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Encouraging Sustainability in Radiation Protection

Refresher Course: Procedures for monitoring the dose to the lens of the eye, the skin and the extremities

Dr. Mercè Ginjaume
Institut de Tècniques Energètiques – Barcelona
Universitat Politècnica de Catalunya

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UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Institut de Tècniques Energètiques

Learning objectives

1.- To be aware of the latest changes in individual monitoring regulation.

2.- To learn how to identify the workplaces requiring monitoring of the extremities, the skin and the lens of the eye.

3.- To be able to decide which is the best monitoring procedure for a given workplace.

4.- To be able to interpret the results of the monitoring and to define radiation protection measures to optimize the workers' procedures and to reduce doses, when appropriate.

Outline

1.- Introduction: scope, references
2.- Regulation in individual monitoring
3.- Assessment of dose levels prior to monitoring
4.- Individual monitoring procedures, performance of personal dosimeters
5.- Interpretation and management of results
6.- Basis for setting a monitoring program
    - Application in an industrial workplace
    - Application in a medical workplace

1. Introduction: scope

Radiation protection is defined by the IAEA as

"The protection of people from harmful effects of exposure to ionizing radiation, and the means for achieving this".

The exposure to IR can result,

- at high exposures, in "tissue" ("deterministic") effects, such as skin burns, cataracts,
- at low exposures, in “stochastic” effects, in particular an increase of risk of cancer.

Monitoring the extremities and the lens of the eye is not always straightforward, and many practical problems arise for the application of monitoring in the workplace.
As a result, monitoring is often not done as it should be, or not done at all.

References

Monitoring the dose to the lens of the eye, the skin and, the extremities. June,2018

INTERNATIONAL STANDARD **ISO 15382**

Second edition 2015-12-01

Radiological protection — Procedures for monitoring the dose to the lens of the eye, the skin and the extremities

Radioprotection — Procédures pour la surveillance des doses au cristallin, à la peau et aux extrémités

17.1.2014 EN Official Journal of the European Union L 13/1

II

(Non-legislative acts)

DIRECTIVES

COUNCIL DIRECTIVE 2013/59/EURATOM of 5 December 2013

laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.

Volume 37 Nos. 2-4 2007 ISSN 0146-6453 ISBN 978-0-7020-3048-2

ICRP Annals of the ICRP

ICRP Publication 103

The 2007 Recommendations of the Internatior Commission on Radiological Protection

Volume 41 Nos. 1-2 2012 ISSN 0146-6453 ISBN 978-0-7020-5227-9

ICRP Annals of the ICRP

ICRP Publication 118

ICRP Statement on Tissue Reactions and Early and Late Effects of Radiation in Normal Tissues and Organs – Threshold Doses for Tissue Reactions in a Radiation Protection Context

IAEA TECDOC SERIES

TECDOC No. 1731

Implications for Occupational Radiation Protection of the New Dose Limit for the Lens of the Eye

IRPA INTERNATIONAL RADIATION PROTECTION ASSOCIATION

IRPA GUIDANCE ON IMPLEMENTATION OF EYE DOSE MONITORING AND EYE PROTECTION OF WORKERS

2. Regulation in individual monitoring Directive 2013/59/EURATOM

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CHAPTER III: **SYSTEM OF RADIATION PROTECTION**

Article 5: **General principles of radiation protection**

Member States shall establish legal requirements and an appropriate regime of regulatory control which, for all exposure situations, reflect a system of radiation protection **based on the principles of justification, optimisation and dose limitation.**

Article 9: **Dose limits for occupational exposure**

CHAPTER VI: **OCCUPATIONAL EXPOSURES**

Article 40: **Categorisation of exposed workers**

Article 41: **Individual monitoring**

https://ec.europa.eu/energy/sites/ener/files/documents/CELEX-32013L0059-EN-TXT.pdf

Chapter III - Section 2: Dose limitation 2/5

Article 9: **Dose limits for occupational exposure**

The limit on **the effective dose** shall be **20 mSv in any single year**. However, in special circumstances, a higher effective dose of up to 50 mSv may be authorised by the competent authority in a single year, provided that the average annual dose over any 5 consecutive years, does not exceed 20 mSv.

Limits on **equivalent dose**:

(a) the limit on the **equivalent dose for the lens of the eye** shall be **20 mSv in a single year** or **100 mSv in any five consecutive years** subject to a maximum dose of 50 mSv in a single year, as specified in national legislation.

(b) the limit on the **equivalent dose for the skin shall be 500 mSv in a year**, this limit shall apply to the **dose averaged over any area of 1 cm^2** , regardless of the area exposed.

Justification of the eye lens dose limit reduction (ICRP 118) 3/5

Several recent lines of evidence from experimental and epidemiological studies have suggested that **these values may be too high, and that radiation cataract may be stochastic**. In part, this re-evaluation of the data is based on the presumption that detectable opacities, given enough time, will progress to visual disability.

ELSEVIER

ICRP Publication 118

ICRP
Annals of the ICRP

ICRP Statement on Tissue Reactions

ICRP PUBLICATION 118, PART 1

Approved by the Commission on 21 April 2011

(.....)

(2) The Commission has now reviewed recent epidemiological evidence suggesting that there are some tissue reaction effects, particularly those with very late manifestation, where threshold doses are or might be lower than previously considered. For the lens of the eye, the threshold in absorbed dose is now considered to be 0.5 Gy.

(3) For occupational exposure in planned exposure situations, the Commission now recommends an equivalent dose limit for the lens of the eye of 20 mSv/year, averaged over defined periods of 5 years, with no single year exceeding 50 mSv.

Chapter VI: Occupational Exposures 4/5

Article 40: **Categorisation of exposed workers**

(a) category A: those exposed workers who are liable to receive - an effective dose greater than 6 mSv per year or

- an equivalent dose greater than **15 mSv** per year for the lens of the eye or greater than 150 **mSv** per year for skin and extremities;

(b) category B: those exposed workers who are not classified as category A workers.

Chapter VI: Occupational Exposures 5/5

Article 41: **Individual monitoring,**

Member States shall ensure that

(a) category A workers are systematically monitored based on individual measurements performed by a dosimetry service.
In cases where category A workers are liable to receive significant internal exposure or significant exposure of the lens of the eye or extremities, an adequate system for monitoring shall be set up.
***H*(eye lens); $H_p(3)$ > 15 mSv/year**
***H*(skin - extremities); $H_p(0.07)$ > 150 mSv/year**

(b) monitoring for category B workers is at least sufficient to demonstrate that such workers are correctly classified in category B. Member States may require individual monitoring performed by a dosimetry service, for category B workers.

3. Assessment of dose levels prior individual monitoring

1/5

Prior to routine monitoring, it is important to assess the dose levels to the skin, the extremities, or the lens of the eye in a workplace field situation in order to decide which method, if any, and which period of routine monitoring is necessary.

1. **Indications from workplace measurements** (Workplace measurements)
2. **Indications from whole body dosimetry** (homogeneous fields)
3. **Indications from literature data** (medical applications, work-load)
4. **Indications from simulations** (numerical data)
5. **Indications from confirmatory measurements.** ⬆ ⬆

3. Assessment of dose levels prior individual monitoring 2/5

Indications from confirmatory measurements

Confirmatory measurements

- ✓ They shall mimic routine measurements.
- ✓ They shall follow ISO recommendations for optimal assessment.
- ✓ The working procedures shall not be changed because of the confirmatory measurements.
- ✓ They must be a representative sample of the annual dose (3 consecutive months, 1 year).

3. Example dose levels

Monitoring the dose to the lens of the eye, the skin and, the extremities. June,2018

NUREG-0713, Vol. 37: **Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2015**

Table 6.2 Maximum Occupational Doses for Each Exposure Category* 2015

Dose Category**	Annual Dose Limit 10CFR20***	Maximum Dose Reported (rem)	Max Dose Percent of the Limit	Number of Individuals with Measurable Dose	Number of Individuals >25% of the Limit	Number of Individuals >50% of the Limit	Number of Individuals >75% of the Limit	Number of Individuals >95% of the Limit	Number of Individuals > Limit
SDE-ME	50 rem	42.612	85%	51,959	28	2	1	-	-
SDE-WB	50 rem	7.792	16%	57,244	-	-	-	-	-
LDE	15 rem	8.082	54%	56,414	13	1	-	-	-
CEDE		0.712		2,431					
CDE		5.937		1,731					
DDE		8.059		55,577					
TEDE	5 rem	8.059	161%	56,732	716	63	12	2	2
TODE	50 rem	8.059	16%	57,215	-	-	-	-	-

Extremities

Eye lens
25% 37.5 mSv

E (total)

* Only records reported by licensees required to report under 10 CFR 20.2206 are included. Numbers have been adjusted for the multiple reporting of transient individuals.

** SDE-ME = shallow dose equivalent to the maximally exposed extremity
SDE-WB = shallow dose equivalent to the whole body
LDE = lens dose equivalent to the lens of the eye
CEDE = committed effective dose equivalent
CDE = committed dose equivalent
DDE = deep dose equivalent
TEDE = total effective dose equivalent
TODE = total organ dose equivalent

*** Shaded boxes represent dose categories that do not have specific dose limits define

In USA, NRC has now established an annual dose limit for the lens of the eye of 5 rem/year (50 mSv/year).
In the Table 15 rem (150 mSv).

3. Example dose levels

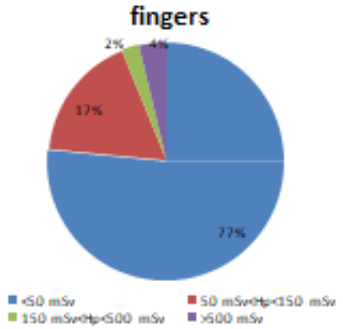
HSE (UK) *Occupational exposure to ionising radiation. Exposures among classified UK workers as reported to the Central index of Dose Information*, 2015
http://www.hse.gov.uk/statistics/ionising-radiation/cidi.pdf

Extremity (2015):
Monitored workers: 12670
Workers>150 mSv: 9; Workers>500 mSv: 1
Nuclear (1); Medical (7); Research (1)

Eye lens (2015):
Monitored workers: 8511
Workers (3-15) mSv: 517; (15-30) mSv: 5; Workers>30 mSv: 1
Nuclear – decommissioning (505-4-0);
Medical (12-1-1); onshore drilling (1-0-0)

3. Example dose levels

Frequency distribution of how many times the annual dose for workers exceed a certain dose level



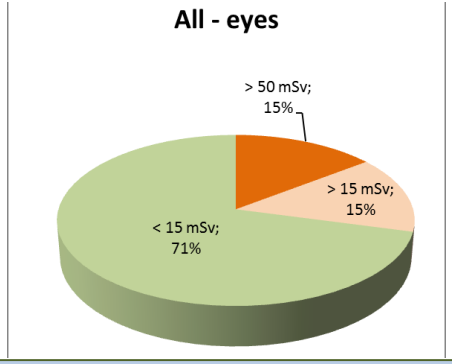
> 500 mSv: exceeding the annual limit

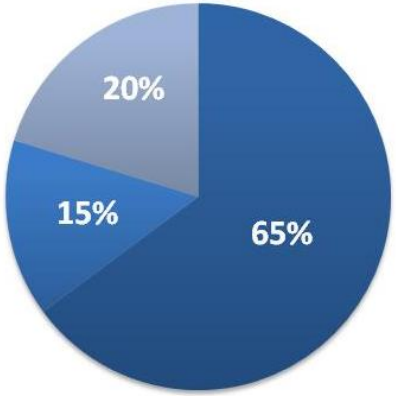
> 150 mSv: exceeding 3/10th of the limit

> 50 mSv: exceeding 1/10th of the limit

< 50 mSv: low doses

ORAMED data. Interventional radiology (extremities and eyes)





- below 250mSv/year
- between 250-500mSv/year
- above 500mSv/year

ORAMED data.
Nuclear medicine diagnostics (extremities)

- The annual dose estimation is above 150 mSv (3/10 of the annual limit) for 51% of the workers.
- 20% of the workers exceed the annual dose limit of 500mSv.

N.B. considering only the procedures measured within the ORAMED project.

3. Workers who may be affected

5/5

Medical workers

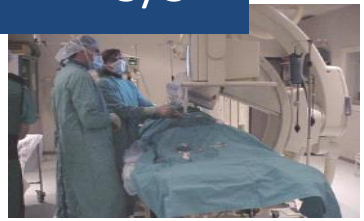
- ✓ Working in fluoroscopically guided or CT-guided interventional procedures.
- ✓ Nuclear medicine workers, i.e. preparation of radiopharmaceuticals, PET/CT, β-sources.
- ✓ Working with cyclotrons.

Workers in nuclear facilities

- ✓ Using glove boxes.
- ✓ Working on decommissioning of nuclear facilities.
- ✓ Handling plutonium or depleted uranium.

Industrial radiographers

Accidental exposures



4. Individual monitoring procedures, performance of personal dosimeters

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ISO 15382:2015

The standard specifies **a procedure for individual monitoring of radiation exposure of the skin , extremities** (hands, fingers, wrists, forearms, feet and ankles) **and lens of the eyes** in planned exposure situations.

It covers practices which involve a risk of exposure to **photons in the range of 15 keV to 3 MeV and electrons and positrons in the range of 500 keV. and 3 MeV**. It does not exposure due to alpha or neutron radiation fields.

4.1 General considerations

4.2 Extremity and skin dosimetry

4.3 Eye lens dosimetry

4.4 Special case: contamination

Locations to monitor; Types of dosemeters; Technical specifications; Application of correction factors.

ISO 15382:2015 CONTENT

Monitoring the dose to the lens of the eye, the skin and, the extremities. June,2018

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4. Individual monitoring procedures, performance of personal dosimeters

4.1 General considerations ISO 15382:2015

- ✓ Extremities, skin, and the lens of the eye needs to be monitored in **non-homogeneous exposure conditions**.
- ✓ **Dose levels recommended to perform monitoring**
  - ✓ Extremities and skin (max. 1 cm^2); when H>150 mSv/year
  - ✓ Eye lens; **if H>15 mSv in 1 y** or **H>6 mSv in consecutive years**

  Based on prior assessment of dose (previous session)
- ✓ The expanded **uncertainty** (95 % coverage) for values of assessed dose near the dose limit should not exceed a factor 1.5 after all corrections have been made **(**ICRP 75).
- ✓ The dosemeter shall be placed **as close as possible** to the most exposed part of the skin surface or to the lens of the eye.

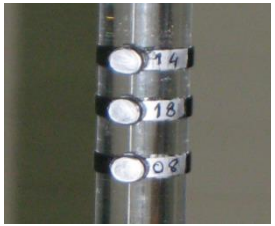
4. Individual monitoring procedures, performance of personal dosimeters

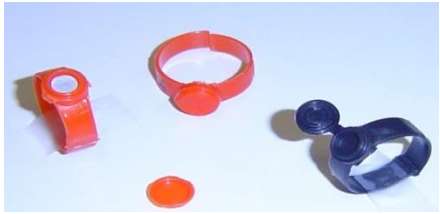
4.2 Extremity and skin dosimetry

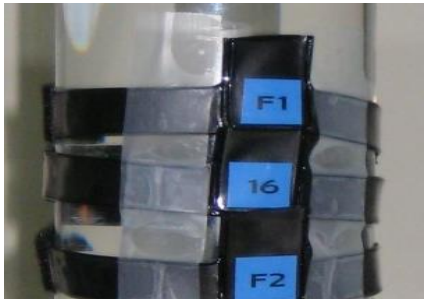
- ✓ Operational quantity: *H*p(0.07).
- ✓ Type of detectors:
  - ✓ Mainly passive: TLD, but also film badges, OSL and RPL.
  - ✓ Dosemeter design: rings, finger-stalls (detector at finger-tip), wrists, loose detectors.
- ✓ Technical specifications: IEC 62387 for passive dosemeters and IEC 61526 for active dosemeters.
- ✓ *Application of correction factors:* Common extremity monitoring positions underestimate the maximum dose.
  - ✓ A correction factor, for the specific routine monitoring position, shall be established and employed.

    i.e (nuclear medicine): ICRP 106 recommends placing the dosemeter on the base of the middle finger with the detector positioned on the palm side. In this case, a correction factor of 3 (6 if the dosemeter faces the back).

Dosemeters for the skin or extremities $H_p(0.07)$ to be worn on fingers or wrist 5/12



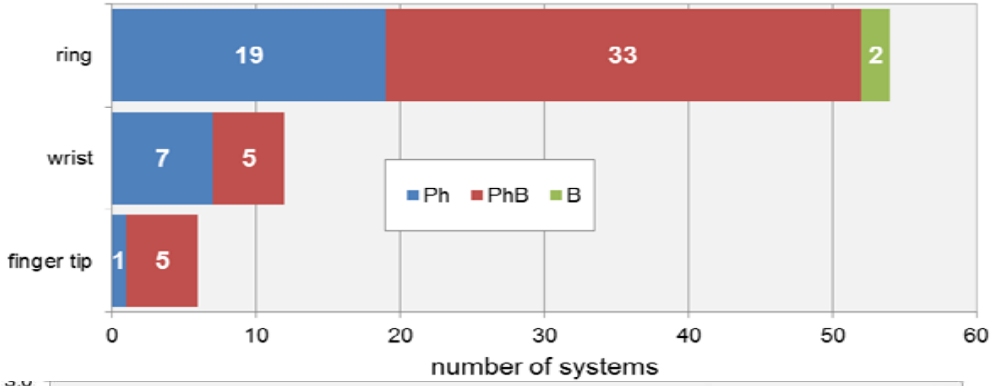


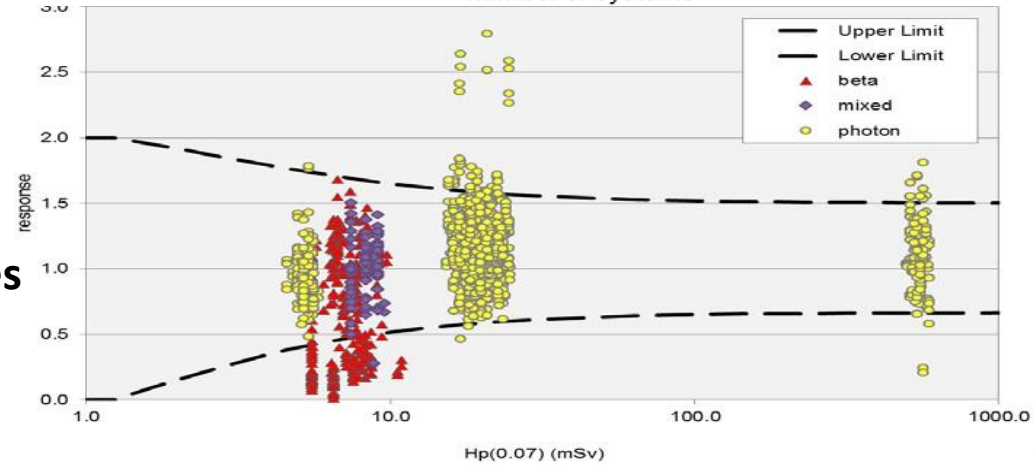


Extremity dosemeter performance $H_p(0.07)$ - EURADOS IC2015$_{ext}$

EURADOS IC2015$_{ext}$
for photons and beta **52 IMS**
from 22 countries, 72 systems.

Radiation	Quality
beta	Kr-85/0°
	Sr-90/0°
	Sr-90/60°
	all betas
photon	RQR3/0°
	RQR3/60°
	W-80/0°
	RQR9/0°
	Cs-137/0°
	all photons
mixed	Sr-90/Cs-137





Results within the trumpet curves

- ✓ 93% of the photon
- ✓ 75 % of the beta
- ✓ 84 % mixed beta-photon

4. Individual monitoring procedures, performance of personal dosimeters

4.3 Lens of the eye dosimetry

- ✓ Operational quantity: *H*p(3)

  If the radiation field is well known in advance, alternatives i.e IAEA, Annex ISO.

Alternative to $H_p(3)$ measurement
IAEA TecDoc 1731(2013) + Annex ISO 15382 (2015)

Photon radiation:

Operational Quantity:

- $H_p(0.07)$ or $H_p(10)$: If E>40 keV, normal or isotropic incidence.

- Else: $H_p(0.07)$.

Dosemeter position:

- Trunk if homogeneous field
- Else: close to the eye.

- If protective equipment

a) Glasses below equiv. layer
b) Apron, below dosemeter underestimates; unprotected dosemeter.

Impact factor	Comment		
A (Energy and angle)	Is the mean photon energy below about 40 keV?		
	If yes ↓ $H_p(0.07)$ may be used but not $H_p(10)$ (see Fig. 6 in Ref. [65] and Fig. 1 in Ref. [66])	If no ↓ Is the radiation coming mainly from the front or is the person moving in the radiation field?	
		If yes ↓ $H_p(0.07)$ or $H_p(10)$ may be used (see Fig. 1 in Ref. [66])	If no ↓ $H_p(0.07)$ may be used but not $H_p(10)$ (see Fig. 1 in Ref. [66])
B (Geometry)	Are homogeneous radiation fields present?		
	If yes ↓ Monitoring on the trunk may be used.	If no ↓ Monitoring near the eyes is necessary.	
C (Protective equipment)	Is protective equipment such as lead glasses, ceiling, table shields, and lateral suspended shields in use?		
	If used for the eye ↓ Monitoring near the eyes and below the protective equipment or below an equivalent layer of material is necessary. Otherwise, appropriate correction factors to take the shielding into account should be applied.	If used for the trunk (e.g. a lead apron) ↓ Monitoring below the shielding underestimates the dose to the lens of the eye as the eye is not covered by the trunk shielding. ↓ Separate monitoring near the eyes is necessary.	

Alternative to $H_p(3)$ measurement
IAEA TecDoc 1731(2013) + Annex ISO 15382 (2015)

Beta radiation:

Operational Quantity:

- If E_{max}<0.7 MeV, monitoring is not required.

- Else: $H_p(3)$ close to the eyes.

- Except when protective equipment (thick to absorb beta radiation), then

only photon radiation needs to be considered (see previous Table, Bremsstrahlung).

Impact factor	Comment	
A (Energy and angle)	Is the maximum beta energy above about 0.7 MeV?	
	If no ↓ No monitoring due to beta radiation is necessary as it does not penetrate to the lens of the eye.	If yes ↓ Monitoring is necessary as described in lines B and C.
B (Geometry)	As beta radiation fields are usually rather inhomogeneous, monitoring of the dose to the lens of the eye is necessary with the dosimeter placed near the eyes. However, it may not be needed if a thick enough shield is used, see impact factor C.	
C (Protective equipment)	Is protective equipment such as shields and glasses that are thick enough to absorb the beta radiation in use?	
	If used for the eye ↓ Consider 'photon radiation' as the beta radiation is completely absorbed in the shielding; however, bremsstrahlung has to be taken into account — the contributions from both that produced outside and that produced inside the shielding.	If not used ↓ $H_p(3)$ is the only appropriate quantity.

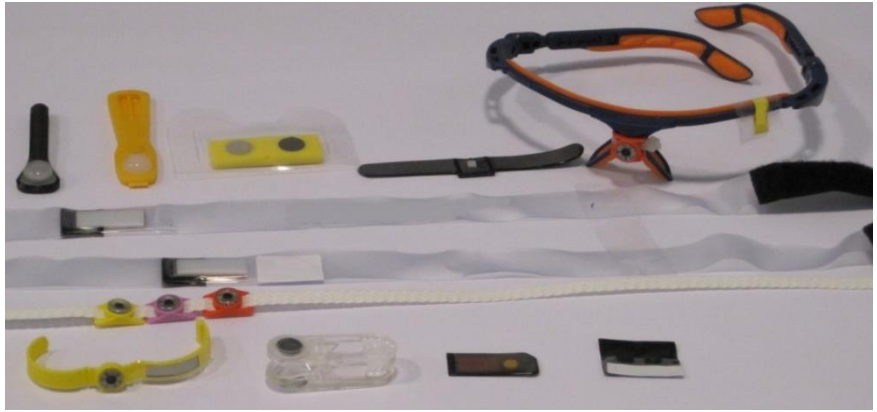
4. Individual monitoring procedures, performance of personal dosimeters

4.3 Lens of the eye dosimetry

- ✓ Operational quantity: *H*p(3)
  If the radiation field is well known in advance, alternatives i.e IAEA.
- ✓ Type of detectors:
  - ✓ Mainly passive: TLD, but also film badges, OSL and RPL.
  - ✓ Dosemeter design: Eye-D (ORAMED), loose detectors.
- ✓ Technical specifications: IEC 62387 for passive dosemeters IEC 61526 for active dosemeters don't include *H*p(3).
- ✓ *Application of correction factors:* If the dosemeter is not worn close to the lens of the eye or behind shielding (lead glasses).
  - ✓ A correction factor shall be established and employed.

  i.e (lead glasses): ISO 15382:2015 recommends a conservative factor 0.2-0.3; 0.5 provided the lenses contain the equivalent of 0,5 mm of lead and the frames include protection).

Dosemeters for the eye $H_p(3)$ to be worn "close to the eye"



Dosemeters intercomparison
EURADOS IC2014$_{eye}$ for photons
20 IMS from 15 different countries

Dosemeters intercomparison
EURADOS IC2016$_{eye}$
for photons and beta
22 IMS from 12 different countries

International Standards (requirements) for personal dosemeters.

Table A.1 — Overview of International Standards for monitors and dosemeters

Type of radia-tion	Area monitors		Individual dosemeters	
	Active	Passive	Active	Passive
Photon and beta particles	IEC 60846-1 $H'(0,07)$ and $H^*(10)$	IEC 62387 $H'(0,07)$ and $H^*(10)$	IEC 61526 $H_p(0,07)$ and $H_p(10)$	IEC 62387 $H_p(0,07)$, $H_p(3)$, and $H_p(10)$
Neutron	IEC 61005[30] $H^*(10)$	—		ISO 21909-1[31] $H_p(10)$

IEC 62387

Edition 1.0 2012-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Radiation protection instrumentation – Passive integrating dosimetry systems for personal and environmental monitoring of photon and beta radiation

Instrumentation pour la radioprotection – Systèmes dosimétriques intégrés passifs pour la surveillance de l'individu et de l'environnement des rayonnements photoniques et bêta

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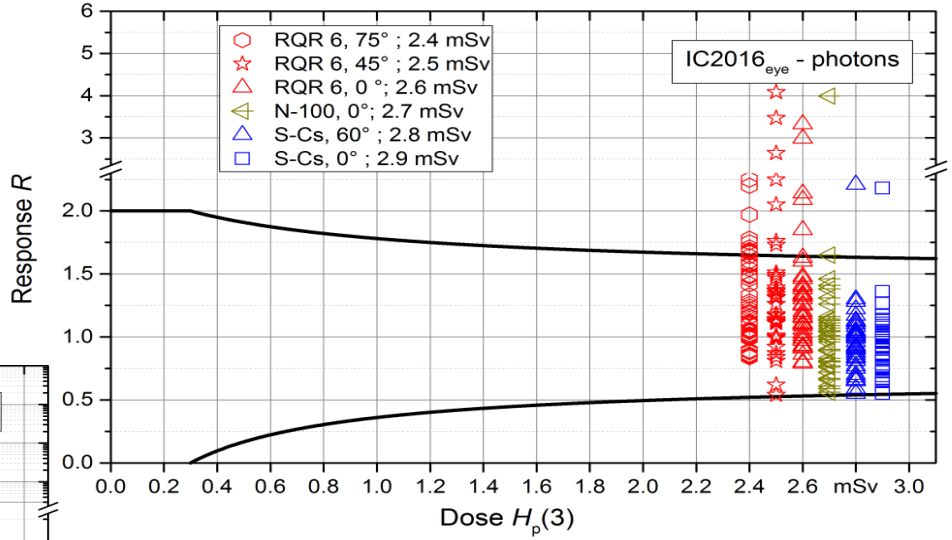
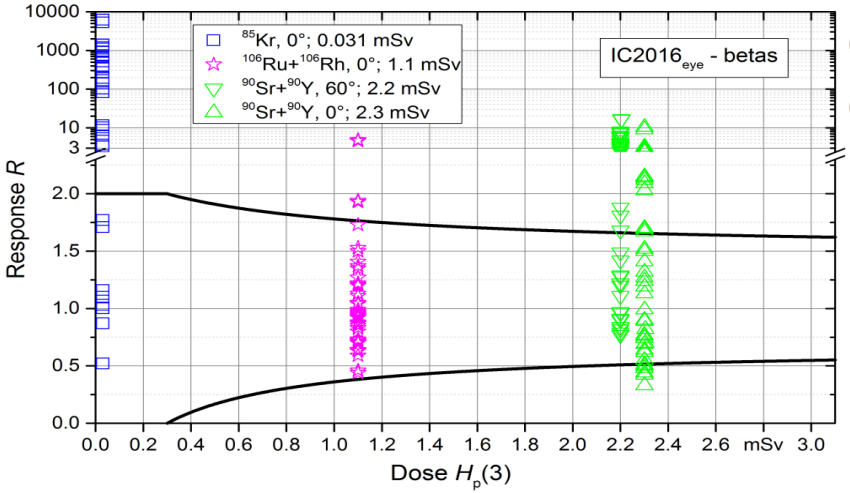
Performance of eye lens dosemeters $H_p(3)$ - EURADOS IC2016$_{eye}$

90% of the photon results are within the trumpet curves





56 % of the beta results are within the trumpet curves.

4. Individual monitoring procedures, performance of personal dosimeters

4.4 Special situation: contamination

- ✓ The monitoring requirements given in the previous part are not applicable in the case of contamination, or where the air is contaminated.
- ✓ Additionally, corrections of the measured dose might need to be made if a dosemeter is contaminated.
- ✓ **The best way to limit cross-contamination is to frequently measure contamination during and after a manipulation.**
- ✓ **In cases of skin contamination with radioactive substances, immediate and rapid decontamination measures are of higher priority than an exact evaluation of skin activity and dose** (methods available i.e VARSKIN).

5. Interpretation and management of results

Analyses of results:

- ✓ The dose results from monitoring of the skin, the extremities, and the lens of the eye shall be treated in a similar way as the dose results from the whole body monitoring.
- ✓ The results shall be evaluated after each monitoring period.
- ✓ In the framework of optimization, dose constraints and reference levels shall be established per monitoring period.

Optimization

- ✓ The application of the ALARA principle is important.
- ✓ Radiation protection measures shall be reviewed and improved, when possible, appropriate shielding, optimization of procedures or the workload shared between more workers.

6. Basis for setting a monitoring program

Hand or finger monitoring shall be considered for workplaces where extremities are particularly close to the radiation beam, also when there is a risk for skin contamination.

Monitoring of the lens of the eye shall be specifically considered for workplaces where the eyes are particularly close to the radiation beam while the rest of the body is protected.

The best monitoring method depends on the type of radiation to which the worker is exposed. Three main impact factors should be taken into account:

- ✓ Energy and angle of incident radiation;
- ✓ Geometry of the radiation field (may change during the monitoring period);
- ✓ Usage of personal protective equipment or thick enough shields and their correct use.

6. Basis for setting a monitoring program - Application in an industrial workplace

In **nuclear installations,**

- ✓ low energy betas in the vicinity of unsealed radioactive materials, contaminated areas.
- ✓ high energy betas (above 700 keV) when handling used fuel as well as in nuclear reactors experiencing fuel leakage , and in maintenance works.

- ✓ Areas are well known from operational experience.
- ✓ Information about the energy of beta radiation is obtained from the radionuclide composition, spectrometry or the attenuation of the radiation.

- ✓ Special rules and procedures (large contamination areas)
- ✓ For beta radiation, appropriate shielding.

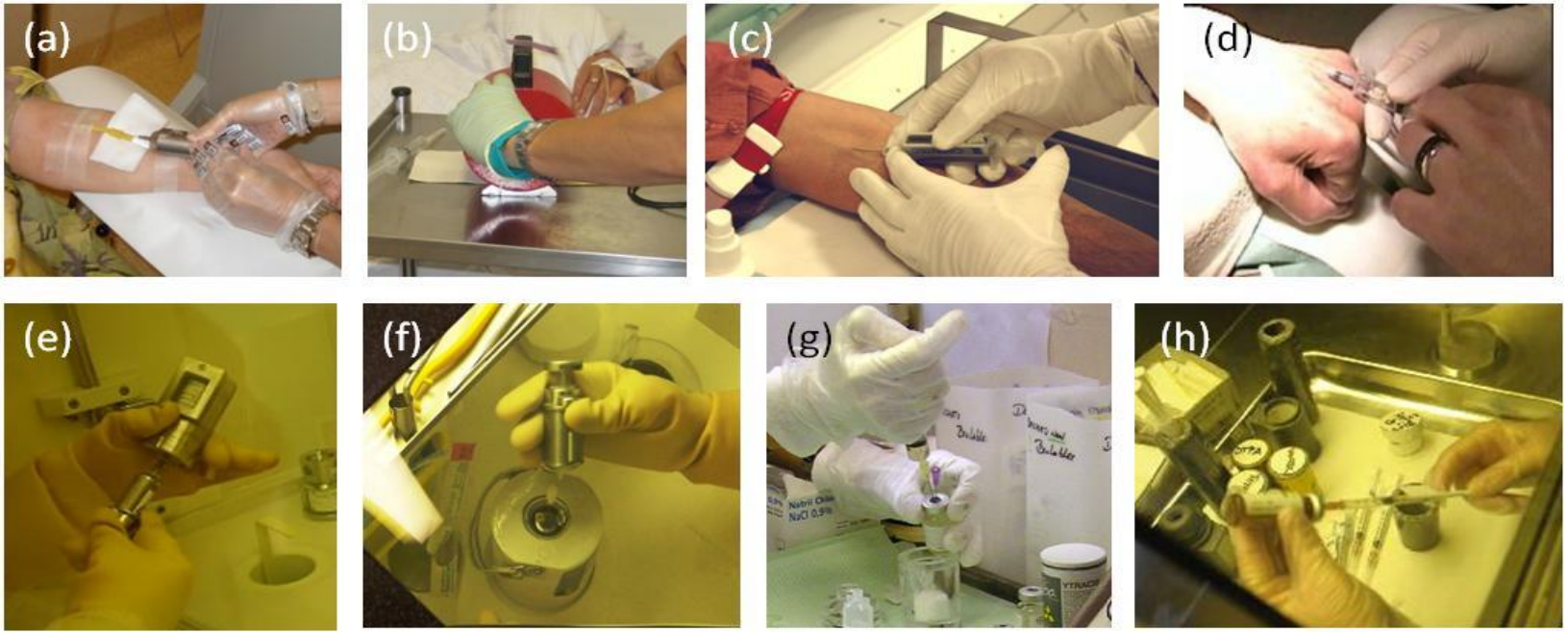
6. Basis for setting a monitoring program - Application in a medical workplace

In **medical fields**, the type of radiation and radionuclides are very well known. Doses to the extremities and to the lens of the eye can be high for some specific workplaces.

Nuclear medicine,
Monitoring of doses to **fingers** should be performed on routine basis, or at least (depends on workload, pilot measurements); staff involved in administration and preparation of pharmaceuticals.
Eye lens monitoring is in general not needed if whole body dosemeter below 15 mSv.

Radiation protection tools: Shielding of vials and syringes are essential.

http://www.oramed-fp7.eu/en/Training-material



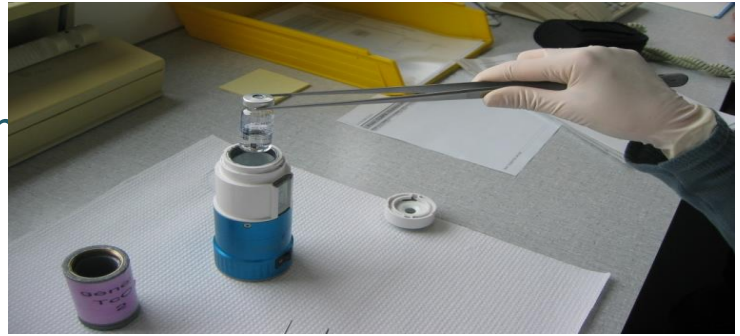
Examples of good administration (a) (b) and preparation (e) (f) practices, and examples for bad administration (c) (d) and preparation (g) (h) practices.

ORAMED Recommendations for nuclear medicine 1/2

1. Extremity monitoring is a necessity in nuclear medicine (NM).
2. The base of the index finger of the non dominant hand with the detector (TLD) placed towards the inside of the hand is the recommended position for routine extremity monitoring in NM.
3. The maximum dose to the hand can be obtained by multiplying the reading of the dosemeter worn in the base of the index of the non dominant hand by 6.
4. Shielding of vials and syringes are essential and a precondition but not a guarantee for low exposures.
5. The minimum acceptab red for a syringe is 2 mm of tungsten for ^{99m}Tc and 5 n fo For ^{90}Y, 10 mm PMMA c be n shielding of tungsten pr hie bremsstrahlung radiatic

ORAMED Recommendations for nuclear medicine 2/2

6. The minimum acceptable shielding required for a vial is 3mm and 3cm lead for ^{99m}Tc and ^{18}F respectively. For ^{90}Y an acceptable shielding is obtained with 10 mm PMMA with an external layer of few mm of lead.
7. Training and education on good practice (e.g. procedure planning, repeating procedures using non radioactive sources) are more relevant parameters than the experience of the worker.
8. All tools increasing the distance (e.g. forceps) between the hand/finger and the source are very effective for dose reduction.
9. Working fast is not sufficient, the use ce are more effective than pushing on th



6. Basis for setting a monitoring program - Application in a medical workplace

Interventional radiology,
Monitoring of doses to **fingers or wrists** and **eyes** should be performed on routine basis, or at least (depends on workload, pilot measurements).

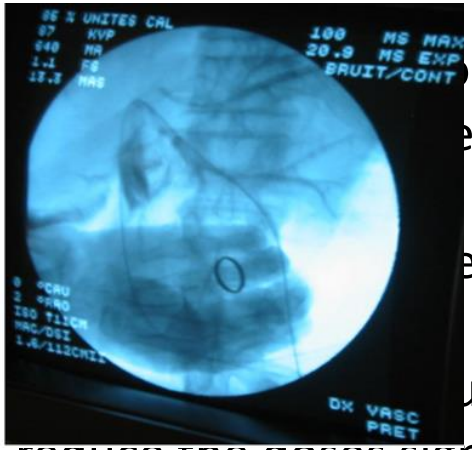
Room and personnel protective equipment should be properly used.
Optimization of procedures and training helps reducing doses.

Avoid the direct exposure of hands to primary radiation

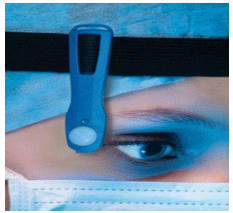
ORAMED Recommendations for interventional radiology 1/2

- ✓ Only dedicated interventional radiology *equipment* and *room (properly shielded)* should be used.
- ✓ Personal protective equipment should be used (at least collar and lead aprons) be preferred.
- ✓ The roo and positioned properly.
  - ✓ Car when assisting personnel sta n the operators needs to mo
  - ✓ The ced as close to the patient as p
  - ✓ If b e of lateral shield is very imp ands.

ORAMED Recommendations for interventional radiology 2/2



- ✓ The tube should b perating table. The higher doses at the legs in this ed by a properly positioned table shield.
- ✓ The femoral acce ed whenever it is possible from medical point of vi
- ✓ Going outside th uring the image acquisition is a practice which can reduce the doses significantly.
- ✓ Avoiding the direct exposure of hands to primary radiation.
- ✓ Monitoring of doses to fingers or wrists and eyes should be performed on routine basis .



Summary, final considerations

The transposition of the 2013/59 EURATOM Directive will not imply major changes in individual monitoring for most workers.
Although there are no changes related to extremity monitoring, efforts are needed to ensure its appropriate use (maximum skin, dose; beta detection, comfort, active dosemeters).

The main changes are related to the reduction of the dose limit for the lens of the eye.
This new limit will require $H_p(3)$ monitoring in some workplaces (i.e. interventional radiology).

- Design of new dosemeters and procedures (comfort),
- Set-up of new calibration procedures,
- Assessment of dose levels (confirmatory measurements),
- Development of new monitoring procedures.

Thank you for your attention

The Hague, 4th June 2018

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Institut de Tècniques Energètiques

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