IMPROVEMENT AND RENEWAL OF MEASUREMENT TECHNOLOGIES of INDIVIDUAL EXPOSURES

EDF – NPP

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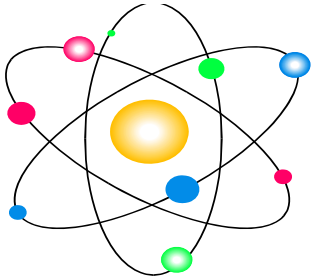
OBJECTIVES

- **Context of dose measurement**
- **External Exposure Measurement**
  - **γ Gamma**
    - **γ Passive dosimetry**
    - **γ Operational dosimetry**
  - **ηNeutron**
    - **ηPassive dosimetry**
    - **ηOperational dosimetry**
  - **δ Skin dose evaluation**



- **Internal Exposure Measurement**
- **Feedback**

1 Context of dose measurement : the “EDF fleet”

1 EPR under commissioning Penly 3

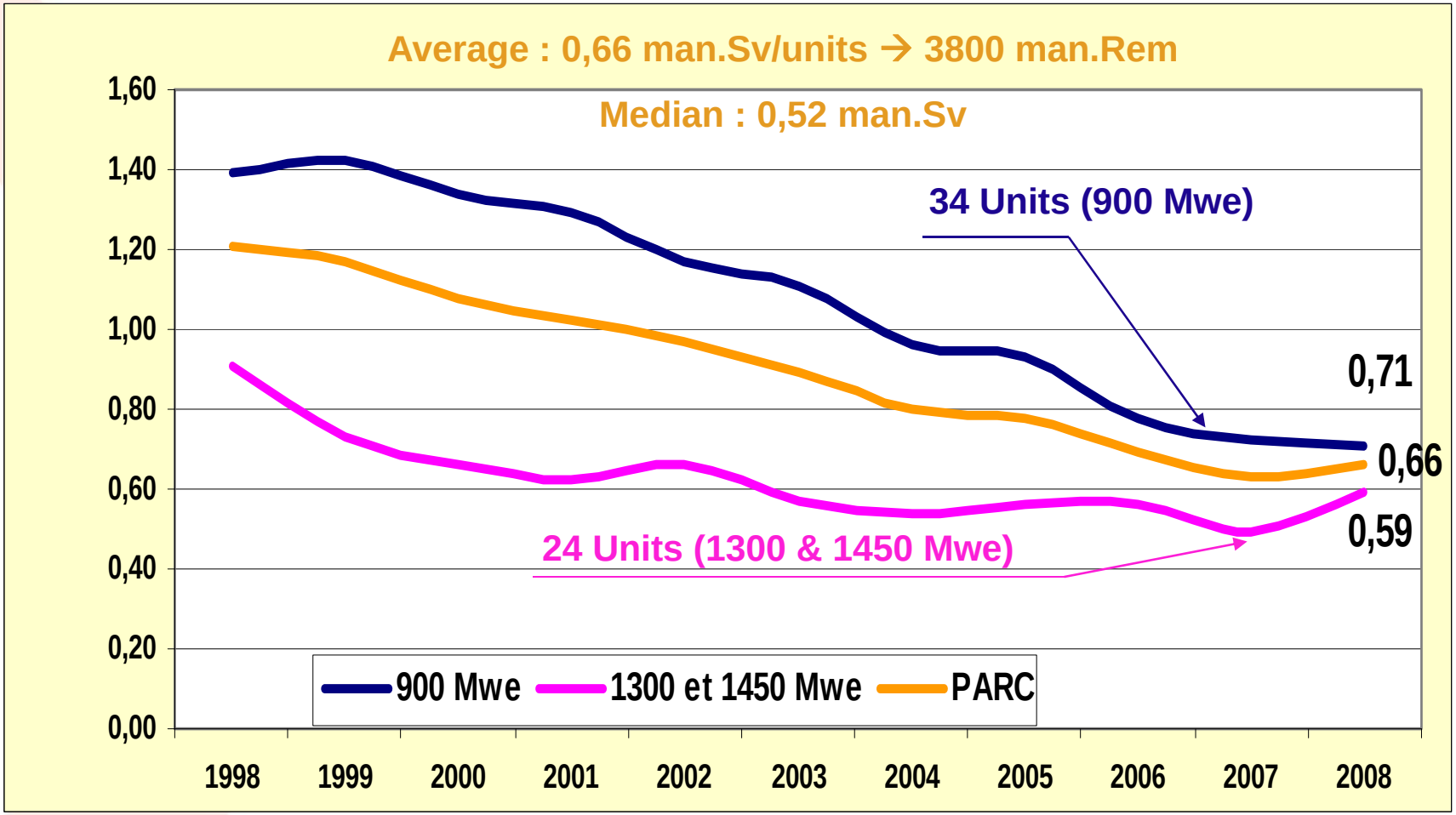
1 EPR under construction Flamanville 3

58 units in operation (2008)

Nuclear	418 TWH	87%
Hydro	45 TWH	10 %
Coal	16 TWH	3 %

The world electricity consumption should double between now and the end of 2030

1 Collectives Doses (man.Sv/units) : → up to 2008



1 Context of dose measurement

Under French Law, it is mandatory to monitor individual exposure in two ways :

✓**Passive dosimetry : a passive dosimeter (film badges, OSL, …) is worn for a month. The dose is recorded each month.**

✓**Operational dosimetry : electronic dosimeter which gives the dose in real time**

Since 2003, EDF has launched studies to improve measurement of occupational doses

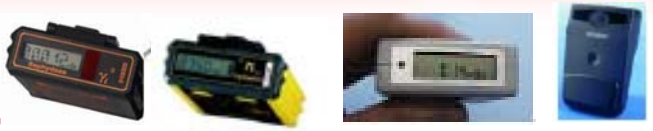
➔ **New equipment to measure and to interpret levels of external exposure as well as levels of external and internal contamination was developed or bought.**

2 External Exposure : “Gamma” measurement

- **Passive dosimetry :**
  - **Since the 70’s the passive dosimetry was monitored by film badges (Kodak type 2)**
  - **Early in 2001, EDF decided to updated the technology and choose the Optically Stimulated Luminescence (OSL – LCIE Landauer) badges** [First results were presented at the ISOE Congress in Nantes in 2005]
  - **In 2006, OSL became the passive dosimeter for all the units. The threshold of recording was reduced :**

	Film	OSL
Threshold of Recording	0,20 mSv	0,10 mSv
Reading Step	0,10 mSv	0,05 mSv

2 External Exposure : "Gamma" measurement



- ✓**Operational dosimetry**
  - ✓**EDF also replaced all its electronic dosimeters.**

Different types of dosimeters were in operation during the period 1979 → 2005

  - ✓**Between 2005 and early 2008 all electronic dosimeters were replaced by SAPHYMO dosimeters « Saphydose Gamma i [Sgi]© ».**

That represented about 18 000 dosimeters.

  - ✓**At first, these new Sgi required adaptations to be :**
    - ➢ **Less sensitive to the electromagnetic perturbations**
    - ➢ **Less sensitive to the effect of static electricity**
    - ➢ **More audible when in alarm**

2 External Exposure : "Gamma" measurement

- ✓**Sgi's performances :**
  - ✓**More precise measurement : dose is about 20 % lower in comparison with the result given by the DOT80 (one of our previous dosimeter which overestimate the dose)**
  - ✓**Sgi allowed to update the threshold of sensitivity by a factor of 10:**

	< Sgi	> Sgi
Threshold of Recording	0,01 mSv	0,001 mSv
Reading Step	0,01 mSv	0,001 mSv

These modifications result in an increase in the collective dose registered for all the fleet

- ✓**A significant number of "dose rate alarms" occurred. This new functionality shows that, some time, workers were exposed to a source of radiation (hot spot)**

2 External Exposure : "Neutron" measurement

✓… Until 2004, neutron dosimetry was just a complementary dosimetry

✓It was measured with :

✓Bubbles dosimeter or DINEUTRON

✓Since a new requirement (December 2004), it is now mandatory to wear both passive and operational neutron dosimeters …

✓… so that is why EDF has launched a study of passive and operational neutron dosimeters

2 External Exposure : “Neutron” measurement

- ✓**Passive dosimetry : “NEUTRAK T”**
- ✓**This dosimeter designed by Landauer company offers :**
  - ✓**Large operation range : energies from 40 keV to 40 MeV**
  - ✓**As well as energies of thermal neutrons**
- ✓**Accuracy**
  - ✓**Threshold of recording : 0,1 mSv**
  - ✓**Reading Step : 0,01 mSv**
  - ✓**Comparison with bubbles dosimeter as a reference shows that measures are in accordance above 0,4 mSv**

2 External Exposure : "Neutron" measurement

✓Operational dosimetry

- ✓**In order to remove bubble dosimeters, EDF wanted an electronic one able to give directly in real time the value of doses**
- ✓**Finaly, EDF chose the DMC 2000 GN manufactured by MGPi company**
- ✓**Display of neutron dose and dose alarm :**

DMC 2000 GN		
Recording	Threshold	0,001 mSv
	Reading Step	0,001 mSv
Dose Alarm	Threshold	0,010 mSv
	Reading Step	0,010 mSv
Dose Rate Alarm	Threshold	0,100 mSv
	Reading Step	0,010 mSv

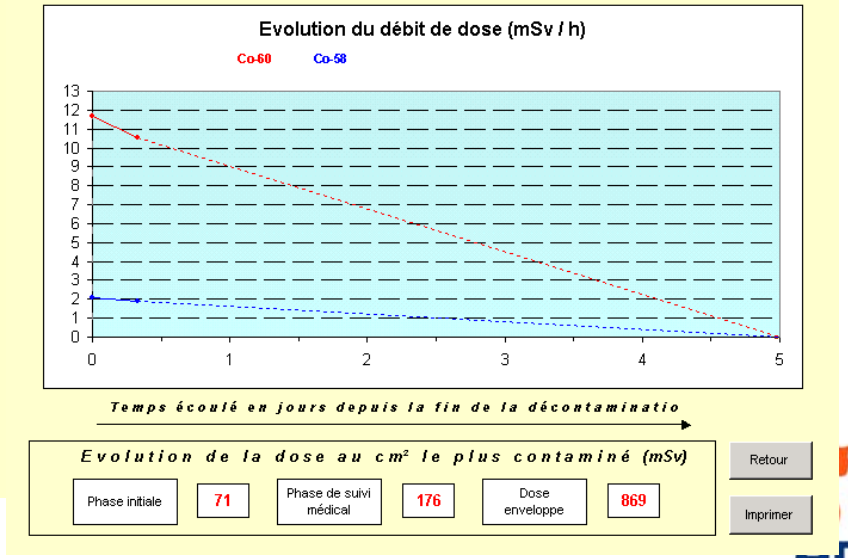
✓**1000 dosimeters were spread in our NPP between November 2008 and March 2009**

2 External Exposure : skin dose evaluation

✓**In 2006, a new method to evaluate the skin dose was implemented.**

It involves :

1. **Locating & evaluating the contamination**
2. **Measuring the number of shocks per second (c/s) through a cover with a hole …**
3. **… and the same measurement through a full cover**
4. **Identifying the element (γ spectrometry or smears)**
5. **Evaluating skin dose using "DEQ PEAU" software after having evaluated the time of exposure**

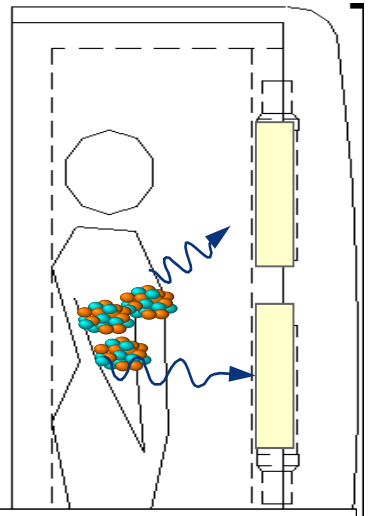


3 Internal Exposure measurement

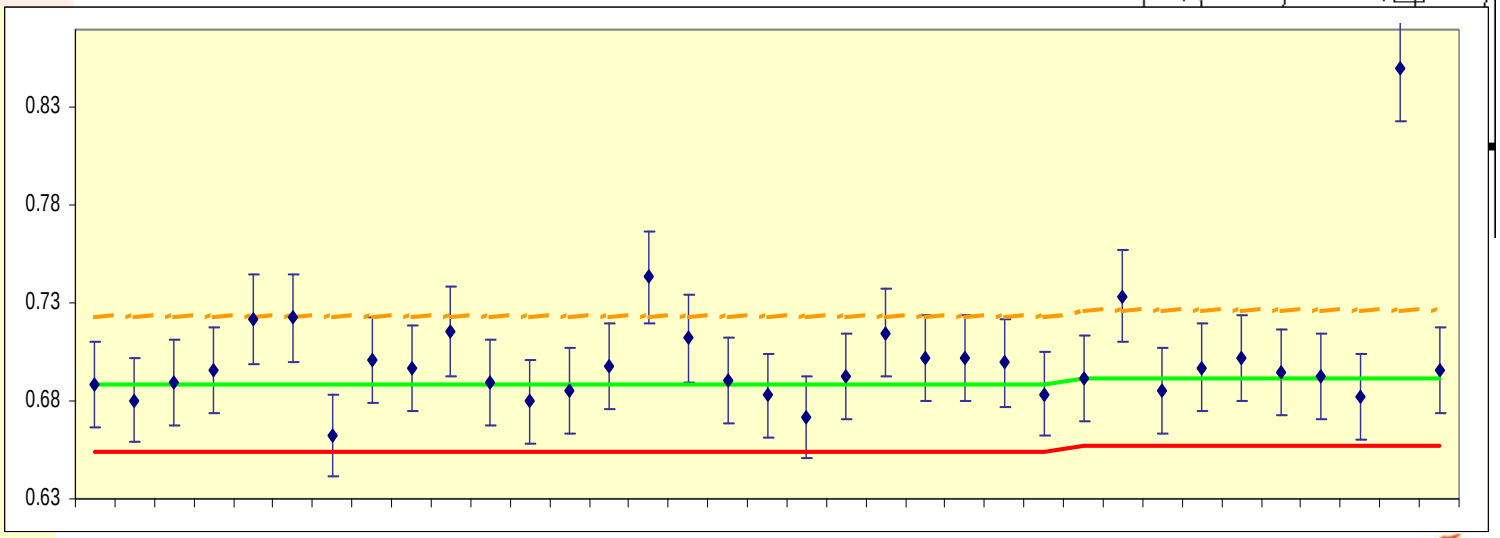
✓**Calculated dosimetry**

The internal exposure is survey by medical using anthropogammametrics measurement.

It could be completed by radiotoxic analysis



- **Efficiency**
- **+ 8 %**
- **True Value**
- **- 5 %**



4 Feedback …

- The improvement or renewal of measurement devices has allowed us :
  - to strengthen the quality of monitoring
  - to strengthen the traceability of individual exposures
  - to improve the quality and accuracy of measurements
  - to decrease recording thresholds
  - to set dose rate alarms.
- However, investigations continue to identify causes of discrepancies between different generations and types of dosimeters.
- A next step will consist in developing and implementing a remote monitoring system including an survey room in controlled area.

END

NUCLEAR : the clean air energy

ANY QUESTIONS ?