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GREEK ATOMIC ENERGY COMMISSION

Key challenges in external dosimetry

Following the 2013/59 Euratom Directive

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COUNCIL DIRECTIVE 96/29/EURATOM

Whereas the development of scientific knowledge concerning radiation protection, as expressed in particular in Recommendation No 60 of the International Commission on Radiological Protection, makes it convenient to revise the basic standards and to lay them down in a new legal instrument;

Article 16

Without prejudice to the provisions of Article 15:

(a) For external radiation, the values and relationships given in Annex II shall be used to estimate the relevant effective and equivalent doses;

E. **Operational quantities for external radiation**

Operational quantities for external radiation are used for individual monitoring for radiation protection purposes:

1. Individual monitoring:

   personal dose equivalent $H_p(d)$,

   d: depth in mm in the body.

2. Area monitoring:

   ambient dose equivalent $H^*(d)$,

   directional dose equivalent $H'(d, \Omega)$,

   d: depth in mm under the surface of the sphere given in A,

   Ω: angle of incidence.

3. For strongly penetrating radiation a depth of 10 mm, for weakly penetrating radiation a depth of 0,07 mm for the skin and 3 mm for the eye is recommended.

COUNCIL DIRECTIVE 2013/59/EURATOM of 5 December 2013

- **Recital no 7**

… The provisions of this Directive should follow the situation based approach introduced by ICRP Publication 103 and distinguish between existing, planned and emergency exposure situations. Taking into account this new framework, this Directive should cover all exposure situations and all categories of exposure, namely occupational, public and medical exposures.

- **Recital no 9**

… Calculation of doses from measurable quantities should rely on scientifically established values and relationships. Recommendations for such dose coefficients have been published and updated by ICRP, taking scientific progress into account. A collection of dose coefficients based on its earlier recommendations in ICRP Publication 60, is available as ICRP Publication 119. However, in ICRP Publication 103, a new methodology was introduced by ICRP to calculate doses based on the latest knowledge on radiation risks, and this should, where possible, be taken into account in this Directive.

- **Recital no 10**

… For external exposure, values and relationships have been published following the new methodology in ICRP Publication 116 (Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures, 2010.). These data, as well as the well-established operational quantities, should be used for the purpose of this Directive.

- **Definitions**

96. "standard values and relationships" means values and relationships recommended in chapters 4 and 5 of ICRP Publication 116 for the estimation of doses from external exposure …

- **Article 13**

Estimation of the effective and equivalent dose For the estimation of effective and equivalent doses, the appropriate standard values and relationships shall be used. For external radiation, the operational quantities defined in section 2.3 of ICRP Publication 116 shall be used

PD 101/2018

Article 13

(Article 13 of the Directive)

Estimation of the effective and equivalent dose

1. For the estimation of the effective and equivalent doses, the appropriate standard values and relationships shall be used. The operational quantities defined in Section 2.3 of ICRP Publication 116 shall be used for external radiation and those defined in ICRP Publication 119 for internal radiation. In both cases the updates that EEAE has approved shall be used.

2. a) For occupational exposure from external radiation, the personal dose equivalent at 10 mm depth, Hp(10), is used as a conservative approach of the effective dose, in case no personal protective equipment is used. When personal protective equipment is used, the appropriate conversion algorithms are used, as necessary.

b) For the estimation of the effective dose for the lens of the eye from external radiation, the personal dose equivalent at 3 mm depth, Hp(3), is used.

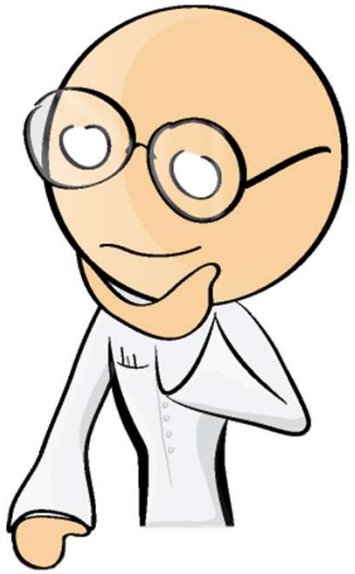
c) For the estimation of the equivalent dose for skin and extremities from whole-body uniform external radiation, the personal dose equivalent at 0,07 mm depth Hp(0,07) is used. In the case of radiation to a part of the skin or extremities, the appropriate conversion algorithms are used, as necessary.

Key challenges for the dose assessment

- **Effective dose**
  - increased emphasis on the organs in the head and neck region

  i.e. brain was part of the “remainder” now w_T=0,01
- **Equivalent dose to the lens of the eye**
  - esp. with the reduction of the dose limit

  for the occupational exposure 150 mSv-> 20 mSv



Assessment of the effective dose, E

Pilot study measurements for the assessment of the effective dose (interventional procedures)

- Without thyroid protection
  - ~1.35 ratio of effective dose values calculated based on ICRP 103/ICRP60

- With thyroid protection
  - The reduction of the effective dose was up to 2.7 times when the assessment was based on ICRP 60
  - The reduction of the effective dose was up to 2 times when the assessment was based on ICRP 103.

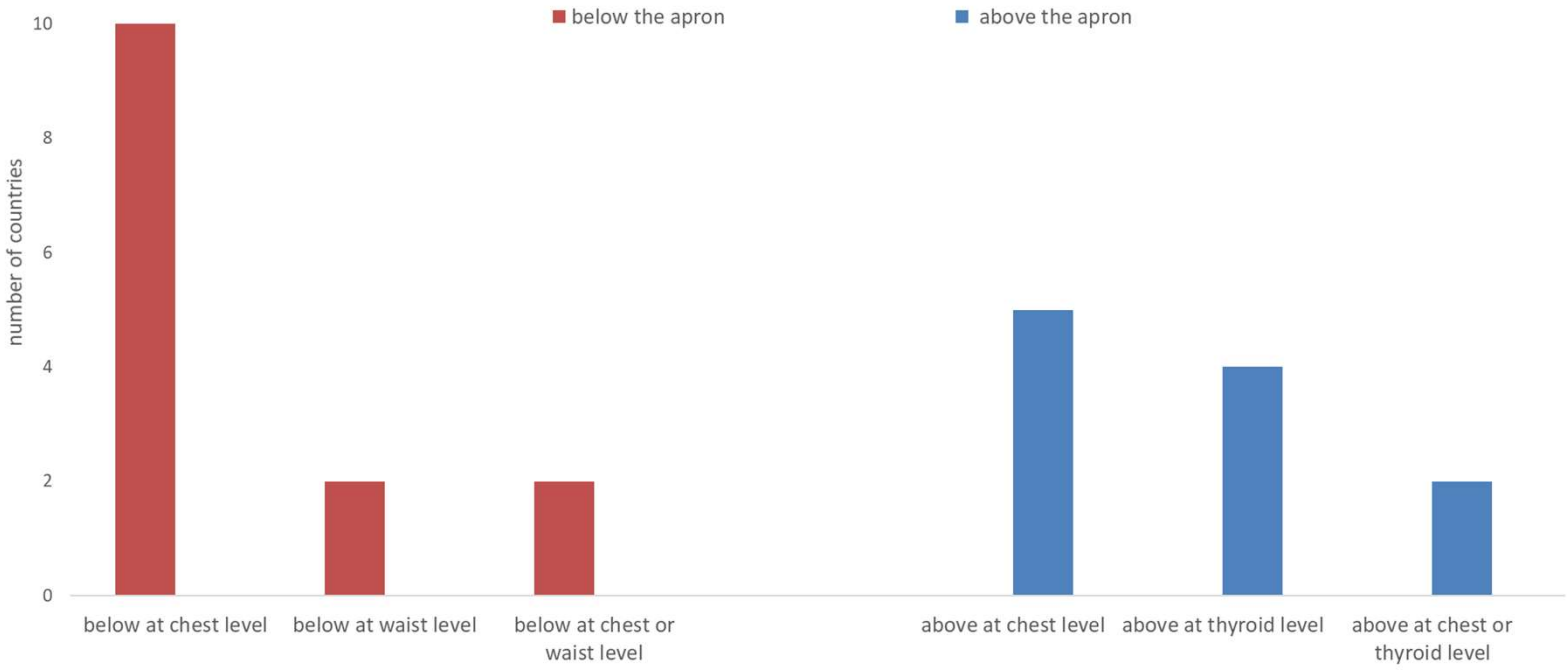
Literature review for the assessment of the effective dose (interventional procedures)

Double or single dosimetry: This is the question?!

- Single
  - $E=H_p(10)_{under}$
  - $E = H_p(10)_{over}/\gamma$ *range of* γ *10* to 33
- Double
  - $E=\alpha\ H_p(10)_{under}+ \beta\ H_p(10)_{over}$ *range of* α 0.6 τo 1.64 and *range of* β *0.025* τ*o 0.075*

Literature review for the assessment of the effective dose (interventional procedures)

Double or single dosimetry: This is the question?!



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A European survey on the regulatory status for the estimation of the effective dose and the equivalent dose to the lens of the eye when radiation protection garments are used

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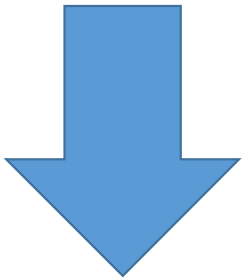
Double or single dosimetry: This is the answer?!

- ✓The routine is one dosemeter worn over the radiation protection apron
- ✓The estimation of E is performed by the local RPO or the dosimetry service. Leaflet with guidelines. The usual γ factor ~ 21
- ✓However, when decided by the RPO of the facility, two dosemeters can be used. In this situation attention should be paid using the proper labeling of the dosemeters so that the users do not mix them up.
- ✓The estimation is performed by the dosimetry service (α=1.6 β=0.075)
- ✓Both $H_p(10)$ values (over and under) and the effective dose are kept in the National Dose Registry.

Literature review for the use of radiation protective equipment

- Changes in the optimization of the use of radiation protection garments: thickness of lead apron, the importance of thyroid collar, the use of ceiling suspended screens



✓Strongly advice about the use of personal protective equipment

✓Special attention where room protective equipment can not be used

Assessment
of the dose to
the lens of the eye

Challenges of today in eye lens monitoring

- Operational quantity for the eye lens monitoring, *Hp*(3)
- Dedicated eye lens dosemeter
- Dosemeter position
- Estimation of the dose to the lens of the from the whole body dosemeter:
  - *Ratio (eye lens/thyroid) 0.4 to 1.9*
  - *Ratio (eye lens/chest) 0.5 to 1.8*

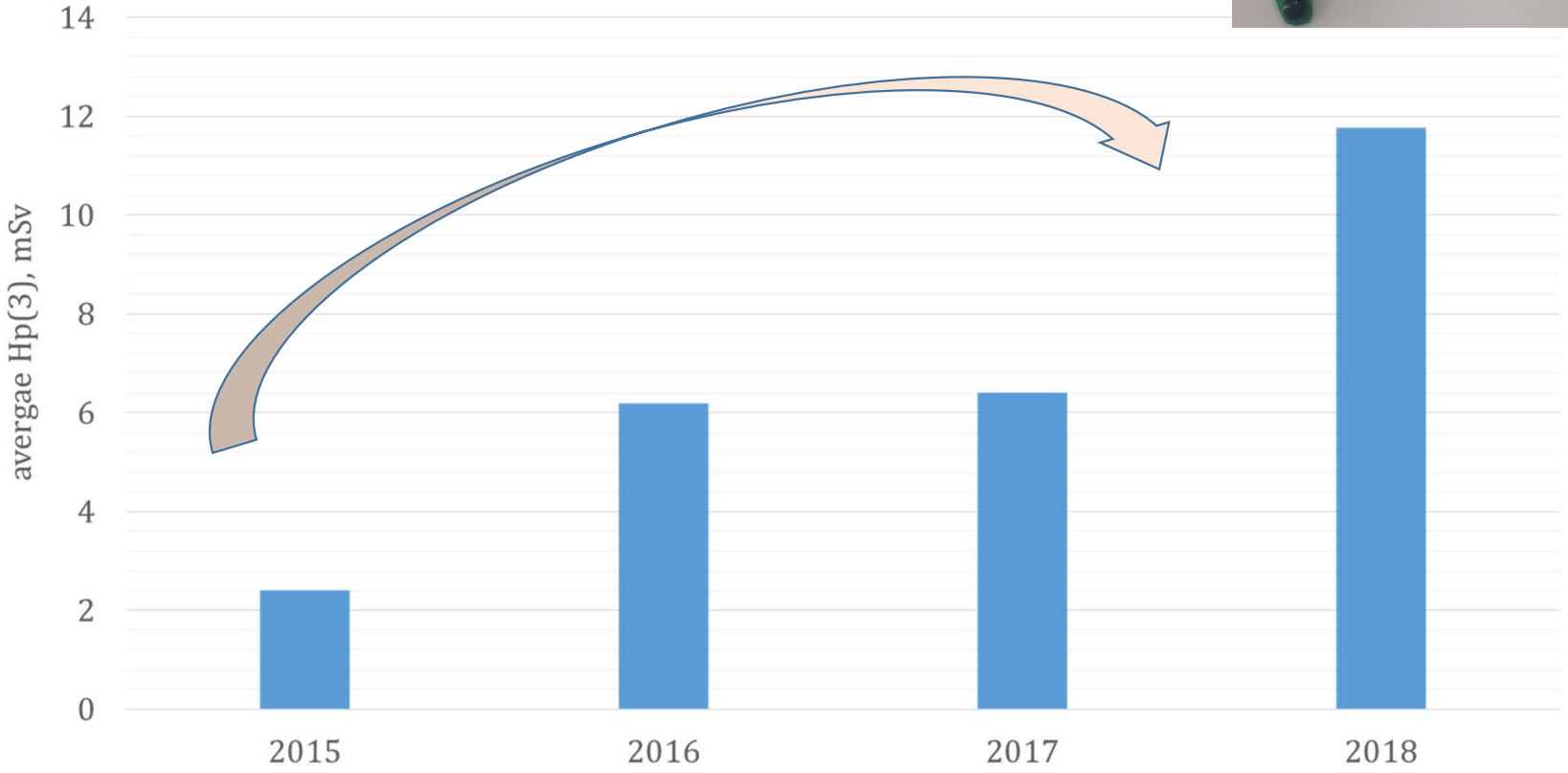
- A rule of thumb for the estimation of the eye lens dose 0.75 of the thyroid dose

Challenges of today in eye lens monitoring

- Influence of protective devices
- Lead glasses 8 to 10 times (most frequent range)
- Celling suspended screen 3 to 11 times (most frequent range)

Pilot study measurements

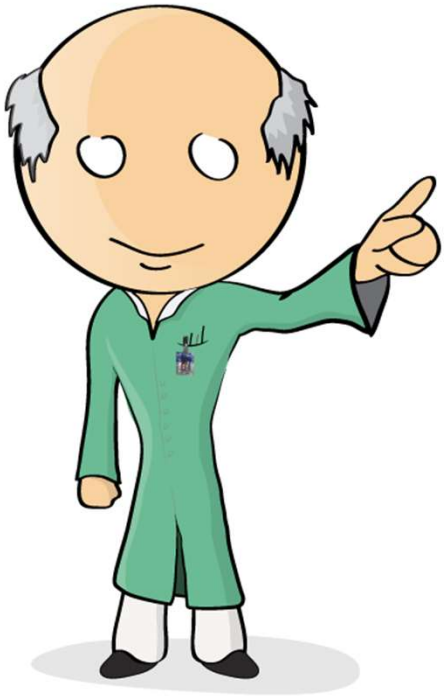
- ORAMED dosemeters



Eye lens monitoring in Greece, today

- The eye lens monitoring is officially performed with dedicated eye lens dosemeters.
- Guidelines are given where to wear the dosemeters combined with the lead glasses. There is no official algorithm for the assessment of the dose.
- In many cases the dose to the lens of the eye is estimated by the whole body dosemeter. However, this is not registered in the NDR.

summary

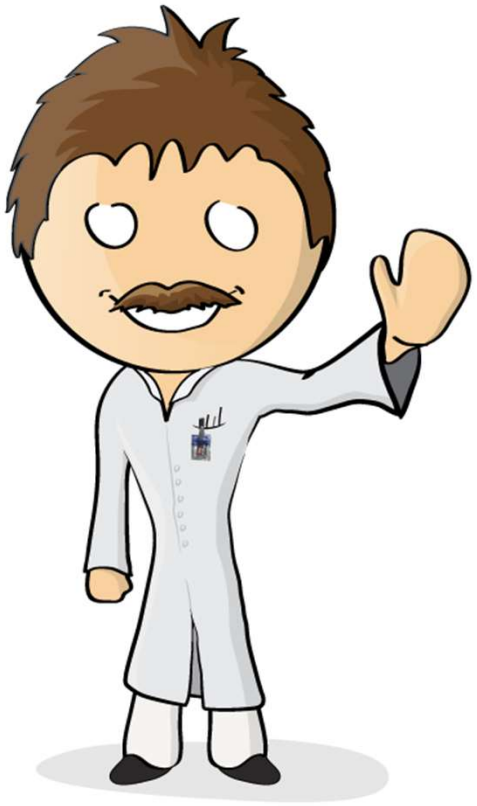


Assessment of the effective dose

- The use of one dosemeter over the protection; to be corrected using a reduction factor;
- The use of two dosemeters, one over and one under the protection, using the proposed algorithm.

Attention not to mix up the dosemeters

summary



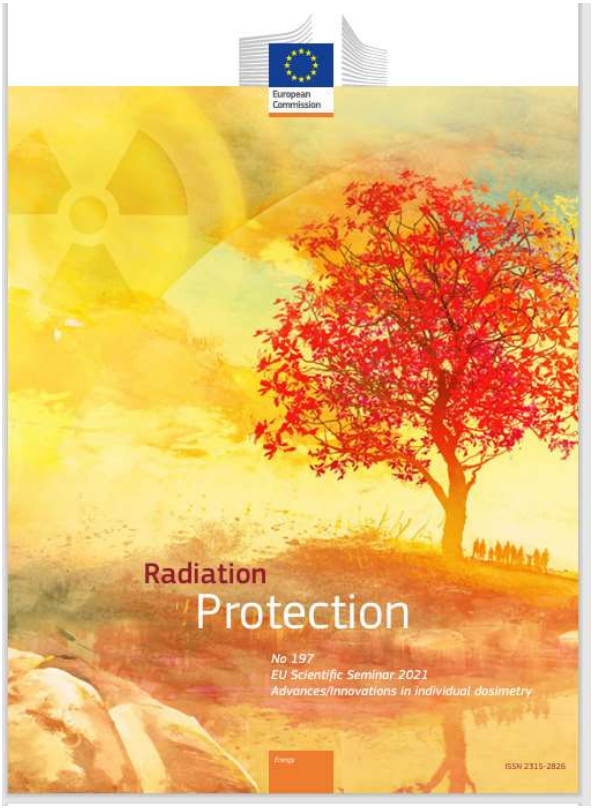
Assessment of the dose to the lens of the eye

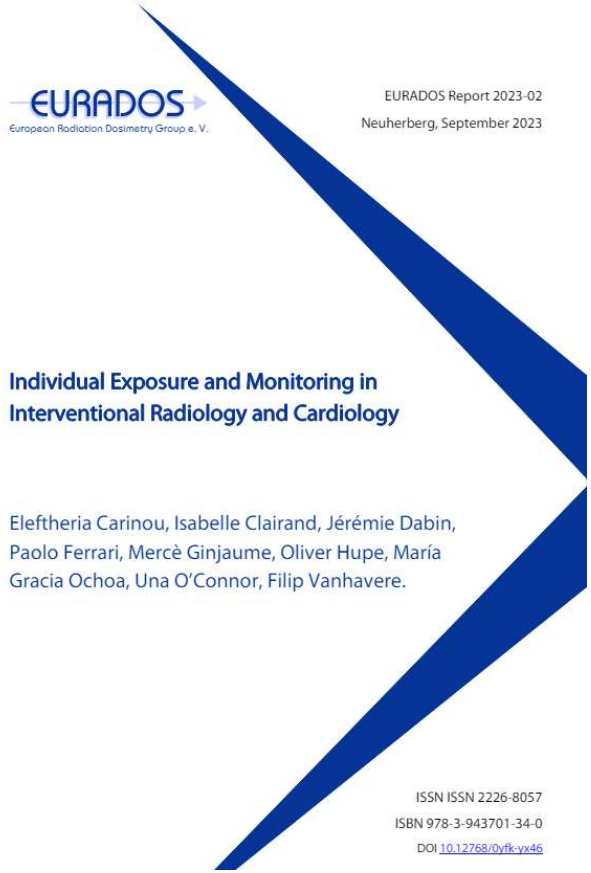
- One dedicated eye lens dosemeter placed close to the eyes and measuring $H_p(3)$ when the expected dose levels are >6 mSv
- One dosemeter worn over the protection and measuring $H_p(10)$ or $H_p(0.07)$. Assessment by the RPO

acknowledgments

- To my colleagues from the Dosimetry Department

- To my colleagues from Eurados WG12





Thank you very much

for your attention!

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NDR and parameters to be kept

- the results of double dosimetry,
- the measured values of $H_p(3)$,
- the correction factor for the applied protective measures …
- To be in line with the new GDPR

A. **Data to be included in the data system for individual radiological monitoring**

3. Data on the worker's identity shall include the worker's:

   (a) surname;

   (b) first name;

   (c) sex;

   (d) date of birth;

   (e) nationality; and

   (f) unique identification number.

4. Data on the undertaking shall include the name, address and unique identification number of the undertaking.

5. Data on the employment of the worker shall include:

   (a) the name, address and unique identification number of the employer;

   (b) the starting date of individual monitoring; and where available, the end date;

   (c) the categorisation of the worker in accordance with Article 40.

6. The results of the individual monitoring of the exposed worker shall include the official dose record (year; effective dose in mSv; in the event of non-uniform exposure, equivalent doses in the different parts of the body in mSv; and in the event of an intake of radionuclides, the committed effective dose in mSv);

Dose constraint

- 2013/59

- "dose constraint" means a constraint set as a prospective upper bound of individual doses, used to define the range of options considered in the process of optimisation for a given radiation source in a planned exposure situation;

- 96/29

- "dose constraint" a restriction on the prospective doses to individuals which may result from a defined source, for use at the planning stage in radiation protection whenever optimization is involved.