

Chapter 5

Measurement of R&D personnel: Persons employed and external contributors

This chapter provides guidance on defining, identifying and measuring research and experimental development (R&D) personnel, the people who perform R&D, the highly trained scientists and engineers (researchers), technicians with high levels of technical experience and training, and supporting staff who contribute directly to carrying out R&D projects and activities in R&D-performing statistical units. A distinction is made between internal R&D personnel, those employed by the statistical unit, and external R&D personnel. The activities that characterise R&D personnel are listed. Definitions are provided for R&D personnel, external R&D personnel, researchers, technicians and equivalent staff, other supporting staff, full-time equivalent (FTE) of R&D personnel, and the headcount (HC) of R&D personnel. The role of doctorate and master's students as R&D personnel is discussed. Examples are provided to assist in making decisions about who are to be included as R&D personnel and who not. The resulting statistics on the number, availability and demographic characteristics of human resources that contribute to R&D activities are used by researchers and by policy makers concerned with the sustainability of the R&D enterprise.

5.1. Introduction

5.1 Policy makers and scholars have a clear interest in and need for information on the size, availability and demographic characteristics of human resources that directly contribute to the R&D activities of institutions, economic sectors and nations as a whole. Those persons contributing to R&D include highly trained researchers, technicians with high levels of technical experience and training, and other supporting staff who contribute directly to carrying out R&D projects and activities in R&D-performing statistical units. R&D personnel may be directly employed either by the statistical unit (internal R&D personnel) or by other units (external R&D personnel) contributing directly to the intramural R&D of the statistical unit about which data is being reported. There are a number of specific circumstances in which R&D personnel are engaged in R&D activities but receive no compensation or remuneration for their contribution to the intramural R&D of a statistical unit. This chapter provides guidance on defining, accurately identifying and measuring R&D personnel. R&D personnel data complement R&D expenditure data (covered in Chapter 4 of this manual), which measure the total costs of performing R&D, including the remuneration of R&D personnel.

Basic categorisation concepts

5.2 In order to identify and distinguish R&D personnel from the total personnel in a statistical unit performing R&D, the following list of key R&D-related tasks can be used as a reference. R&D personnel:

- perform scientific and technical work for an R&D project (setting up and carrying out experiments or surveys, building prototypes, etc.)
- plan and manage R&D projects
- prepare interim and final reports for R&D projects
- provide internal services for R&D projects (e.g. dedicated computing or library and documentation work)
- provide support for the administration of the financial and personnel aspects of R&D projects.

5.3 Any individual undertaking one or more such tasks is contributing to the intramural R&D activities of the statistical unit and is to be included in the R&D personnel totals, irrespective of their function (formal role) or their employment status in the statistical unit.

5.4 On the other hand, not all of the personnel contributing to or facilitating the performance of R&D activities are to be included in the R&D personnel totals. Only those individuals who make a direct contribution to R&D activities (as described above) are included in the statistical measurement of R&D personnel. R&D personnel exclude individuals undertaking indirect support or ancillary activities in R&D-performing units. Examples of indirect support and ancillary activities are:

- specific services to R&D provided by central computer departments and libraries
- services by central finance and personnel departments dealing with R&D projects and R&D personnel
- the provision of services for security, cleaning, maintenance, canteens, etc., to R&D-performing units.

5.5 While personnel providing such services are not included in the statistical unit's R&D personnel totals, their related costs (including the remuneration of the personnel providing such services) should be included in the statistical unit's R&D expenditures and be reported as "other current costs". It may be necessary to prorate such costs in order to exclude non-R&D activities within the statistical unit (see Chapter 4, Section 4.2).

5.2. Coverage and definition of R&D personnel

Initial coverage: persons employed and external contributors

5.6 **R&D personnel in a statistical unit include all persons engaged directly in R&D, whether employed by the statistical unit or external contributors fully integrated into the statistical unit's R&D activities, as well as those providing direct services for the R&D activities (such as R&D managers, administrators, technicians and clerical staff).**

5.7 Persons providing indirect support and ancillary services, such as canteen, maintenance, administrative and security staff, should be excluded, even though their wages and salaries are included in "other current costs" when measuring R&D expenditure.

5.8 R&D units may be organised differently and may use different forms of engagement for their R&D personnel. Therefore, when measuring human resources devoted to R&D, all R&D personnel of the statistical unit should be counted.

5.9 Two main groups of individuals who potentially contribute to the R&D activities can be identified in a statistical unit (with some differences according to the institutional sector it belongs to):

- Persons employed by the statistical unit who contribute to the unit's intramural R&D activities (used interchangeably with the term "**internal R&D personnel**" in this manual).

- External contributors to the unit's intramural R&D activities (used interchangeably with the term "**external R&D personnel**" in this manual). This group includes two subgroups: (i) persons who receive wages/salaries but not from the statistical unit performing the R&D and (ii) a number of special cases of persons external to a statistical unit who contribute to intramural R&D.

5.10 R&D personnel broadly include all individuals who are working in or for a statistical unit, whether full-time or part-time, and are contributing to the intramural R&D. They can be either persons employed by the statistical unit or persons employed by other units contributing to the statistical unit's intramural R&D activities. In this respect, both groups include independent and dependent workers. Table 4.1 provides a breakdown of the categories of personnel relevant for R&D measurement. These categories are based on terms and concepts in the United Nations' *International Recommendations for Industrial Statistics* (United Nations, 2009).

5.11 The identification of the personnel (both internal and external) delivering services for intramural R&D performance is essential for measurement purposes. As a practical consideration, an R&D-performing unit can report on the characteristics of its R&D personnel (sex, age, level of qualification, etc.; see Section 5.4) to statistical surveys only if it is involved in selecting the individuals who provide it with services for intramural R&D. As a result, if a service provision contract includes the identification of the individuals who will deliver the service, such individuals (and their demographic characteristics) could be reported as external R&D personnel by the unit receiving their services. Otherwise, it should be assumed that the service will be purchased from outside suppliers employing unidentified personnel. This distinction is relevant for the measurement of R&D personnel (i.e. whether to include or exclude the persons providing a service as part of the statistical unit's R&D personnel totals) but does not affect the measurement of R&D expenditure since both activities are included in the same category of "other current costs" (although costs for individuals identified as external R&D personnel should be reported as a specific sub-item, if possible). See further guidance on reporting R&D personnel and R&D expenditure in Section 5.2 of this chapter and Chapter 4, Section 4.2.

- For example, if a person is hired by a staffing agency to contribute on-site R&D-related clerical work, but the clerk may be replaced by the staffing agency without the direct input/approval of the R&D-performing statistical unit, that clerk is not R&D personnel, but the clerk's costs (or actually the full costs paid to the staffing agency) would be included in "other current costs" (just not in the "external personnel" subcategory).

Persons employed (internal personnel) contributing to a unit's intramural R&D

5.12 In most statistical units, intramural R&D is performed primarily by persons employed by the statistical unit. "Persons employed" includes both employees (dependent workers) and some types of independent workers.

Employees include all persons who work in or for the statistical unit, who have a contract of employment with the unit, and who receive compensation in cash or in kind at regular intervals of time. Employees engaged in activity ancillary to the main activity of the unit are also included, as well as the following groups: persons on short-term leave (sick leave, annual leave or vacation); persons on special paid leave (educational or training leave, maternity or parental leave); persons on strike; and part-time workers, seasonal workers and apprentices when on the payroll. Employees also include persons working physically outside the statistical unit's premises, when paid by and under the control of the unit (outworkers); for example, outside service engineers and repair and maintenance personnel are employees, i.e. dependent workers. If any of these persons contribute to the statistical unit's intramural R&D, they are counted as internal R&D personnel.

5.13 For statistical units in the Business enterprise sector, the definition of "persons employed" includes unpaid family workers and working proprietors (i.e. active business partners) as "independent workers". Silent or inactive partners whose principal activity is conducted outside of the statistical unit should be excluded.

5.14 By assumption, there are no independent workers among "persons employed" in the Government, Higher education and Private non-profit sectors (with the exception of households, to the extent that they are included, by convention, in the Private non-profit sector). In these sectors, almost all the "persons employed" are employees.

External personnel contributing to a unit's intramural R&D

5.15 Statistical units performing R&D increasingly rely on contributions by external personnel to improve the effectiveness of their internal R&D staff or to bring in-house specific knowledge and skills not internally available. In such cases the external personnel are fully integrated into the intramural R&D activities of the reporting statistical unit, and their work is managed by the reporting statistical unit. Such external R&D personnel services should not be confused with a unit's extramural R&D activities, that is, the acquisition of R&D from external units in fulfilment of specific orders, but not as an integrated part of the reporting unit's intramural R&D projects (see Chapter 4, Section 4.2 on "Other current R&D costs" and on "Distinguishing between intramural and extramural costs related to labour"). Nor should such external R&D personnel contributions be confused with the acquisition of services to support the intramural R&D performance delivered by external units without a specific agreement on who – one or more individuals – would deliver them.

5.16 "External R&D personnel" includes persons who are not employed in the reporting statistical unit but who provide direct services that are an integral part of the statistical unit's R&D projects or activities. That is, they contribute directly to the intramural R&D of the reporting statistical unit. "External R&D personnel" includes both self-employed professionals effectively acting as intramural R&D consultants and persons fulfilling the provision of

a scientific or technical service by their external employer(s) to the statistical unit reporting intramural R&D. Leased employees are included in this category. Leased employment entails the provision for a fee of human resources for client businesses. Leased employees are on the payroll of an employment (or staffing) agency rather than the payroll of the statistical unit paying the fee. This provision of human resources is typically conducted on a short-term basis. (See specific exclusions in the notes to Table 5.1.)

Table 5.1. **Personnel to be tracked as part of a statistical unit's intramural R&D personnel**

	Institutional sectors			
	Business enterprise	Government	Higher education	Private non-profit
Persons employed (internal personnel) contributing to a unit's intramural R&D				
Dependent	Employees ¹	Employees ¹	Employees ¹	Employees ¹
Independent	Working proprietors ²	Not applicable	Not applicable	Only applicable for Households
	Unpaid family workers ³			
Special cases of external personnel contributing to a unit's intramural R&D⁴				
May be dependent or independent		R&D grant holders; Doctoral/Master's students ⁵	Doctoral/Master's students ⁵ ; R&D grant holders; Professors emeritus	Volunteers ⁶
External personnel contributing to a unit's intramural R&D				
Dependent	Professionals and technical employees acting as intramural R&D consultants in fulfilment of the provision of a scientific or technical service by their employer(s) to the statistical unit reporting intramural R&D.			
Independent	Leased employees ⁷ are included in this category. Self-employed professionals acting as intramural R&D consultants			

1. The category "employees" is intended to include all persons engaged in the economic activity of the statistical unit other than working proprietors and unpaid family workers. It includes outworkers when they are paid by and are under the control of the same statistical unit. Employees engaged in activity ancillary to the main activity of the unit are also included, as well as the following groups: persons on short-term leave (sick leave, annual leave or vacation); persons on special paid leave (educational or training leave, maternity or parental leave); persons on strike; part-time workers, seasonal workers and apprentices when on the payroll.

2. Includes active business partners. Silent or inactive partners whose principal activity is conducted outside of the statistical unit should be excluded.

3. Family workers who receive pay for work performed should be classified as employees.

4. These categories may apply in more than one sector. Those where they are expected to have the largest impact are highlighted.

5. Students should be included only under the condition that they are formally engaged in R&D of the host institution.

6. Volunteers who are contributing to the intramural R&D activities of non-profit institutions should be clearly identified by the statistical unit reporting R&D activities, in terms of qualification and tasks actually undertaken.

7. Leased employment entails the provision for a fee of human resources for client businesses. Leased employees are on the payroll of an employment agency rather than the payroll of the statistical unit paying the fee. This provision of human resources is typically conducted on a short-term basis. The following are *excluded* from leased employment: Purchased or managed services, such as janitorial, guard or landscape services; Professional or technical services purchased from another firm, such as software consulting, computer programming, engineering, and accounting services. Exclude temporary staffing obtained from a staffing service, contractors, subcontractors or independent contractors if such personnel are not contributing directly to the intramural R&D of the statistical unit.

5.17 For the purpose of this manual, a concise definition of external R&D personnel can be given with reference to the main characteristics of R&D personnel not belonging to the group of “persons employed”:

5.18 External R&D personnel are independent (self-employed) or dependent (employee) workers fully integrated into a statistical unit’s R&D projects without formally being persons employed by the same R&D-performing statistical unit.

5.19 External R&D personnel are usually professionals or technicians with a high degree of skill and specialisation in R&D activities. Since the skills of external R&D personnel are assumed, by definition, to be equivalent to those of similar employed internal R&D personnel, it is possible that a statistical unit in any economic sector could perform intramural R&D by engaging the services only of external R&D personnel and not have any employed R&D personnel.

5.20 Quite often external R&D personnel are self-employed professionals and, as such, they should be classified as individual business enterprises. In some cases, they are employees of external organisations, research institutes or enterprises that market technical or scientific services that are delivered by skilled employees. In other cases, employment agencies do not sell a specific “R&D service” to customers but offer the option of hiring skilled workers for a given period of time to meet a specific customer’s need. Additionally, some individuals are employees of institutions – for instance, university professors or public researchers, in some countries – who are allowed by their employers to engage in market-based professional R&D activities while still fulfilling their institutional job requirements. In such situations, it is not unusual for a single individual to have multiple affiliations, and therefore the same individual could be reported by two or more institutions.

5.21 In addition to self-employed persons and employees of other statistical units who are hired as external R&D personnel, there are several other categories of individuals who perform tasks similar to such individuals and therefore should be included in external R&D personnel totals.

5.22 In the Higher education sector, doctoral and master’s students (see text below, “Treatment of doctoral and master’s level students” for guidance on their inclusion) and individuals who are R&D grant holders could be treated differently in accordance with their employment status. If a higher education institution gives them a status of employees (or, conversely, the institution’s employees were enrolled as doctoral students),—i.e. they are on the payroll of the university—such persons should be included in R&D personnel totals as “persons employed” (internal R&D personnel) by the university (or by any other statistical unit in the Higher education sector). However, if they are not on the payroll of the university, such doctoral students and grant holders should be included in the R&D personnel totals as external R&D personnel when receiving compensation, whatever its source and funding channel, for the R&D activity they undertake. It is also possible that doctoral students who do not receive

funding are nonetheless included in R&D personnel totals as external R&D personnel. This guidance for students who do not receive funding holds also for master's level students, as long as they are enrolled in research master's degree programmes and the FTE research component can be reliably identified and separated from the tuition component.

5.23 A specific type of external R&D personnel can be identified (almost exclusively) in the Higher education sector, namely that of a “professor emeritus”. These individuals are retired professors who continue to research and collaborate in the academic activities of their former employer – usually a university – without receiving any compensation (although, they may receive some logistical support for their activities). To qualify as an external contributor to the higher education statistical unit's intramural R&D, such individuals must have been on the payroll of a university before retiring and they must still be actively involved in research even though they are, quite often, no longer involved in teaching. Since their contribution to the intramural R&D of an institution may not be negligible, it is therefore appropriate to include them in the external R&D personnel totals.

5.24 There is a final category of persons that potentially might be included (for measurement purposes) in external R&D personnel: that of individuals contributing to intramural R&D on a voluntary basis. Volunteers are unpaid workers providing a statistical unit with a defined and active R&D contribution, under the responsibility of the R&D-performing unit. This category could make a more significant difference to estimated totals in the case of the Private non-profit sector. Volunteers can be included in the external R&D personnel totals only under very strict criteria:

- They contribute to the R&D intramural activities of (private non-profit) institutions.
- Their research skills are comparable to those of employees. For example, individuals who volunteer to participate as subjects in clinical trials, lend computer processing support to R&D projects, etc., should not be included in the external R&D personnel totals.
- Their R&D activities are systematically planned according to both the needs of the volunteers and to those of the institution.
- Their contribution should be appreciable and an essential condition for enabling the institution to undertake an intramural R&D activity or project.

R&D personnel and R&D expenditure categories crosswalk

5.25 The treatment of R&D personnel and their related costs may differ according to their employment status (see Table 5.2) as explained below. As already noted there are two main groups of individuals that may be distinguished when reporting R&D personnel and their costs—R&D persons employed that

comprise internal personnel and external R&D personnel. The latter includes persons employed by others and several special cases of external personnel who are not employees.

Table 5.2. Identification and reporting of R&D personnel and categories of R&D expenditures

Classification	Persons' employment status	Description	Institutional sector	Reporting of R&D expenditures
Internal R&D personnel contributing to a unit's intramural R&D	Person employed (dependent)	Employees ¹	Not relevant for government and higher education sectors and for most private non-profit institutions	Labour costs (payroll data)
	Person employed (independent)	Working proprietors, unpaid family workers, etc		Usually not reported because they do not receive remuneration
External R&D personnel: employees	Self-employed consultants	Contributors to the intramural R&D of their customers on a contractual basis		Other current costs-external R&D personnel
	Employees of other units hired as R&D consultants	Contributors to the intramural R&D of their employers' customer on a salary basis		Other current costs-external R&D personnel
External R&D personnel: special cases	Doctoral/Master's students		To be found primarily in higher education institutions but also in other institutional sectors	Other current costs-external R&D personnel (to the extent students receive R&D grants or external wages/salaries)
	R&D grant holders		To be found mainly in higher education institutions and in government R&D institutions	Other current costs-external R&D personnel (to the extent R&D grants would be reported)
	Volunteers		To be paid special attention within private non-profit institutions	Usually not reported because they do not receive remuneration
	Professors emeritus (similar to volunteers)		Specific case to be found almost exclusively in higher education institutions	Usually not reported because they do not receive remuneration

1. Includes Doctoral/Master's students on the R&D performing unit's payroll. It may be useful to obtain separate counts for students on payrolls of higher education institutions.

Group 1. Internal R&D personnel (i.e. persons employed contributing to a unit's intramural R&D), including:

- Employees (i.e. persons employed, dependent workers) working on R&D are considered an integral part of the statistical unit and their salaries/wages should be included in the **labour costs** of the reported intramural R&D expenditure. Doctoral/Master's students are included in the internal R&D personnel totals if they are on the payroll of the statistical unit to which they contribute R&D. (See text below, "Treatment of doctoral and master's level students" for further classification guidance.)
- Working proprietors and other persons employed as independent workers are usually not directly paid for their work.

Group 2 (i). External R&D personnel who are not employed by the statistical unit reporting its R&D but are employed by others and who provide direct services as an integral part of an R&D project or activity of the reporting unit, under a specific contract, should not be included in the R&D labour costs. Rather, their costs should be included with **other current costs** (preferably in a subcategory other current R&D costs—external R&D personnel) under the unit's intramural R&D expenditure. They can be:

- Employees of other units hired as R&D consultants, contributing to the intramural R&D of the customers of their employers on a salary basis.
- Self-employed consultants, contributing to the intramural R&D of their customers on a contractual basis. Self-employed consultants are also commonly referred to as "R&D contractors".

Group 2 (ii). External personnel who are not employed by the unit but who undertake R&D tasks similar to that provided by other internal R&D personnel:

- Doctoral/Master's students are included in the external R&D personnel totals if they receive compensation for their R&D activity, other than through wages/salaries provided by the R&D-performing statistical unit. If they are compensated through "R&D grants" or external wages/salaries, these should be reported as "other current R&D costs—external R&D personnel". (See text below, "Treatment of doctoral and master's level students" for further classification guidance.)
- R&D grant holders do not receive a salary. Monetary costs associated to their R&D grants can be reported, if available, in other current R&D costs.
- Volunteers contributing to intramural R&D are usually not directly paid for their work.
- Professors emeritus contributing to intramural R&D mainly in higher education institutions are usually not directly paid for their work.

As outlined above, total R&D personnel are composed of two main groups of individuals: persons employed performing R&D (i.e. internal R&D personnel, a sub-group of the total persons formally employed by the statistical unit) and

persons performing R&D not employed by the statistical unit (i.e. external R&D personnel). It is recommended that, as far as possible, data for these two groups should be separately identified, collected and reported in terms of both personnel and expenditure data. The need for consistency between R&D personnel and expenditure data, as well as the need for accurate reporting on the composition of the R&D workforce, provide the basis for this recommendation.

5.26 When collecting data from units that provide (lease) R&D personnel to other R&D-performing units, it is important that these R&D personnel service providers not include such external R&D personnel and their related R&D costs as part of their own intramural R&D. To do so would result in double counting. Since it may be the case that R&D personnel service providers also perform intramural R&D (either for own use or for sale), such units may have difficulty differentiating between personnel and expenditures for intramural R&D and for external R&D activities.

Treatment of doctoral and master's level students

5.27 Master's and doctoral students can be identified according to the level of their studies. They have completed university education at bachelor's level (ISCED level 6) and are studying at the master's (ISCED level 7) or doctoral level (ISCED level 8), respectively. (See Section 5.4, "R&D personnel and researchers by formal qualification", for definitions of ISCED categories.)

5.28 Doctoral students attend "tertiary programmes which lead to the award of an advanced research qualification [and which] are therefore devoted to advanced study and original research and are not based on course work only." Such students are usually required to submit a thesis or dissertation of publishable quality that is the product of original research and represents a significant contribution to knowledge. As a result, doctoral students at the ISCED level 8 *who are engaged as researchers* should be included in R&D personnel and expenditure measures of higher education institutions. The difficulty of identifying the borderline between the R&D and education and training activities of doctoral students (and of their teachers/mentors) is discussed in general terms in Chapter 9, Section 9.2.

5.29 In principle, all doctoral students contribute to the R&D activities of the university in which they are enrolled. Furthermore, universities are often entitled to a number of rights on the outcome of research on the basis of the supervision time and access to facilities. However, there may be no formal obligation for them to spend their time contributing to the intramural R&D performed by the university or even if there is, such obligations may not be enforced. By convention, a distinction is made between doctoral students receiving compensation or other types of financial support from the university (or from any other source) for their R&D activity and doctoral students without any compensation or financial support. In some cases, such compensation are salaries—the doctoral students are on the university's

payroll; in other cases, they simply receive a grant, usually a research grant or one with a research component. For practical reasons, it cannot be assumed that students without salaries/grants substantially contribute to their universities' R&D. Students receiving salaries or grants are more likely to do so. Only the latter should be included in the overall R&D personnel counts (internal or external depending on their funding arrangements); while the former may be included as external R&D personnel depending on particular circumstances, as explained below.

5.30 Master's students may in some cases be counted as researchers. This applies, in particular, to students following an ISCED level 7 research master's programmes, i.e. those leading to the award of research qualifications that are designed explicitly to train participants in conducting original research but are below the level of a doctoral degree. However, it is important to include in R&D personnel totals only master's students receiving some form of payment for their R&D activity or for which a significant FTE research component can be reliably identified and separated from the tuition component totals.

5.31 To facilitate international comparability, the following heuristic guidance on the classification and treatment of students engaged in R&D is recommended. Students are initially identified as students engaged in R&D, as described above.

- Case 1: Doctoral/master's students are paid—either through salaries or grants—by the R&D-performing unit to do research. They are internal R&D personnel and their costs are included with labour costs. They are not separately counted as students.
- Case 2: Doctoral students receive external or no funding to do research in the R&D-performing unit. They are external R&D personnel and their costs (when they are funded) are included with “other current costs-external R&D personnel”. Their costs can be tracked and reported by the performing unit, or they can be estimated at a sector level by the triangular approach (see Chapter 4, Section 4.4); steps should be taken to avoid the possibility of double counting. This guidance also extends to master's students to the extent they are receiving funding that is explicitly for R&D or for which a significant FTE research component can be reliably identified and separated from the tuition component. To the extent possible, it is recommended to obtain counts of doctoral/master's students, particularly for the Higher education sector. For some countries, it also may be useful to separately count doctoral students and master's students.
- Case 3: Doctoral students conduct only independent research, whether funded or not. They are not covered in R&D personnel counts but their funding may be counted with “other current costs” if they receive an external grant (that can be estimated at a sector level by the triangular approach; see Chapter 4, Section 4.4). This guidance also extends to master's students to the extent they are receiving funding that is explicitly for R&D.

R&D personnel by function

5.32 Following the identification of the individuals who potentially might contribute to the intramural R&D of a statistical unit, criteria are needed to identify the actual R&D personnel, i.e. those having effectively performed R&D in the reporting statistical unit during a specific reference period:

- For external R&D personnel contributing to a statistical unit's activities, there is no difference between potential and actual R&D performance, since such personnel are identified on the basis of specific evidence that they contribute to an intramural R&D activity.
- For "persons employed" by the statistical unit, including working proprietors, paid employees and other persons, one needs to consider the tasks undertaken by each individual in the R&D performance of the statistical unit in order to identify those having delivered a "direct" contribution to intramural R&D in the reference year. By convention, any kind or level (intensity) of direct contribution to R&D is sufficient to be classified as "R&D persons employed". Nevertheless, it is recommended to include in R&D personnel totals only those persons employed who have made an appreciable contribution to the intramural R&D as a percentage of their working time (with reference to a work year). See text on "Full-time equivalent (FTE) of R&D personnel" for general guidance on what might constitute an "appreciable" contribution.

5.33 Both groups of R&D personnel will need to be classified according to their R&D function: **researchers**, **technicians** and **other supporting staff**. This classification is often misinterpreted because of the common use of the terminology in a number of different contexts. In this respect, it is stressed that in this manual this classification of R&D personnel refers to the actual function (in terms of tasks) of the individuals contributing to the intramural R&D activities of the statistical unit. From a practical perspective, it is acknowledged that reporting units (and even statistical offices compiling R&D data) may sometimes rely on existing and easily accessible criteria for categorising R&D personnel. Hence, it may be useful to summarise criteria that should *not* be the sole basis for classifying R&D personnel as "researchers", "technicians" or "other supporting staff", although these criteria may *help* in identifying the appropriate classification category.

- *It is not based on job positions.* Although some employees have job contracts as "researchers", it does not necessarily mean that they undertake the tasks of "researchers" in all of their employer's R&D activities. In some cases, a "researcher" could perform the tasks of a "technician" in a specific R&D project. The latter should be reported in R&D statistics. Conversely, individuals with a formal position of "technician" could be asked to perform tasks similar to that of "researchers" for a specific project: again, it is the latter (i.e. the tasks actually performed by the individual) that should define what is reported on R&D surveys.

- It is not based on formal qualifications or level of education. While persons who hold a doctorate degree will most likely be involved in R&D projects as “researchers”, it should not be assumed that the R&D tasks undertaken by all individuals will always be consistent with their qualifications. For example, a technician with several years of work-related experience, but only a secondary education degree, might undertake tasks similar to that performed by a “researcher” in a given context.
- It is not based on seniority at work. It is not uncommon for young “researchers” to manage complex R&D projects and for colleagues (or consultants) with more experience to have functionally different roles (technical or administrative support, for instance).
- It is not based on employment relationships with the R&D-performing unit. Although most intramural R&D activities are managed by employees (or by working proprietors in small enterprises), it is also possible for external R&D personnel to perform the same R&D tasks as “persons employed”. As a consequence, a statistical unit can perform intramural R&D relying only on the R&D activity undertaken by external R&D personnel.

5.34 At times it may be necessary for analytical purposes to link the R&D personnel categories defined below to other labour force and employment data using international standard classifications such as the *International Standard Classification of Occupations* (ISCO) (UN-ILO, 2012) and the *International Standard Classification of Education* (ISCED) 2011 (UNESCO-UIS, 2012). See the text below for the classification of R&D personnel and researchers by formal qualification. In terms of identifying the main occupations in which R&D workers are found, ISCO-08 is the relevant reference document: researchers are classified in ISCO-08 Major Group 2, “Professionals”, and in “Research and Development Managers” (ISCO-08, 1223); technicians and equivalent staff are classified in ISCO-08 Major Group 3, “Technicians and associate professionals”; and other R&D supporting staff are essentially found in ISCO-08 Major Groups 4, “Clerks”; 6, “Skilled agricultural and fishery workers”; and 8, “Plant and machine operators, and assemblers”. By convention, R&D personnel working in defence are classified in ISCO-08 Major Group 0, “Armed forces occupations”.

Researchers

5.35 **Researchers are professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods.**

5.36 Researchers may be involved fully or partially in different types of activities (e.g. basic or applied research, experimental development, operating research equipment, project management, etc.) in any sector of the economy. Researchers identify options for new R&D activities, and plan for and manage them by using high-level skills and knowledge developed through formal education and training or from practical experience in performing research.

Researchers play an essential role in the conduct of an R&D project or activity. R&D projects generally are led by researchers (as contrasted with other R&D personnel who might serve as the lead on component parts of a project. Accordingly, every statistical unit performing R&D has at least one person who is a researcher; the researcher can be part of the unit's internal or its external R&D personnel, but need not be engaged full-time on R&D activities.

5.37 The tasks implemented by researchers in the framework of specific R&D projects or general R&D activities typically include:

- conducting research, experiments, tests and analyses
- developing concepts, theories, models, techniques, instrumentation, software and operational methods
- gathering, processing, evaluating, analysing, and interpreting research data
- evaluating the results of investigations and experiments and posing conclusions using different techniques and models
- applying principles, techniques and processes to develop or improve practical applications
- advising on designing, planning and organising the testing, construction, installation and maintenance of structures, machines, systems and their components
- providing advice and support to governments, organisations and businesses on the application of research results
- planning, directing and coordinating the R&D activities of institutions that provide related services to other organisations
- preparing scientific papers and reports.

5.38 Managers and administrators engaged in the planning and management of the scientific and technical aspects of a researcher's work are also classified as "researchers". Their position in the unit is usually equal or superior to that of persons directly employed as researchers; they are sometimes part-time researchers.

5.39 For practical reasons, doctoral students engaged in R&D should be counted as "researchers". They typically hold basic university degrees (ISCED level 7) and perform research while working towards their doctoral thesis (ISCED level 8). When they cannot be identified separately, they may be included either with technicians or with researchers; however, such practices may cause inconsistencies in the researcher series.

Technicians and equivalent staff

5.40 Technicians and equivalent staff are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, the physical and life sciences, or the social sciences, humanities and the arts. They participate in R&D by performing scientific and technical tasks involving

the application of concepts and operational methods and the use of research equipment, normally under the supervision of researchers.

5.41 In most cases technicians and equivalent staff do not run R&D projects independently of researchers. They essentially are implementing directions, on the basis of their experience and qualifications, which are given by researchers who are responsible for managing the R&D projects.

5.42 Nonetheless, technicians and equivalent staff tend to have a high level of autonomy in accomplishing their tasks since they are usually highly skilled workers. Tasks implemented by technicians and equivalent staff typically include:

- carrying out bibliographic searches and selecting relevant material from archives and libraries
- preparing computer programs
- carrying out experiments, tests and analyses
- providing technical assistance and support in R&D, or testing prototypes
- operating, maintaining and repairing research equipment
- preparing materials and equipment for experiments, tests and analyses
- recording measurements, making calculations and preparing charts and graphs
- collecting information using accepted scientific methods
- assisting in analysing data, keeping records and preparing reports
- carrying out statistical surveys and interviews.

Other supporting staff

5.43 **Other supporting staff includes skilled and unskilled craftsmen, and administrative, secretarial and clerical staff participating in R&D projects or directly associated with such projects.**

5.44 Other supporting staff includes any number of different jobs and skills. In principle, any activity contributing directly to the performance of intramural R&D that is not undertaken by researchers or technicians is undertaken by the supporting staff. Consequently, it is nearly impossible to provide an exhaustive list or description of the activities potentially carried out by R&D supporting staff; these activities range from administrative and secretarial work to the provision or the management of materials and devices needed to run an R&D project. These R&D personnel typically perform supporting functions connected to R&D such as planning, information and financial support, legal and patent services, and assistance in assembling, adjusting, maintaining and repairing scientific equipment and instruments. Managers and administrators dealing mainly with financial and personnel matters and general administration, insofar as their activities are a direct service to R&D, are included as "other supporting staff".

5.45 Importantly, only “direct support services” are included in R&D personnel statistics. For example, if the budget of a large R&D project is managed by an employed accountant working only for a specific research team, then a “direct” service provision can be identified: the accountant should be reported in the “other supporting staff” R&D personnel function and the related compensation costs should be reported in the “labour costs” of the R&D-performing statistical unit. On the other hand, if the “general accounting branch” of a large enterprise has the responsibility for managing the budgets of several intramural R&D projects carried out by different teams, then those activities represent an “indirect” administrative service: no R&D personnel are reported and the administrative costs generated by the R&D activities will be reported, for the purposes of R&D surveys, in “other current costs”.

5.3. Recommended measurement units

5.46 The measurement of R&D personnel (both internal R&D personnel and external R&D personnel) involves three exercises:

1. measuring their number in headcounts (HC)
2. measuring their R&D activities in full-time equivalent (FTE) or person-years
3. measuring their characteristics.

5.47 The value of collecting both HC and FTE statistics is based on the observation that R&D may be the primary function of some individuals (e.g. researchers in an R&D laboratory) but a secondary function of others (e.g. members of a design and testing establishment). It may also be a significant part-time activity (e.g. university professors, doctoral/master’s students, consultants and other external experts) and not necessarily involve R&D personnel on a full-time basis. Including only individuals whose primary function is R&D would result in an underestimation of the efforts devoted to R&D; however, including everyone spending any time at all on R&D in the R&D personnel totals would lead to an overestimation. The number of persons engaged in R&D must, therefore, be expressed both in HCs and FTEs: the two statistics provide users with complementary information.

5.48 To ensure compatibility between the two data series (FTEs and HCs), an integrated approach to measuring R&D personnel is proposed on the basis of the following principles:

- FTE is considered the main R&D personnel statistic for international comparisons.
- The use of HCs is mostly recommended in terms of exploring, usually in percentage terms, the characteristics of R&D personnel.
- Direct collection of R&D personnel data is the recommended methodology to be used for the production of both FTE and HC data series.

- There should be consistency between FTE and HC data regardless of whether the FTE and HC data are collected in a single statistical exercise or result from a coordinated effort of data collection from different statistical and/or administrative sources.
- When no direct data collection is possible, an estimation process can be undertaken in order to derive FTE and HC indicators from administrative data.
- Either *ex-ante* or *ex-post*, R&D personnel data must be consistent with R&D expenditure data, principally with the categories of “labour costs” and “other current costs-external R&D personnel”.

Full-time equivalents (FTEs) of R&D personnel

5.49 The Full-time equivalent (FTE) of R&D personnel is defined as the ratio of working hours actually spent on R&D during a specific reference period (usually a calendar year) divided by the total number of hours conventionally worked in the same period by an individual or by a group.

5.50 National statistical offices compiling R&D data should pay specific attention to the quantification of total working time, which is the basis for the calculation of full-time equivalent R&D personnel. Even though the evaluation of total working time and of working time devoted to R&D is not necessarily straightforward (particularly not for external R&D personnel), by convention it is noted that no one person can account for more than **one FTE** in a single year and hence cannot perform more than **one FTE on R&D** on an annual basis.

5.51 In practice, however, it may not always be easy to apply this principle. Some researchers, for example, may have activities in several R&D units. This is a common situation for academics who also are external R&D consultants to business enterprises. In such cases, it may be necessary to reduce the FTE of a single individual to one, if such information on multiple R&D contributions to multiple statistical units is available. The same principle should be adopted in those cases when the total R&D FTEs are estimated on the basis of administrative data.

5.52 In order to be included in the R&D personnel totals, an individual should make an appreciable contribution to the R&D performed. Therefore, for both internal personnel and external personnel, it is recommended to express FTEs in decimals and to check for the significance of the contribution to a unit's R&D performance by individuals spending less than **0.1 FTE on R&D** on an annual basis (i.e. 10 per cent of the total working time, which is about 20 working days per year).

5.53 It should be noted that when very small contributions to R&D, in terms of working time, are included in the R&D personnel totals (a few days per year of R&D activity, for instance), it could be difficult – both at the unit level and at an aggregate level – to report appropriately about the characteristics of the

R&D personnel (their R&D function, for example), as noted in Section 5.2 and further detailed in Section 5.4 below.

5.54 Total R&D personnel in FTE terms includes the R&D performance, on an annual basis, by **all individuals** – internal R&D personnel and external R&D personnel, including volunteers – who contributed to the intramural R&D of a statistical unit, an institutional sector or a country.

5.55 Total employed R&D personnel in FTE terms includes the R&D performance, on an annual basis, by all internal personnel who contributed to the intramural R&D of a statistical unit, an institutional sector or a country.

5.56 Reporting units should be explicitly advised to include the relevant R&D contribution (in terms of working time) of full-time and part-time individuals, including permanent and temporary personnel, in their FTE totals. See this Section on “Estimation of FTE indicators” for examples on how reporting units might calculate the FTE R&D contributions of various R&D personnel if they do not keep detailed records of the R&D activities of their staff.

5.57 Even though it is recommended that the FTE of all individuals contributing to intramural R&D in the reference period be individually calculated in order to estimate the total FTE R&D personnel, some statistical units responding to R&D surveys may choose to produce their estimates based on the “average number” of individuals contributing to the intramural R&D during the reference period. In this case, it is strongly recommended to check for consistency between the reported total FTE R&D personnel and the reported total HC R&D personnel. By convention, any measure of R&D personnel expressed in FTE terms should be equal to or less than the same measure expressed in HC terms, at any level of aggregation.

Headcount (HC) of R&D personnel

5.58 The headcount (HC) of R&D personnel is defined as the total number of individuals contributing to intramural R&D, at the level of a statistical unit or at an aggregate level, during a specific reference period (usually a calendar year). Various options are available for reporting headcount numbers:

- number of persons engaged in R&D at a given date (e.g. end of period)
- average number of persons engaged in R&D during the (calendar) year
- total number of persons engaged in R&D during the (calendar) year.

These three options may result in different numbers, and the last option is prone to double counting. The preferred approach for measuring headcount data for R&D personnel should be as of a given date (first option). Preferably, the point in time should be the same for all reporting units within all sectors of the reporting country. The choice of the point in time should take into account potential seasonality and other factors that may skew totals during the year and is left to each country to decide, as this seasonality may be highly country-specific.

Insofar as possible, the date used should be similar to that used for collecting other statistical headcount series (e.g. employment, education) with which the R&D series are likely to be compared.

5.59 Consistency between HC and FTE totals is a priority when producing R&D personnel data. As a result, all individuals included in the FTE totals should also be included in the HC totals, i.e. everyone who contributed to intramural R&D in the reference period should be reported consistently both in HC and in FTE terms. Similarly, individuals engaged in R&D who are not included in FTE totals (i.e. individuals spending less than 0.1 FTE on R&D on an annual basis) also should not be included in R&D personnel HC totals. It should be noted that the inclusion of all individuals who might make very small contributions to R&D activities could greatly exaggerate reported R&D personnel totals, making international comparisons problematic and making reporting on R&D personnel characteristics difficult (see Section 5.4).

5.60 When reporting headcount aggregate numbers of, it is likely that individuals who contribute to the R&D of two or more statistical units (either business enterprises or other institutions) will be double-counted. The indicator may be interpreted as a sum of jobs. Working in terms of FTE totals provides a more accurate estimate of the human resource input to R&D.

5.61 When there is incomplete information available on the characteristics of external R&D personnel, rather than not reporting them in HC totals, it is recommended to collect as much information as possible on them and report them in a line separate from persons employed. Ideally, some basic R&D personnel indicators – both FTE and HC – should be collected by their type of employment as detailed in Section 5.2: such as persons employed (whose remuneration is reported in the “labour costs”); paid external R&D personnel (whose remuneration is reported under a specific sub-category of “other current costs-external R&D personnel”); and all others (who are contributing to intramural R&D activity without any compensation). To summarise, the recommendations for producing HC statistics by means of direct data collection (surveys) are as follows:

- Identify total R&D personnel including internal personnel engaged in R&D and all external R&D personnel contributing to intramural activities. (Regarding the total number of internal personnel, it is recommended to use, as a reference, up-to-date administrative registers and, for the business sector, official business registers when available.)
- Compile and report the data on internal R&D personnel separately from the data on external R&D personnel (both compensated and unpaid personnel). Separate totals should be compiled for students working in R&D who are part of the external R&D personnel totals.
- Produce separate HC time series for the two groups of the R&D personnel. A number of basic features of this group of workers should be available to the statistical unit since they include internal personnel working in the unit and

involved in R&D, as well as external R&D personnel who have contributed “on site”, or at least in close geographical proximity, to the unit’s R&D activities. If this is not possible, compile such data at least for the internal R&D personnel who have contributed to intramural R&D in the reference period.

Coordinated data collection of FTE and HC data

5.62 The step-by-step survey process for collecting HC and FTE totals is summarised in Box 5.1.

Box 5.1. Data collection and reporting process

1. Total persons employed in the statistical unit that performed intramural R&D in the reference year (usually available from business registers). All of them are “potentially” R&D contributors (N_t).
2. Persons employed in the statistical unit (HC) who actually contributed to intramural R&D in the reference year (HC_{int}).
3. Persons employed in the statistical unit (FTE) who actually contributed to intramural R&D in the reference year, weighted for the share of the working time devoted to R&D; 100% = 1 (FTE_{int}).
4. External R&D personnel (including unpaid personnel) (HC) who actually contributed to intramural R&D in the reference year (HC_{ext}).
5. External R&D personnel (including unpaid personnel) (FTE) who actually contributed to intramural R&D in the reference year, weighted for the share of the working time devoted to R&D, 100% = 1 (FTE_{ext}).

$$\text{Total R\&D personnel (HC)} = HC_{int} + HC_{ext}$$

$$\text{Total R\&D personnel (FTE)} = FTE_{int} + FTE_{ext}$$

$$\text{Employed R\&D personnel/Total persons employed ratio} = FTE_{int} / N_t$$

5.63 It is highly recommended that R&D surveys collect on a single form all available data on both R&D-related expenditures and R&D personnel (HCs), including their level of engagement in R&D (represented by FTEs) directly from R&D-performing units. This approach minimises the costs of data collection and provides the highest degree of consistency between the different R&D indicators. Such expenditure-personnel consistency checks should be part of the data-capture process. By convention, FTE counts should be less than or equal to HC counts.

5.64 The basic relationships between R&D expenditure and HC and FTE R&D personnel totals are summarised in Table 5.3.

Table 5.3. **Consistency in R&D data collection**

R&D expenditure		FTE R&D personnel totals		HC R&D personnel totals
Labour costs	↔	Internal R&D personnel (persons employed)	≤	Internal R&D personnel (persons employed)
Other current costs-external R&D personnel	↔	External R&D personnel	≤	External R&D personnel
Not applicable		Unpaid R&D personnel	≤	Unpaid R&D personnel

Estimating FTE and HC indicators of R&D personnel

Estimation of FTE indicators

5.65 Under some circumstances, it may not be possible to carry out direct data collection of FTE and HC personnel. Thus, in order to make R&D personnel data available, it may be necessary to estimate these indicators on the basis of information available from sources other than direct surveys. In such circumstances it is strongly recommended that national statistical offices check for consistency between reported R&D expenditure and estimated R&D personnel totals.

5.66 The FTEs of R&D personnel should be estimated at the level of the reporting unit. This is done using information available at the level of the institution (e.g. from administrative data) or sometimes at the level of individuals (e.g. time-use surveys). Time-use surveys can be a useful source of data in the absence of other robust data sources and are commonly used for deriving FTEs of R&D personnel in the higher education sector. See Chapter 9 for more details regarding Higher education time-use surveys.

5.67 The first step for estimating FTE R&D personnel is to collect detailed information (from administrative sources if survey data are not available) on the actual or contractual (normative/statutory) involvement of R&D personnel in intramural R&D. This approach could be straightforward when estimating public research institutions (or universities) totals since working roles and employment statuses in those sectors are often formally defined.

5.68 Data for full-time R&D personnel and part-time R&D personnel should be separately identified and reported, for both “R&D persons employed” and “external R&D personnel”. A full-time person therefore will be identified with reference to their employment status, the type of contract (full-time or part-time worker) and the level of their engagement in R&D.

5.69 Accordingly, one FTE of R&D personnel is equivalent to one individual working full-time on R&D. It is measured by combining two variables: actual involvement in R&D activities and formal engagement on the basis of normative/

statutory working hours. When information on one of these two variables is not available, the calculation could be based on only one of the two criteria.

5.70 Also when estimating FTE data, there are a number of challenges:

- identifying the time spent on R&D by an individual worker or by a group of R&D contributors versus the time spent on other activities
- taking into account the different employment patterns of the relevant R&D personnel, i.e. working full-time, part-time or on a temporary basis
- selecting the appropriate data sources and methods to compile FTE totals.

5.71 The process of estimation can be summarised in the following formula:

$$\text{FTE} = \text{ftRD} + (\text{ntuRD}/\text{stu})$$

Where:

ftRD: number of full-time R&D personnel;

ntuRD: number of working hours spent on R&D by other categories of personnel;

stu: number of normative/statutory working hours of full-time personnel for a given sector/country.

5.72 For personnel not working full time on R&D, different circumstances can be identified:

- persons employed working part-time on R&D, as a result of either a reduced work schedule or a limited involvement in R&D activities
- persons employed (or external R&D personnel) working on a temporary basis during the reference period for which the FTE is calculated (e.g. a calendar year).

5.73 The following examples indicate how the formula could be used in the calculation of FTE totals:

- a full-time employee spending 100% of time on R&D during a year = 1 FTE
- a full-time employee spending 30% of time on R&D during a year = 0.3 FTE
- a full-time R&D person spending 100% of time on R&D employed at an R&D institution only for six months = 0.5 FTE
- a full-time employee spending 40% of time on R&D during half of the year (the person is only active for 6 months per year) = 0.2 FTE
- a part-time employee (working 40% of a full-time year) engaged only in R&D (spending 100% of time on R&D) during a year = 0.4 FTE
- a part-time employee (working 40% of a full-time year) spending 60% of time on R&D during half of the year (person is only active for 6 months per year) = 0.12 FTE.

Estimation of HC indicators

5.74 In compiling information on the size and composition of R&D personnel in HC terms, it is recommended to use, as much as possible, the data available from administrative and personnel registers (including payroll data, if relevant), as well as data from business registers when available. To the extent national statistical offices

are unable to produce consistent HC indicators for all groups of R&D personnel (internal R&D personnel, paid external R&D personnel, and unpaid/volunteer external R&D personnel), it is recommended that national statistical offices focus on identifying and estimating HC indicators for internal R&D personnel (i.e. R&D persons employed by the statistical unit performing the intramural R&D).

5.4. Recommended distribution of aggregate R&D personnel totals

HC and FTE R&D personnel characteristics

5.75 To address the needs of data users, aggregate HC and FTE totals should be distributed, to the extent practical, across a number of different variables: notably by sex, function, employment status, age and formal qualification, but also by seniority level, geographic origin and personnel flows.

R&D personnel by sex

5.76 In line with the Beijing Declaration following the 1995 World Conference on Women (United Nations, 1995), every effort should be made to produce gender-disaggregated data for statistics on R&D personnel. This applies to both FTE and HC totals and should be based on reliable information about the individuals belonging to both groups of R&D personnel: internal R&D personnel and external R&D personnel.

R&D personnel by R&D function

5.77 A key variable of interest is the distribution of R&D personnel by R&D function (researchers, technicians and equivalent staff, and other supporting staff). Even when the direct collection of personnel data is problematic, the identification of “who is doing what” in intramural R&D projects helps verify the accuracy of the R&D performance being reported by statistical units. Further, the collection and reporting of R&D personnel totals by function highlight the contribution by researchers to the overall R&D effort within a statistical unit, a sector of the economy or the entire economy. This breakdown is recommended for both FTE and HC measures of internal R&D personnel and of external R&D personnel.

R&D personnel by employment status

5.78 It is recommended that every individual included in R&D personnel totals be identified as an internal R&D personnel (i.e. “R&D person employed” whose remuneration is reported in the “labour costs”), as paid/compensated “external R&D personnel” (whose remuneration is reported under a specific sub-item of “other current costs”), or as “external R&D personnel” volunteers or volunteer equivalents (who are contributing to intramural R&D activity without any compensation). This breakdown is recommended for both FTE and HC measures of R&D personnel.

To the extent practical, it could also be useful to collect the breakdown between permanent employment and temporary employment. Some indicators, e.g. the average annual salary of a FTE researcher, could be made available only for R&D persons employed (whose data can be assumed to be already available in their employers' records).

R&D personnel by age

5.79 To report R&D personnel and specifically “researchers” by age, a breakdown into six categories is recommended. These categories are in line with the United Nations Provisional Guidelines on Standard International Age Classifications (United Nations, 1982):

- under 25 years
- 25-34 years
- 35-44 years
- 45-54 years
- 55-64 years
- 65 years and more.

5.80 Age data are often unavailable for external R&D personnel since age generally is not (or cannot be) an influential factor for hiring an individual to contribute to a statistical unit's intramural R&D. However, since there is considerable interest in age data, priority should be given to collecting this information for HCs of internal R&D personnel and of external R&D personnel only if the available information is reliable.

R&D personnel and researchers by formal qualification

5.81 In terms of classifying R&D personnel and specifically “researchers” by formal qualification, the *International Standard Classification of Education (ISCED) 2011* (UNESCO-UIS, 2012) is the relevant reference document. Five classes are recommended for the purpose of R&D statistics: separately, ISCED levels 5, 6, 7 and 8, and ISCED levels 1-4 combined. A breakdown into these five classes should allow for full comparability with other economic and social statistics.

5.82 The ISCED levels are defined exclusively by level of education, regardless of the field in which personnel are qualified.

- *Holders of university degrees at doctoral or equivalent level (ISCED level 8).* This category includes holders of degrees earned at universities proper and also at specialised institutes with university status.
- *Holders of university degrees at master's or equivalent level (ISCED level 7).* This category includes holders of degrees earned at universities proper and also at equivalent tertiary educational institutions.

- *Holders of university degrees at bachelor's or equivalent level (ISCED level 6)*. This category includes holders of degrees earned at universities proper and also at equivalent tertiary educational institutions.
- *Holders of other tertiary level diplomas (ISCED level 5)*. Subject matter is typically specialised, presented at a level requiring the equivalent of full secondary level education to master it. It provides a practically oriented/occupation-specific education and may also provide a pathway to other programmes at a tertiary level.
- *Holders of post-secondary non-tertiary diplomas (ISCED level 4)*. This class includes holders of degrees providing students who completed ISCED level 3 with the non-tertiary qualifications required for progression to tertiary education or for employment when their ISCED level 3 qualification does not grant such access.
- *Holders of diplomas of upper secondary education (ISCED level 3)*. This class includes not only all ISCED level 3 diplomas obtained in the secondary school system but also equivalent level 3 vocational diplomas obtained from other types of educational establishments.
- *Other qualifications*. These include holders of diplomas below ISCED level 3 or with education not falling under any of the other six classes.

5.83 However, it is recognised that it is difficult to collect reliable information on the level of education of internal personnel (and even more so for external personnel) and that employers do not necessarily keep updated records of the level of education attainment of their employees. In this respect, for the breakdown of R&D personnel and researchers by formal qualification priority should be given to collecting this information for HCs of internal R&D personnel.

R&D personnel by seniority level

5.84 Data on “seniority levels” can improve knowledge on R&D management practices and provide invaluable insight on researchers’ careers. For this variable, priority should be given to collecting this information for HCs of internal R&D personnel in the Government (see Chapter 8) and Higher education sectors (see Chapter 9).

R&D personnel by geographic origin

5.85 Data users are also interested in the geographic origin of R&D personnel, mainly to monitor the international mobility of researchers and of R&D personnel in general. Different criteria can be used to identify national origin: nationality, citizenship or country of birth. Other criteria may also be of interest, such as country of previous residence, previous occupation or country of study at the highest level. All have advantages and disadvantages and provide different types of information. The combination of two or more of these criteria will provide considerably more analytical information. On the other hand, it is difficult to identify reliable sources of information when collecting such data from employers. Priority should be given to collecting this information for HCs of internal R&D personnel.

R&D personnel flows

5.86 Finally, indicators on the flows of R&D personnel (newly recruited vs. leaving/retiring personnel), to complement available information that mainly focuses on the stock of R&D personnel, are frequently requested by users. Such information assists employers, analysts and policymakers to anticipate needs and possible shortages of R&D personnel. These indicators are of particular interest at the sector level, and therefore priority should be given to collecting this information only for HCs of internal R&D personnel.

Recommended tables on HC and FTE R&D personnel and researchers

5.87 To the extent practical, countries should separately collect information on the demographic characteristics of internal R&D personnel (R&D persons employed) and external R&D personnel. Such collections will over time allow for a more complete recording of all persons engaged in R&D and further enhance international comparisons. However, it is also recognised that such collections may be difficult if not impossible for some countries and that international comparisons may be misleading if countries report different aggregates of R&D personnel totals. Therefore it is recommended that priority be given to reporting national aggregates on internal R&D personnel and specifically “researchers” for the following demographic variables. For presentation purposes, and to differentiate these totals from those that include external R&D personnel, such aggregates are referred to as “national employed R&D personnel totals”. For comparison, aggregated totals of internal R&D personnel plus external R&D personnel are referred to as “national R&D personnel totals”.

5.88 Below are exemplars of recommended tables that should be produced for R&D personnel totals.

Table 5.4.a. **Total national R&D personnel by sector and by employment status**
(FTE and HC by sex)

	Sector				Total
	Business enterprise	Government	Higher education	Private non-profit	
a) Internal R&D personnel (i.e. employed R&D personnel)					
b) External R&D personnel (R&D personnel whose costs are reported as “other current costs-external R&D personnel”)					
c) Unpaid external R&D personnel (including volunteers and professors emeritus)					
Total					

Table 5.4.b. Total researchers by sector and by employment status
(FTE and HC by sex)

	Sector				Total
	Business enterprise	Government	Higher education	Private non-profit	
a) Internal researchers (i.e. employed researchers)					
b) External researchers (researchers whose costs are reported as "other current costs – external R&D personnel")					
c) Unpaid external researchers (including volunteers and professors emeritus)					
Total					

Table 5.4.c. Total national employed R&D personnel by sector and by R&D function
(FTE and HC by sex)

	Sector				Total
	Business enterprise	Government	Higher education	Private non-profit	
Researchers					
Technicians and equivalent staff					
Other supporting staff					
Total					

Table 5.4.d. Total national employed researchers by sector and by age
(HC by sex)

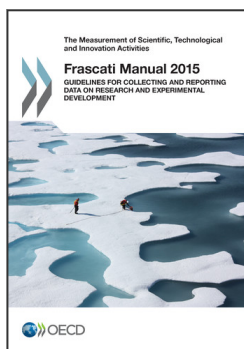
	Sector				Total
	Business enterprise	Government	Higher education	Private non-profit	
Under 25 years					
25-34 years					
35-44 years					
45-54 years					
55-64 years					
65 years and more					
Total					

**Table 5.4.e. Total national employed researchers by sector
and by level of formal qualification**
(HC by sex)

Holders of	Sector				
	Business enterprise	Government	Higher education	Private non-profit	Total
Tertiary degrees					
Doctoral or equivalent (ISCED 8)					
Master's or equivalent (ISCED 7)					
Bachelor's or equivalent (ISCED 6)					
Other tertiary level diplomas (ISCED 5)					
Other degrees (ISCED 1 to 4)					
Total					

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