective 6)
- Hydrology – excludes scientific activities on: water supplied and disposal (objective 2) and water pollution (objective 3)
- Sea and oceans
- Atmosphere
- Other scientific activities on the exploration and exploitation of the earth

Excludes: scientific activities on pollution (objective 3), soil improvement (objective 2), land-use and fishing (objective 6).

2. Infrastructure and general planning of land use – scientific activities on infrastructure and land development, including research on the construction of buildings. More generally, it covers all scientific activities relating to the general planning of land-use. This includes

scientific activities into protection against harmful effects in town and country planning but not scientific activities into other types of pollution (objective 3).

2.1 Transport systems – covers scientific activities on transport systems, including road accident prevention and ancillary services such as electronic traffic aids and radar stations. Also included is general scientific activities on transport systems, road and rail traffic, inland waterway and sea transport, air traffic, pipeline transport systems, works transport systems, combined transport systems and scientific activities on the potential effects on the environment of the planning and operation of transport systems. Scientific activities on transport equipment is included only when it forms part of the co-ordinated programmes for the development of improved and safer transport systems, otherwise, such research is classified in objective 7.

2.2 Telecommunications systems – covers scientific activities on telecommunications services and the planning and organization of telecommunications networks. It includes, in particular, general scientific activities on telecommunications systems, telephones, telex, data transmission, radio and television (including cable TV).

2.3 Other scientific activities – covers scientific activities on the infrastructure and general planning of land-use.

Examples:

- General scientific activities
- General planning of land-use
- Construction and planning of buildings
- Civil engineering – excludes scientific activities on building materials and industrial processes (objective 7)
- Water supply

3. Control and care of the environment – covers scientific activities into the control of pollution, aimed at the identification and analysis of the sources of pollution and their causes, and all pollutants, including their dispersal in the environment and the effects on man, species (fauna, flora, microorganisms) and biosphere. Development of monitoring facilities for the measurement of all kinds of pollution is included. The same is valid for the elimination and prevention of all forms of pollution in all types of environment.

Examples:

- General scientific activities on the environment
- Protection of atmosphere and climate
- Protection of ambient air
- Solid waste
- Protection of ambient water
- Protection of soil and groundwater
- Noise and vibration
- Protection of species and habitats
- Protection against natural hazards
- Radioactive pollution
- Other scientific activities on the environment

4. Protection and Improvement of human health – scientific activities aimed at protecting, promoting and restoring human health broadly interpreted to include health aspects of nutrition and food hygiene. It ranges from preventative medicine, including all aspects of medical and surgical treatment, both for individuals and groups, and the provision of hospital and home care, to social medicine and pediatric and geriatric research.

Examples:

- General scientific activities
- Medical scientific activities, hospital treatment, surgery
- Preventive medicine
- Biomedical engineering and medicines
- Occupational medicine
- Nutrition and food hygiene
- Drug abuse and addiction
- Social medicine
- Hospital structure and organization of medical care
- Other medical scientific activities

5. Production, distribution and rational utilization of energy – covers scientific activities into the production, storage, transportation, distribution and rational use of all forms of energy. It also includes scientific activities on processes designed to increase the efficiency of energy production and distribution, and the study of energy conservation.

Examples:

- Fossil fuels and their derivatives
- Nuclear fission
- Radioactive waste management including decommissioning with regard to fuel/energy
- Nuclear fusion
- Renewable energy sources
- Rational utilization of energy

6. Agricultural production and technology – covers all scientific activities on the promotion of agriculture, forestry, fisheries and foodstuff production. It includes: scientific research on chemical fertilizers, biocides, biological pest control and the mechanization of agriculture; research on the impact of scientific activities in the field of developing food productivity and technology.

6.1 Agriculture – covers scientific activities on animal products, veterinary medicine, crops, food technology and other scientific activities on agricultural production and technology.

6.2 Fishing – covers scientific activities on fishing, salting, drying and initial freezing of products (but not on preparation and canning (7)), scientific activities on fish-farming, exploration of new fishing grounds, exploration and development of new and unconventional sources of seafood.

6.3 Forestry – covers scientific activities into the ecological and economic aspects of forestry and timber production.

7. Industrial production and technology – covers scientific activities on the improvement of industrial production and technology. It includes scientific activities on industrial products and their manufacturing processes except where they form an integral part of the pursuit of other objectives (e.g. defence, space, energy, agriculture).

Examples:

- Increasing economic efficiency and competitiveness
- Manufacturing and processing techniques
- Petrochemical and coal by-products
- Pharmaceutical products
- Manufacture of motor vehicles and other means of transport
- Aerospace equipment manufacturing and repairing
- Electronic and related industries
- Manufacture of electrical machinery and apparatus
- Manufacture of non-electronic and non-electrical machinery
- Manufacture of medical and surgical equipment and orthopaedic appliances
- Manufacture of food products and beverages
- Manufacture of clothing and textiles and leather goods
- Recycling

8. Social structures and relationships – scientific activities on social objectives, as analysed in particular by social and human sciences, which have no obvious connection with other objectives. This analysis includes quantitative, qualitative, organizational and forecasting aspects of social problems.

Examples:

- Education, training, recurrent education and retraining
- Cultural activities
- Management of businesses and institutions
- Improvement of working conditions
- Social security system
- Political structure of society
- Social change, social processes and social conflicts
- Other scientific activities with regard to society

9. Exploration and exploitation of space – all civil space scientific activities. Corresponding scientific activities in the defence field is classified in objective 12. (Although civil space research is not, in general, concerned with particular objectives, it frequently has a specific goal, such as the increase of general knowledge (e.g. astronomy), or relates to particular applications (e.g. telecommunications satellites)).

Examples:

- General scientific activities
- Scientific exploration of space

- Applied research programs
- Launch systems
- Space laboratories and space travel
- Other research on the exploration and exploitation of space

10. Non-oriented research – basic activities motivated by scientific curiosity with the objective of increasing scientific knowledge. It also includes funding used to support postgraduate studies and fellowships.

Examples:

- Mathematics and Computer Sciences
- Physical Sciences
- Chemical Sciences
- Biological Sciences
- Earth and Related (Environmental) Sciences (environnement)
- Engineering Sciences
- Medical Sciences
- Agricultural Sciences
- Social Sciences
- Humanities

11. Other civil research – civil scientific activities which cannot (yet) be classified to a particular objective.

12. Defence – covers scientific activities for military purposes. It also includes basic research and nuclear and space research financed by ministries of defence. Civil scientific activities financed by ministries of defence, for example, in the fields of meteorology, telecommunications and health, should be classified in the relevant objectives.

5. Expenditures and personnel of scientific and technological establishment engaged in activities in the natural sciences and engineering, by region

Since 1978, Statistics Canada has been collecting detailed expenditure and person year data on intramural scientific activities of federal government departments and agencies by region. These data, coupled with data from other surveys, have been used by policy planners in federal and provincial governments, research managers and the media to assess the provincial distribution of science activities in Canada.

Again this year, we are asking for the information at the regional level. We are also asking for information in both natural science and engineering establishments as well as those performing activities in the social sciences and humanities, as international gross domestic expenditures on research and development (GERD) statistics include activities in both science fields.

The Canada total expenditures and personnel reported for the actual year must be consistent with data reported on intramural expenditures, column one and total personnel.

6. Transfers for natural sciences and engineering activities

Include payments or recipients for contracts, transfers and joint programs from / to other federal government departments. Please identify the amount and names of the origination and recipient programs.

Please forward the completed questionnaire and listing of extramural performers directly to:

Operations and Integration Division, Statistics Canada
 2nd Floor, Section B-17, Jean Talon Building, 150 Tunney's Pasture Driveway, Ottawa, Ontario, K1A 0T6
 Phone Number: 613-951-2591 or toll free at 1-800-387-0479
 Fax number: 613-951-0709 or toll free at 1-800-755-5514
 Email: infotechsurv@statcan.gc.ca

Your participation is greatly appreciated and will contribute to providing useful information on federal S&T expenditures. You will be able to access these results through "The Daily" and the publication "Federal Scientific Activities", Catalogue no 88-204-X on Statistics Canada's web site. The data will also be available on Science.gc.ca. **THANK YOU FOR YOUR CO-OPERATION.**