DIRECTION TECHNIQUE DIPNN
LA GRANDE HALLE

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The new monetary value system of the person.sievert at EDF

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Sommaire

- **What is the monetary value of the person.sievert ?**
  Introduction to the EDF system
- **Reminder : Outcomes of the ISOE survey (Uppsala, 2018)**
- **Use cases of the monetary value of the person-sievert at EDF**
- **Update of the monetary value of the person.sievert at EDF**
- **Conclusion**

I. The monetary value of the person-sievert (α **value**)

Decision aiding tool to implement radiation protection (RP) optimisation

Optimisation of RP principle :

ICRP Pub. 103 (§212) :

« to keep the magnitude of individual doses, the number of people exposed, and the likelihood of incurring exposures [...] **as low as reasonably achievable [ALARA], economic and social factors being taken into account** »

French regulation : Public Health Code (art. L1333-2)

« the magnitude of people exposure, the likelihood of incurring exposures and the number of people expose have to be kept **as low as reasonably achievable technical knowledge, economic and societal factors being taken into account** »

I. The monetary value of the person-sievert (**α value**)

Introduced by ICRP in the frame of Cost Benefit Analyses (CBA) (ICRP Pub. 22 (1973), 26 (1977), 37 (1983), 55 (1990), …)

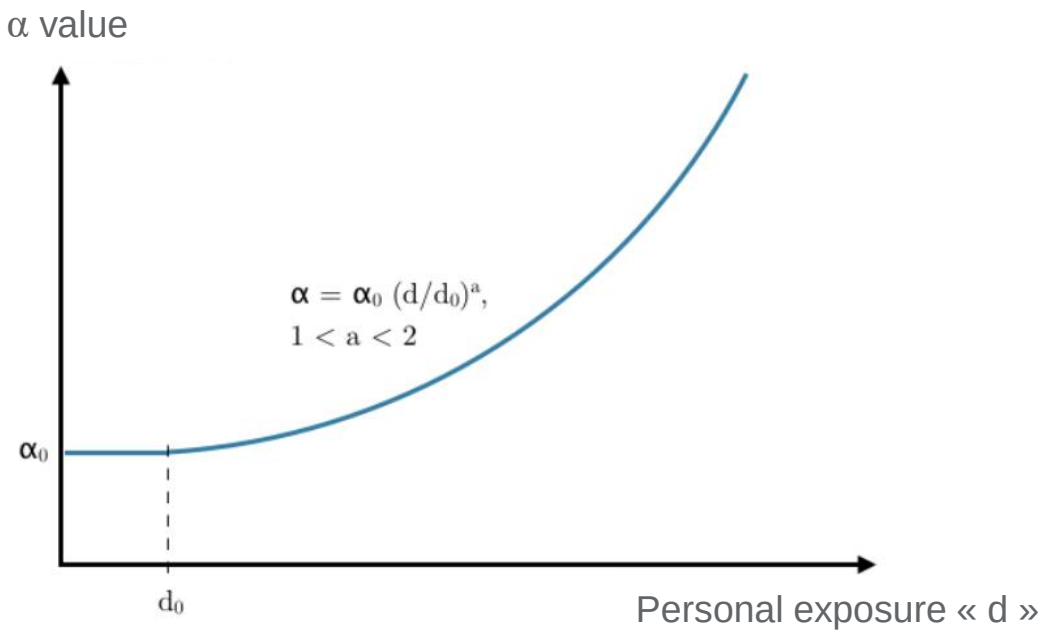
Quantification of costs (€) of a protection action vs benefits (reduction of the sanitary detriment associated to radiation exposure) that it provides

Question the « raisonnableness » : the increase of the cost of the protection measure should be balanced by a reduction of the sanitary detriment (collective dose)

→ **Monetary value of the person-sievert (valeur d'α)** : to associate to a dosimetric gain (dose saved) unit a monetary value

= Quantity (in €/Person.Sv) defined *a priori* to compare directly the advantage of a reduction in collective dose and the cost to achieve this reduction

I. The monetary value of the person-sievert (**α value**)



Model selected by EDF in 1992

$\alpha(d) = \alpha_0 \times (d/d_0)^a$ for $d \geq d_0$; if not, $\alpha = \alpha_0$

Where :
α_0 is the base value,
d the personal exposure magnitude of the exposed population,
d_0 the minimal personal exposure for the exposed population (=1 mSv),
a the coefficient describing the level of risk aversion (= 1,5 since 2002 at EDF).

$$\alpha_0 \left(\frac{€}{Person.Sv}\right) = \frac{proability\ of\ health\ effect}{Person.Sv} \ x \ \frac{€}{probability\ of\ health\ effect}$$

« Radiation detriment »
(→ Linear Non-Threshold (LNT) hypothesis)

« Value of a Statistical Life (VSL) »
≠ *Price of a human life !!!!*

I. The monetary value of the person-sievert (**α value**)

<u>Decision-aiding tool</u> in the radiation protection optimisation process

The α value is not the sole support of the decision and is part of a broader process (“one item of the optimization analysis”) → **part of a multicriteria approach**

It is not uncommon that a protection action is implemented even if the α value is exceeded.

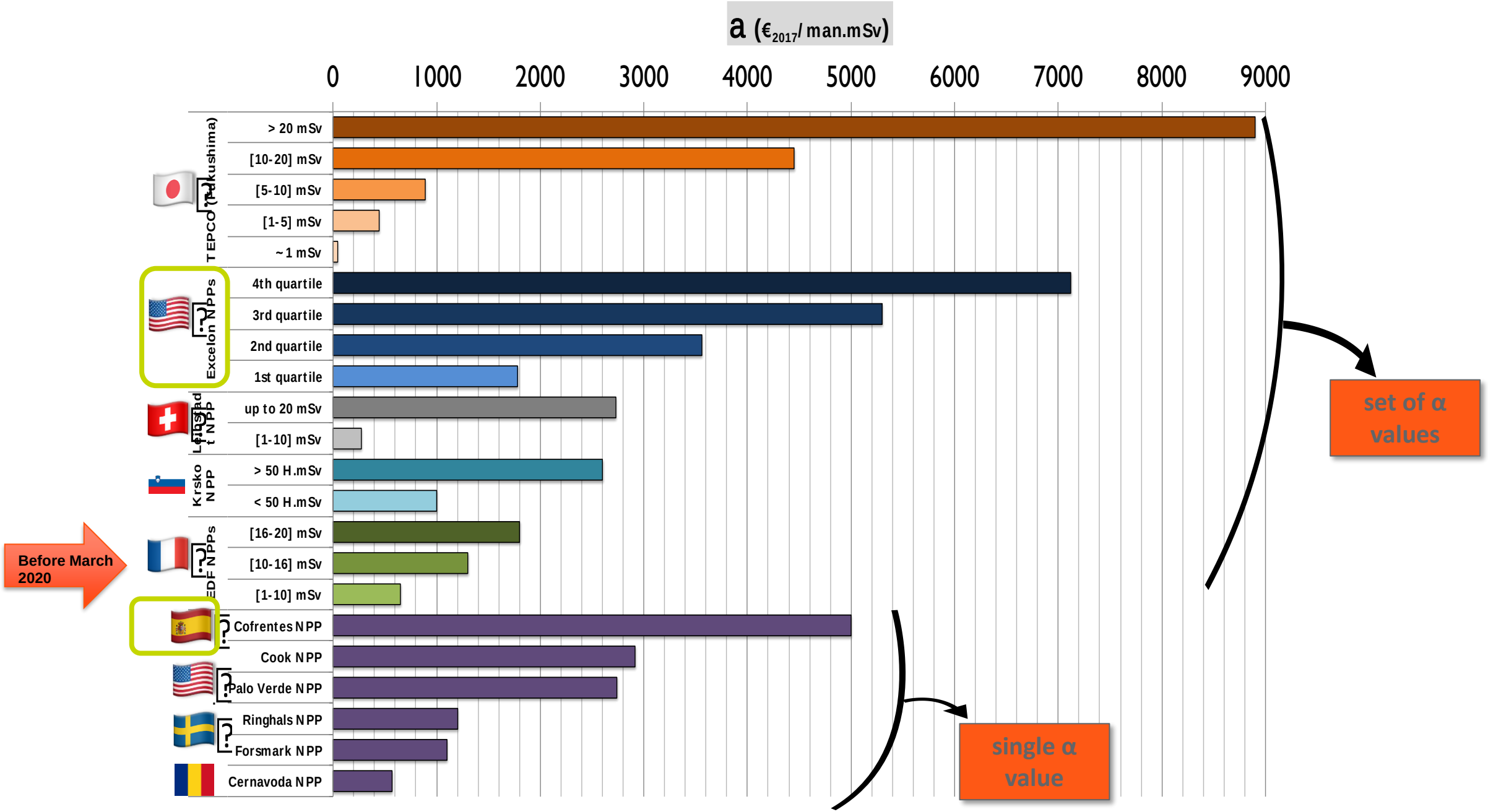
There is not a unique α value, shared at the international level : although its elaboration is based on a rational approach, it depends on specific parameters that may vary across the countries (economical and social factors, …)

II. The ISOE questionnaire outcomes (reminder)

See :

The values and the uses of the reference monetary value of the man.sievert. Results of an international survey (S. Andresz, T. Jobert and C. Schieber, Radioprotection 2020, 55(3), 207–214 © SFRP, 2020, https://doi.org/10.1051/radiopro/2020058)

The reference monetary value of the man.sievert – Outcomes of an ISOE survey (S. Andresz, T. Jobert, C. Schieber, ISOE Symposium, Uppsala, 26th June 2018)

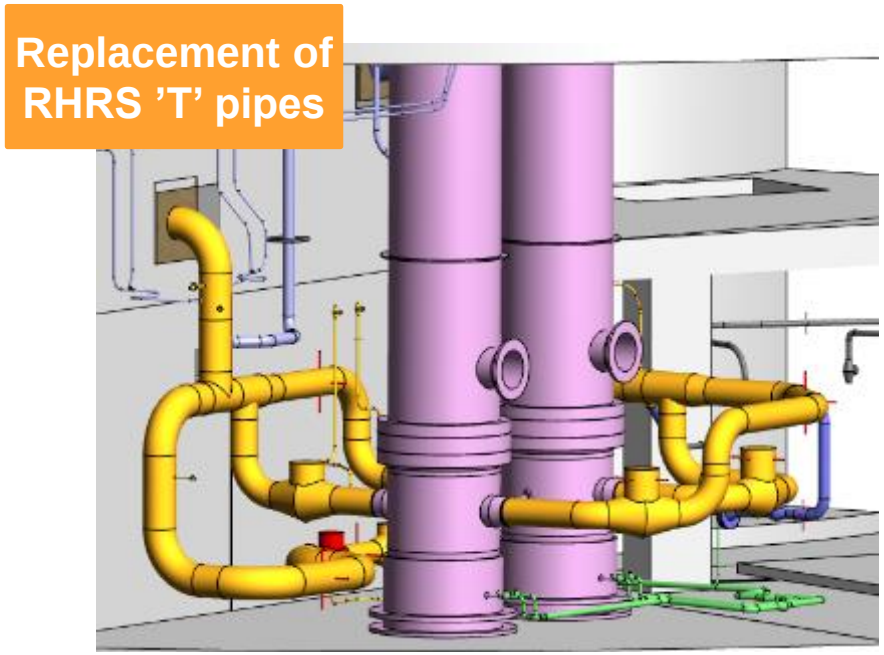

a (€2017/ man.mSv)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
TEPCO (Fukushima)
> 20 mSv
[10-20] mSv
[5-10] mSv
[1-5] mSv
~1 mSv
Excelon NPPs
4th quartile
3rd quartile
2nd quartile
1st quartile
Leibstadt NPP
up to 20 mSv
[1-10] mSv
Krsko NPP
> 50 H.mSv
< 50 H.mSv
EDF NPPs
[16-20] mSv
[10-16] mSv
[1-10] mSv
Cofrentes NPP
Cook NPP
Palo Verde NPP
Ringhals NPP
Forsmark NPP
Cernavoda NPP
Before March 2020
set of α values
single α value

III. Use cases of the α value at EDF

Mainly used fot major projects or large scale radiation protection measures (not a day-to-day tool) : « Go/no go », prioritization of scenarios or options of projects of the EDF operating fleet or design of new reactors (new built)

Wide spectrum of use ; e.g. :

CVCS boremeter, stellite surfaces optimisation of new reactor design, primary circuit surface cleaning after steam generator replacement, implementation of the Risk Management Supervision Room, robots for reactor pit decontamination, RHRS/CVCS chemical cleaning and other circuit clean-up operations*, gamma-camera, replacement of containing antimony mechanical seals, optimisation of temporary shielding during outage and shielding design, …



*** : cf. « Implementing ALARA in the nuclear sector » (Bernard Le Guen and Georges Ferry , IRPA SFRP days, February 2017)**

IV. Update of the α value system at EDF

Why an update the α value system ?

- Some evolutions since the last update in 2002 (state of the art to evaluate the VSL, new scientific data, new ICRP publications)
- Need to take into account the operating feedback experience

Dose range (in mSv)	α value (in €/Person.mSv, $€_{2000}$)
[1-10[	650
[10-16[	1300
[16-20[	1800

Only value used in practice

Monetaty value of the Person.Sv given the dose ranges in 2002

- EDF RP Objective : personal dose over a 12-period < 14 mSv
- Comparison with international practices (cf. section II)

IV. Update of the α value system at EDF

$$\alpha_0 \left(\frac{€}{Person.Sv} \right) = \frac{probability\ of\ health\ effect}{Person.Sv} \ x \ \frac{€}{probability\ of\ health\ effect}$$

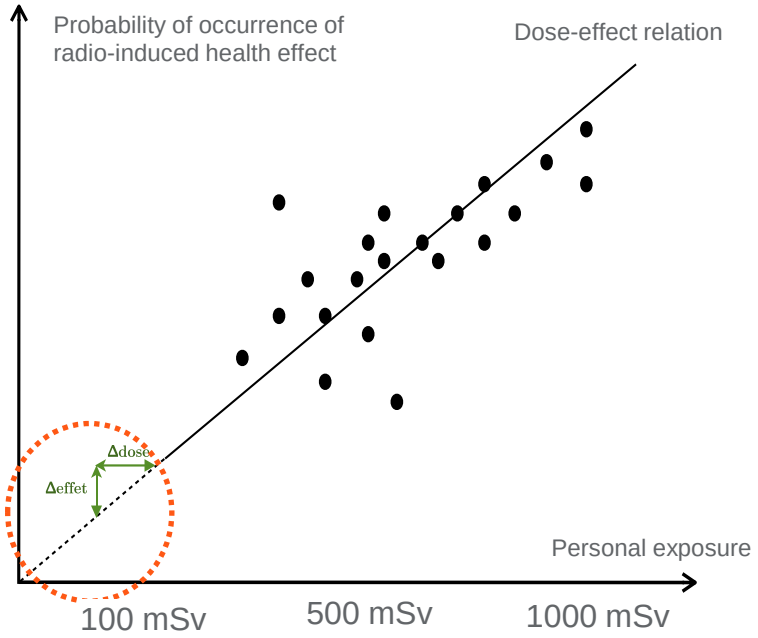
« Radiation detriment »
(→ Linear Non-Threshold (LNT) hypothesis)

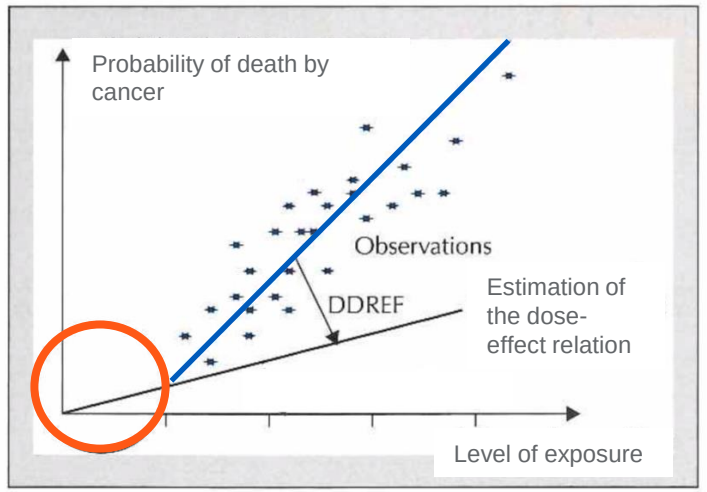
« Value of a Statistical Life (VSL) »
≠ the price of a human life !!!!

IV. Update of the α value system at EDF

<u>Radiation detriment :</u> concept used to quantify the health impact of stochastic effects (cancer and heritable effects) from low-dose and low-dose-rate radiation exposures, considering both the probability of occurrence and the severity of these effects.

EDF followed the recommandations of ICRP Publication 103 (2007) which update the radiation detriment for workers, from **$5{,}6.10^{-2}$ Sv^{-1}** to **$4{,}2.10^{-2}$ Sv^{-1}**





Risk of radiation exposure to low doses and low dose rates

Source : Traduction of *Evaluation du détriment associé à l'exposition aux faibles doses et faibles debits de dose dans le système de radioprotection – Environ Risque Santé 2012*

Steps and parameters of detriment calculation

	1) Nominal risk	2) Detriment
Steps	1. Calculation of lifetime attributable risk 2. Transfer of risk estimates across populations 3. DDREF application 4. Average over sexes and populations 5. Integration of heritable effects	6. Adjustement for lethality 7. Adjustment for quality of life 8. Adjustment for years of life lost
Data	- Cancer baseline rates - Survival function - Risk models for cancers - Age-distribution of populations	- Lethality fraction - Minimum weight for non-lethal cancers - Years of cancer-free life lost
	Dependent on radiation dose	*Independent of radiation exposure*

Source : *Calculation procedure of radiation detriment in Publication 103 (ICRP, 107)*

IV. Update of the α value system at EDF

<u>The value of a statistical life (VSL)</u> : of course, there is no price for life ! Can be defined as the statistical value attributed to an avoided death

- « human capital » approach : the value of a person is equal to his contribution to the economy during the period between his death and his life expectancy
- « implicit costs » approach : to analyse habits and practices of people to determine their implicit expenses to decrease a risk
- « willingness to pay » approach : refers to the amount of money that individuals would be ready to spend to decrease a risk → in general, consists in questioning directly people about their choices and preferences

Used to calculate the previous alpha value. Nowadays, generally abandonned

Used in public health policy (road safety, reduction of the atmospheric pollution impact, …)

EDF retained the « *reference value, cross-sectoral and unique* » recommended in the French report of the Commissariat général à la stratégie et à la prospective (CGSP), government Commission chaired by E. Quinet, in 2013 :

VSV = 3 millions €$_{2013}$

IV. Update of the α value system at EDF

Input data updated:

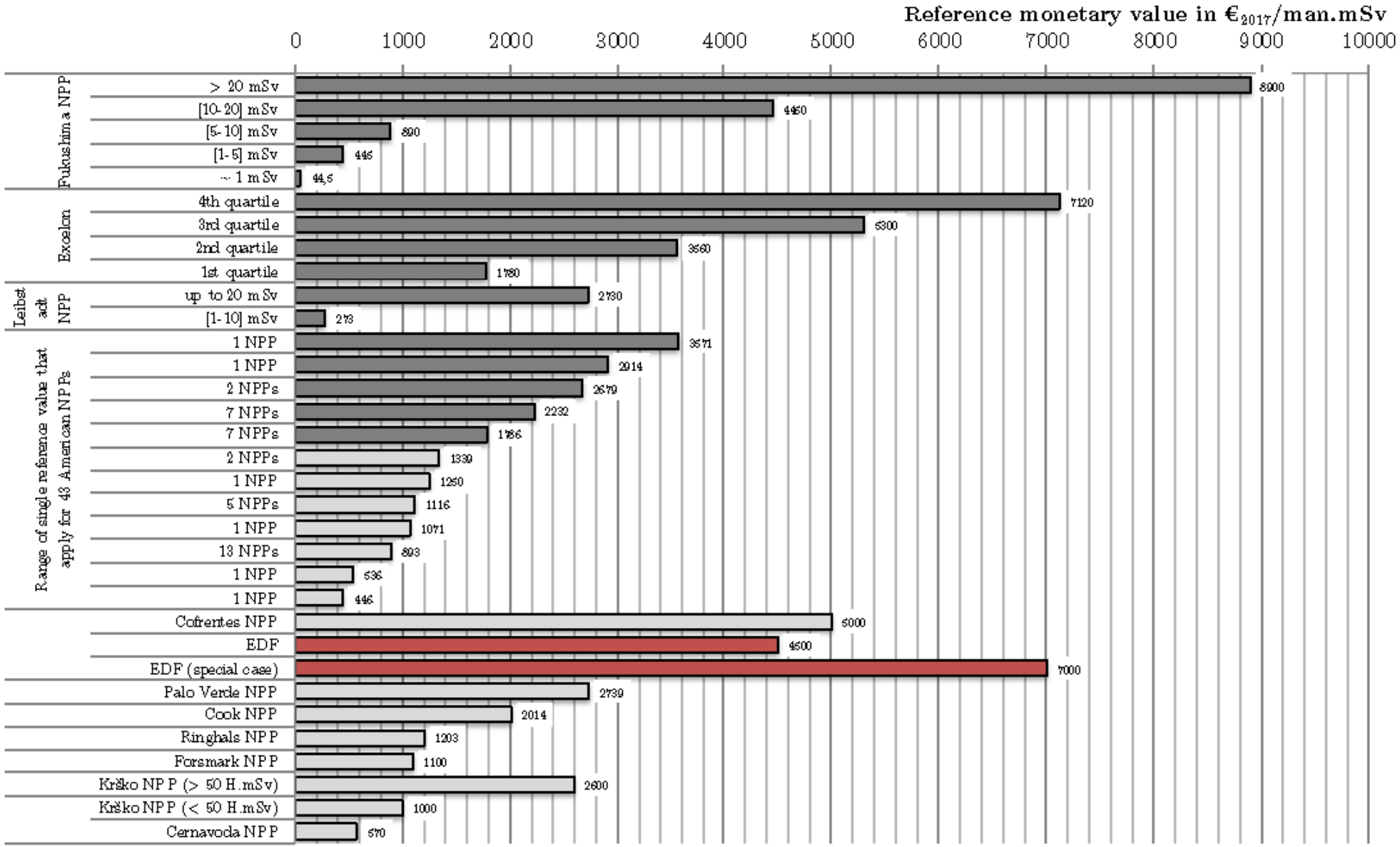
- **Feedback related to EDF practices → a unique nominal value,**
- **Detriment : value calculated by ICRP (4.2% / Sv)**
- **VSL : value recommended by the Quinet report (French government) : 3.14 millions €$_{2017}$ or 124 200 €$_{2017}$ / year**
- **Loss of life expectancy due to cancer death: 16 years**
- **Calculation of the new alpha value: $\alpha(d) = \alpha_0 \times (d/d_0)^a$ for d = 14 mSv : in this case, the risk aversion is maximal and applies to all workers**

α = 4500 k€$_{2017}$ / Person.Sv

NB : It is also possible to raise the nominal alpha value, taking into account a comprehensive evaluation of issues and impacts related to the occupational risk prevention program →

α = 7000 k€$_{2017}$ / Person.Sv

IV. Update of the α value system at EDF



V. Conclusion

New system of the monetary value of the Person.Sv at EDF :

- **A unique nominal value reflecting the EDF objective to avoid any personal dose > 14 mSv/12 consecutive months**

$$\alpha = 4500\ k€_{2017} / H.Sv$$

- **Updated from last ICRP data (radiation detriment) and socio-economic works at the French government level (Quinet report, 2013)**
- **Possibility to raise the alpha value in very specific and argumented cases**
- **Entered into force to mid 2020**

The α value remains a decision-aiding tool used in the frame of CBA and does not prejudge the final decision

In any case, the α value can be used by itself to justify a decision to not implement a protection measure.

Merci
Des questions ?

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