I - INTRODUCTION
EDF (Electricité de France) owns 57 operating reactors distributed on 20 sites. Individual monitoring for intakes of radionuclides is done by whole body gamma countings and excretion bioassays. This monitoring concerns all EDF workers (about 20,000), and also subcontractor personnel (about 40,000 people per year).
The aim of monitoring is to detect any intake above the recording level and to assess, as precisely as possible, internal doses. ICRP publications N°30 and 54 are used for internal dose calculations (1).

II - MATERIALS ET ET METHODS
II-1 WHOLE BODY COUNTERS

Whole body countings (approximately 200,000 per year) are made by occupational health services on each nuclear site.
The equipment consists of:
- two whole body counters with two large NaI detectors, the approximate detection limit is 150 Bq in Co-60 for a 1-minute count.
- one shielded chair with two smaller NaI detectors (one for thyroid and one for thoraco-abdominal region), specially designed for iodine contamination case, or casualties on stretchers.
The counters are included in a medical network, connected by means of a security bridge to the nuclear site network. This special medical software program incorporates:

- an operating system containing a module to ensure the quality control of measurements
- a measurement interpretation system with a screening histogram facility for activity alarm levels and spectrometry gamma analysis
- an administrative database for nationwide monitoring of all EDF and non-EDF workers (2).

The quality assurance program daily checks the background level, the electronic parameters of the MCA acquisition cards, and the response of the system using a reference source placed in a fixed geometry. Quality measurements are compared with target values and a warning indicates any system alteration when the values are overrun.

A preliminary screening program sets up an alarm when derived reference levels are reached in predefined energy zones. The principle of the program is based on the division of the spectrum into twenty energy zones, each of 100 keV, and the transformation into an histogram. The height of a step is proportional to the number of counts recorded in the energy class corrected by subtraction of background noises and compton counts. The height is also inversely proportional to the ALI of a radionuclide chosen in the class. This program has been made with the legal authority (OPRI: Office de Protection contre les Rayonnements Ionisants). When alarm level is reached, spectrum analysis allows nuclide identification and activity calculation. At the same time, a working site investigation is carried out and the legal authority (OPRI) is informed.

The database encloses administrative and occupational inquiries, all the body counting measures and results.

II-2 RADIOTOXICOLOGY ANALYSES ON BIOLOGICAL SAMPLES

An EDF central radiotoxicology laboratory, located in the suburbs of Paris, analyses all the biological samples (about 8,000 per year, urines, faeces or nose blows) and centralises the results.

On the occupational health service’s request, the following analyses can be done:

- tritium activity measurements (liquid scintillation) with a detection limit of 75 Bq per litre,
- gamma spectrometry (HPGe detectors) on urines and faeces ash samples with a detection limit of 0.5 Bq per sample for one hour of counting (3),
- alpha spectrometry (after chemical treatment) on urines and faeces ash samples with a lower detection limit of 0.2 mBq per sample for 72 hours of counting,
- Beta and alpha total counts (ZnS scintillators) on nose blows used for monitoring alpha risks.
II-3 TYPES OF MONITORING

Routine, operational and special monitoring programs are carried out.
Routine monitoring is performed by body counting twice a year for EDF workers and on arrival and before leaving
the plant for other on-site workers.
During all the shutdown operations, biological samples for radiotoxicology analysis are taken if necessary: urines,
faeces or nose blows.
In special cases, when activities detected by body counting reached the derived reference level, urine and faecal
samples of three days are sent to the Laboratory.

II-4 QUALITY INSURANCE PROGRAMS

Quality insurance programs are applied for measurements and also for dose assessments.

For the measurements, especially for low activities of alpha emitters, yearly comparison exercises are organized by
PROCORAD association (CEA and COGEMA laboratories). More than 50 European and American laboratories
have participated in recent years (4).
By another way, OPRI, the radiation protection office of the Ministry of Health, organises intercomparison
measurements of laboratories.

For the quality control on dose assessment, the EDF laboratory participates in the comparison exercises planned by
EURADOS-CENDOS Working Group 6 (5).

III – RESULTS

III-1 COLLECTIVE DOSES

These results show that the collective effective dose is extremely low: 259.5 man-mSv for 93 cases over 17 years.
The protection methods used appear to be efficient.
III-2 INDIVIDUAL DOSES

The total of individual doses is very low. The internal contamination level is very low, and frequently negligible. Nevertheless, in some special cases, adding effective dose to external exposure doses could lead to a total dose higher than the regulatory limits.

The alpha emitters accounted for 68% of the total collective dose, against 32% for the gamma emitters with a significant place for Co-60.
<table>
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<th>YEAR</th>
<th>0.5 ≤ HE &lt; 5 mSv</th>
<th>5 ≤ HE &lt; 50 mSv</th>
<th>HE ≥ 50 mSv</th>
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<tr>
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</table>

① only dose equivalents higher than 0.5 mSv are recorded
② α = transuranium isotopes
③ table does not included 1999 results waiting for dose calculations
REFERENCES


2. Bailloeuil C., Gonin M., To measure internal exposure to ionising radiation, EDF is equipping its nuclear power station medical units with new whole body counting systems, IV congreso de Proteccion Radiologica de Paises Europeos del Mediterraneo Occidental, 219-220, Barcelone (1998).

