



The revival of nuclear power and radiation protection

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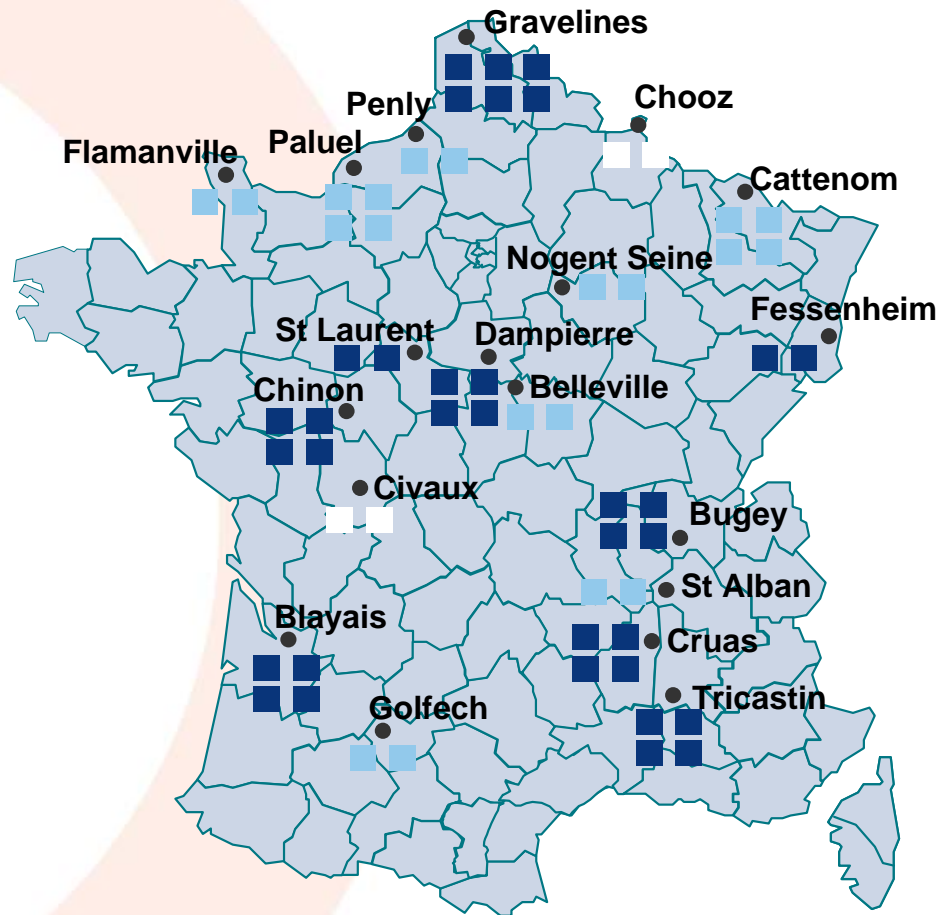
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The French nuclear fleet

Nuclear power plants



■ 900 MW

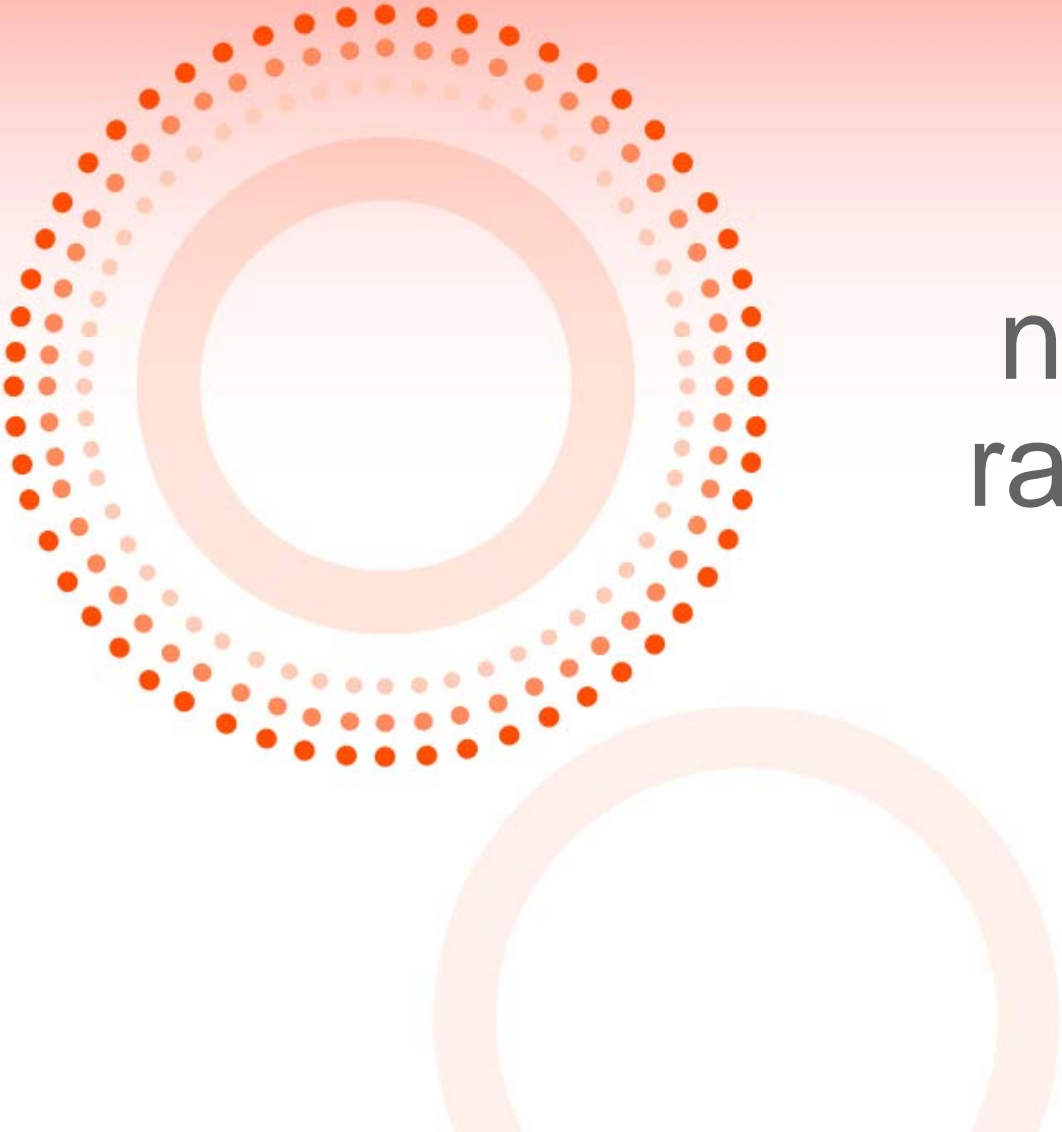
■ 1 300 MW

■ 1 500 MW

- The largest generation fleet in Europe, homogenous as well as concentrated

- 58 reactors in operation
- spread over 19 sites
- the same technology: PWR (pressurized water reactor)
- 3 reactor series:
- 900 MW : 34 units, that is 31 GW
- 1 300 MW : 20 units, that is 26 GW
- 1 500 MW (N4) : 4 units, that is 6 GW

- EDF is the owner of the nuclear plants and the sites themselves



Prospects for the development of nuclear power and radiation protection challenges



Prospects for the development of nuclear power

◎ International community confronted with:

- Rising electricity consumption world wide,
- The fight against global warming,
- Exhaustion of hydrocarbon deposits,
- Permanently high oil prices,

+ 60% by 2030
(International Energy Agency)

40 years for oil
70 years for natural gas

◎ In France: 80% of generation coming from nuclear power, 50g/KWh of CO₂ against 400 in Europe


◎ A growing number of countries consider that nuclear power is an answer

◎ Challenges for EDF

- Position itself as an investor and industrial partner
- 4 priority countries: USA, China, United Kingdom and South Africa

25 reactors under construction

220 projects being studied



Radiation protection achievements and performance



Collective radiation exposure

◎ ALARA approach: As Low As Reasonably Achievable, from 1992

- Involvement of management

- Contracting firms very rapidly joined in: signature of a charter between EDF and its contractors in 1997

 - ⇒ **Considerable progress on high dose worksites, systematic dose planning and optimisation approach introduced**

 - ⇒ **Results of collective radiation exposure limited by significant differences between sites**

◎ Reduction of the source term based on a 2-pronged approach, from 2002

- Cleanup of 4 units

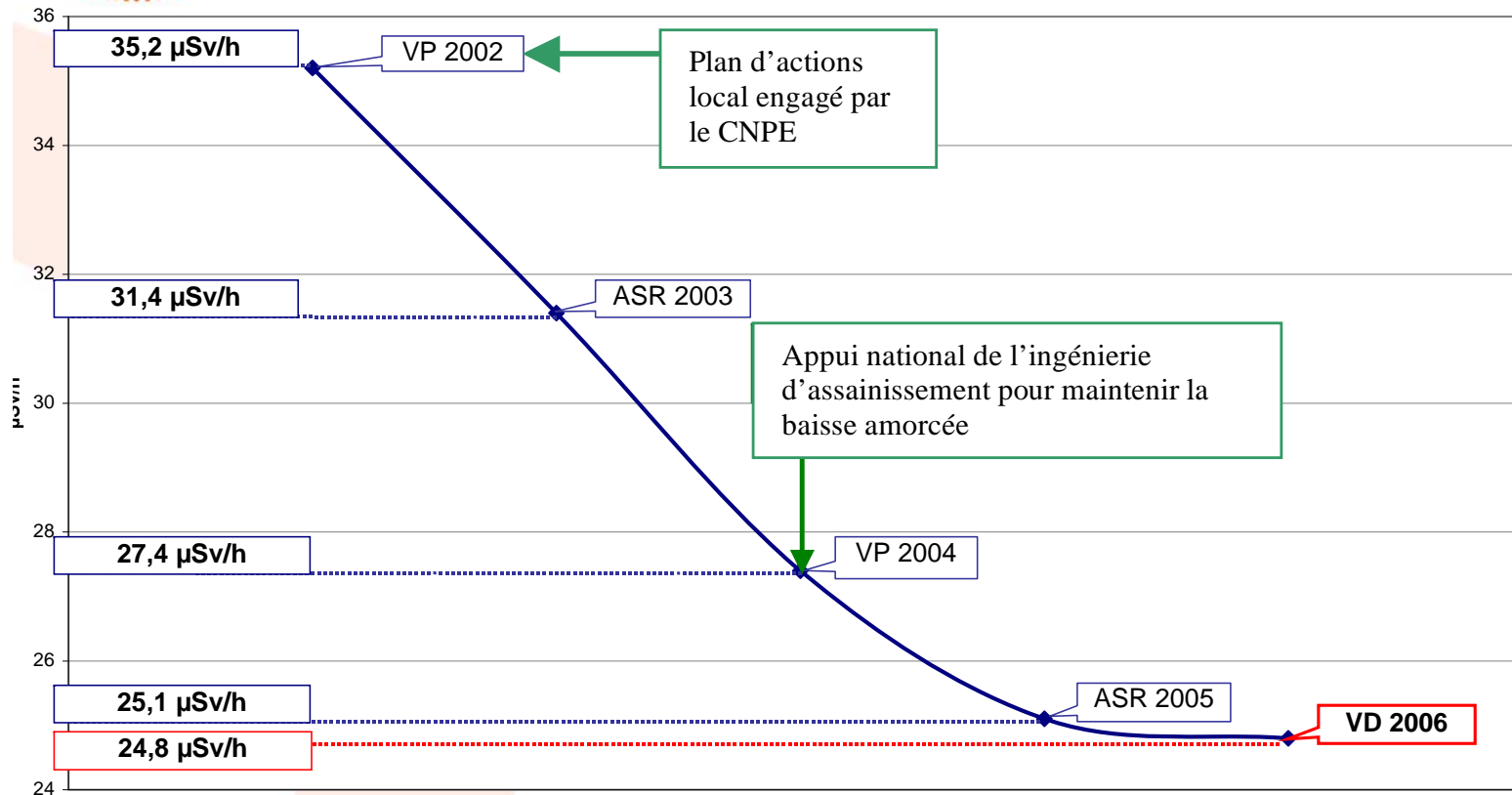
 - **Based on the characteristics of the unit,**

 - **With an overall approach**

 - **Calculation of reductions obtained using PANTHERE**



Collective radiation exposure



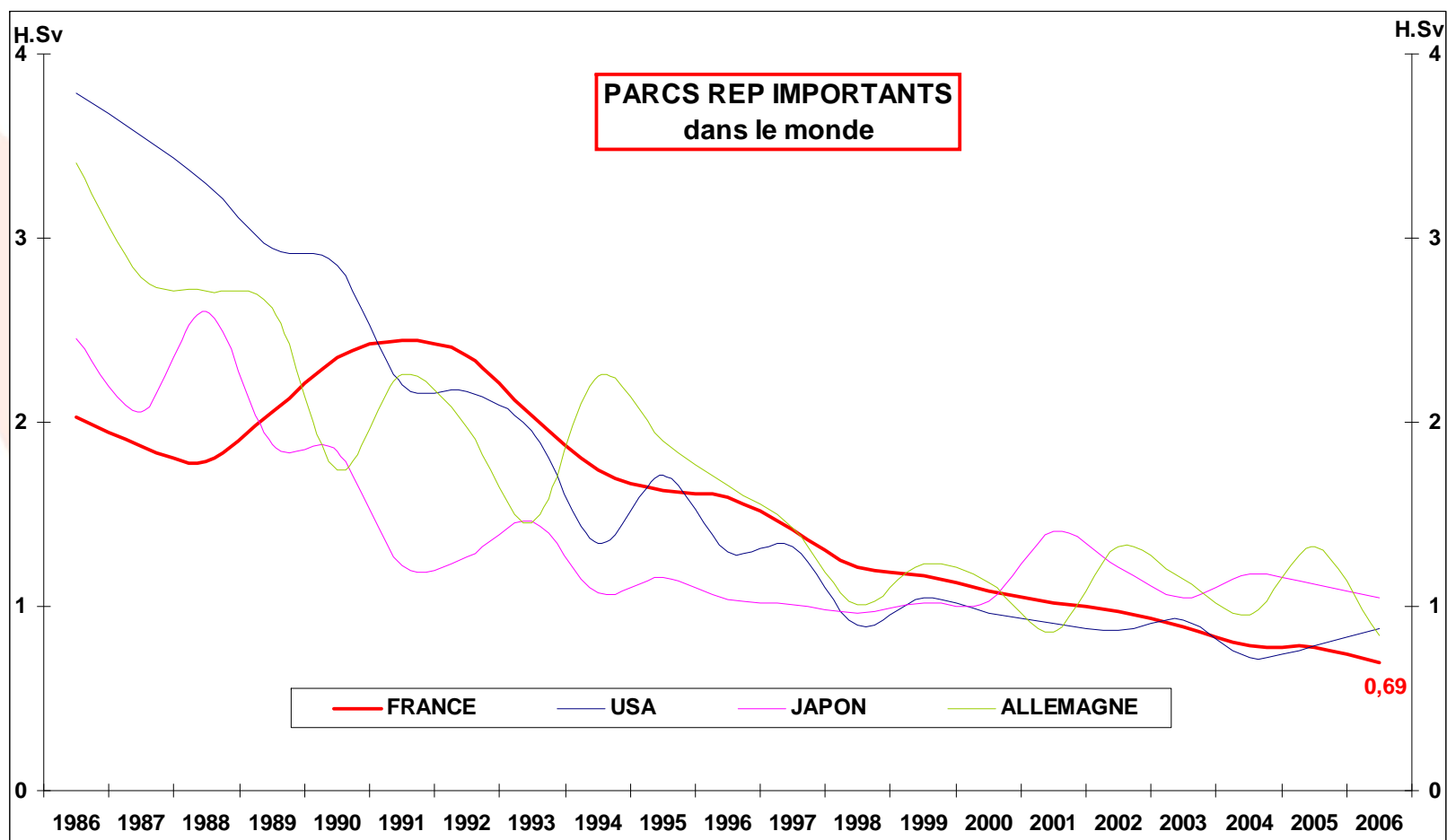
Example of Chinon unit 2:

collective dose divided by the number of hours spent in the RCA over an outage

• Zinc injection

- Use of international operating experience
- Experiments carried out on 2 units:
 - Bugey 2 - unit contaminated with cobalt : + 20% reduction
 - Bugey 4 – steam generator replacement

Collective radiation exposure



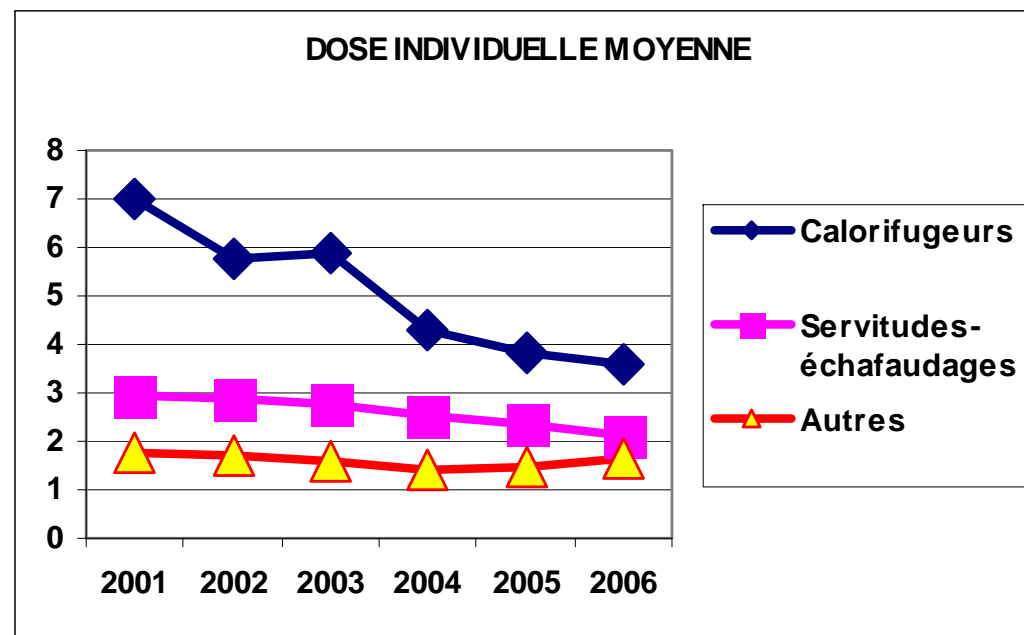
The efforts by EDF and contractors have reduced collective radiation exposure by a factor of four per reactor in nearly 15 years:

From 2.44 M.Sv in 1991 to 0.63 M.Sv in 2007



Individual radiation exposure

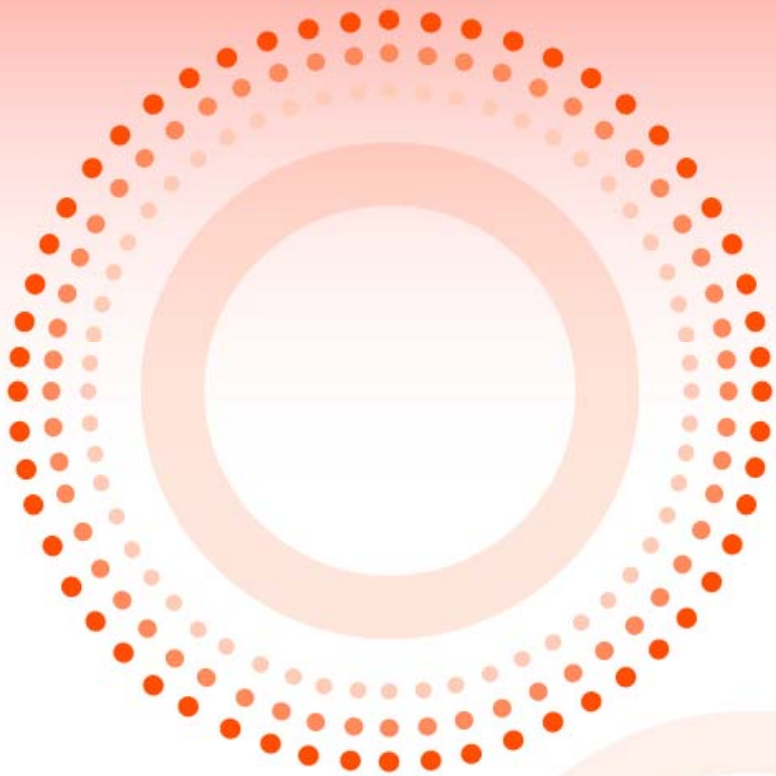
- EDF attaches great attention to individual radiation exposure
 - In 1992, 1200 workers, recorded annual doses above 20 mSv, against none as from 2004,
 - In 1998, 125 workers recorded doses between 20 and 18mSv, against none as from 2004,
 - In 2001, 92 workers recorded doses between 18mSv and 16 mSv, against 2 in 2007,
 - The average individual dose dropped from 4.6 mSv/year in 1992 to 1.47 in 2007.
- Specific studies of the crafts with the highest doses: example of insulators
 - 3.31 mSv against 1.47 on average over the fleet,
 - Specific action plan



Control of high risk situations

- Red areas (dose rate > 100 Sv/h): requirements additional to French regulations
 - Area locked with a double locking system (2 keys necessary to open it),
 - Risk assessment performed with counter-measures associated in the event of entry being necessary – Use of human error reduction tools
 - Opinion of the department competent in radiation protection and authorisation of senior management for any entries into a red area;
 - In 2007: 14 red area events
- Radiography tests
 - As a result of an incident in 2001: introduction of essentially 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 are not fulfilled, for 30,000 radiographic shots per year.

Future radiation protection challenges





Future challenges

- ◎ Collective radiation exposure: continuation of the cleanup programme (unit or systems) and zinc injection experiments
- ◎ Control of high risk situations: essential management role concerning the knowledge of standards and checking that planned measures are applied
- ◎ 3 major challenges to be faced:
 - a context of skills renewal (succession planning) → make radiation protection 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,
 - General adoption of radiation protection practices by all professions using ionising radiation.
- ◎ Hence the necessary commitment of the world radiation protection community rather than further increasing the statutory framework.