Occupational dosimetry for NORM industry in France

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RADIATION PROTECTION

ICRP
IAEA International Standards

No Legally Binding

Euratom Basic Safety standards

Parliament

Law

Government / ASN participation

Decrees and orders

Legally Binding

ASN/ Approved by Government

Technical Décisions
(Generic Requirements)

ASN

Individual decisions
Registration ;Licensing; approval
(Specific requirements)

ASN

ASN Guides

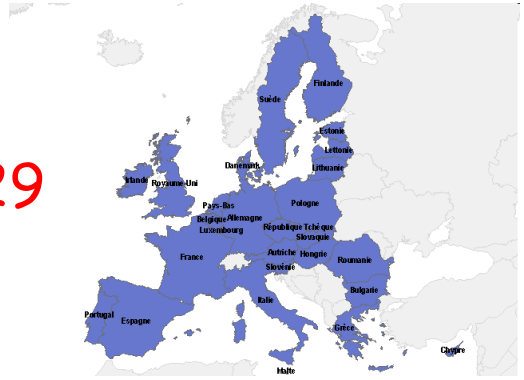
No Legally Binding

French Basic Legal Framework

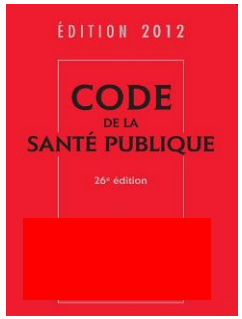
Euratom Treaty

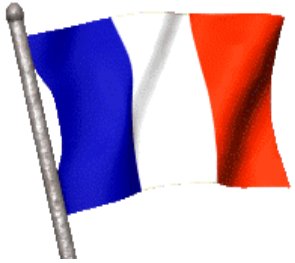
Basic Safety Standards EURATOM 96/29

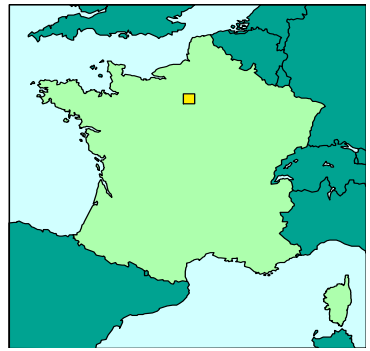
Other directives, regulations …



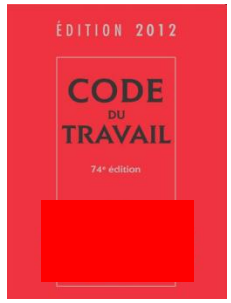
Code of Public Health







Labour Code

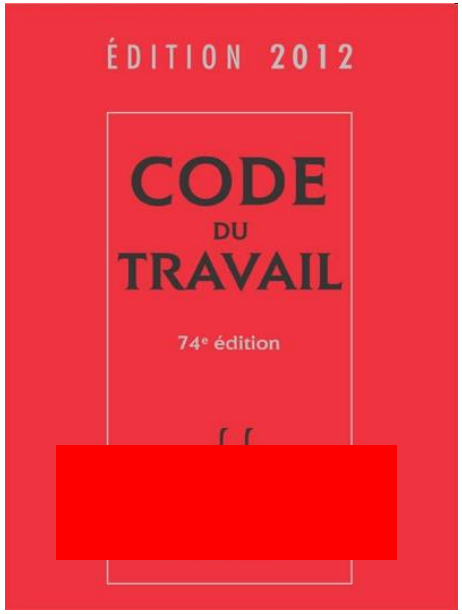


Principles and implementing provisions

Limits for workers for usual conditions of work

EFFECTIVE DOSE = The sum of the effective doses received through external and internal exposure must not exceed 20 mSv over twelve consecutive months

Methodology for dose calculation :ministerial order 01/09/2003



Dosimetric monitoring for usual conditions of work

Under the responsibility of the employer

External dosimetry

- **Supervised area**
  - Individual passive dosimetry
- **Controlled area**
  - Individual passive dosimetry
  - Individual operational dosimetry

  (Managed by the qualified expert under the responsibility of the employer)

Internal dosimetry :

Bioassays, anthroporadiametry where contamination risk exist on occupational physician prescription

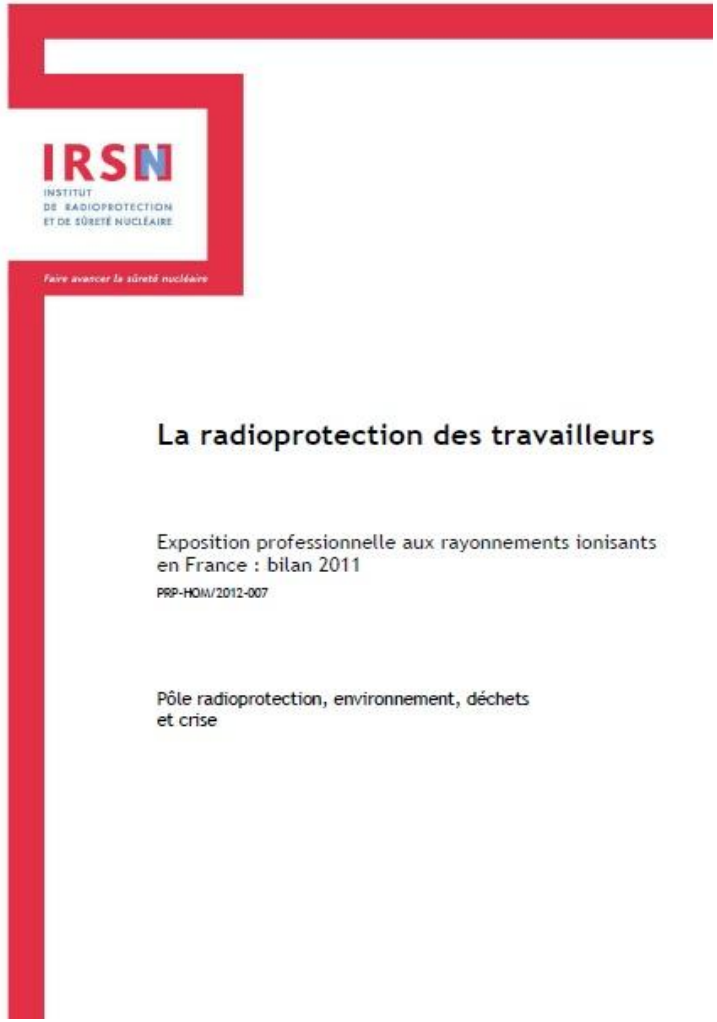
Record of occupational doses
National dose register

Results of :

- Individual external passive dosimetry
- Individual internal dosimetry

are directly sent by the approved dosimetry organisms to the national dose register (SISERI) managed by the Institute of radiation protection and nuclear safety (IRSN)

Annual reporting of IRSN to ASN



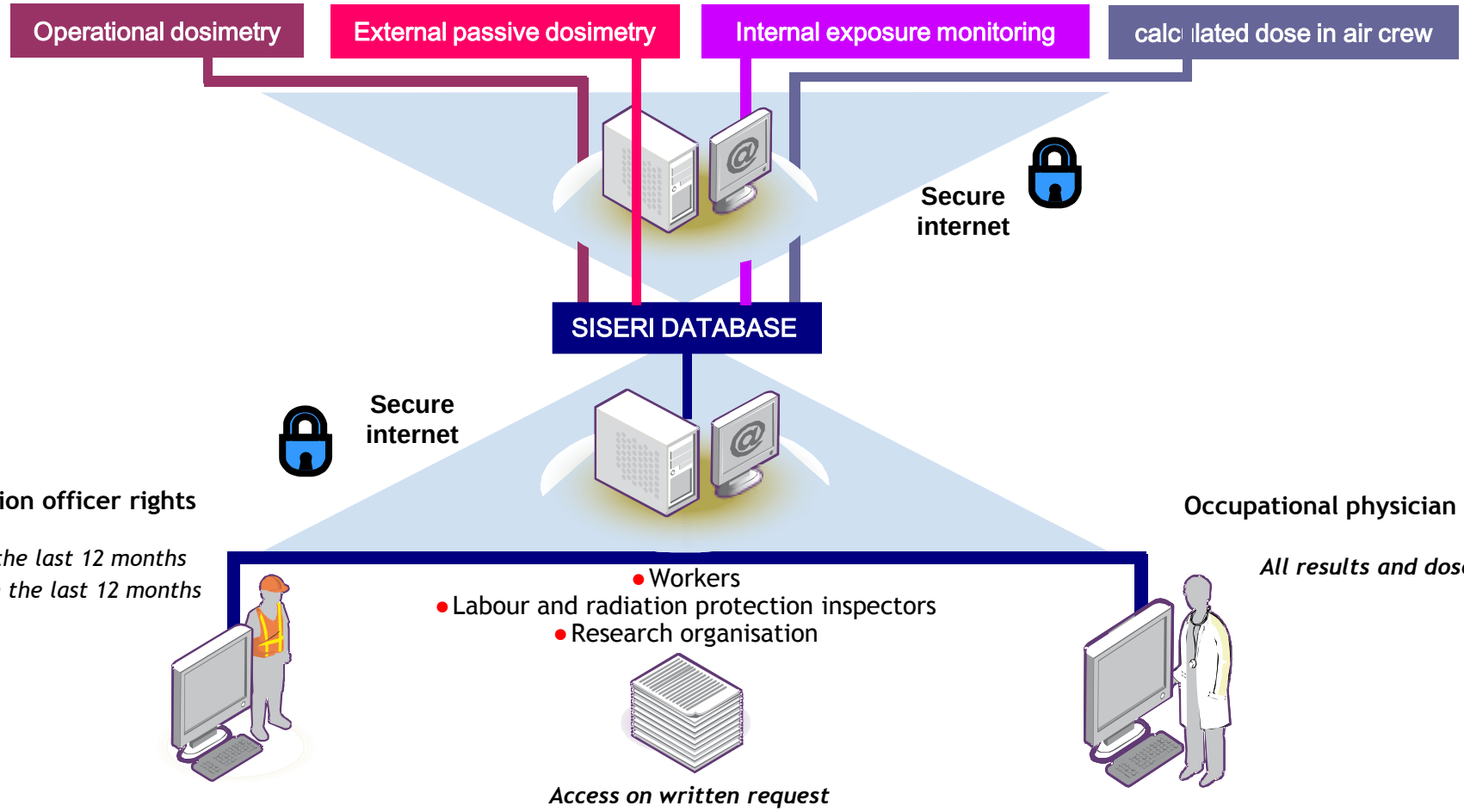
General operating principle of SISERI

Operational dosimetry
Dose registration at each exit
Radiation protection officers (RPO) transmit all the individual results on a weekly basis

Passive dosimetry
Measurements performed by accredited labs approved by the authority
Each lab transmits all the individual results on a monthly basis

Internal exposure monitoring
In vivo and/or *in vitro* measurements performed by accredited labs approved by the authority
Each lab transmits all results on a monthly basis
Internal dose is calculated and transmitted by occupational physician

Aircrew doses
The individual dose is monthly calculated by each company (with SIEVERT) taking into account the individual flight plan
Each company transmits all the individual results on a monthly basis



Occupational dosimetry

- Performed by dosimetry organisms accredited according to ISO/CEI/17 025 by COFRAC and then approved by ASN for a maximum of 5 years
- No specific agreement related to the dosemeters, as far as they comply with the appropriate national/international standards
- 18 organisms are approved by ASN to perform external and internal dosimetry (343 988 workers monitored for external exposure, 341 377 routine exams for internal exposure in 2011 in France : IRSN source)
- Inspection planning by ASN of each approved dosimetry laboratory at least once during approved period

ASN Dosymetry Approval procedure Flowchart

Steps	Stakeholders	Flowchart	Timetable	Documentation	Proof of completion
1	ASN	If applicable, inform holders of approvala that expire (good practice)	Deadline - 4 months (good practice)	Table: "suivi des agréments"	CODEP
		Receiving of a application file for approval	deadline - 3 months		COARR
2	ASN	Is the application file completed ? — No → Supplement request — Yes → Supplement reception? — Yes →	For the initial application supplements, within 4 months following the receipt of the request	Procedure ASN/AUT/31	CODEP
					COARR
		No → New request to petitioner (good practice)	Within 2 months following the request (good practice)		CODEP
3	ASN	Administrative and technical file study + posible visit		Procedure ASN/AUT/31	
		Is further information or document needed? — Yes → further information or document request		Procedure ASN/AUT/31	CODEP
		No → information and document reception? — Yes →		Procedure ASN/AUT/31	COARR
		No → New request to petitioner (good practice)	Within 2 months following the supplements request (good practice)	Procedure ASN/AUT/31	CODEP
		ASN Decision			DGA Decision
4	ASN	Notification of Decision and publication at the "Bulletin Officiel" of ASN Completion of approval			CODEP and e-mail to ASN publication pole

Occupational dosimetry for NORM industries

- Requirements appliable to all practices involving ionising radiations, whatever be the field (nuclear, industry, medical, research, transport,…) **are appliable to NORM if added exposure level exceed 1mSv/year for workers** (article R.4451-143 of labour code)

1 organism is presently approved by ASN to perform natural external and internal dosimetry using integrated TLD and radon assessment dosemeter

about 100 workers monitored in 2011 in France

Natural external & Internal dosimetry :

Integrated dosimeter combining Individual passive dosimetry and dosimeter for assessment of exposure to radon

NATURAL RADIOACTIVITY: AN OCCUPATIONAL DOSIMETRY SERVICE

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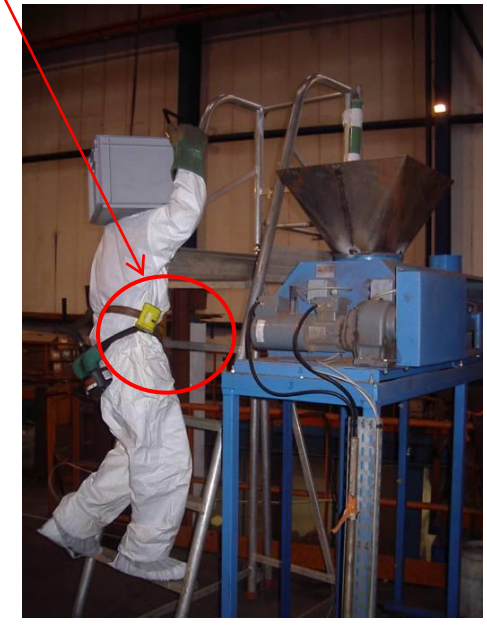
5th EAN-NORM workshop DRESDEN , december, 4-6, 2012

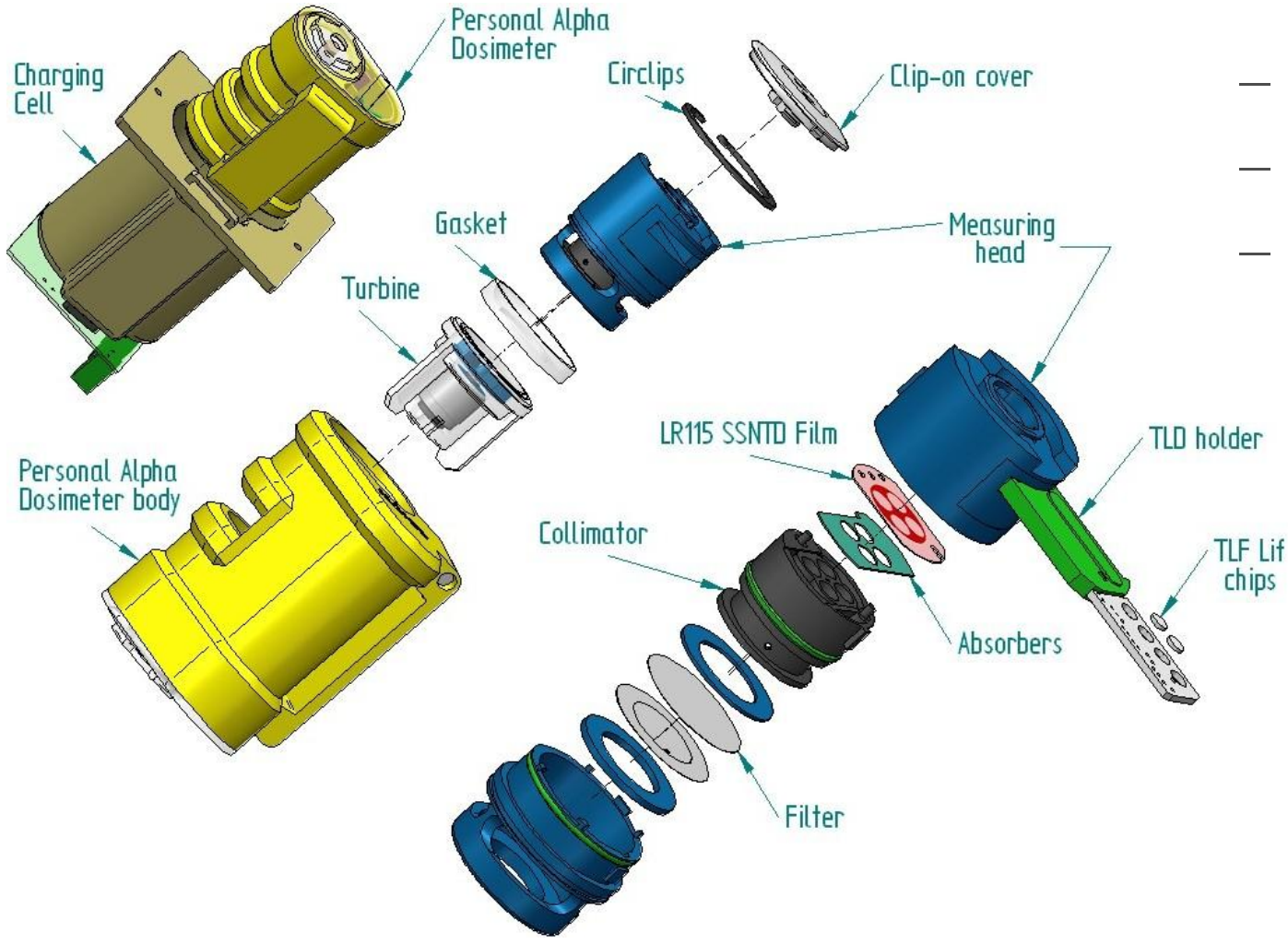
OCCUPATIONAL DOSIMETRY SERVICE

The dosimetric survey of occupationaly exposed workers is based on using a personal monitoring device intégrating measurements of the three radiologicals risks find in **NORM Industries**:



- *Short lived alpha emitters:*
  222 and 220 Radon daughters
- *Long lived alpha emitters from U and Th series in dust*
- *Ambient gamma fields*

ALGADE PERSONAL ALPHA DOSIMETER PAD



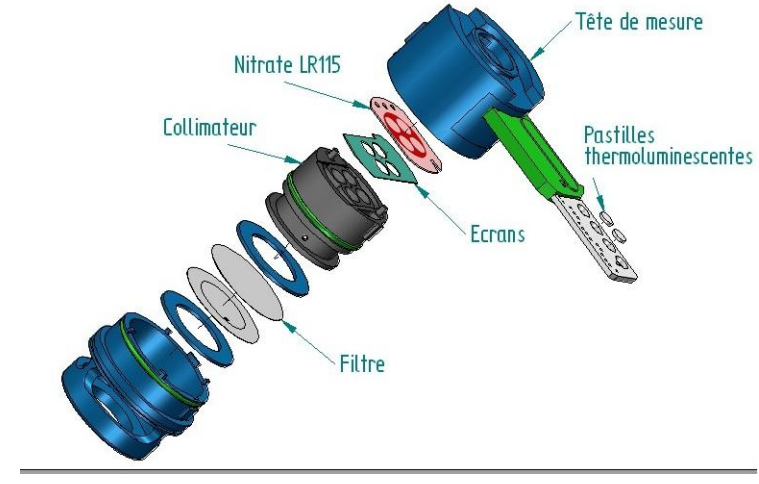
- Charging unit
- Personal Sampler,
- Measuring head
  - Rn222, Rn222 and Rn220 progeny (detector LR115 cellulose nitrate)
  - Long Lived Radioactive Dust (1.2 µm filter)
  - Gamma radiations (TLD lithium fluoride)

PAD Caracteristics

Air-Sampler

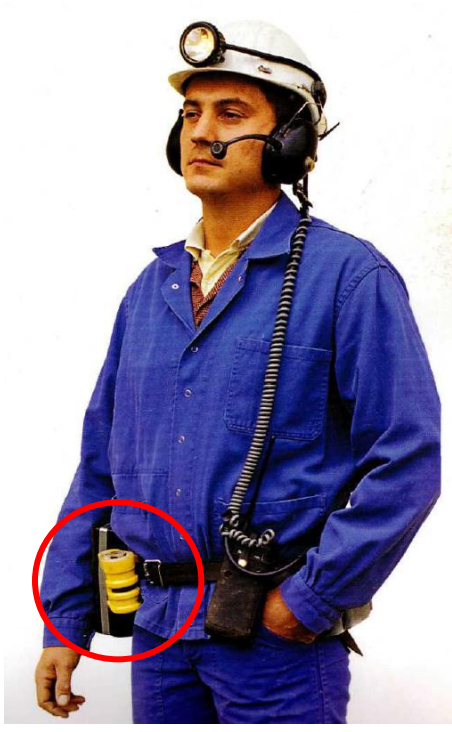
- Polycarbonate housing; Weight : *300 g*
- Dimensions : *(94 x 79 x 63) mm*
- *Centrifugal turbine powered by a Cd –Ni battery*
- Mean Flow rate : *5 $l.h^{-1}$*
- Autonomy : *12 h (after 12h charging time ; automatic on/off switch by insertion in the charging docks*
- Collection efficiencie *AMAD >1 μm : ρ>90% AMAD high cut off : 10 µm*

Measuring head



- Body : *Polyethylene high density*
- Weight : *28 g*
- Filter : *cellulose acetate ,1.2 µm porosity ,18 mm usable Ø*
- *4 carbone collimators*
- *4 energy-absorbing screens Mylar 8,23 ,36 µm thickness*
- Solid stade nuclear trace detector : *LR115 cellulose nitrate*
- Option *: TLD with 2 lithium fluoride pellets*

Use of the Personal Alpha Dosimeter worn by the agents



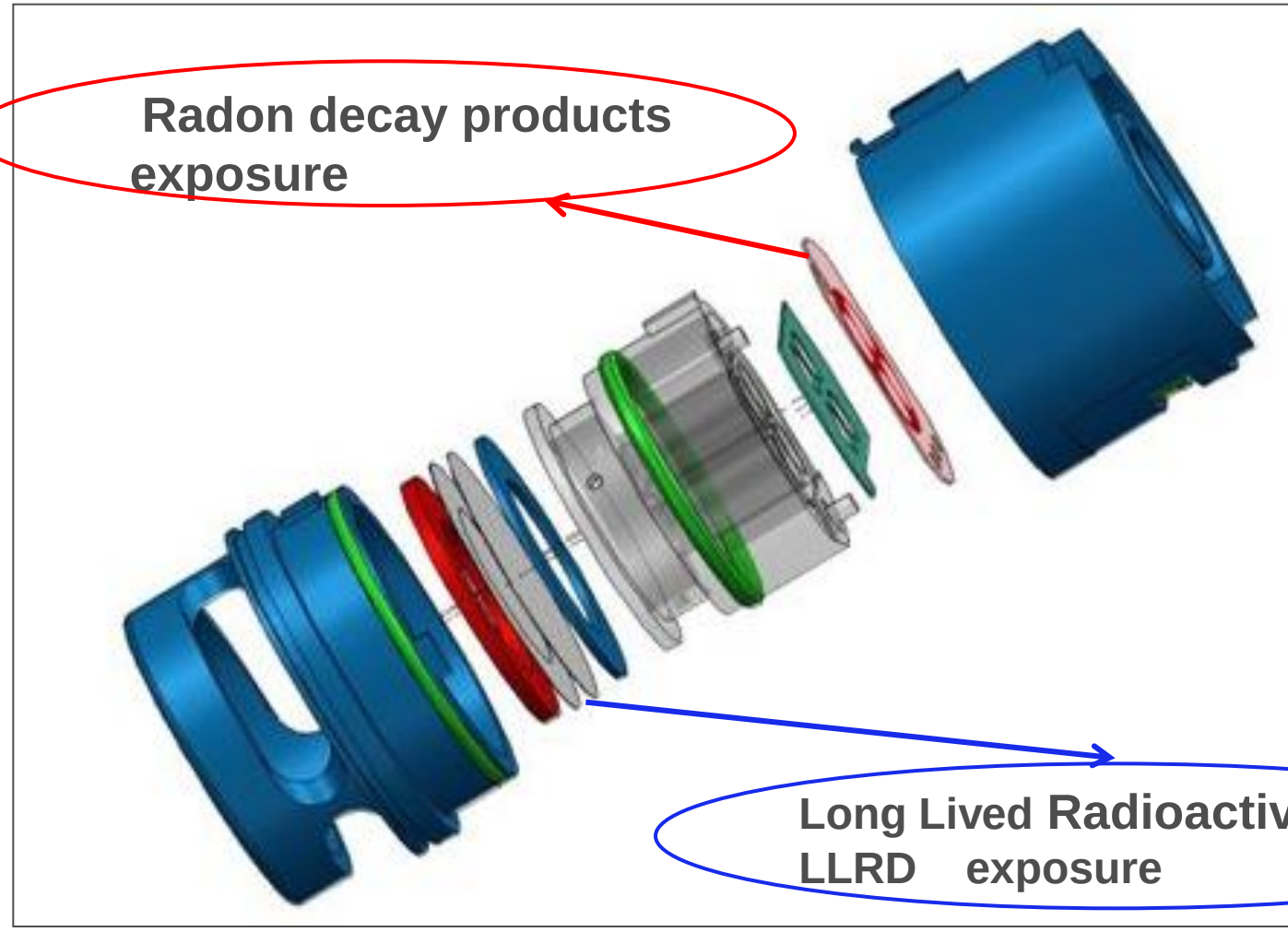
- Worn at the belt during the working time
- Use of a charging unit out of working period
- Weekly measurement of sampling flow rate
- Exposure period : monthly or quartely

The measuring heads are sent to the lab for analysis at the end of the period

charging unit (25 cells)

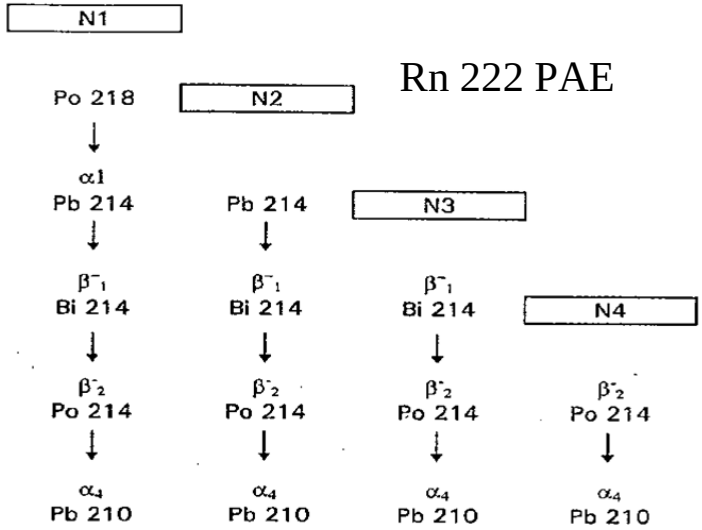
LABORATORY PROCESSING

Internal exposure monitoring



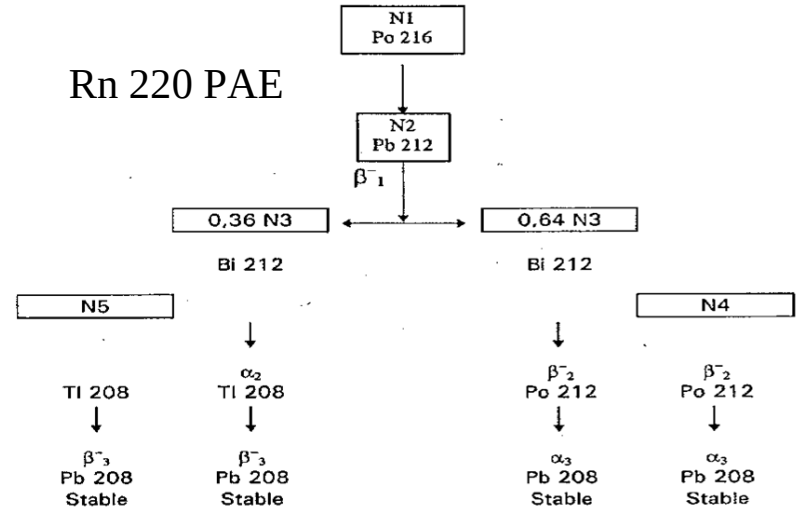
Internal Exposure Monitoring

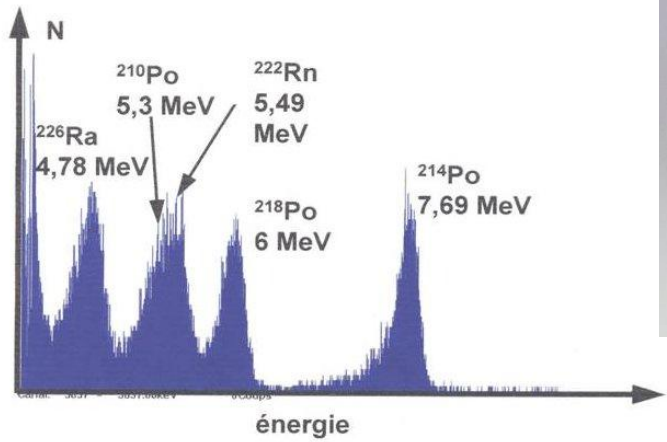
Exposure to Potential Alpha Energy PAE due to radon 222 and 220 decay products

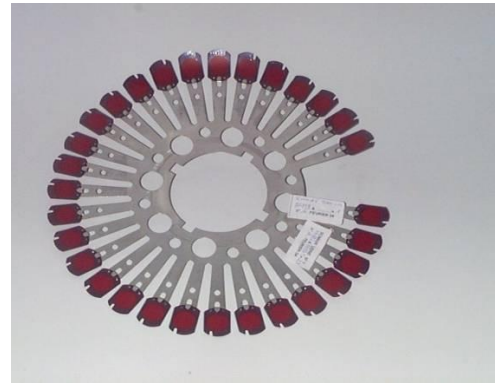


Rn 222 PAE

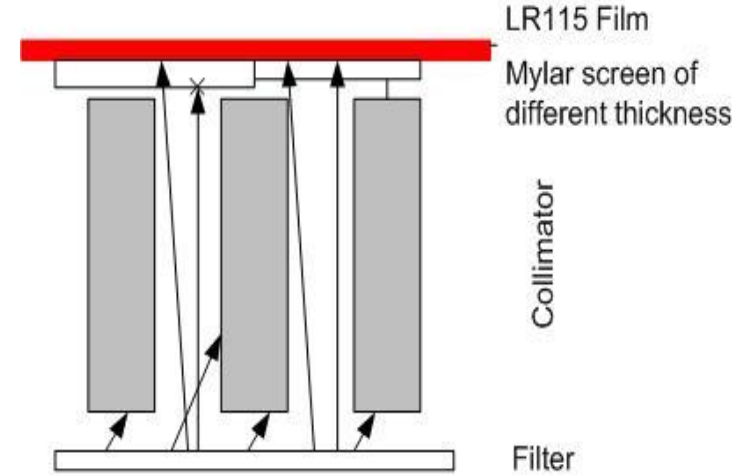
Rn 220 PAE







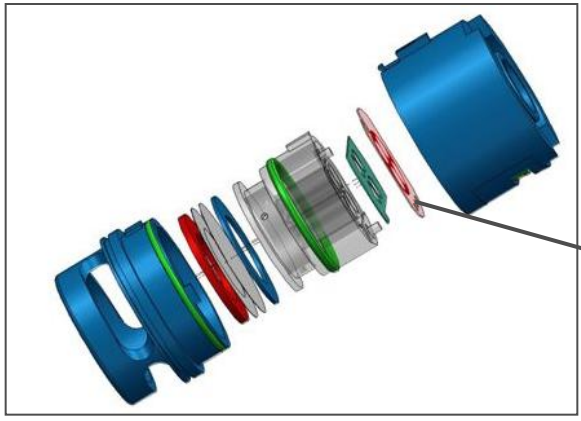
LR115 detector



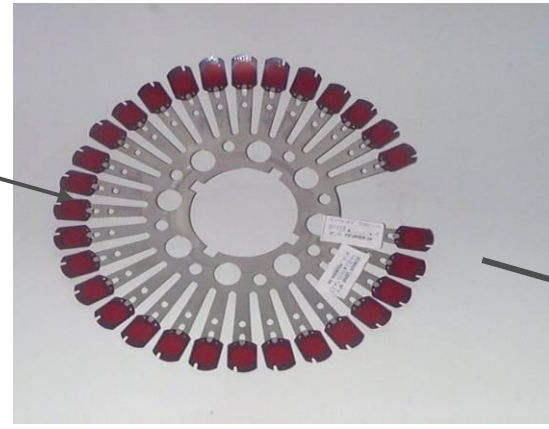
Internal Exposure Monitoring

PROCESSING OF LR115 FILMS

Reception

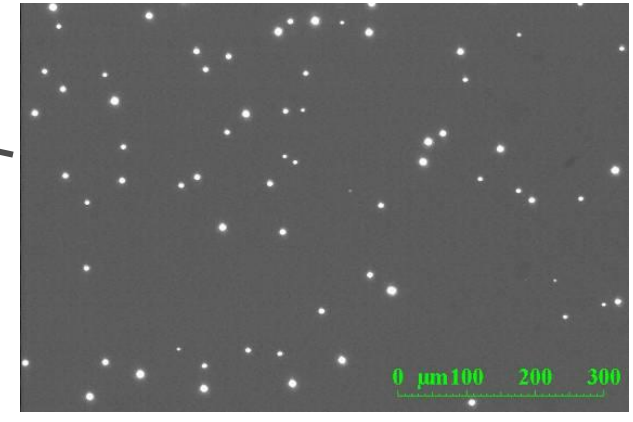


conditioning



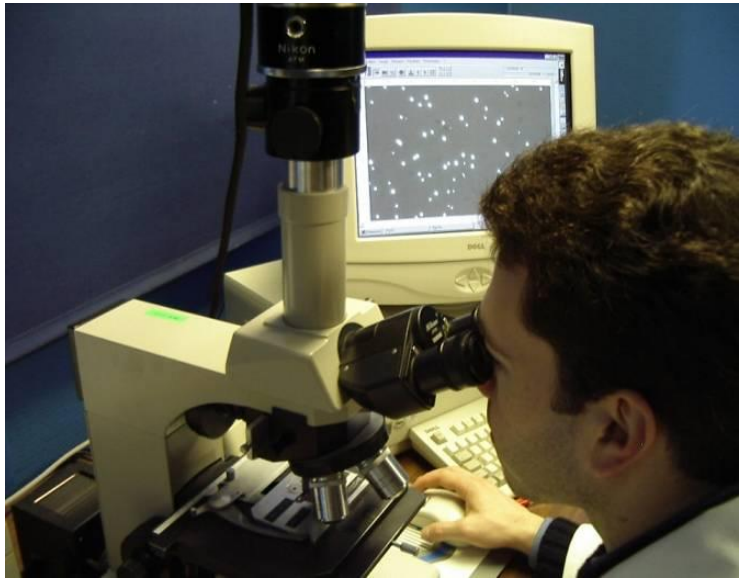
Etching in a NaOH bath

Traces obtained after etching

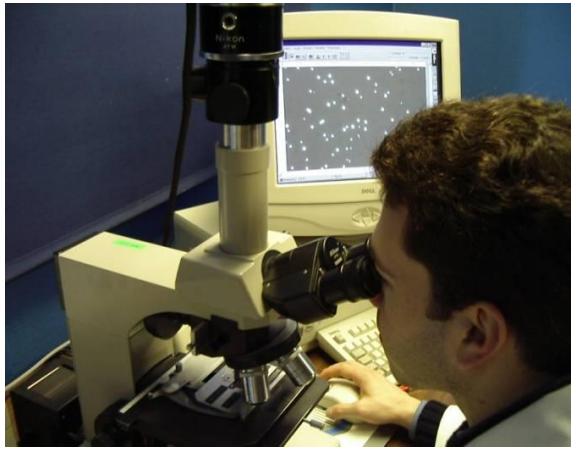


automated reading on 4 measuring ranges

Po218, Po214, Po212, Rn222



Internal Exposure Monitoring



PROCESSING OF LR115 FILMS (2)

Automated reading on 4 measuring ranges N1,N2,N3,N4

↓

Number of alpha tracks Po218, Po214, Po212, Rn222

↓

Potential Alpha Energy expression (*norme NF ISO 11665-2 –Oct 2012*)

PAE Rn 222 (nJ) = 6(N1-0.56 N3-1.099N4) + 7.7 (N2-0.045N4) x0.00016 / 0.8 x 1.037.10-3

PAE Rn 220 (nJ) = (8.78 N3 + 6.08x 0.56 N3) x0.00016 / 0.8 x 1.037.10-3

↓

Results:

Individual exposure in **mJ.m^{-3}.h or in WLM** (*1 WLM = 3.56 mJ.m-3.h)*

Concentration in µJ.m^{-3} vs wearing time (*1 WL =20.8 µJ.m-3)*

Detection limit :

Potential Alpha Energy Radon daughters : 160 nJ

DOSE ASSESSMENT

CALCULATION OF EFFECTIVE DOSES RESULTING FROM INTERNAL EXPOSURES

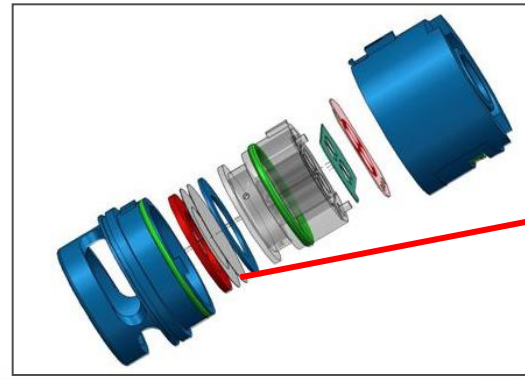
Short-lived radon daughters

	Workers	Public
Radon 222	**1,4 mSv/mJ.m^{-3}.h** or 17 mJ ≡ 20 mSv (inhalation flow rate : 1,2 m^3.h^{-1})	**1,1 mSv/mJ.m^{-3}.h** or 0,7 mJ ≡ 1 mSv (inhalation flow rate : 0,8 m^3.h)
Radon 220	**0,5 mSv/mJ.m^{-3}.h** or 48 mJ ≡ 20 mSv (inhalation flow rate : 1,2 m^3.h)	

Reference : 96/29/Euratom Directive, Appendix III
ICRP Recommendation n° 65 (September 1993)
French Ministry of Health decree 1er September 2003, Appendix III

Internal Exposure Monitoring

Long Lived alpha Radioactive Dust « LLRD » exposure



LLRD collected on the sampling filter are counted in the laboratory on a silicium junction

↓

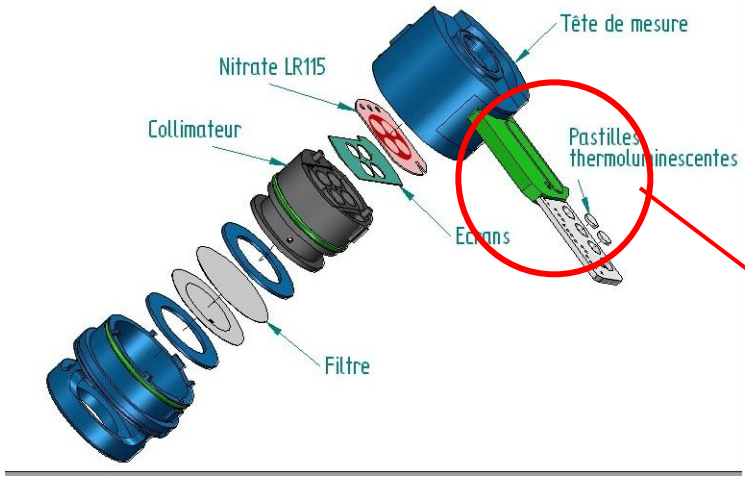
Result of alpha activity in Bq

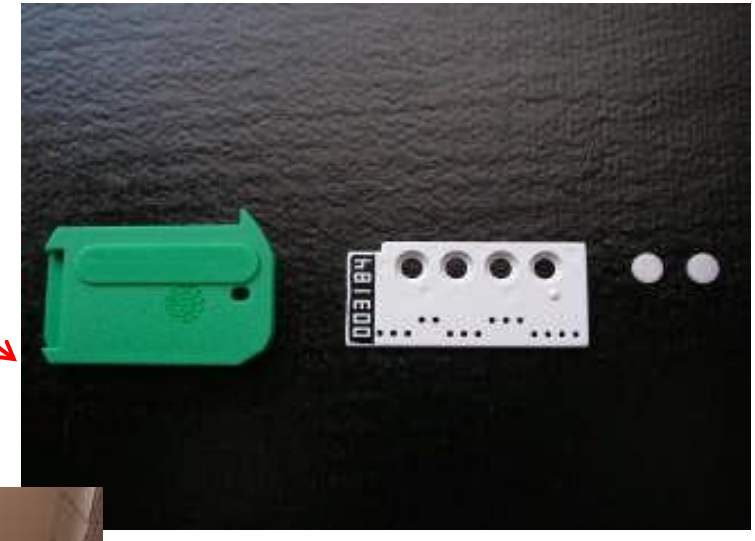
Detection limit : 14 mBq)

Individual exposure = (Activity / flow rate of PAD) in Bq.m-3.h and Bq

Dose assessment in mSv with dose coefficient (mSv/Bq inhaled) given by ICRP recommendations and according to French regulation , with aérosol caractéristics

External Exposure Monitoring





Thermoluminescent detector with 2 lithium fluoride pellets collects equivalent doses from gamma ambient radiations

Results in term of dose equivalent Hp(10) in mSv

Detection limit : 0.1 mSv

OCCUPATIONAL DOSIMETRY SERVICE

The Data Management

- Monthly (yearly) statistical and collective reports for management and administration
- Monthly (yearly) confidential report individual exposure card for workers and doctors
- Sent to the national dose register SISERI

Individual exposure sheet

Reference A-DO-6211 V1

Dosimeter Numb	Name: First Name Date of birth: Registration:	Employer: Perimeter: Sub perimeter:	Period From Jan. 2011 to Dec. 2011

Period	PAE Rn222 (mJ.h.m-3)	PAE Rn220 (mJ.h.m-3)	U ore Dust (Bq.h.m-3)	U ore concentrate (Bq.h.m-3)	Th ore Dust (Bq.h.m-3)	External Exposure (mSv)	Effective Dose E (mSv)
January 2011	0,024	0,025	0,000	0,000	0,000	0,014	0,061
February 2011	0,023	0,025	0,000	0,000	0,000	0,027	0,072
March 2011	0,029	0,000	0,000	0,000	0,000	0,064	0,105
April 2011	0,000	0,000	0,000	0,000	0,000	0,010	0,010
May 2011	0,000	0,000	0,000	0,000	0,000	0,005	0,005
June 2011	0,000	0,000	0,000	0,000	0,000	0,011	0,011
July 2011							
August 2011	0,024	0,000	0,000	0,000	0,000	0,069	0,103
September 2011	0,032	0,000	0,000	0,000	0,000	0,067	0,112
October 2011	0,047	0,027	0,000	0,000	0,000	0,021	0,101
November 2011	0,046	0,000	0,000	0,000	0,000	0,033	0,097
December 2011	0,000	0,000	0,000	0,000	0,000	0,055	0,055
Total on the period	0,225	0,077	0,000	0,000	0,000	0,376	0,732
Limit 12 months	14,280	40,000	1 780,000	9 000,000	0,000	20,000	20,000
Total on the working life							
For 34 working years	16,231	5,070	1 770,080	0,000	0,000	37,043	82,183

E = (PAE Rn222 x 1.4 mSv/mJ.m-3.h) + (PAE Rn220 x 0.5 mSv/mJ.m-3.h) + (U ore dust x 0.00935 mSv/Bq x 1.2 m3.h-1) + (U ore concentrate x 0.00185 mSv/Bq x 1.2 m3.h-1) + (Th ore dust x 0.0187 mSv/Bq x 1.2 m3.h-1) + Ext. Exp

Worker Dosimetry Report

Reference
A-DO-6207 V1

Perimeter:
Perimeter Code :

Exposure period : September 2012

						Exposures					Equivalent Dose							
Sub Perimeter	Dosimeter Number	Name	First name	Employer	Detector number	PAE Rn222 (mJ.h.m-3)	PAE Rn220 (mJ.h.m-3)	U ore Dust (Bq.h.m-3)	U ore concentrate (Bq.h.m-3)	Th ore dust (Bq.h.m-3)	PAE Rn222 (mSv)	PAE Rn220 (mSv)	U ore dust (mSv)	U ore concentrate (mSv)	Th ore dust (mSv)	external (mSv)	Effective Dose (mSv)	Effective Dose 12 months (mSv)
1					85430	0,000	0,000	3,118			0,000	0,000	0,035			0,047	0,082	0,687
1					85431	0,000	0,000	0,000			0,000	0,000	0,000			0,026	0,026	0,600
1					85432	0,000	0,000	0,000			0,000	0,000	0,000			0,057	0,057	0,730
1					85433	0,000	0,000	0,000			0,000	0,000	0,000			0,000	0,000	0,144
1					85434	0,000	0,000	0,000			0,000	0,000	0,000			0,012	0,012	0,534
1					85435	0,000	0,000	0,000			0,000	0,000	0,000			0,035	0,035	0,489

Worker Dosimetry Report

Reference
A-DO-6208 V0

Perimeter:
Perimeter Code :

Exposure Period : October 2011 to September 2012

					Exposures					Equivalent Dose						
Sub Perimeter	Dosimeter Number	Name	First name	Employer	PAE Rn222 (mJ.h.m-3)	PAE Rn220 (mJ.h.m-3)	U ore Dust (Bq.h.m-3)	U ore concentrate (Bq.h.m-3)	Th ore dust (Bq.h.m-3)	PAE Rn222 (mSv)	PAE Rn220 (mSv)	U ore Dust (mSv)	U ore concentrate (mSv)	Th ore Dust (mSv)	external (mSv)	Effective Dose (mSv)
1					0,148	0,049	3,118			0,207	0,025	0,035			0,420	0,687
1					0,000	0,000	0,000			0,000	0,000	0,000			0,000	0,000
1					0,236	0,057	0,000			0,330	0,029	0,000			0,241	0,600
1					0,134	0,105	0,000			0,188	0,053	0,000			0,489	0,730
1					0,000	0,000	0,000			0,000	0,000	0,000			0,144	0,144
1					0,160	0,099	0,000			0,224	0,050	0,000			0,260	0,534

Dosimetry of all workers monitored

Reference A-DO-6209 V0

Perimeter name :
Perimeter code :

Effective Doses

Exposure period: September 2012

Sub perimeter	Employer	Total controled workers	Collective Dose (H.mSv)	Effective doses distribution (mSv)												Exposures (mSv)		
				d=0	0 < d <= 0,10	0,10 < d <= 0,20	0,20 < d <= 0,30	0,30 < d <= 0,40	0,40 < d <= 0,50	0,50 < d <= 0,60	0,60 < d <= 0,70	0,70 < d <= 0,80	0,80 < d <= 0,90	0,90 < d <= 1,00	1,00 < d <= 1,50	d > 1,50	Max	Percentile 90%	Average (on total workers)
xxxxxx	Internal workers	10	0,388	1	9												0,082	0,066	0,039
xxxxxx	SP total	10	0,388	1	9												0,082	0,066	0,039
yyyyyy	Internal workers	3	0,086		3												0,043	0,043	0,029
yyyyyy	SP total	3	0,086		3												0,043	0,043	0,029
	Perimeter total	13	0,474	1	12												0,082	0,066	0,036

Dosimetry of all workers monitored

Reference A-DO-6210 V0

Perimeter name :
Perimeter code :

Effective Doses

Exposure period: October 2011 to September 2012

Sub perimeter	Employer	Total controled workers	Average monitored workers	Collective Dose (H.mSv)	Effective doses distribution (mSv)												Exposures (mSv)			
					d=0	d<= 1,0	1,0 <d<= 2,0	2,0 <d<= 4,0	4,0 <d<= 6,0	6,0 <d<= 8,0	8,0 <d<= 10,0	10,0 <d<= 12,0	12,0 <d<= 14,0	14,0 <d<= 16,0	16,0 <d<= 18,0	18,0 <d<= 20,0	d> 20,0	Max	Percentile 90%	Average (on total workers)	Average (on average workers)
xxxxxx	Internal workers	11	9,27	5,799	1	9	1											1,082	0,730	0,527	0,625
xxxxxx	SP total	11	9,27	5,799	1	9	1											1,082	0,730	0,527	0,625
yyyyyy	Internal workers	3	3,00	1,132		3												0,435	0,435	0,377	0,377
yyyyyy	SP total	3	3,00	1,132		3												0,435	0,435	0,377	0,377
	Perimeter total	14	12,27	6,931	1	12	1											1,082	0,730	0,495	0,565

PAD references

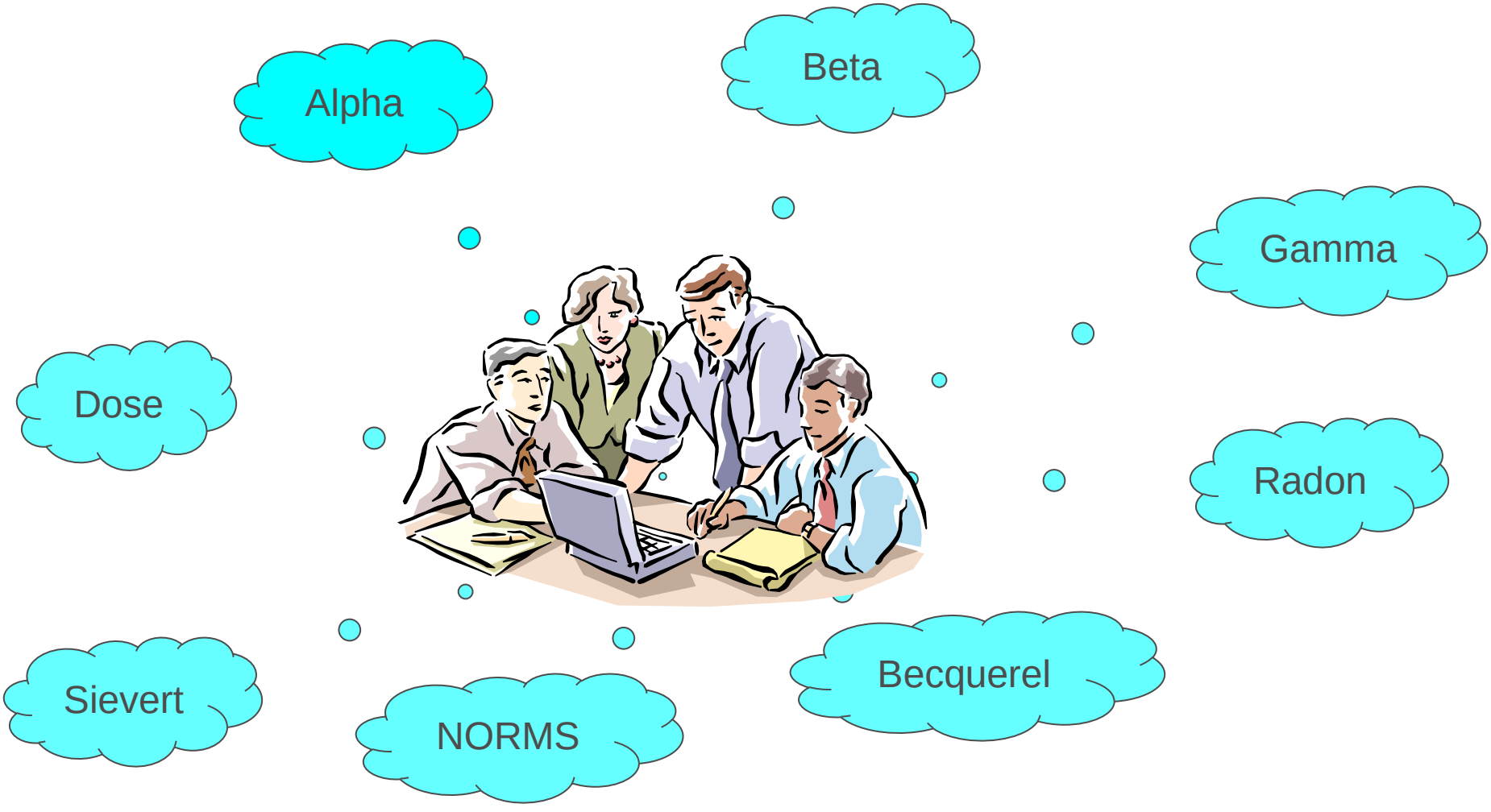
History : Uranium mines since 1983

- 1983 French Uranium mines
- 1987 AREVA Group Gabon and Niger
- 90's Canada both AREVA and CAMECO
- 1993 WISMUT GmbH Germany
- 1996 DIAMO Czech Republic
- 2008-2010 AREVA group Centrafrique, Namibia, Kazakstan

now , **NORMS** in France

- Decommissioning TIO2 pigment production facilities
- Niobium mining project
- Decommisioning production of phosphate fertilisers facilities
- Zircon and zirconium industry

and **Underground workplaces** with radon (caves , closed metallic mines survey)



..... THANK YOU FOR YOUR ATTENTION