

**OCCUPATIONAL EXPOSURES IN FRANCE IN 2006  
(BASED ON PASSIVE DOSIMETRY)**

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Introduction

To fulfil its tasks of consolidating results from occupational exposure measurements for statistical purposes (tasks conferred by decrees), the Institute for Radiological Protection and Nuclear Safety (IRSN) produces an annual evaluation of the exposure of workers to ionizing radiation ([www.irsn.org](http://www.irsn.org)). For the time being this analysis is done on the basis of the statistics transmitted to the IRSN by the approved passive dosimetry services.

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## Occupational exposures in 2006

In 2006, 278,150 workers (total monitored workforce both in industrial and medical sectors) received a collective dose of 52.07 man.Sv. The average annual individual dose for all monitored workers was 0.19 mSv and the average annual individual dose for monitored workers recording a dose higher than the recording threshold was 1.6 mSv. Only 11,484 workers recorded an annual individual dose higher than 1 mSv (4.1 % of the total workforce monitored). Twenty six workers recorded an annual individual dose higher than 20 mSv and among them, 5 workers recorded an annual individual dose higher than 50 mSv.

Four major domains may be considered, grouping respectively medical and veterinary activities, research and expertise activities, activities in the nuclear industry and those carried out in non-nuclear industries. Figure 1 illustrates the substantial differences in dose distribution for these four major domains in 2006.

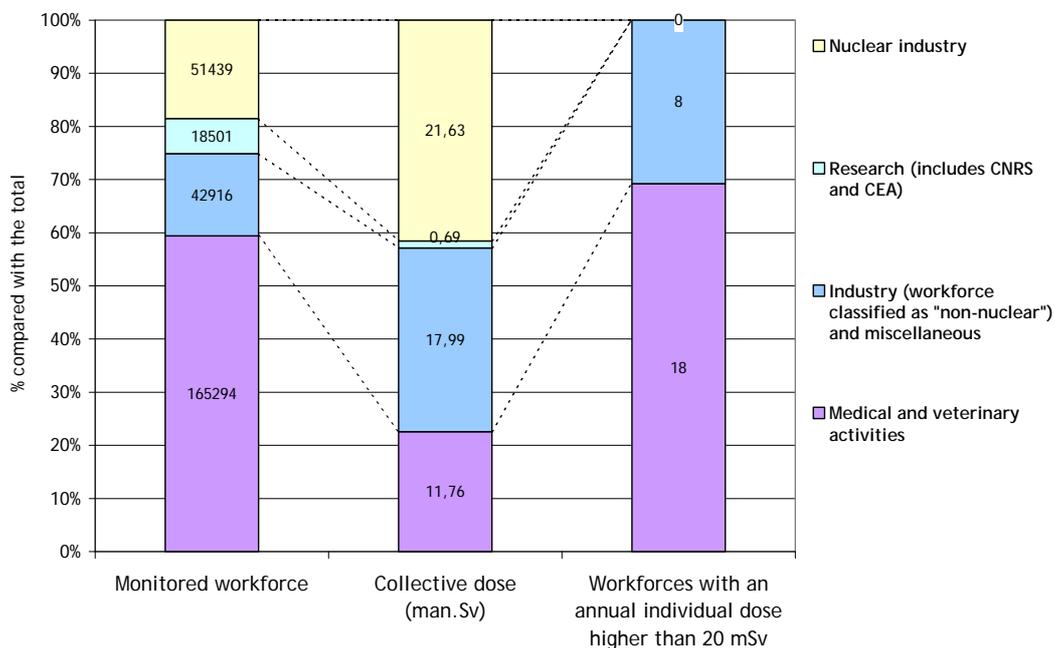


Figure 1 – Synthetic evaluation of external occupational exposure in 2006 by domains (monitored workforce, collective and effective doses where the annual individual dose is higher than 20 mSv)

Thus the medical sector accounts for over half the workforce monitored <sup>1</sup>, represents a little more than 20% of the collective dose but groups three quarters of the workers with an annual dose exceeding the regulatory limit of 20 mSv. The nuclear industry accounts for one fifth of the workforce and nearly half the total collective dose. Research is of minor importance in the collective dose and the "traditional" industry accounts for one third of the total collective dose in 2006.

All domains combined, only 17% of workers received at least once a dose higher than the recording threshold of the dosimeter.

<sup>1</sup> 101,800 monitored workers are counted particularly in medical radiology in 2006 (more than 36% of the total workforce). Medical radiology covers the techniques of conventional radiology, mammography, computed tomography and interventional radiography.

Trend analysis on the 1996-2006 period

If one takes a closer look to the evolution in the collective dose for all monitored workers, side by side with the changes in the number of these workers, over the 1996-2006 period (figure 2), it can be noticed that the collective dose drops regularly whereas the number of monitored workers tends to increase.

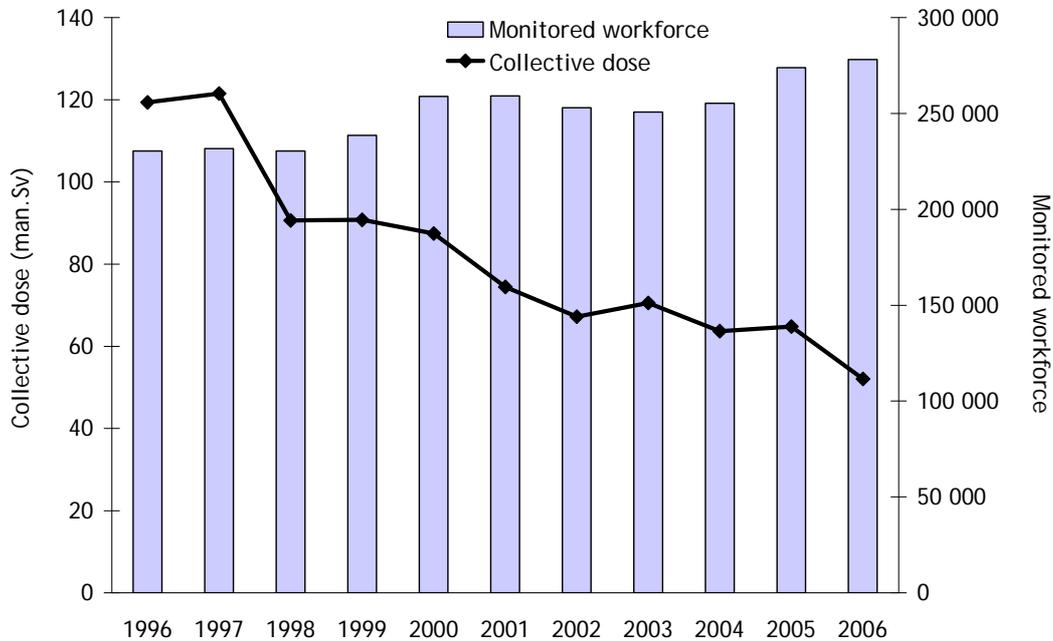


Figure 2 – Trends in monitored workforce and collective dose on the period 1996-2006

The nuclear industry, in which substantial efforts have been made to develop radiation protection, shows the clearest drop in the collective dose (the collective dose has been divided by two between 1996 and 2006, figure 3). In a less spectacular manner since the collective dose is lower, the medical and veterinary activities sector has also seen a decrease by a factor of two during the last 10 years.

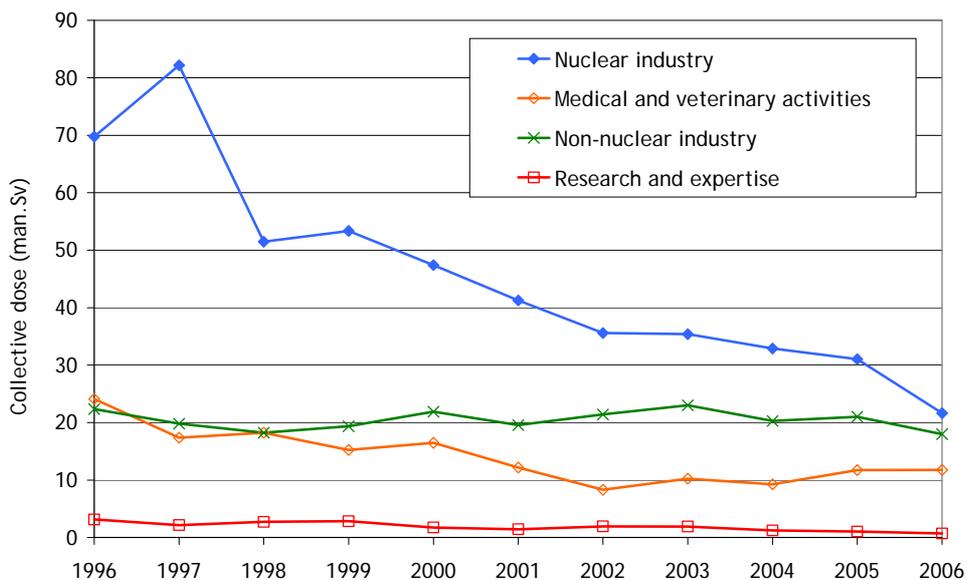


Figure 3 – Trends in collective dose from 1996 to 2006

### Monitored workers with an annual dose exceeding the regulatory limit of 20 mSv

26 cases of annual doses exceeding the regulatory limit of 20 mSv<sup>2</sup> were listed for 2006. This figure is subject to changes. In deed, a dose of more than 20 mSv is not permanently recorded in the IRSN's SISERI database<sup>3</sup> until there is confirmation from the occupational health doctor at the end of an inquiry.

These cases are not easily explained beyond acknowledged incidents or working conditions that are known to induce significant doses. In the great majority of cases in which the dose is cancelled at the medical doctor's request, this was due to dosimeters that had been exposed (intentionally or accidentally) although they had not been worn.

In some cases the dose was recorded as a precaution even though the result was considered dubious (for example, the operator thinks that his dosimeter was exposed in a radiation room where he himself was not present).

Conversely, it is possible that an exceeding of the regulatory limit might not be known because the worker simply did not wear his dosimeter.

Figure 4 illustrates the changes in the number of monitored workers with an annual dose higher than 20 mSv between 1996 and 2006.

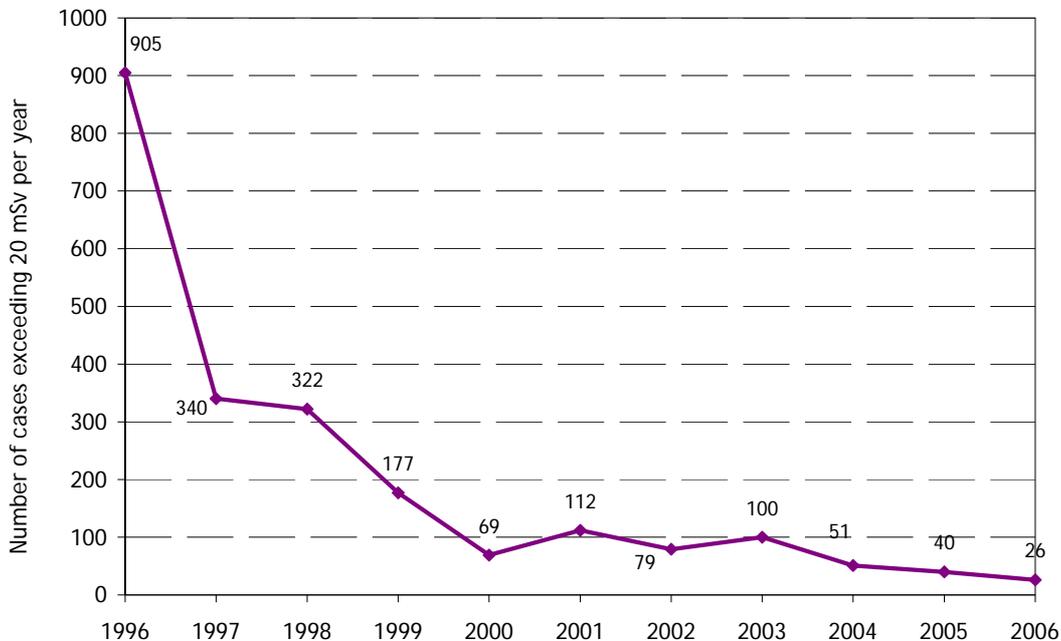


Figure 4 - Changes in the number of monitored workers with an annual dose higher than 20 mSv. 1996 to 2006

<sup>2</sup> The regulatory limit for the effective dose received over twelve consecutive months was 35 mSv up to 31 March 2005, when it dropped to 20 mSv.

<sup>3</sup> IRSN introduced the SISERI system to centralise, consolidate and store all the results from individual measurements of worker exposure, for use for statistical or epidemiological purposes. These results are also returned under certain conditions to medical officers and individuals skilled in radiological protection for use in optimising medical monitoring and the radiological protection of workers.

## Neutron dosimetry

In 2006, neutron dosimetry involved 25,861 workers. The collective "neutron" dose was 1.16 man.Sv (figure 5), with the activities in the Melox (Mox fabrication) facility accounting for 64% of this dose. There was no exceeding of regulatory limits due to the "neutron" doses (neither for whole body nor extremities) and the maximum individual "neutron" dose recorded was 6.4 mSv in 2006.

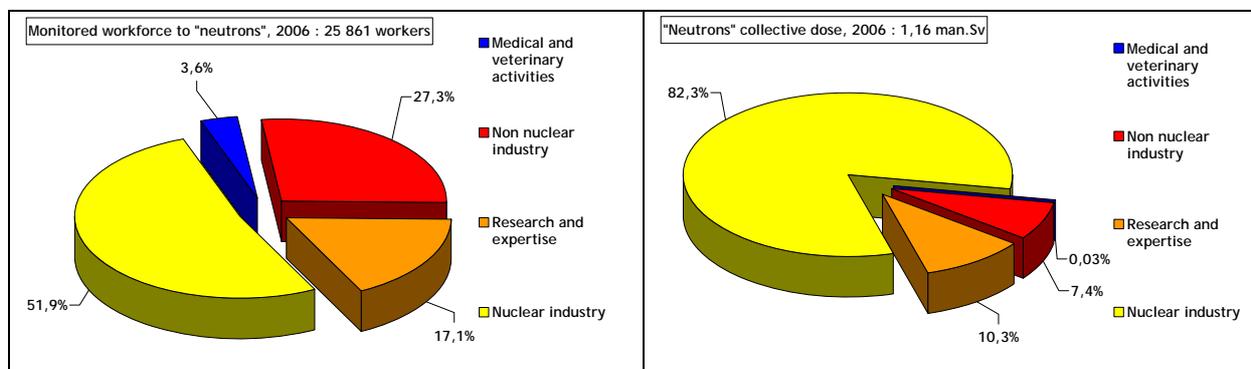


Figure 5 – Monitored workforce to "neutrons" and collective dose, 2006

## Wrists and fingers dosimetry

Extremity dosimeters (rings, "wrist" dosimeters) are worn by workers whose hands or members may be subjected during their work to significant exposure to ionizing radiation with respect to the rest of their bodies. This is the case for example for surgeons performing interventional radiology or operators handling radioactive sources in glove boxes.

In 2006, "wrist" dosimetry showed a total dose of 34 Sv for 14,631 workers monitored (figure 6).

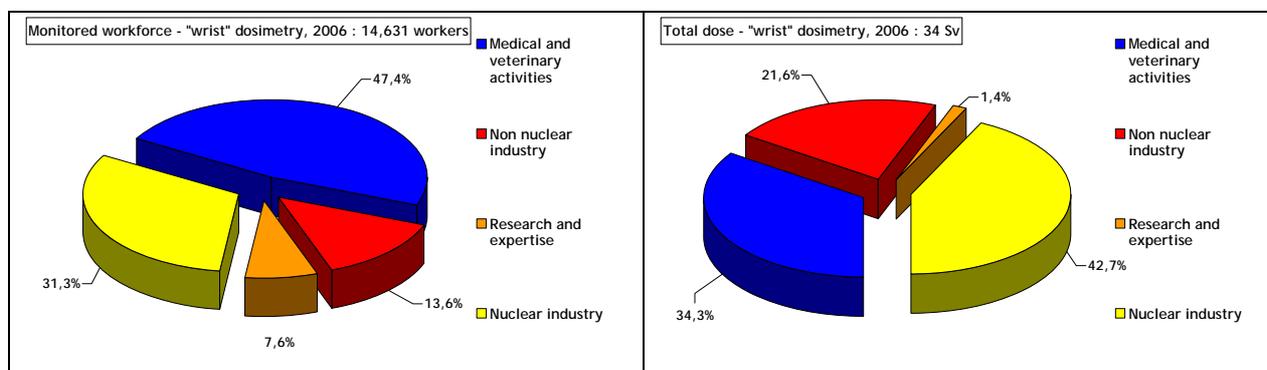


Figure 6 – Monitored workforce and collective dose – "wrist" dosimetry, 2006

The total dose for "ring" dosimetry was 36.6 Sv for 6,071 workers monitored in 2006 (figure 7). There was one case exceeding the limit of 500 mSv for "ring" dosimetry (thermoluminescent dosimeter) in the nuclear medicine.

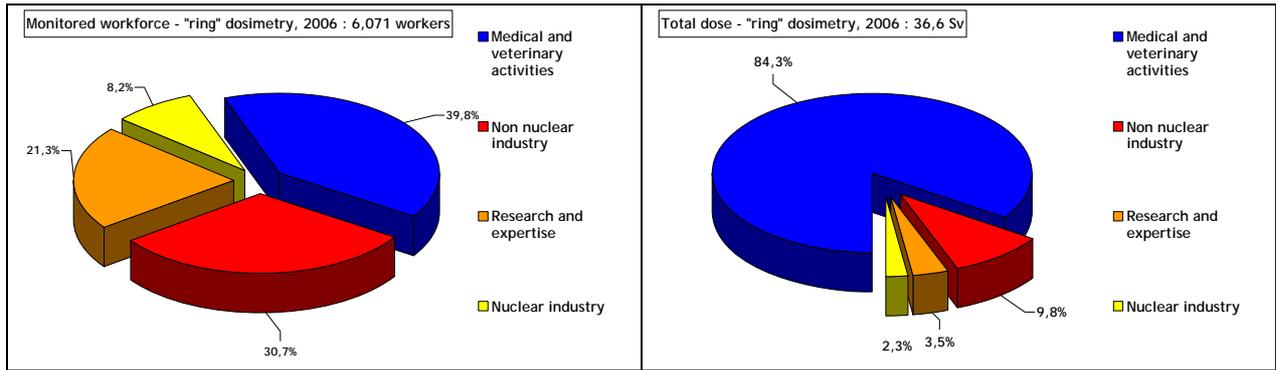


Figure 7 – Monitored workforce and collective dose – “ring” dosimetry, 2006

## Conclusion and prospects

The assessment for the external exposure of workers in 2006 was realised with the same method as years before. The variations observed from one year to another are low with regard to the collective dose.

Several key points already underscored in 2005 were confirmed.

The first one is the decrease in collective doses which began at the end of the 1990's. This has continued, especially in the nuclear industry and medical sectors while the corresponding number of workers monitored has increased. This positive change is due to the application of European directive 96/29/Euratom (1996), before it was even transposed into French regulations in March 2003. In the non-nuclear industry sector however, the collective doses have been mostly constant for the past ten years or so.

The second point is that the number of workers who received an annual dose greater than 20 mSv in 2006 has again decreased. As in the preceding years, the sectors with the most exposed workers are the medical and the non-nuclear industry sectors.

There are several ways to improve the robustness of future annual dosimetric evaluations:

- first, continuing the operational deployment of the SISERI system. Over time, this will allow for easier recording and processing of data and will improve occupational exposure statistics. It will allow for comparison of the results obtained from passive dosimetry and operational dosimetry, which is one of the elements for consolidation of dosimetric data;
- then establishing a new nomenclature of jobs and activities. This nomenclature, which would be common to employers, dosimetric monitoring laboratories and the IRSN, which is in charge of collecting and processing all dosimetric information (SISERI), is necessary to obtain better information to be used for analyzing data.

To obtain the complete panorama of external exposures to ionizing radiation at work places, the evaluation must also be widened:

- first, to supplement the assessment with data from the defence sector, in conjunction with the Radiological Protection Service of the Armed Forces which handles dosimetric monitoring for military personnel;
- and then to introduce doses received outside of the territory and to distinguish the data by workers' category (A and B in France).

***KEYWORDS: Occupational exposures***