Radiation protection challenges at EDF

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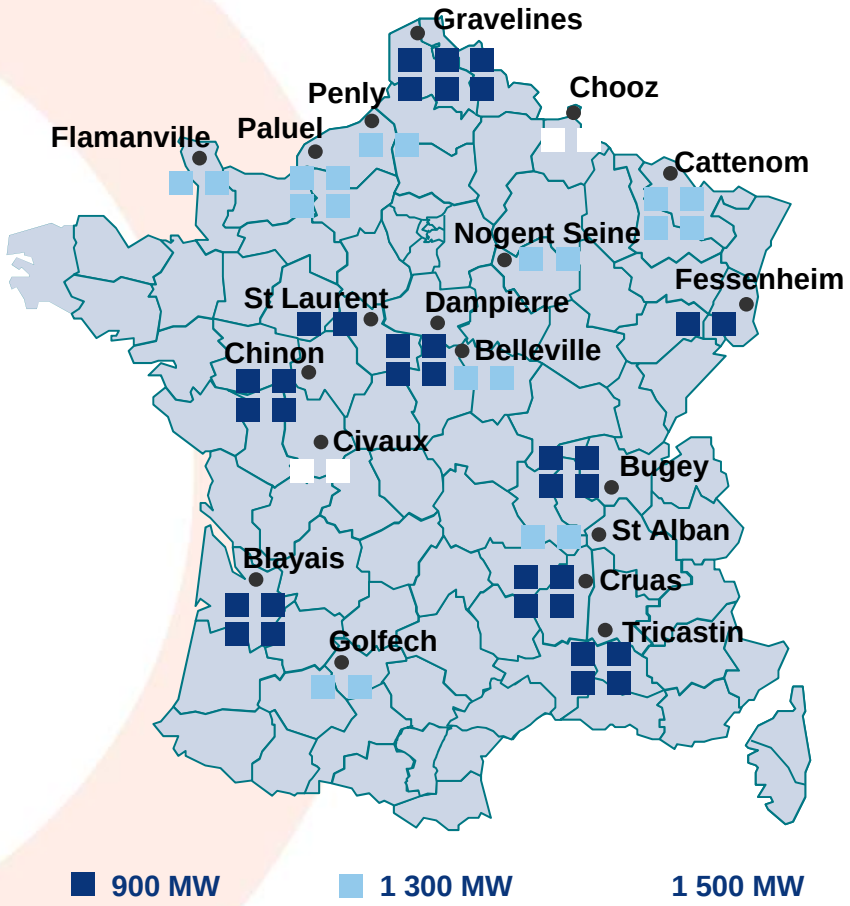
Occupational Health and Well Being VP

EDF Generation and Engineering

The French nuclear fleet

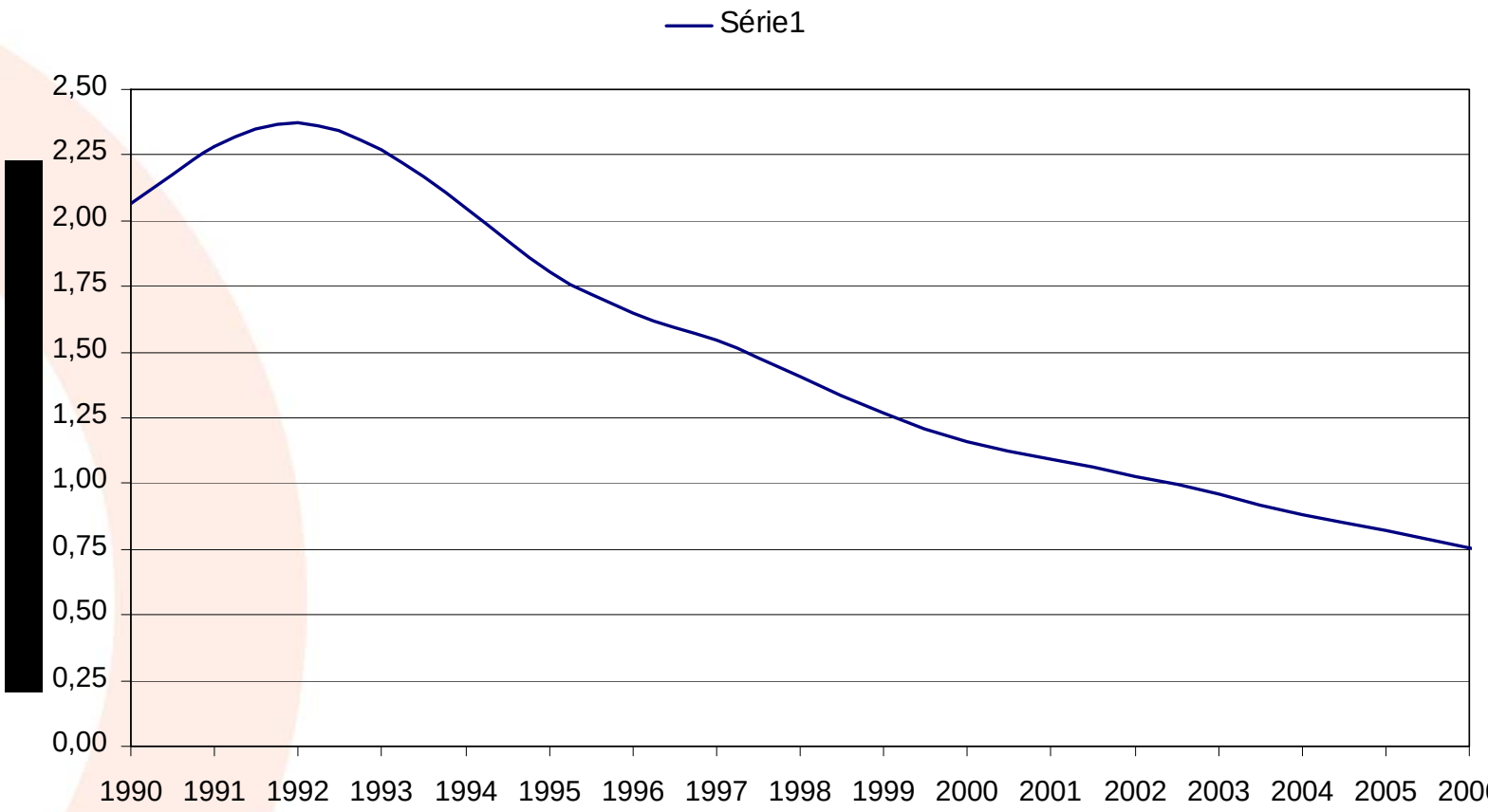
Nuclear power plants



- The largest generation fleet in Europe:
  - 58 reactors in operation,
  - Spread over 19 sites,
  - The same technology:
    PWR (pressurized water reactor),
  - 3 reactor series:
    - 900 MW: 34 units (31 GW),
    - 1 300 MW: 20 units (26 GW),
    - 1 500 MW (N4): 4 units (6 GW).
- EDF is the owner of the NPPS and of the sites.
- A new reactor EPR on construction in FLAMANVILLE and a planned new reactor in PENLY

Radiation protection achievements and performance

Collective radiation exposure

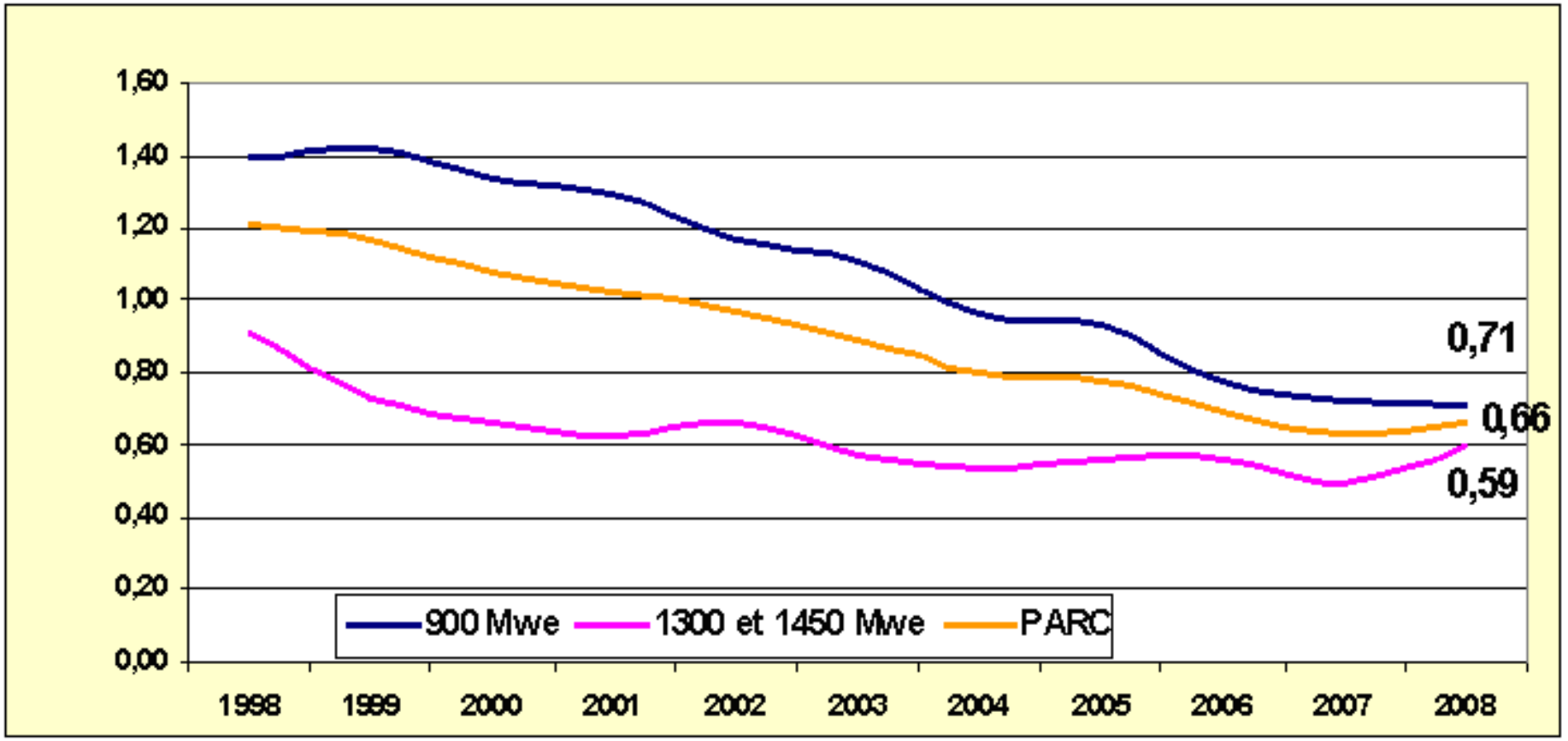


The efforts made by EDF and its contractors have contributed to reduce the collective radiation exposure per reactor by a factor of four in 15 years:

From 2.44 man.Sv in 1991 to 0.66 man.Sv in 2008

Collective radiation exposure

… for the total fleet



Control of source term

- Efforts on chemistry of the primary circuit to maintain and/or reduce source term: shutdown procedures, optimization of pH, filtration/resins, zinc injection, etc.:
  - Zinc injection to reduce the contamination of the primary circuit:
    - Use of international operating experience,
    - Experiments carried out on 2 units:
      - Bugey 2 - unit contaminated with cobalt: reduction by 20%,
      - Bugey 4 - steam generator replacement.

- Efforts on the reduction of the source term:
  - Give to NPP simple tools to identify (CZT) and to treat (flushing, etc.) pollutions,
  - National engineering project for “PWR high-dosimetry cleaning”.

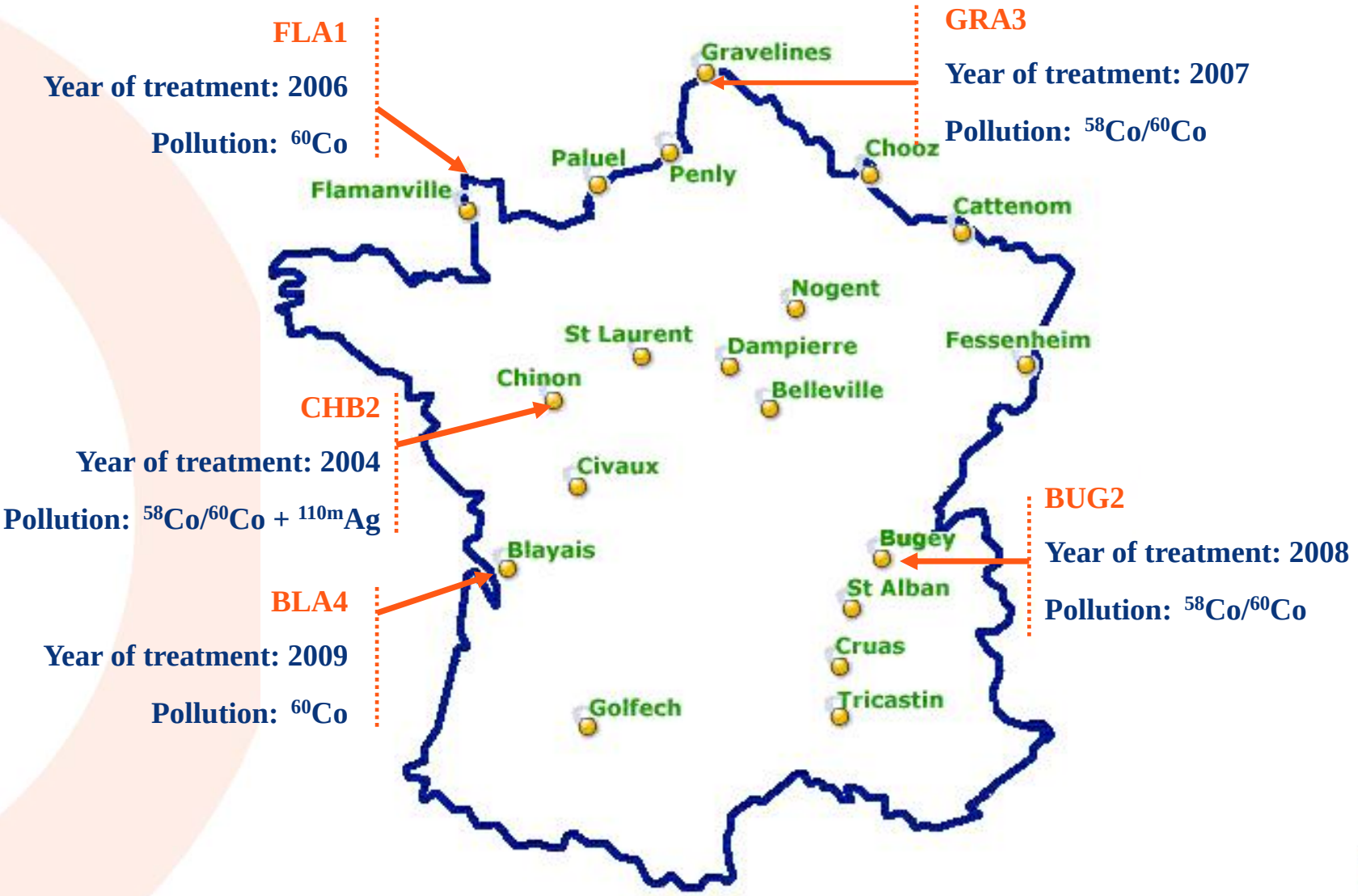
National engineering project for reduction of source term

- Treatment of 5 reactors between 2004 and 2009,

- Specific action plan developed for each reactor with:
  - Preventive actions (good practices, training, etc):
    - Control of source term,
    - Avoid re-pollution.
  - Curative actions:
    - Eradicate hot spots and fixed contamination,
    - Protect the workers from residual and recurring zones of pollution.

- Estimated saving of collective dose: about 1 Sv/reactor for the next 5 years.

National engineering project for reduction of source term



Optimization of radiation protection

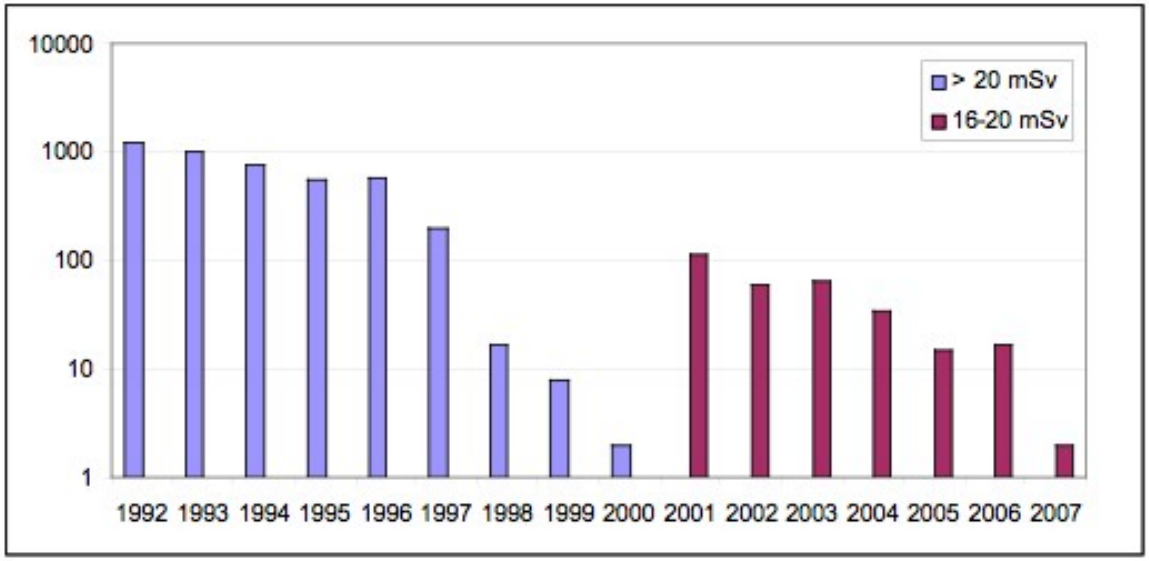
- Since 1992 ALARA approach has intensively been applied at EDF:
  - Involvement of management,
  - An important challenge: significant human and financial means,
  - Contracting firms rapidly involved: in 1997 signature of a charter between EDF and its contractors to make radiation protection a priority,
  - Considerable progress on high dose works, introduction of systematic dose planning and optimization approach.

- Development and use of a new information system for radiation protection (PREVAIR) as a tool to develop ALARA approach.

Optimization of radiation protection: individual radiation exposure

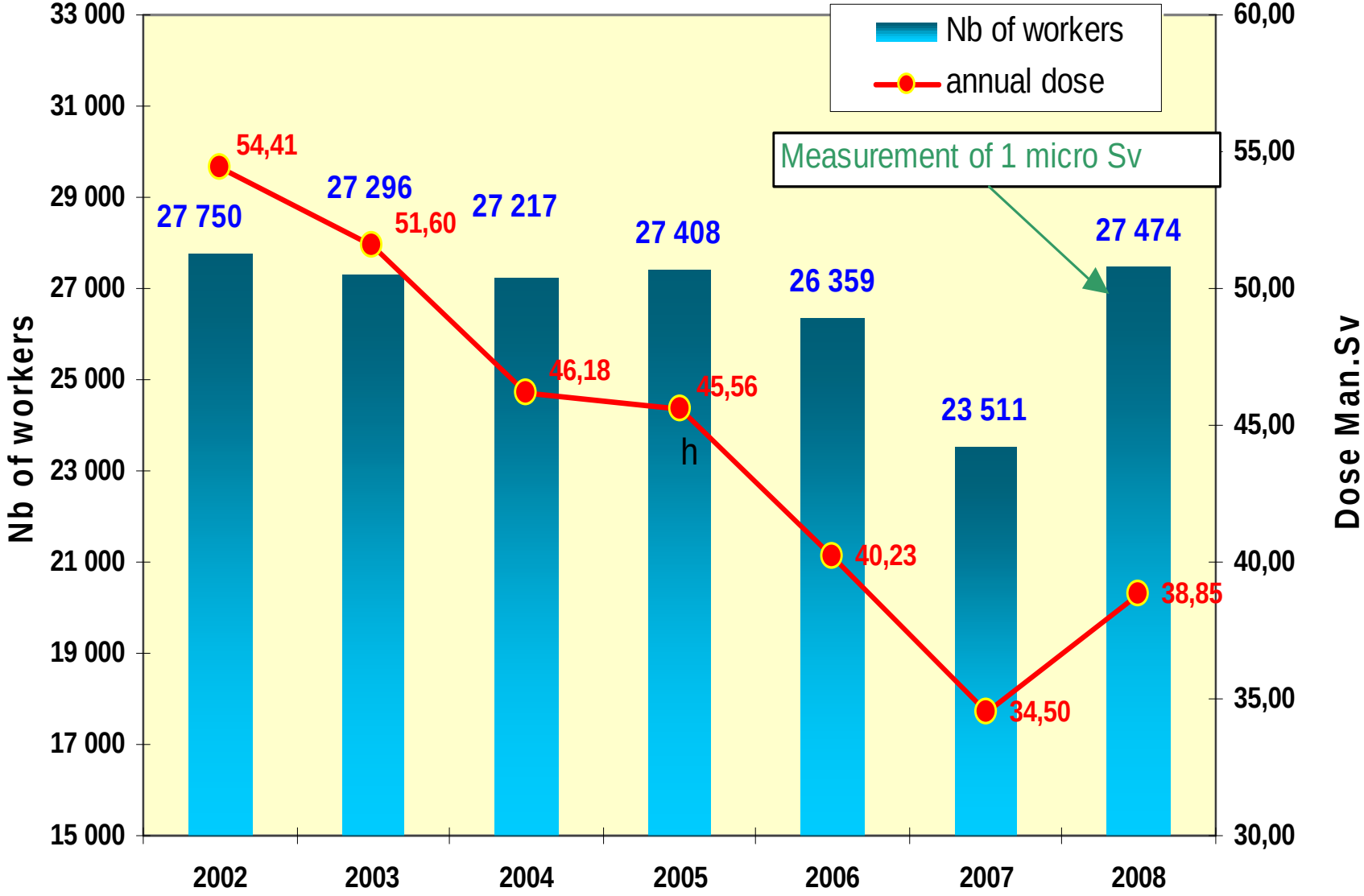
- Efforts were made on individual radiation exposure and positive results were obtained:
  - In 1992, 1200 workers recorded annual doses above 20 mSv, none in 2004,
  - In 1998, 125 workers recorded doses between 18 and 20 mSv, none in 2004,
  - In 2001, 92 workers recorded doses between 16 mSv and 18 mSv, only 2 in 2007,
  - The average individual dose dropped from 4.6 mSv/yr in 1992 to 1.47 in 2007.

Number of persons with annual individual dose higher than 20 mSv or between 16 and 20 mSv in EDF PWRs



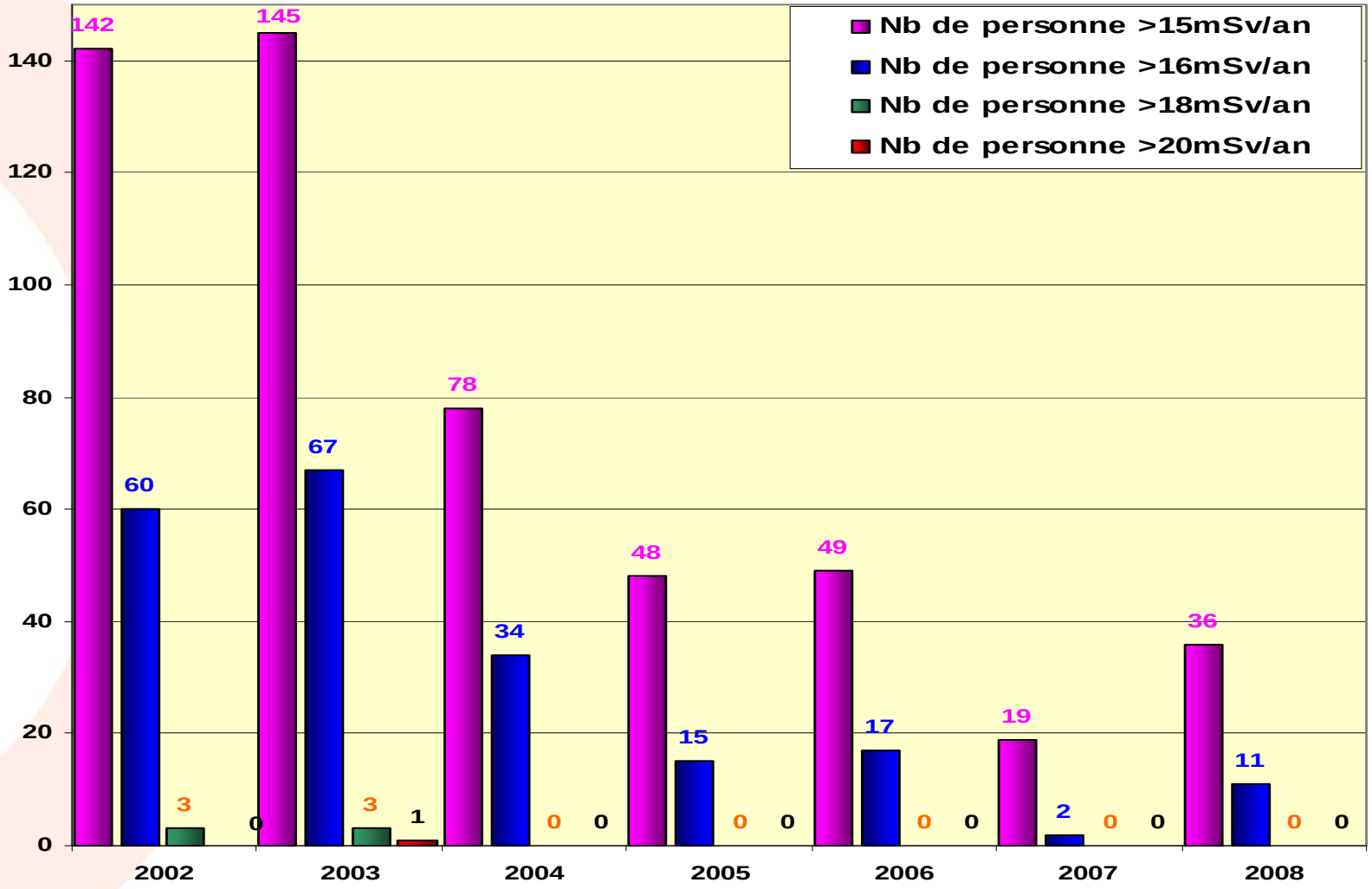
Individual dose

… number of workers



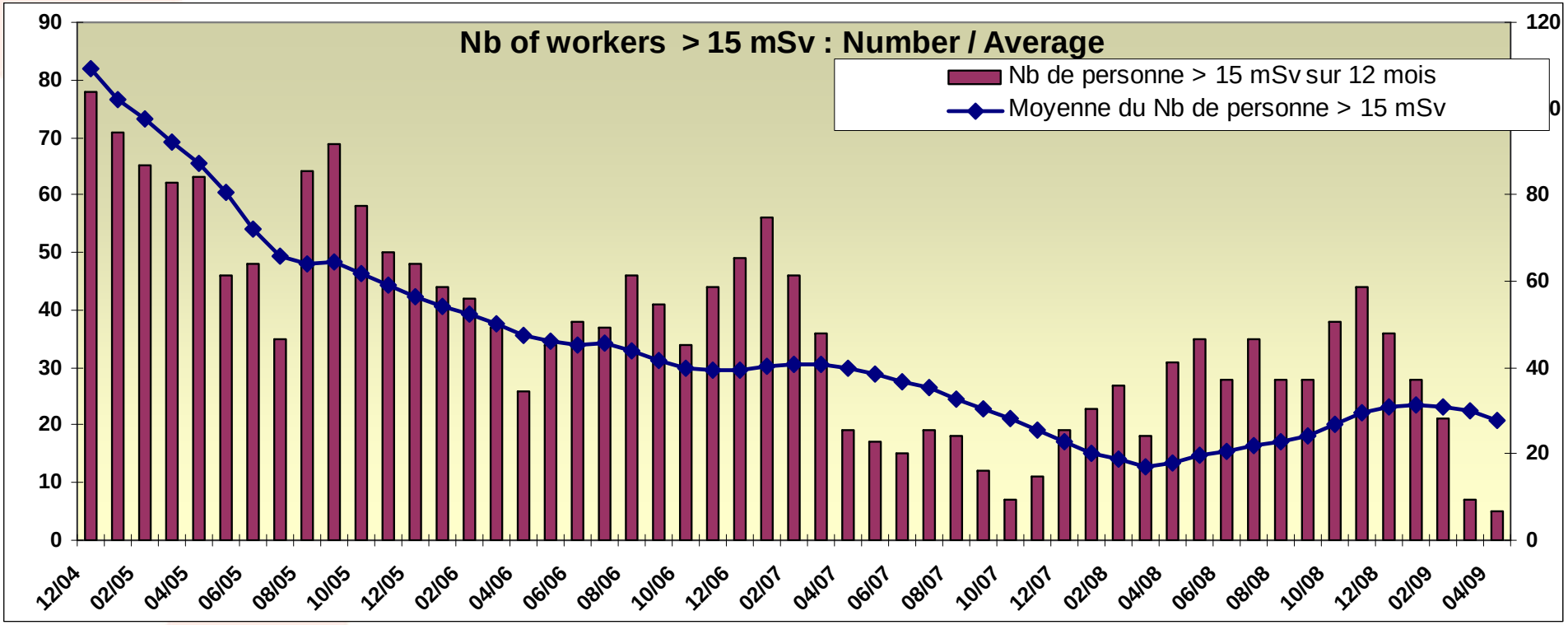
Individual dose

… per dose-range



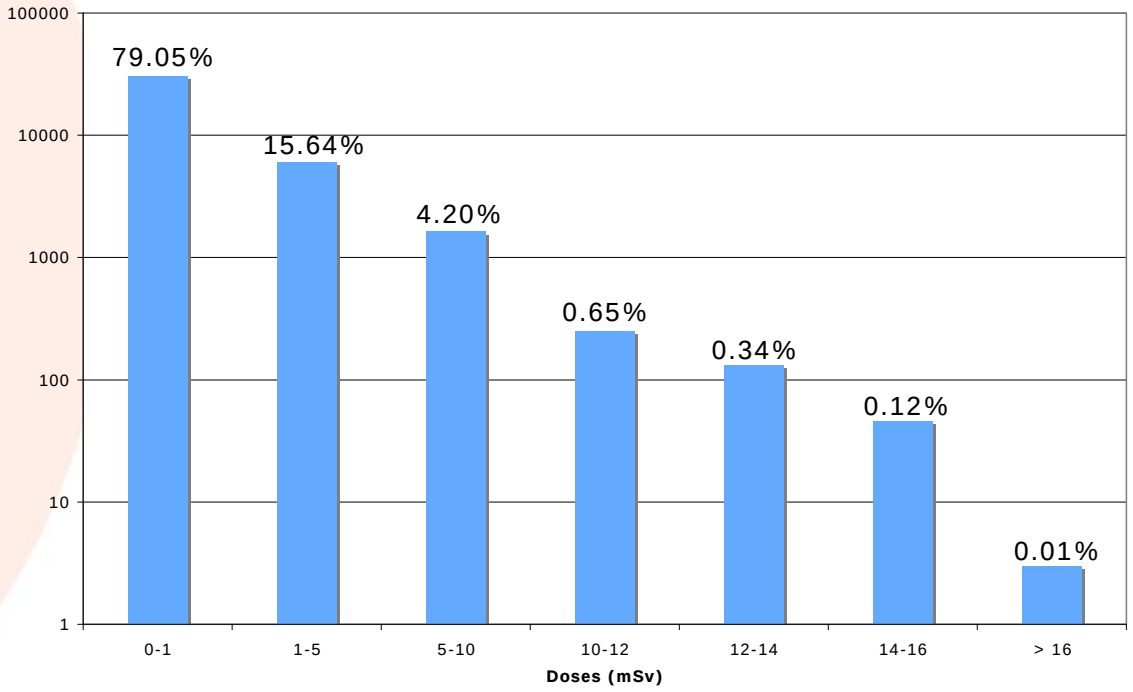
Individual dose

… number of workers > 15 mSv over 12 months



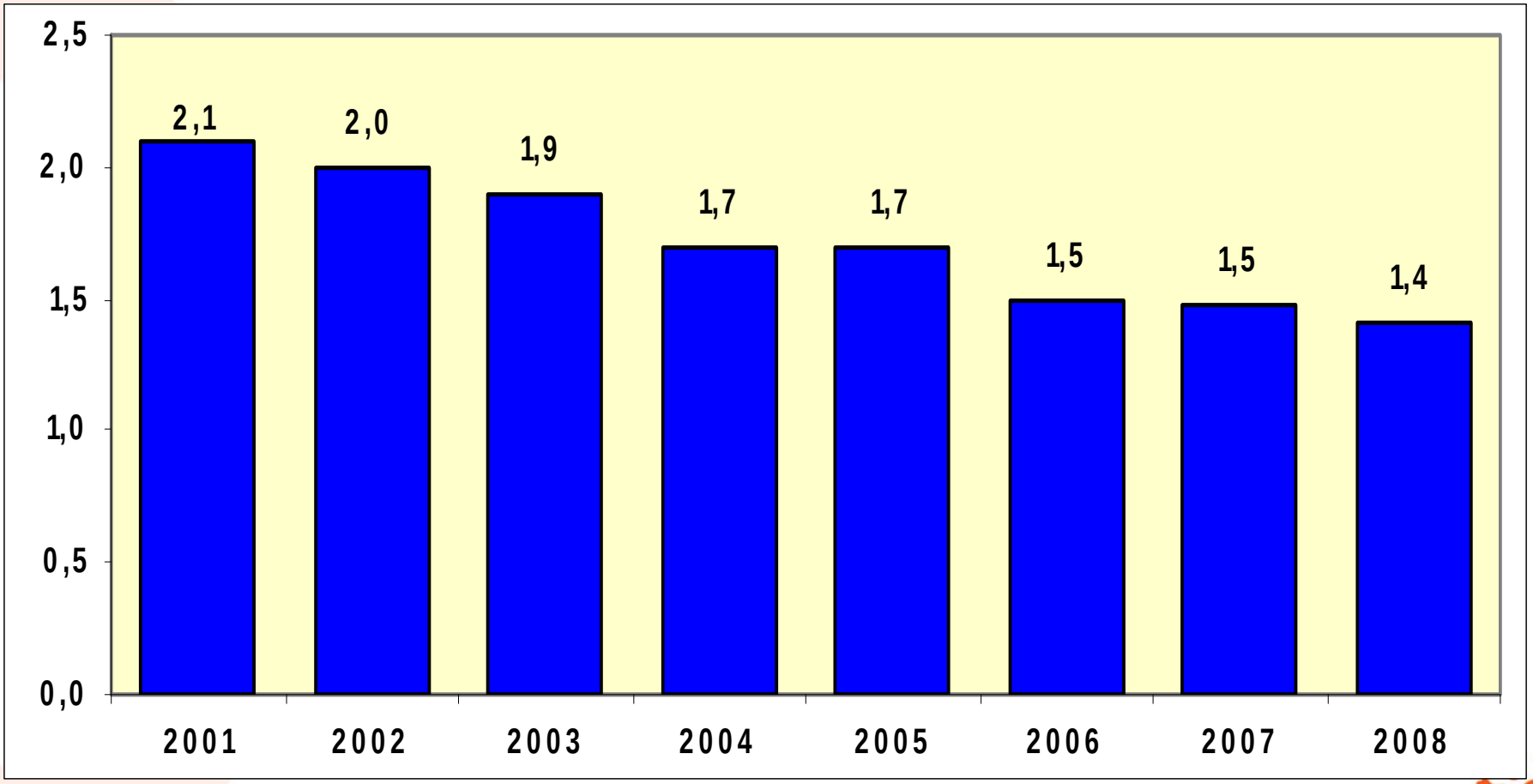
Optimization of radiation protection: individual radiation exposure

- Generally, efforts to reduce the highest individual doses to favor equity between workers:
  - Few hundred workers > 10 mSv/y,
  - Represent 1% of the total number of workers,
  - Receive between 13 and 15% of the total collective dose.

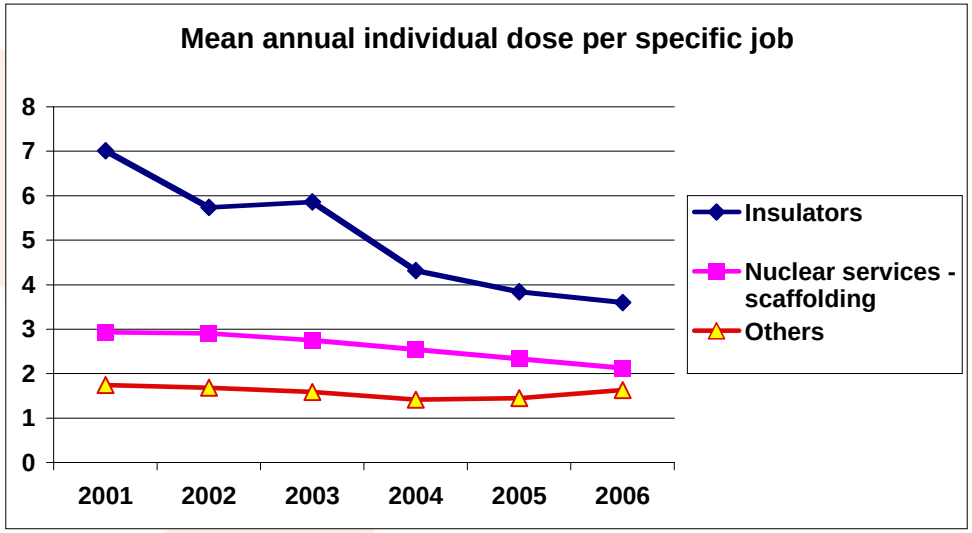


Individual dose

… average individual dose per worker



Action plans for specific jobs

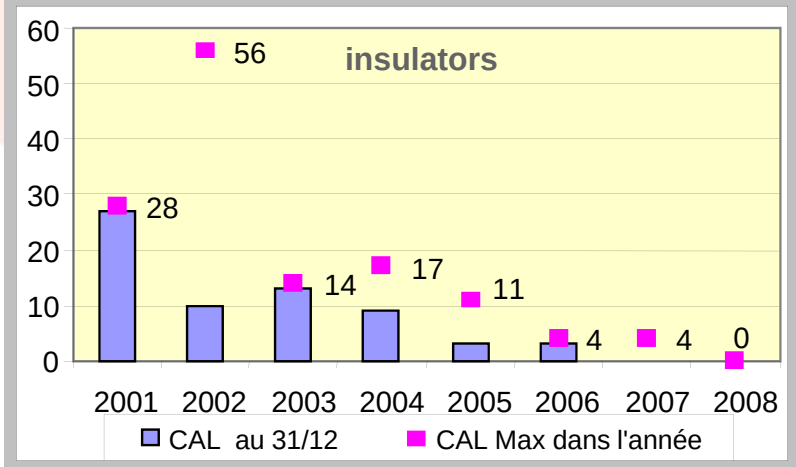


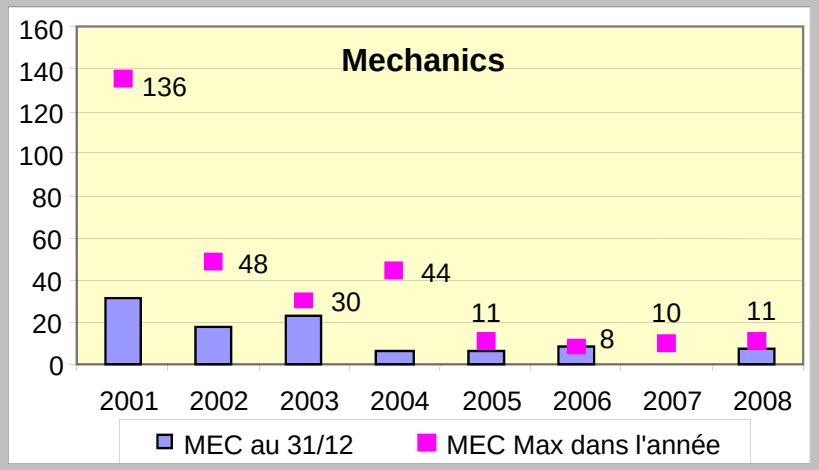
- Some specific jobs concerned by high annual individual doses:
  - Example of mean individual dose of insulators: 3.31 mSv/yr against 1.47 mSv/yr on average over the fleet for all jobs.

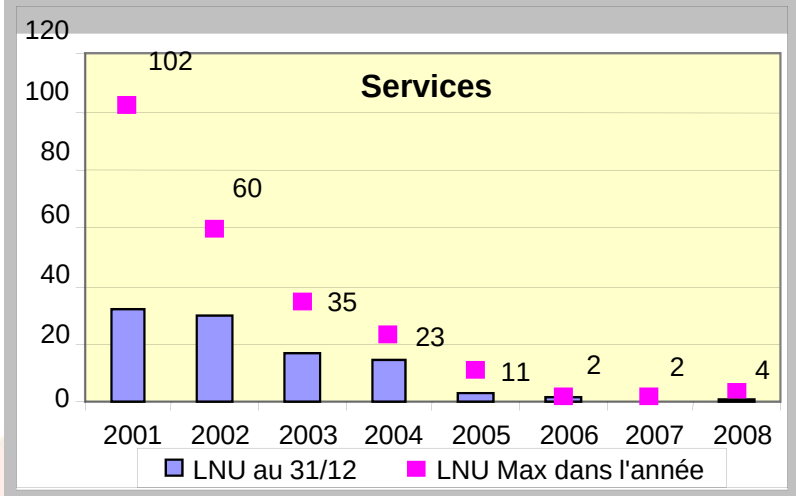
- Efforts on specific jobs with high individual radiation dose:
  - Specific action plan for insulators:
    - Ergonomic studies identified hardness issue for this task,
    - Replacement of mineral wool insulators by encapsulated insulators.
  - Specific action plan for biological shielding:
    - Improvement of the efficiency of the installation of biological shielding.

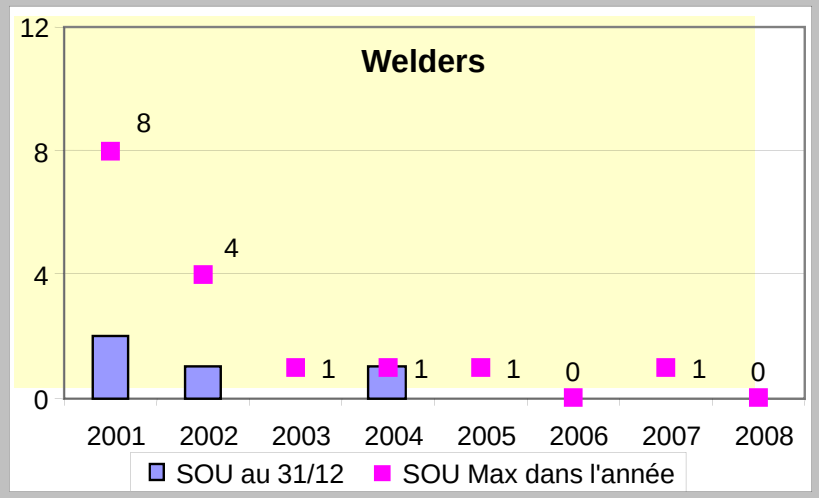
Individual dose per speciality

… number of workers > 16 mSv per year









Renewal of measurement systems

- Electronic personal dosimeters: new gamma dosimeters and neutron dosimeters (for neutron both passive and electronic ones),
- Improvement and renewal of Continuous Air Monitors in the controlled area to favor the detection and avoid the diffusion of contamination,
- Start of the partial renewal of Personal Contamination Monitors at the exit of contaminated or controlled areas,
- Use of teledosimetry: in 2009, spreading of electronic dosimeters with a specific transmission module (Zig Bee) in all NPPs (in a limited quantity) to allowed the follow-up of some specific tasks by teledosimetry.

Control of high risk situations

- High radiation areas in France “Red areas “(dose rate > 100 mSv/h) - EDF imposes additional requirements compared to the French regulations:
  - Area locked with a double locking system (2 keys necessary to open it),
  - Risk assessment performed with preventive actions associated in case of entry being necessary – Use of human error reduction tools,
  - Advices of the HP department and authorization of senior management for any entry into a red area,
  - In 2007: 14 red area events.
- Radiography examinations
  - As a result of an incident in 2001: implementation of technical measures (dosimeters with alarms, etc.),
  - Ergonomic study to strengthen the technical measures: luminous marking barriers, sentinel barriers, etc.
  - A testing coordination and scheduling unit established in 2006,
  - In 2007, less than 20 events where part of the requirements were not fulfilled, for 30,000 radiographic activities per year.

Future challenges for radiation protection

Future challenges

- Maintain efforts to pursue the decrease of collective radiation exposure:
  - Continuation of the cleanup program:
    - Curative actions by decontaminating specific systems within one unit,
    - Preventive actions by initiating larger studies and communication of “good practices and advices” to maintain the units clean.
  - Continuation of zinc injection experiments.
- Maintain and initiate new efforts to homogenize individual doses by reducing the highest doses.
- Development of Remote Monitoring Systems and associated central monitoring room on all sites.
- Control of high-risk situations:
  - Essential management role concerning the knowledge of standards and checking that planned measures are applied.

Future challenges

- 3 major challenges to be faced:
  - Ensure a good and efficient radiation protection in new reactors (EPR) by taking into account our feedback experiences.
  - A context of skills renewal (succession planning): maintain radiation protection as be a part of our industry's culture,
  - For countries turning to or increasing the role of nuclear power, benefit from the most advanced radiation protection organisations and encourage continuing progress.
- Hence the necessary commitment of the world radiation protection community rather than further increasing the regulatory framework.