



# The revival of nuclear power and radiation protection

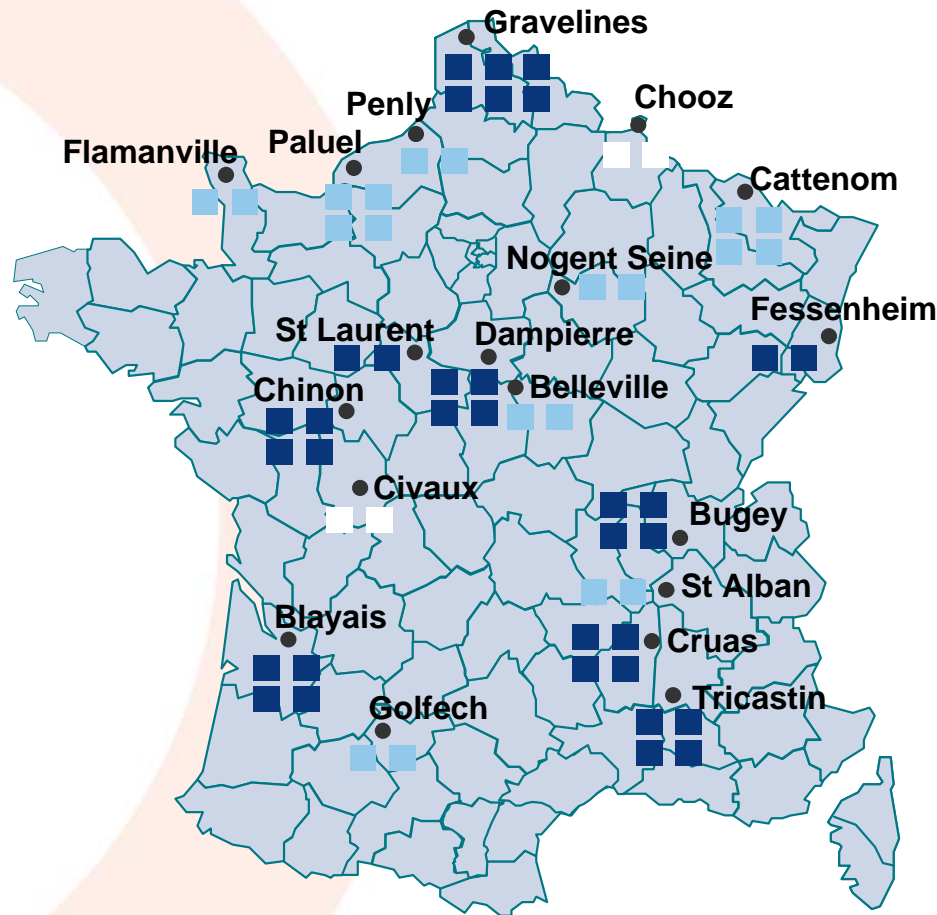
**Dominique MINIERE**

Deputy Senior Vice-President,  
Generation Nuclear Power  
Operations, EDF



# The French nuclear fleet

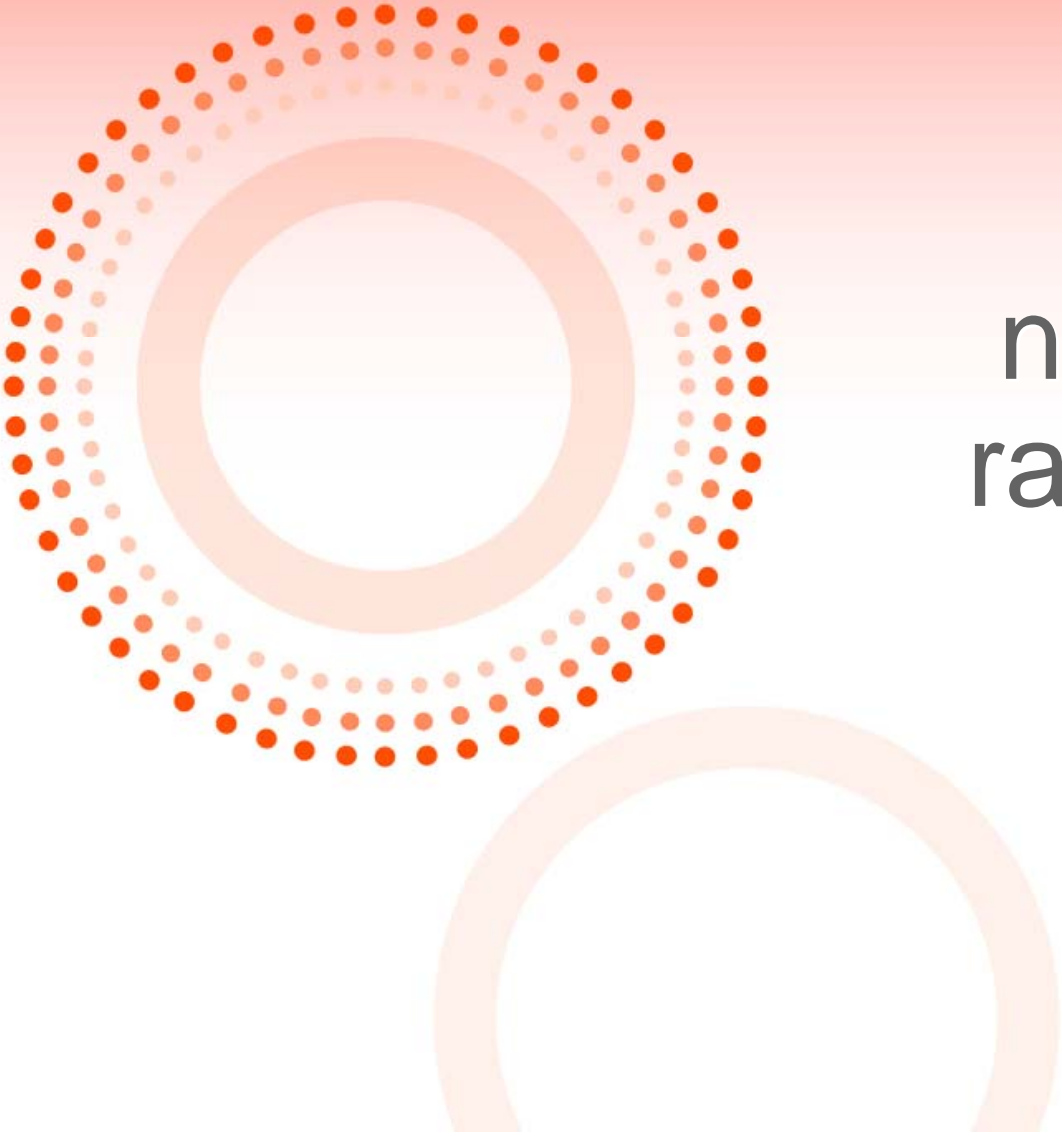
## Nuclear power plants



□ 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 CO<sub>2</sub> 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

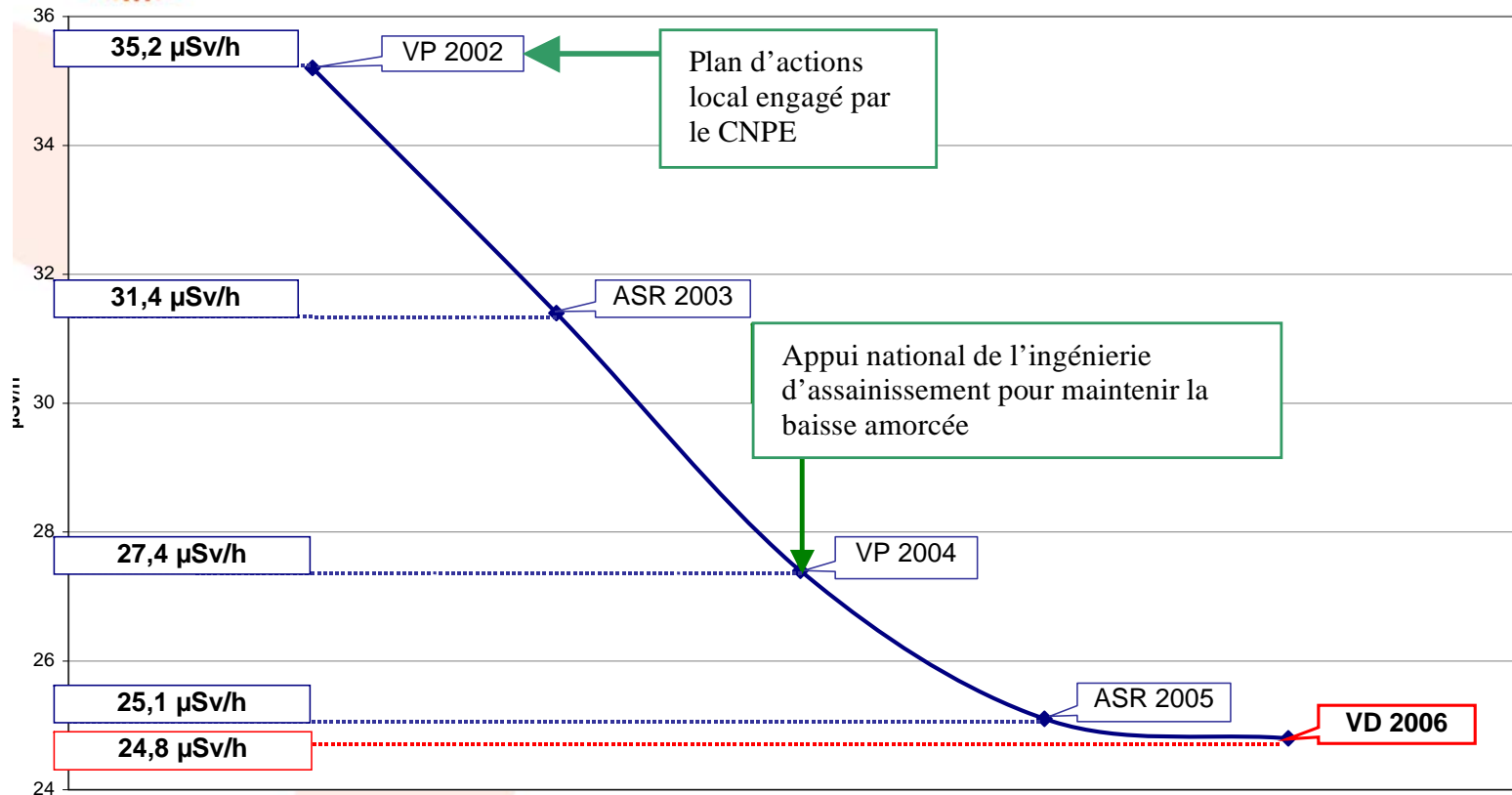
  - **Based on the characteristics of the unit,**

  - **With an overall approach**

  - **Calculation of reductions obtained using PANTHERE**



# Collective radiation exposure



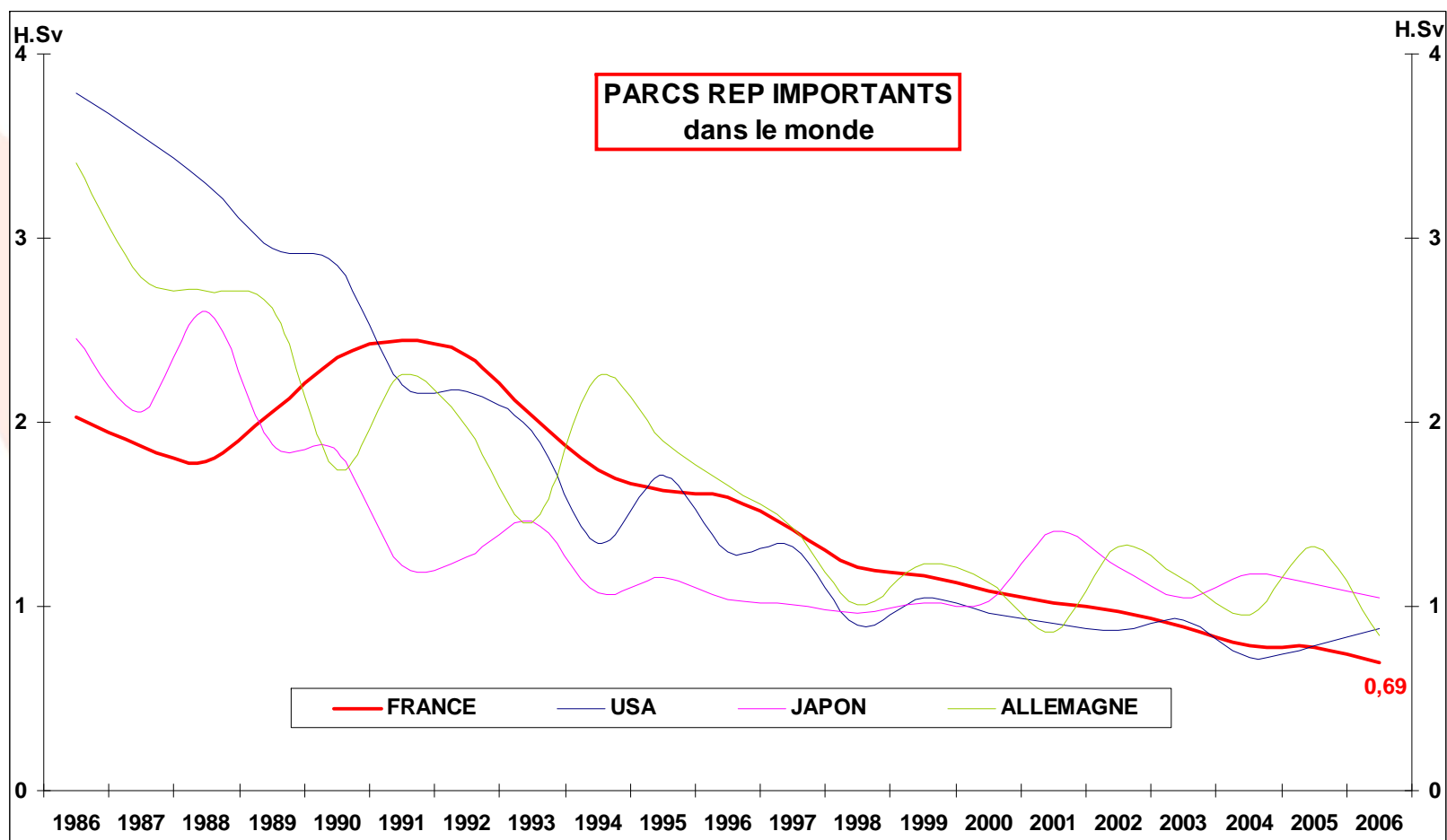
Example of Chinon unit 2:

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



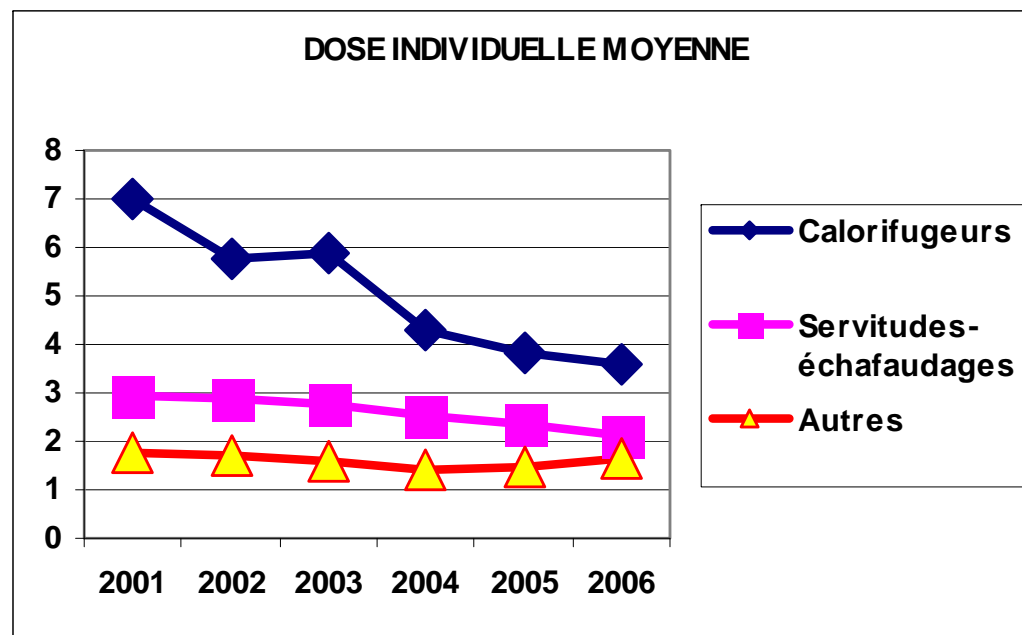
The efforts by EDF and contractors have reduced collective radiation exposure by a factor of four per reactor in nearly 15 years:

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



# Individual radiation exposure

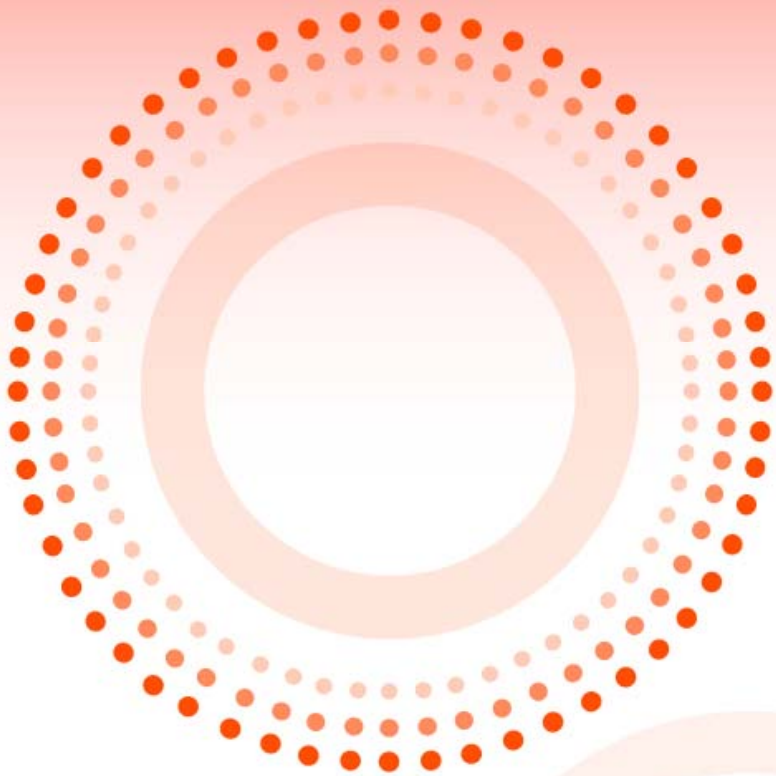
- EDF attaches great attention to individual radiation exposure
  - In 1992, 1200 workers, recorded annual doses above 20 mSv, against none as from 2004,
  - In 1998, 125 workers recorded doses between 20 and 18mSv, against none as from 2004,
  - In 2001, 92 workers recorded doses between 18mSv and 16 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.