Definitions of Research and Development: An Annotated Compilation of Official Sources

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Contents

Introduction

This publication provides definitions of research and development from several U.S. and international sources.

The first section (I) presents statistical definitions of R&D from the Organisation for Economic Co-operation and Development (OECD) *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development*. The next three sections are organized by sectors of the U.S. economy that perform or fund R&D—businesses (II), the federal government and state governments (III), and academic and nonprofit organizations (IV). Sources for definitions of R&D include the Office of Management and Budget (OMB), federal procurement, tax and accounting guidance, and surveys from the National Center for Science and Engineering Statistics (NCSES), National Science Foundation (NSF). The last section (V) presents R&D definitions from statistical manuals on National Accounts and globalization.

R&D definitions are provided unedited as they appear in their original sources. Unless otherwise noted in the body of the publication, the definitions were downloaded in April and May 2017.

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I. OECD—Frascati Manual

Description: The updated *Frascati Manual* (7th ed., OECD 2015) provides the definition of research and experimental development (R&D) and of its components, basic research, applied research, and experimental development. These definitions are essentially unchanged from those in previous editions of the manual. Where there are differences, they reflect changes in culture and the use of language. To provide guidance on what is and what is not an R&D activity, five criteria are provided requiring the activity to be novel, creative, uncertain in its outcome, systematic, and transferable and/or reproducible.

Definition:

2.5 Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture and society—and to devise new applications of available knowledge.

2.6 A set of common features identifies R&D activities, even if these are carried out by different performers. R&D activities may be aimed at achieving either specific or general objectives. R&D is always aimed at new findings, based on original concepts (and their interpretation) or hypotheses. It is largely uncertain about its final outcome (or at least about the quantity of time and resources needed to achieve it), it is planned for and budgeted (even when carried out by individuals), and it is aimed at producing results that could be either freely transferred or traded in a marketplace. For an activity to be an R&D activity, it must satisfy five core criteria.

2.7 The activity must be:

- novel
- creative
- uncertain
- systematic
- transferable and/or reproducible.

2.8 All five criteria are to be met, at least in principle, every time an R&D activity is undertaken whether on a continuous or occasional basis. The definition of R&D just given is consistent with the definition of R&D used in the previous editions of the *Frascati Manual* and covers the same range of activities.

2.9 The term R&D covers three types of activity: basic research, applied research and experimental development. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Applied research is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

Distribution by type of R&D

2.23 A breakdown by type of R&D is recommended for use in all four of the sectors used in this manual [Business enterprise; Higher education; Government; and Private nonprofit].

2.24 There are three types of R&D:

- basic research
- applied research
- experimental development.

Basic research

2.25 Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

Applied research

2.29 Applied research is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective.

Experimental development

2.32 Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

Source: OECD, *Frascati Manual 7.0*, Chapter 2. The full *Frascati Manual* and current and upcoming online Annexes are available at http://oe.cd/frascati.

II. U.S. Business Enterprise R&D

A. Financial Accounting Standards Board

Description: Financial Accounting Standards Board (FASB) Accounting Standards Codification (ASC) provides U.S. GAAP (generally accepted accounting principles) for businesses. ASC is organized by "topics" and Topic 730 is devoted to Research and Development (formerly covered in FASB Statement No. 2 "Accounting for Research and Development Costs"). Material formerly covered in FASB Statement No. 68 "Research and Development Arrangements" also appears under Topic 730. The FASB material below, copyrighted by the Financial Accounting Foundation, 401 Merritt 7, Norwalk, CT 06856, is used with permission.

Definitions:

Topic 730 Research and Development, 730-10-20 Glossary

Research is planned search or critical investigation aimed at discovery of new knowledge with the hope that such knowledge will be useful in developing a new product or service (hereinafter

"product") or a new process or technique (hereinafter "process") or in bringing about a significant improvement to an existing product or process.

Development is the translation of research findings or other knowledge into a plan or design for a new product or process or for a significant improvement to an existing product or process whether intended for sale or use. It includes the conceptual formulation, design, and testing of product alternatives, construction of prototypes, and operation of pilot plants.

Topic 730 Research and Development, 730-10-55 Implementation Guidance and Illustrations

Examples of Activities Typically Included in Research and Development 55-1.

The following activities typically would be considered research and development within the scope of this Topic (unless conducted for others under a contractual arrangement [See NOTES below]):

a. Laboratory research aimed at discovery of new knowledge

b. Searching for applications of new research findings or other knowledge

c. Conceptual formulation and design of possible product or process alternatives

d. Testing in search for or evaluation of product or process alternatives

e. Modification of the formulation or design of a product or process

f. Design, construction, and testing of preproduction prototypes and models

g. Design of tools, jigs, molds, and dies involving new technology

h. Design, construction, and operation of a pilot plant that is not of a scale economically feasible to the entity for commercial production

i. Engineering activity required to advance the design of a product to the point that it meets specific functional and economic requirements and is ready for manufacture

j. Design and development of tools used to facilitate research and development or components of a product or process that are undergoing research and development activities.

Examples of Activities Typically Excluded from Research and Development 55-2.

The following activities typically would not be considered research and development within the scope of this Topic:

a. Engineering follow-through in an early phase of commercial production

b. Quality control during commercial production including routine testing of products

c. Trouble-shooting in connection with break-downs during commercial production

d. Routine, ongoing efforts to refine, enrich, or otherwise improve upon the qualities of an existing product

e. Adaptation of an existing capability to a particular requirement or customer's need as part of a continuing commercial activity

f. Seasonal or other periodic design changes to existing products

g. Routine design of tools, jigs, molds, and dies

h. Activity, including design and construction engineering, related to the construction, relocation, rearrangement, or start-up of facilities or equipment other than the following:

    1. Pilot plants (see [h] in the preceding paragraph)

    2. Facilities or equipment whose sole use is for a particular R&D project [See NOTES below.]

i. Legal work in connection with patent applications or litigation, and the sale or licensing of patents.

NOTES:

Topic 730 covers R&D expense, or R&D costs funded by the reporting entity. Accounting for the costs of R&D activities conducted for others under a contractual arrangement is part of accounting for contracts in general (see for example Topic 606). See also paragraphs 25-8 to 25-10 under 730-20-25.

See Subtopic 912 under 730 for guidance to government contractors related to identifying R&D activities included in government contracts and the accounting for such activities.

For guidance on research and development arrangements see Subtopics 730-20 and 810-30. For guidance regarding design and development costs for products to be sold under long-term supply arrangements, see Subtopic 340-10. Topic 850 specifies disclosure requirements for related party transactions.

For guidance on materials, property, plant, and equipment acquired or constructed for R&D projects see paragraph 25-2 under 730-10-25 and Topic 360. For intangibles and contract services used for R&D see paragraph 25-2 under 730-10-25 and Topic 720.

For guidance on computer software as a cost of R&D (formerly covered in part in FASB Statement No. 86 “Accounting for the Costs of Computer Software to Be Sold, Leased, or Otherwise Marketed” paragraphs 28-36) see Topic 730 subtopic 10, especially paragraphs 25-3 and 25-4. Subtopic 350-40 covers general guidance on costs of computer software developed or obtained for internal use and Subtopic 985-20 covers computer software intended to be sold, leased or marketed. In particular, paragraph 985-20-25-1 offers guidance regarding costs incurred to establish the technological feasibility of a computer software product. For guidance related to a funded software-development arrangement, see paragraphs 985-605-25-86 through 25-87.

The accounting for recognized intangible assets acquired by an entity, other than intangibles acquired in a business combination, is specified in Topic 350 (formerly covered in FASB Statement No. 142 "Goodwill and Other Intangible Assets"). Research and development assets acquired in a business combination or an acquisition by a not-for-profit entity is covered in Subtopic 805-20.

The material from FASB in this section was compiled in the summer of 2016 and is not meant to be an exhaustive summary of U.S. business R&D accounting guidance.

Source: FASB, ASC. Full FASB statements and other pronouncements are available at https://asc.fasb.org and http://www.iasplus.com/en-us/standards/fasb/expenses/asc730.

B. U.S. Code of Federal Regulations

Description: Section 1.174-2 of the U.S. Code of Federal Regulations (*Title 26, Internal Revenue*) specifies the definition of R&D for tax filing purposes.

Definition:

1.174-2 Definition of research and development expenditures.

(a) *In general.*

(1) The term *research or experimental expenditures*, as used in section 174, means expenditures incurred in connection with the taxpayer's trade or business which represent research and development costs in the experimental or laboratory sense. The term generally includes all such costs incident to the development or improvement of a product. The term includes the costs of obtaining a patent, such as attorneys' fees expended in making and perfecting a patent application. Expenditures represent research and development costs in the experimental or laboratory sense if they are for activities intended to discover information that would eliminate uncertainty concerning the development or improvement of a product. Uncertainty exists if the information available to the taxpayer does not establish the capability or method for developing or improving the product or the appropriate design of the product. Whether expenditures qualify as research or experimental expenditures depends on the nature of the activity to which the expenditures relate, not the nature of the product or improvement being developed or the level of technological advancement the product or improvement represents.

(2) For purposes of this section, the term *product* includes any pilot model, process, formula, invention, technique, patent, or similar property, and includes products to be used by the taxpayer in its trade or business as well as products to be held for sale, lease, or license.

(3) The term *research or experimental expenditures* does not include expenditures for:

(i) The ordinary testing or inspection of materials or products for quality control (quality control testing);

(ii) Efficiency surveys;

(iii) Management studies;

(iv) Consumer surveys;

(v) Advertising or promotions;

(vi) The acquisition of another's patent, model, production or process; or

(vii) Research in connection with literary, historical, or similar projects.

Source: 26 CFR 1.174-2. Available at https://www.law.cornell.edu/cfr/text/26/1.174-2.

C. Business Enterprise R&D

NCSES Business Research and Development and Innovation Survey

Description: The Business R&D and Innovation Survey (BRDIS), successor to the Survey of Industrial Research and Development, is the primary source of information on R&D performed or funded by businesses within the United States and covers for-profit, nonfarm businesses with five or more employees. The survey is conducted by the U.S. Census Bureau for the National Center for Science and Engineering Statistics, National Science Foundation. For more information and statistics see https://www.nsf.gov/statistics/srvyindustry/.

Definition:

Research and development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge and to devise new applications of available knowledge. This includes a) activities aimed at acquiring new knowledge or understanding without specific immediate commercial applications or uses (basic research); b) activities aimed at solving a specific problem or meeting a specific commercial objective (applied research); and c) systematic work, drawing on research and practical experience and resulting in additional knowledge, which is directed to producing new products or processes or to improving existing products or processes (development). R&D includes both direct costs such as salaries of researchers as well as administrative and overhead costs clearly associated with the company's R&D.

The term R&D does NOT include expenditures for:

- Costs for routine product testing, quality control, and technical services unless they are an integral part of an R&D project
- Market research
- Efficiency surveys or management studies
- Literary, artistic, or historical projects, such as films, music, or books and other publications
- Prospecting or exploration for natural resources

The following are examples of activities that typically would be excluded from research and development (in accordance with FASB Statement No. 2 "Activities Constituting Research and Development" http://www.fasb.org/pdf/fas2.pdf):

a. Engineering follow-through in an early phase of commercial production.

b. Quality control during commercial production including routine testing of products.

c. Trouble-shooting in connection with break-downs during commercial production.

d. Routine, on-going efforts to refine, enrich, or otherwise improve upon the qualities of an existing product.

e. Adaptation of an existing capability to a particular requirement or customer's need as part of a continuing commercial activity.

f. Seasonal or other periodic design changes to existing products.

g. Routine design of tools, jigs, molds, and dies.

h. Activity, including design and construction engineering, related to the construction, relocation, rearrangement, or start-up of facilities or equipment other than (1) pilot plants and (2) facilities or equipment whose sole use is for a particular research and development project.

i. Legal work in connection with patent applications or litigation, and the sale or licensing of patents.

Does R&D include development of software and Internet applications?

Research and development activity in software and Internet applications refers only to activities with an element of uncertainty and that are intended to close knowledge gaps and meet scientific and technological needs…. regardless of the eventual user (internal or external).

R&D activity in software INCLUDES:

- Software development or improvement activities that expand scientific or technological knowledge
- Construction of new theories and algorithms in the field of computer science

R&D activity in software EXCLUDES:

- Software development that does not depend on a scientific or technological advance, such as:
    - supporting or adapting existing systems
    - adding functionality to existing application programs, and
    - routine debugging of existing systems and software
- Creation of new software based on known methods and applications
- Conversion or translation of existing software and software languages
- Adaptation of a product to a specific client, unless knowledge that significantly improved the base program was added in that process

Source: NCSES, 2016 BRDI-1 survey form and 2016 BRDIS Q-by-Q Instructions. Available at https://www.nsf.gov/statistics/srvyindustry/.

III. Federal and State Government R&D[1]

A. Office of Management and Budget Circular A-11

Description: The U.S. Office of Management and Budget (OMB) prescribes budget regulations for federal agencies. Part II of Circular A-11 covers development of the president's budget and provides guidance on agency submissions to OMB. Section 84 of the circular defines budget authority, outlays, and offsetting receipts for the conduct of R&D, construction and rehabilitation of R&D facilities, and R&D equipment.

Definition:

Conduct of research and development (R&D): Research and experimental development activities are defined as creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of people, culture, and society—and to devise new applications using available knowledge.

Include:

- Administrative expenses for R&D, such as the operating costs of research facilities and equipment and other overhead costs.

Exclude:

- Investments in physical assets such as major equipment and facilities that support R&D programs. These investments should generally be reported under physical assets.

- Routine product testing, quality control, collection of general-purpose statistics, routine monitoring, and evaluation of an operational program (when that program is not R&D). Spending of this type should generally be reported as non-investment activities.

- Training of scientific and technical personnel should be reported as conduct of education and training. However, if an activity includes a mixture of R&D objectives as well as the education of graduate students, agencies should report under the lowest relevant line item.

Basic research is defined as experimental or theoretical work undertaken primarily to acquire new knowledge of underlying foundations of phenomena and observable facts. Basic research may include activities with broad or general applications in mind, such as the study of how plant genomes change, but should exclude research directed towards a specific application or requirement, such as the optimization of the genome of a specific crop species.

Applied research is defined as original investigation undertaken in order to acquire new knowledge. Applied research is, however, directed primarily towards a specific practical aim or objective.

Experimental Development is defined as creative and systematic work, drawing on knowledge gained from research and practical experience, which is directed at producing new products or

processes or improving existing products or processes. Like research, experimental development will result in gaining additional knowledge.

For reporting experimental development activities, include the following:

- The production of materials, devices, and systems or methods, including the design, construction and testing of experimental prototypes.

- Technology demonstrations, in cases where a system or component is being demonstrated at scale for the first time, and it is realistic to expect additional refinements to the design (feedback R&D) following the demonstration. However, not all activities that are identified as "technology demonstrations" are R&D.

Exclude:

- User demonstrations where the cost and benefit of a system are being validated for a specific use case. This includes low-rate initial production activities.

- Pre-production development, which is defined as non-experimental work on a product or system before it goes into full production, including activities such as tooling, and development of production facilities. For example, exclude activities and programs that are categorized as "Operational Systems Development" in the Department of Defense's budget activity structure. Activities and programs of this type should generally be reported as investments in other major equipment.

Physical assets are commodity inventories; and land, structures, equipment, and intellectual property (e.g., software or applications) that have an estimated useful life of two years or more. This character class code is used to enter amounts for the purchase, construction, manufacture, rehabilitation, or major improvement of physical assets regardless of whether the assets are owned or operated by the Federal Government, States, municipalities, or private individuals. The cost of the asset includes both its purchase price and all other costs incurred to bring it to a form and location suitable for its use. Within this character class code, agencies are also required to identify spending for R&D facilities and major equipment.

For reporting construction of R&D facilities, include the following:

- Construction of facilities that are necessary for the execution of an R&D program. This may include land, major fixed equipment, and supporting infrastructure such as a sewer line, or housing at a remote location. Many laboratory buildings will include a mixture of R&D facilities and office space. The fraction of the building directly related to the conduct R&D may be calculated based on the percentage of the square footage.

Exclude:

- Construction of other facilities, such as office space (which should be reported in the other construction and rehabilitation category on line 1313 or 1314).

- Major movable R&D equipment.

For reporting Major equipment R&D (lines 1321 and 1322), include the following:

- Acquisition, design, or production of major movable equipment, such as mass spectrometers, research vessels, DNA sequencers, and other movable major instruments for use in R&D activities.

- Programs of $1 million or more that are devoted to the purchase or construction of R&D major equipment (see section 84.3(a)).

Exclude:

- Minor equipment purchases, such as personal computers, standard microscopes, and simple spectrometers.

Source: OMB Circular A-11. Available at https://www.whitehouse.gov/omb/circulars/.

B. Office of Management and Budget Circular A-136

Description: The U.S. Office of Management and Budget (OMB) prescribes budget regulations for financial reporting requirements for federal agencies. Part II of Circular A-136 covers agency financial reporting guidance to OMB's Office of Federal Financial Management (OFFM). Section II.4.10.4 defines financial reporting of research and development.

Definition:

Research and development investments are expenses included in the calculation of net costs to support creative and systematic work undertaken to increase the stock of knowledge and to use such knowledge and practical experience for devising new or improved products and processes, with the expectation of maintaining or increasing national economic productive capacity or yielding other future benefits. Reporting must include data, in nominal dollars, on investment for the year being reported upon and the preceding four years. Additional years' data may also be reported if such data would provide a better indication of the investment.

Continued categorization of research and development expenses as investment for stewardship purposes is predicated on demonstrated outputs and outcomes consistent with the intent of the program. SFFAS No. 8 [Statements of Federal Financial Accounting Standards, see section C below] describes the criteria which will be met for these expenses to continue to be categorized as stewardship investments. Outcome and output measures that are used to justify continued treatment of expenses as stewardship investments should be clearly identified in the agency's financial statement and the relationship of the outcomes and outputs to the stewardship investments should be readily apparent.

Source: OMB Circular A-136. Available at https://www.whitehouse.gov/omb/circulars/.

C. Statements of Federal Financial Accounting Standards

Description: Statements of Federal Financial Accounting Standards, issued by the Federal Accounting Standards Advisory Board (FASAB), set forth generally accepted accounting principles for federal agencies. Chapter 7 of *Statement of Federal Financial Accounting Standards No. 8: Supplementary Stewardship Reporting* is devoted to R&D. Paragraph 96 of chapter 7 is devoted to the definition of R&D. See FASAB Handbook, Version 16 (June 2017) at http://files.fasab.gov/pdffiles/2017_fasab_handbook.pdf.

Definitions:

"Investment in research and development" refers to those expenses incurred to support the search for new or refined knowledge and ideas and for the application or use of such knowledge and ideas for the development of new or improved products and processes with the expectation of maintaining or increasing national economic productive capacity or yielding other future benefits. Research and development is composed of

- Basic research: systematic study to gain knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind;

- Applied research: systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met; and

- Development: systematic use of the knowledge and understanding gained from research for the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes.

Source: FASAB Handbook, Version 16. Available at http://files.fasab.gov/pdffiles/2017_fasab_handbook.pdf.

D. Federal Acquisitions Regulations

Description: The Federal Acquisitions Regulations (FAR) were established to codify uniform policies for the acquisition of supplies and services by executive agencies. Basic research is defined in FAR Part 2–Definitions of Words and Terms, subpart 2.101 "Definitions." Applied research and development are defined in FAR Part 35–Research and Development Contracting, subpart 35.001 "Definitions." Full text of FAR Parts is available at https://www.acquisition.gov/?q=browsefar.

Definitions:

Basic research means that research directed toward increasing knowledge in science. The primary aim of basic research is a fuller knowledge or understanding of the subject under study, rather than any practical application of that knowledge.

Applied research means the effort that (a) normally follows basic research, but may not be severable from the related basic research; (b) attempts to determine and exploit the potential of scientific discoveries or improvements in technology, materials, processes, methods, devices, or techniques; and (c) attempts to advance the state of the art. When being used by contractors in cost principle applications, this term does not include efforts whose principal aim is the design, development, or testing of specific items or services to be considered for sale; these efforts are within the definition of "development," given below.

Development, as used in this part, means the systematic use of scientific and technical knowledge in the design, development, testing, or evaluation of a potential new product or service (or of an improvement in an existing product or service) to meet specific performance requirements or objectives. It includes the functions of design engineering, prototyping, and engineering testing; it excludes subcontracted technical effort that is for the sole purpose of developing an additional source for an existing product.

Source: The Federal Acquisitions Regulations (FAR). Available at https://www.acquisition.gov/?q=browsefar.

E. Department of Defense Research, Development, Test, and Evaluation Budget Activities

Description: The Research, Development, Test, and Evaluation (RDT&E) budget activities are broad categories reflecting different types of Department of Defense (DOD) science and technology activities. These definitions guide internal budget documents and submissions of data to other government agencies. The following is drawn from DOD's Financial Management Regulation (DOD 7000.14-R), Volume 2B, Chapter 5 (Research, Development and Evaluation Appropriations). The full text of Chapter 5 is available at http://comptroller.defense.gov/FMR/vol2b_chapters.aspx.

Definitions:[2]

Budget Activity 1, Basic Research. Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to long-term national security needs. It is farsighted high payoff research that provides the basis for technological progress. Basic research may lead to: (a) subsequent applied research and advanced technology developments in Defense-related technologies, and (b) new and improved military functional capabilities in areas such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support. Program elements in this category involve pre-Milestone A efforts.

Budget Activity 2, Applied Research. Applied research is systematic study to understand the means to meet a recognized and specific need. It is a systematic expansion and application of knowledge to develop useful materials, devices, and systems or methods. It may be oriented, ultimately, toward the design, development, and improvement of prototypes and new processes to meet general mission area requirements. Applied research may translate promising basic research into solutions for broadly defined military needs, short of system development. This type of effort may vary from systematic mission-directed research beyond that in Budget Activity 1 to sophisticated breadboard hardware, study, programming and planning efforts that establish the initial feasibility and practicality of proposed solutions to technological challenges. It includes studies, investigations, and non-system specific technology efforts. The dominant characteristic is that applied research is directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters. Applied Research precedes system specific technology investigations or development. Program control of the Applied Research program element is normally exercised by general level of effort. Program elements in this category involve pre-Milestone B efforts, also known as Concept and Technology Development phase tasks, such as concept exploration efforts and paper studies of alternative concepts for meeting a mission need.

Budget Activity 3, Advanced Technology Development (ATD). This budget activity includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment. Budget

Activity 3 includes concept and technology demonstrations of components and subsystems or system models. The models may be form, fit, and function prototypes or scaled models that serve the same demonstration purpose. The results of this type of effort are proof of technological feasibility and assessment of subsystem and component operability and producibility rather than the development of hardware for service use. Projects in this category have a direct relevance to identified military needs. Advanced Technology Development demonstrates the general military utility or cost reduction potential of technology when applied to different types of military equipment or techniques. Program elements in this category involve pre-Milestone B efforts, such as system concept demonstration, joint and Service-specific experiments or Technology Demonstrations and generally have Technology Readiness Levels of 4, 5, or 6. (For further discussion on Technology Readiness Levels, see the Assistant Secretary of Defense for Research and Engineering's Technology Readiness Assessment (TRA) Guidance.) Projects in this category do not necessarily lead to subsequent development or procurement phases, but should have the goal of moving out of Science and Technology (S&T) and into the acquisition process within the Future Years Defense Program (FYDP). Upon successful completion of projects that have military utility, the technology should be available for transition.

Budget Activity 4, Advanced Component Development and Prototypes (ACD&P). Efforts necessary to evaluate integrated technologies, representative modes or prototype systems in a high fidelity and realistic operating environment are funded in this budget activity. The ACD&P phase includes system specific efforts that help expedite technology transition from the laboratory to operational use. Emphasis is on proving component and subsystem maturity prior to integration in major and complex systems and may involve risk reduction initiatives. Program elements in this category involve efforts prior to Milestone B and are referred to as advanced component development activities and include technology demonstrations. Completion of Technology Readiness Levels 6 and 7 should be achieved for major programs. Program control is exercised at the program and project level. A logical progression of program phases and development and/or production funding must be evident in the FYDP.

Budget Activity 5, System Development and Demonstration (SDD). SDD programs have passed Milestone B approval and are conducting engineering and manufacturing development tasks aimed at meeting validated requirements prior to full-rate production. This budget activity is characterized by major line item projects and program control is exercised by review of individual programs and projects. Prototype performance is near or at planned operational system levels. Characteristics of this budget activity involve mature system development, integration and demonstration to support Milestone C decisions, and conducting live fire test and evaluation and initial operational test and evaluation of production representative articles. A logical progression of program phases and development and production funding must be evident in the FYDP consistent with the Department's full funding policy.

Budget Activity 6, RDT&E Management Support. This budget activity includes management and support for research, development, test and evaluation efforts and funds to sustain and/or modernize the installations or operations required for general research, development, test and evaluation. Test ranges, military construction, maintenance support of laboratories, operation and maintenance of test aircraft and ships, and studies and analyses in support of the RDT&E program are funded in this budget activity. Costs of laboratory personnel, either in-house or contractor operated, would be assigned to appropriate projects or as a line item in the Basic Research, Applied Research, or ATD program areas, as appropriate. Military construction costs directly related to major development programs are included in this budget activity.

Budget Activity 7, Operational System Development. This budget activity includes development efforts to upgrade systems that have been fielded or have received approval for full rate production and anticipate production funding in the current or subsequent fiscal year. All items are major line item projects that appear as RDT&E Costs of Weapon System Elements in other programs. Program control is exercised by review of individual projects. Programs in this category involve systems that have received approval for Low Rate Initial Production (LRIP). A logical progression of program phases and development and production funding must be evident in the FYDP, consistent with the Department's full funding policy.

Source: DOD, Financial Management Regulation (DOD 7000.14-R), Volume 2B, Chapter 5. Available at http://comptroller.defense.gov/FMR/vol2b_chapters.aspx.

F. Surveys on Federal R&D Funding

- Federal Funds for Research and Development
- Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions
- Federally Funded R&D Centers (FFRDCs)

NCSES Survey of Federal Funds for Research and Development

Description: The Survey of Federal Funds for Research and Development is the primary source of information about federal funding for R&D in the United States. The survey is an annual census completed by the federal agencies that conduct R&D programs. For general information about this survey please see https://www.nsf.gov/statistics/srvyfedfunds/.

Definitions:

R&D: Research and experimental development (R&D) activities are defined as creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of people, culture, and society—and to devise new applications using available knowledge.

For reporting R&D activities, include the following:

- Administrative expenses for R&D, such as the operating costs of research facilities and equipment and other overhead costs.

Exclude:

- Investments in physical assets such as major equipment and facilities that support R&D programs. These investments should generally be reported under R&D Plant (see Tables 1, 1B, 2, 9, and 13).
- Routine product testing, quality control, collection of general-purpose statistics, routine monitoring, and evaluation of an operational program (when that program is not R&D).
- Training of scientific and technical personnel should be reported as conduct of education and training.

RDT&E (for DOD only): The Department of Defense's Research, Development, Test, and Evaluation (RDT&E) can be both (1) activities for the development of a new system, or to expand the performance of fielded systems, and (2) an appropriation. The RDT&E budget activities are broad categories reflecting different types of RDT&E efforts, which include Basic Research (BA 1); Applied Research (BA 2); Advanced Technology Development (ATD) (BA 3); Major Systems Development, which includes Advanced Component Development and Prototypes (ACD&P) (BA 4), System Development and Demonstration (SDD) (BA 5), and RDT&E Management Support (BA 6); and Operational Systems Development (BA 7). The definitions of these categories are established by Department of Defense Instruction 5000.02, "Operation of the Defense Acquisition System." For more information, see Budget Activities 1 through 7 in the DOD Financial Management Regulation (FMR), Volume 2B, Chapter 5, pages 5-4, 5-5, and 5-6 at http://comptroller.defense.gov/Portals/45/documents/fmr/Volume_02b.pdf.

R&D plant: R&D plant is defined as spending on both R&D facilities and major equipment as defined in Office of Management and Budget (OMB) Circular A-11 Section 84 (Schedule C) and includes physical assets, such as land, structures, equipment, and intellectual property (e.g., software or applications) that have an estimated useful life of two years or more. Reporting for R&D plant includes the purchase, construction, manufacture, rehabilitation, or major improvement of physical assets regardless of whether the assets are owned or operated by the Federal Government, States, municipalities, or private individuals. The cost of the asset includes both its purchase price and all other costs incurred to bring it to a form and location suitable for use.

For reporting construction of R&D facilities and major moveable R&D equipment, include the following:

- Construction of facilities that are necessary for the execution of an R&D program. This may include land, major fixed equipment, and supporting infrastructure such as a sewer line, or housing at a remote location. Many laboratory buildings will include a mixture of R&D facilities and office space. The fraction of the building that is considered to be R&D may be calculated based on the percentage of square footage that is used for R&D.

- Acquisition, design, or production of major moveable equipment, such as mass spectrometers, research vessels, DNA sequencers, and other moveable major instrumentation for use in R&D activities.

- Programs of $1 million or more that are devoted to the purchase or construction of R&D major equipment.

Exclude the following:

- Construction of other non-R&D facilities

- Minor equipment purchases, such as personal computers, standard microscopes, and simple spectrometers (report these costs under total R&D, not R&D Plant)

Obligations for **foreign R&D plant** are limited to federal funds for facilities that are located abroad and used in support of foreign R&D.

Type of R&D: Type of R&D has three components for non-DOD respondents: basic research, applied research, and development.

Basic research: Basic research is defined as experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts. Basic research may include activities with broad or general applications in mind, such as the study of how plant genomes change, but should exclude research directed towards a specific application or requirement, such as the optimization of the genome of a specific crop species. Basic research represents Department of Defense Budget Activity 1.

Applied research: Applied research is defined as original investigation undertaken in order to acquire new knowledge. Applied research is, however, directed primarily towards a specific practical aim or objective. Applied research represents Department of Defense Budget Activity 2.

Experimental development: Experimental development is defined as creative and systematic work, drawing on knowledge gained from research and practical experience, which is directed at producing new products or processes or improving existing products or processes. Like research, experimental development will result in gaining additional knowledge.

For reporting experimental development activities, include the following:

- The production of materials, devices, and systems or methods, including the design, construction, and testing of experimental prototypes.

- Technology demonstrations, in cases where a system or component is being demonstrated at scale for the first time, and it is realistic to expect additional refinements to the design (feedback R&D) following the demonstration. However, not all activities that are identified as "technology demonstrations" are R&D.

For DOD Agencies, development itself is divided into three categories: advanced technology development, major systems development, and operational systems development.

- Advanced technology development: This category is used for activities in DOD's budget Activity 3. For more information, see Budget Activity 3 on pages 5-4 and 5-5 of the DOD Financial Management Regulation (FMR), Volume 2B, Chapter 5, at http://comptroller.defense.gov/Portals/45/documents/fmr/Volume_02b.pdf.

- Major systems development: This category is used for activities in DOD's Budget Activities 4 through 6. For more information, see Budget Activities 4 through 6 on page 5-5 of the DOD Financial Management Regulation (FMR), Volume 2B, Chapter 5 at http://comptroller.defense.gov/Portals/45/documents/fmr/Volume_02b.pdf.

  NOTE: As of this FY 2016 data collection, major systems development no longer includes Budget Activity 7.

- Operational systems development: This category is used for activities in DOD's Budget Activity 7. For more information, see Budget Activity 7 on page 5- 6 of the

DOD Financial Management Regulation (FMR), Volume 2B, Chapter 5 at http://comptroller.defense.gov/Portals/45/documents/fmr/Volume_02b.pdf.

NCSES Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions

Description: This is a congressionally mandated survey and is the only source of comprehensive data on federal science and engineering funding to individual academic and nonprofit institutions. For general information see https://www.nsf.gov/statistics/srvyfedsupport/.

Definition:

Research and development (R&D) activities are defined as creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of people, culture, and society—and to devise new applications using available knowledge.

For reporting R&D activities, include the following:

- Administrative expenses for R&D, such as the operating costs of research facilities and equipment and other overhead costs.

Exclude:

- Investments in physical assets such as major equipment and facilities that support R&D programs. These investments should generally be reported under physical assets, discussed under R&D plant.

- Routine product testing, quality control, collection of general-purpose statistics, routine monitoring, and evaluation of an operational program (when that program is not R&D). Spending of this type should generally be reported as non-investment activities.

- Training of scientific and technical personnel should be reported as conduct of education and training.

Advanced technology development (DOD only) is one of the two categories the Department of Defense uses for development (the "D" in R&D). The category advanced technology development is used for the activities in DOD's Budget Activity 3, Advanced Technology Development (ATD). For more information, see Budget Activity 3 on pages 5-4 to 5-5 of the DOD Financial Management Regulation (FMR), Volume 2B, Chapter 5, at http://comptroller.defense.gov/portals/45/documents/fmr/current/02b/02b_05.pdf.

Major systems development (DOD only) is the second of the two categories the Department of Defense uses for development. The category major systems development is used for activities in DOD's Budget Activities 4 through 6. For more information, see Budget Activities 4 through 6 (Advanced Component Development and Prototypes [ACD&P], System Development and Demonstration [SDD], and RDT&E Management Support) on page 5-5 of the DOD Financial Management Regulation (FMR), Volume 2B, Chapter 5 at http://comptroller.defense.gov/portals/45/documents/fmr/current/02b/02b_05.pdf.

NOTE: As of this FY 2016 data collection, major systems development no longer includes Budget Activity 7.

R&D plant is defined as R&D facilities, intellectual property (e.g., software or applications); major fixed equipment, such as reactors, wind tunnels, and particle accelerators; and major moveable equipment, such as mass spectrometers, research vessels, DNA sequencers, and other major moveable instruments for use in R&D activities. Amounts include acquisition of, construction of, major repairs to, or alterations in structures, works, equipment, facilities, or land for use in R&D activities at federal or nonfederal installations. Excluded from the R&D plant category are costs of expendable or movable equipment (e.g., simple spectrometers, standard microscopes), personal computers, and office furniture and equipment. Also excluded are the costs of predesign studies (e.g., those undertaken before commitment to a specific facility). These excluded costs are reported under "total conduct of research and development."

If the R&D facilities are a larger facility devoted to other purposes as well, the funds should be distributed among the categories of support involved as appropriate. In general, another category that would be involved is facilities and equipment for instruction in S&E.

NCSES FFRDC R&D Survey

Description:

The FFRDC Research and Development Survey is the primary source of information on separately budgeted R&D expenditures at federally funded research and development centers (FFRDCs) in the United States. Conducted annually for university-administered FFRDCs since FY 1953 and all FFRDCs since FY 2001, the survey collects information on R&D expenditures by source of funds and types of research and expenses. The survey is an annual census of the full population of eligible FFRDCs. See https://www.nsf.gov/statistics/srvyffrdc/ for more on this survey https://www.nsf.gov/statistics/ffrdclist/ for the Master List of FFRDCs maintained by NCSES.

Definitions:

Research and Development (R&D)

R&D is creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture, and society—and to devise new applications of available knowledge. R&D covers three activities defined below—basic research, applied research, and experimental development.

- Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

- Applied research is original investigation undertaken in order to acquire new knowledge. It is directed primarily towards a specific, practical aim or objective.

- Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is

directed to producing new products or processes or to improving existing products or processes.

Sources: NCSES, Survey of State Government R&D, FY 2016; Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions, FY 2016; Survey of Federal Funds for Research and Development, FYs 2016–17. Available at https://www.nsf.gov/statistics/.

G. State Government R&D

NCSES Survey of State Government R&D

Description: The Survey of State Government R&D is the only source for comprehensive, uniform statistics regarding the extent of R&D activity performed and funded by departments and agencies in each of the nation's 50 state governments, the government of the District of Columbia, and the government of Puerto Rico. See FY 2016 Survey of State Government R&D available at https://www.nsf.gov/statistics/srvystaterd/surveys/srvystaterd-2016.pdf.

For general information see https://www.nsf.gov/statistics/srvystaterd/.

Definition:

R&D comprise creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture, and society—and to devise new applications of available knowledge.

- R&D is aimed at new findings (novel)
    - It has not been done before
    - It may produce findings that could be published in academic journals
    - It includes ideas that could be patented
- R&D focuses on original concepts or ideas (creative)
    - Increases our knowledge of the subject
    - Helps create new products or applications
- R&D outcomes are uncertain (because it's never been done before)
    - Solutions are not always obvious or expected
    - Uncertain about, cost, time, or ability to achieve results
- R&D is planned and budgeted (systematic)
    - Projects processes and outcomes are documented
    - Projects are planned and managed

- R&D results in solutions that others may find useful (transferable)
    - Findings can be generalized to other situations and locations
    - Findings are reproducible
- What is NOT R&D?
    - Construction and acquisition of land and facilities used primarily for R&D (reported separately in this survey)
    - Fixed equipment used primarily for R&D (reported separately in this survey)
    - Program planning and evaluation
    - Business development services for new companies
    - Commercialization (includes promoting/producing the products/services from R&D projects)
    - Economic/policy/feasibility studies
    - General patient services
    - Information systems
    - Management studies
    - Marketing of products/services
    - Market research or analysis
    - Routine data collection/dissemination
    - Routine monitoring/testing
    - Strategic planning
    - Technology transfer

Source: NCSES, FFRDC R&D Survey, FY 2016. Available at https://www.nsf.gov/statistics/.

IV. U.S. Higher Education R&D and R&D by Nonprofit Organizations

A. Guidance from the Office of Management and Budget

Description: The Office of Management and Budget (OMB) issued the Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, Title 2 Part 200 of the Code of Federal Regulations (CFR) in December 2013. This guidance supersedes and streamlines requirements from the following OMB Circulars: A-21, A-50, A-87, A-89, A-102, A-110, A-122, and A-133. The full text of 2 CFR Part 200 is available at http://www.ecfr.gov/cgi-bin/text-idx?SID=68fca03721b9c921be5236306ae7a5fa&tpl=/ecfrbrowse/Title02/2chapterII.tpl.

Previous definitions for R&D reporting relevant to educational institutions, hospitals and nonprofit organizations, state and local governments, and nonprofit organizations were addressed in OMB Circulars A-21, A-110, and A-133. Although these circulars are still available (https://obamawhitehouse.archives.gov/omb/circulars_default) they are, with limited exceptions, no longer applied to assistance awards issued after the implementation date of December 26, 2014.

Definition:

Research and Development (R&D) means all research activities, both basic and applied, and all development activities that are performed by non-federal entities. The term research also includes activities involving the training of individuals in research techniques where such activities utilize the same facilities as other research and development activities and where such activities are not included in the instruction function.

"Research" is defined as a systematic study directed toward fuller scientific knowledge or understanding of the subject studied. "Development" is the systematic use of knowledge and understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes.

Source: 2 CFR 200.87. Available at http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title02/2cfr200_main_02.tpl.

B. Higher Education R&D

NCSES Higher Education Research and Development (HERD) Survey

Description: The Higher Education Research and Development Survey, successor to the Survey of Research and Development Expenditures at Universities and Colleges, is the primary source of information on R&D expenditures at U.S. colleges and universities. The survey collects information on R&D expenditures by field of research and source of funds and also gathers information on types of research and expenses and headcounts of R&D personnel. The survey is an annual census of institutions that expended at least $150,000 in separately budgeted R&D in the fiscal year. For general information about this survey please see https://www.nsf.gov/statistics/srvyherd/.

Definitions:

R&D is creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture, and society—and to devise new applications of available knowledge. R&D covers three activities defined below—basic research, applied research, and experimental development.

- Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

- Applied research is original investigation undertaken in order to acquire new knowledge. It is directed primarily towards a specific, practical aim or objective.

- Experimental development is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.

Source: NCSES, Higher Education Research and Development Survey, FY 2016. Available at https://www.nsf.gov/statistics/srvyherd/.

C. R&D by Nonprofit Organizations

NCSES Survey of Nonprofit Research Activities (NPRA)

Description:

This survey focuses on R&D performed or funded by U.S. nonprofit organizations.

Definition:

For the purposes of this survey, research includes research and experimental development. Research and experimental development comprise creative and systematic work to:

Increase the stock of knowledge, including knowledge of humankind, culture and society OR
Devise new applications of available knowledge (including materials, products, devices, processes, systems, or services)

Research activities must be . . .

- Novel: projects that advance current knowledge or create new knowledge
- Creative: projects focused on original concepts and hypotheses
- Uncertain: project outcomes are unable to be completely determined at the outset
- Systematic: projects are planned and budgeted
- Transferable/Reproducible: project methodology and results are transferable/reproducible to other situations and locations

[The following activities] May meet the criteria for research:

- Laboratory or animal studies
- Clinical trials
- Prototype development
- Outcomes research
- Development/measurement of new methods to deliver/measure social service outcomes
- Policy research
- Humanities research
- Research traineeships
- Other experimental studies

[The following activities] Most likely do not meet the criteria for research:

Internal program monitoring or evaluation

Public service grants or outreach programs

Education or training programs

Quality control testing

Market research

Management studies/efficiency surveys

Literary, artistic, or historical projects, such as films, music, or books and other publications

Feasibility studies, unless included as part of an overall research project

Source: NCSES, Pilot Survey of Nonprofit Research Activities (FY 2015). Available at https://www.nsf.gov/statistics/srvynpra/.

V. R&D in National Accounts and Globalization Manuals

A. R&D in the System of National Accounts (SNA)

Description: The System of National Accounts, 2008 (2008 SNA) is a statistical framework that provides a comprehensive set of macroeconomic accounts for policy and research purposes. The 2008 SNA recognized R&D as investment or produced asset in an economy (SNA 6.230, 10.98). R&D is defined in paragraph 10.103 (chapter 10 "The capital account," section B "Gross capital formation").

Definition:

10.103 Intellectual property products include the results of research and development (R&D). Research and [experimental] development consists of the value of expenditures on creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and use of this stock of knowledge to devise new applications.

Source: United Nations (UN) Statistical Division—2008 System of National Accounts.

B. Measuring R&D in global economic activities

Guidance for official statistics on trade, investment, and international production (called global value chains (GVCs) in recent economics and policy research literature) explicitly cover R&D and related intangible assets under the heading of "intellectual property products" (IPP). (In addition to R&D, IPPs include software and databases, entertainment, literary or artistic originals, and the results from mineral exploration.) The information below briefly covers selected international statistical manuals.

- OECD Handbook on Deriving Capital Measures of Intellectual Property Products, 2010

The Handbook uses the SNA 2008 R&D definition (10.103) and describes domestic R&D output for purposes of national and international economic accounts in terms of three components consistent with both the SNA and Frascati: own account R&D (R&D conducted and used internally regardless of funding source); custom R&D (R&D conducted for, and funded by, another unit); and speculative or non-customized R&D.

- Balance of Payments and International Investment Position Manual, 6th ed., 2009 (BPM6)

This manual covers accounting and statistical standards to compile the balance of payments (BOP), a statement that summarizes economic transactions—including R&D and other IPP—between residents and nonresidents (BMP6 2.2(b)). BPM6 incorporated R&D as an intellectual property product within the balance of payments (see BPM6 Table 10.4 and related text).

- OECD Benchmark Definition of Foreign Direct Investment (FDI), 4th ed., 2008

This manual describes definitions and measurement procedures for FDI flows and stocks consistent with the Balance of Payments and International Investment Position Manual. It also covers definitions of activities of multinational enterprises (MNEs) (AMNE for short) including sales, value added, employment, R&D, and international trade.[3]

- Manual on Statistics of International Trade in Services (MSITS), 2010

This manual covers statistics on international supply of services, including R&D services as defined in MSITS paragraph 3.234.

Definition:

3.234. Research and development services covers those services that are associated with basic research, applied research and experimental development of new products and processes and covers activities in the physical sciences, the social sciences and the humanities.

- Guide to Measuring Global Production, 2015

This manual further elaborates on measurement issues from GVCs and related global manufacturing arrangements and transactions, including exchanges of R&D and other intangibles or intellectual property products. See especially chapter 4 (Ownership of intellectual property products inside global production).

Source: OCED, *Frascati Manual 7.0*, "Measurement of R&D Globalisation," chapter 11. Available at http://oe.cd/frascati.

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United Nations (UN), et al. 2011. *Manual on Statistics of International Trade in Services 2010* (MSITS). Geneva, Switzerland. Available at http://unstats.un.org/unsd/tradeserv/TFSITS/manual.htm.

Notes

[1] Definitions as of 31 January 2018.

[2] As a historical artifact from previous DOD budget authority terminology, funds for RDT&E budget activity categories 1 through 7 are sometimes referred to as 6.1 through 6.7.

[3] For related definitions see Statistics on the Activities of Multinational Enterprises, Chapter 12 in U.S. International Economic Accounts: Concepts & Methods, U.S. Bureau of Economic Analysis, 2014.