

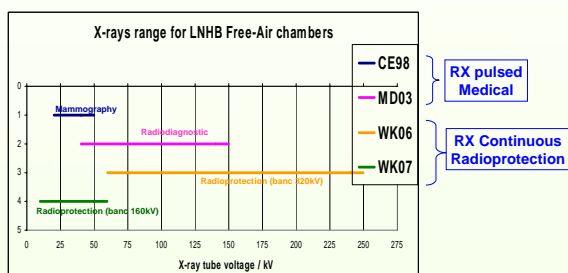
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## CONTEXT

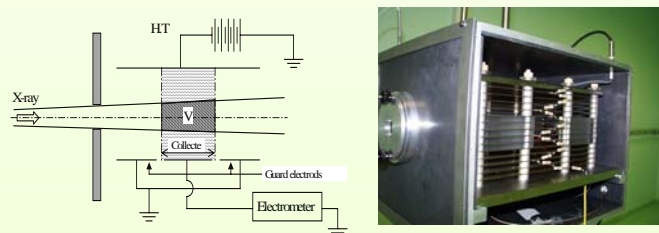
-The EU directive 97/43 introduces the concept of protection against radiation for patients, associated with the ALARP principle (P stands for practicable). It has been transcribed into French regulation by the decree N° 2003-270. In addition to that the mode of enforcement of this new legislation was defined, on one hand, by the decree of March 3, 2003, relating to the obligation of maintenance and quality control of radiological facilities, and, on the other hand, by the decree of February 12, 2004, which fixes the Dose Reference Levels (DRL) for current radiological examinations. -The knowledge of the doses delivered to patients in medical diagnosis is thus henceforth mandatory.

## LNHB X-rays FACILITIES



## METHOD

Air-Kerma (in Gy) measurement with Free-Air Ionization Chamber



$$K_{air} = \frac{Q}{\rho_{air} \cdot V} \frac{W_{air}}{e} \frac{1}{1-g} \cdot \prod_i k_i$$

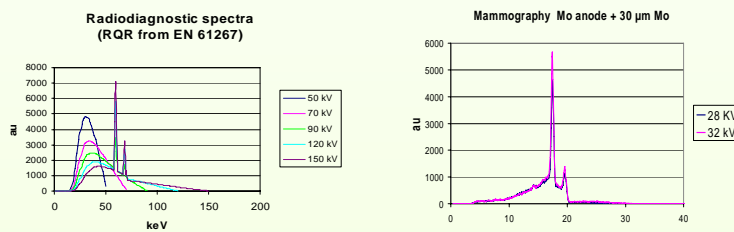
## CONDITIONS OF MEASUREMENT

	Radiodiagnostic	Mammography
Distance between focal spot and reference plane of standard	100 cm	50 cm
Beam dimension in the reference plane	30x30 cm	15 x10 cm
Anode material	W	Mo or Rh
Inherent filtration	2.2 mm Al	0.8 mm Be

Radiations conditions in accordance with EN 61267 (2006)

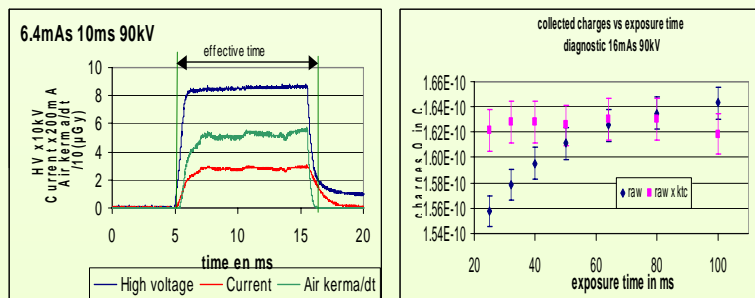
	Radiodiagnostic (RQR)		Mammography (RQR-M)	
Xray tube voltage / (kV)	90	120	28	32
Additional filtration	0.55 mm Al	0.50 mm Al	30 µm Mo	30 µm Mo
Half value layer / (mm Al)	3.32	4.49	0.333	0.367
X-ray tube current / (mA)	10 to 640		100	100
Exposure time / (ms)	1 to 6000		4 to 6000	

## X-Ray SPECTRA



## SHORT TIME PULSES (< 100 ms)

X-ray generators can not deliver constant mAs at short pulses exposure time. For comparison of air kerma vs exposure time we have to measure « effective mAs » (mAs eff) and apply correction factor,  $k_{eff} = (mAs_{th}) / (mAs_{eff})$ . Where « mAs th » is the theoretical mAs delivered by the generator, and « mAs eff » is the integral of current during pulse but limited in the interval where the calculated air kerma/dt is significant.



## FREE-AIR CHAMBERS

Dimension	Radiodiagnostic	Mammography
kV range	40-150	20-50
Plate separation/(cm)	14.5	5.0
Air path length / (cm)	20.4	6.05
Collecting plate width / (cm)	4.844	1.693
Aperture diameter / (cm)	0.997	0.505
Electrical field / (V/cm)	345	500
Measuring volume / (cm <sup>3</sup> )	3.781	0.3391



Free air chambers

## ESTIMATED UNCERTAINTIES

### Diagnostic

$K_{AIR} = 1.201$  mGy for 90kV, 16 mAs, 32 ms, 1 m  
 $K_{AIR} = 0.472$  mGy for 90kV, 6.4 mAs, 20 ms, 1 m

### Mammography

Mo anode + 30 µm Mo additional filtration  
 $K_{AIR} = 20.64$  mGy, 28 kV, 100mAs, 45 cm

Physical constants and correction factors	Value 90 kV	relative uncertainties %	type
$\rho_{air}$	1.293kg/m <sup>3</sup>	0.01	B
$W_{air}/e$	33.97J/C	0.15	B
1-g bremsstrahlung	1.0000	0.01	B
Measuring volume	3.781 cm <sup>3</sup>	0.14	A
Measured Charge	0.2 nC	0.16	A
Temperature	20°C	0.04	B
Pressure	1013 hPa	0.02	B
$k_h$ humidity	0.998	0.03	B
$k_{sc}$ short time	-	0.55	A
$k_a$ air attenuation	1.0068	0.03	B
$k_{ion}$ ion collection	1.0014	0.08	B
$k_{sc}$ scattered radiation	0.9950	0.10	B
$k_{el}$ electron loss	1.0000	0.10	B
$k_d$ field distortion	0.9965	0.04	B
$k_t$ transmission through walls	0.9995	0.02	B
combined uncertainty $u_c$	-	0.63	
expanded uncertainty, $U, k = 2$	-	1.27	

Physical constants and correction factors	Value 28 kV	relative uncertainties %	type
$\rho_{air}$	1.293kg/m <sup>3</sup>	0.01	B
$W_{air}/e$	33.97J/C	0.15	B
1-g bremsstrahlung	1.0000	0.01	B
Measuring volume	0.339 cm <sup>3</sup>	0.46	A
Measured Charge	0.2 nC	0.46	A
Temperature	20°C	0.04	B
Pressure	1013 hPa	0.02	B
$k_h$ humidity	0.998	0.03	B
$k_{sc}$ short time	-	0.00	A
$k_a$ air attenuation	1.0112	0.03	B
$k_{ion}$ ion collection	1.0000	0.08	B
$k_{sc}$ scattered radiation	0.9957	0.10	B
$k_{el}$ electron loss	1.0000	0.10	B
$k_d$ field distortion	1.0000	0.04	B
$k_t$ transmission through walls	0.9998	0.02	B
combined uncertainty $u_c$	-	0.69	
expanded uncertainty, $U, k = 2$	-	1.38	