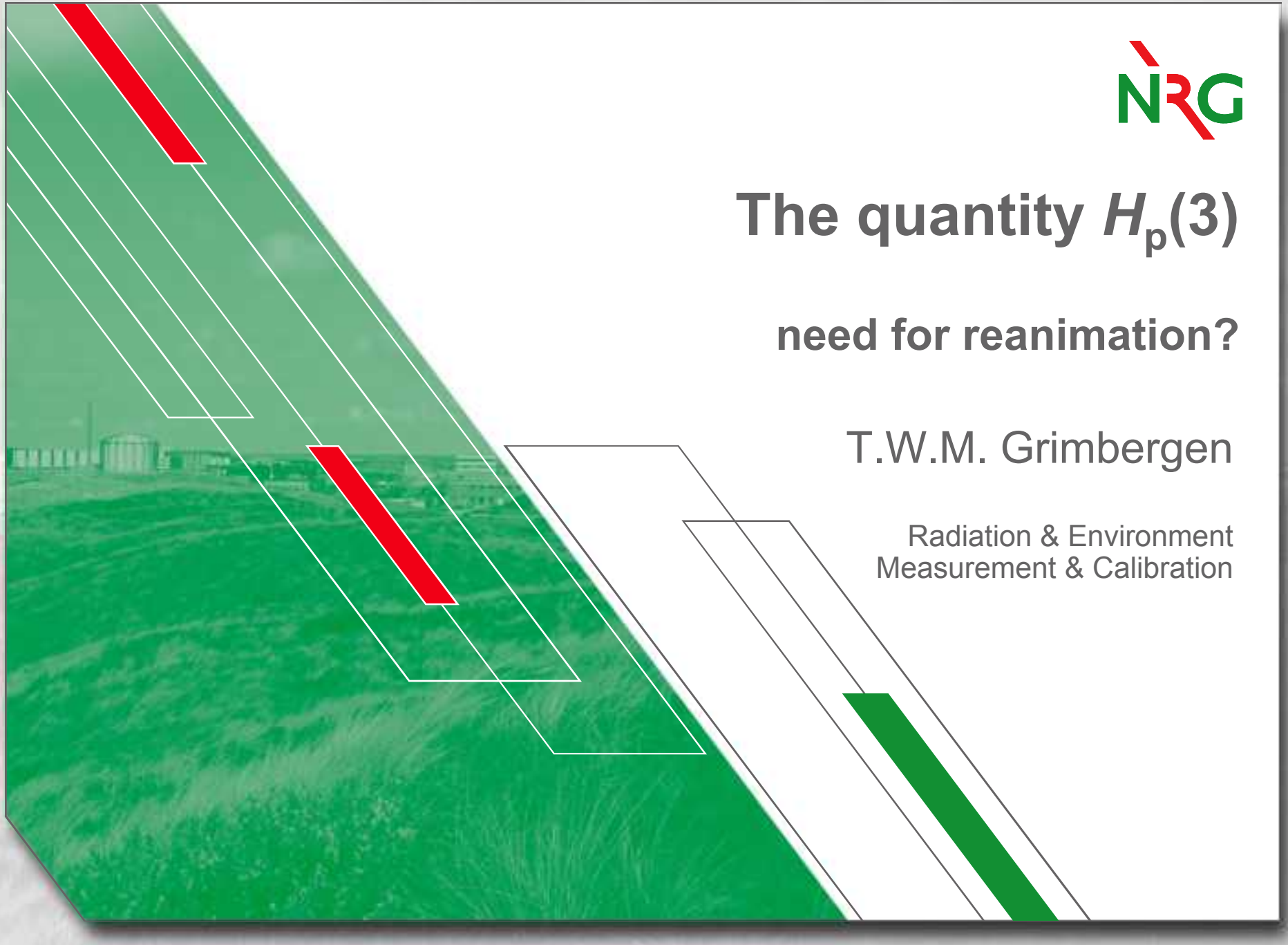


The quantity $H_p(3)$

need for reanimation?

T.W.M. Grimbergen

Radiation & Environment
Measurement & Calibration

Aim

to provide background information about the dosimetric quantity $H_p(3)$

for better understanding and judgment of recent developments around this quantity

Outline

- Refresher: operational quantities for individual monitoring
- What is needed to put them into practice
- History of “patient” $H_p(3)$, from birth until recent developments
- Wrap-up

Limiting quantities

- Effective dose, E (mSv)
- Equivalent tissue dose, H_T (mSv)
- For quantifying limits to exposure from the radiation protection point of view
- Definition based on averaged organ doses in a person
- Therefore, not measurable

toegewezen aan het jaar van inname.

Artikel 77

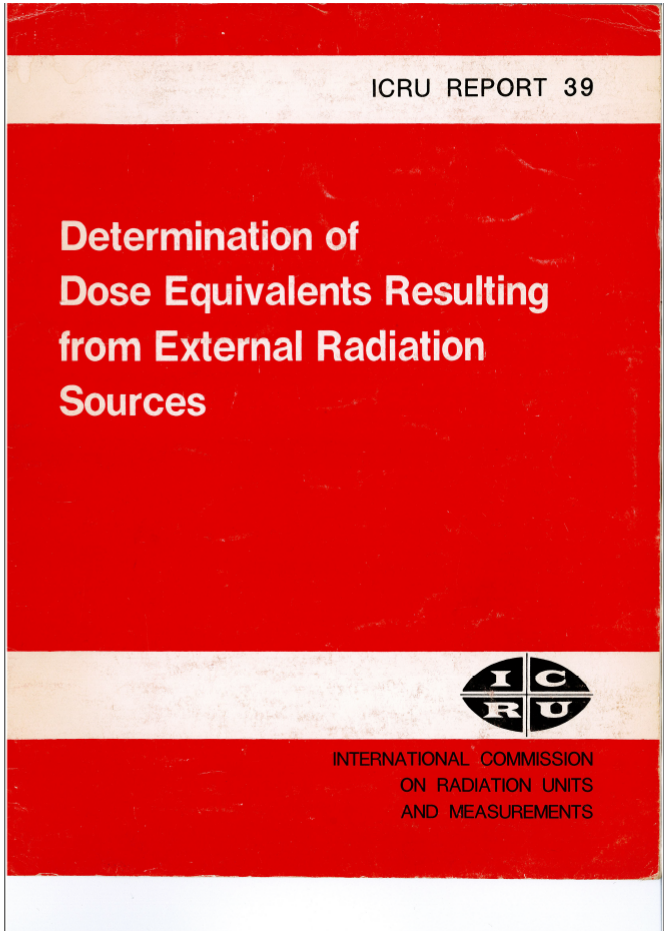
1. De ondernemer zorgt ervoor dat voor blootgestelde werknemers ten gevolge van handelingen die onder zijn verantwoordelijkheid worden verricht, de volgende doses niet worden overschreden:
a. een effectieve dosis van 20 mSv in een kalenderjaar, en met inachtneming daarvan:
b. een equivalente dosis van:
1°. 150 mSv in een kalenderjaar voor de ooglens,
2°. 500 mSv in een kalenderjaar voor de huid, gemiddeld over enig blootgesteld huidoppervlak van 1 cm², of
3°. 500 mSv in een kalenderjaar voor handen, onderarmen, voeten en enkels.
2. In het geval van inwendige besmetting wordt de effectieve volgdosis toegewezen aan het jaar van inname.

Artikel 78

1. De ondernemer zorgt ervoor dat werknemers die jonger zijn dan

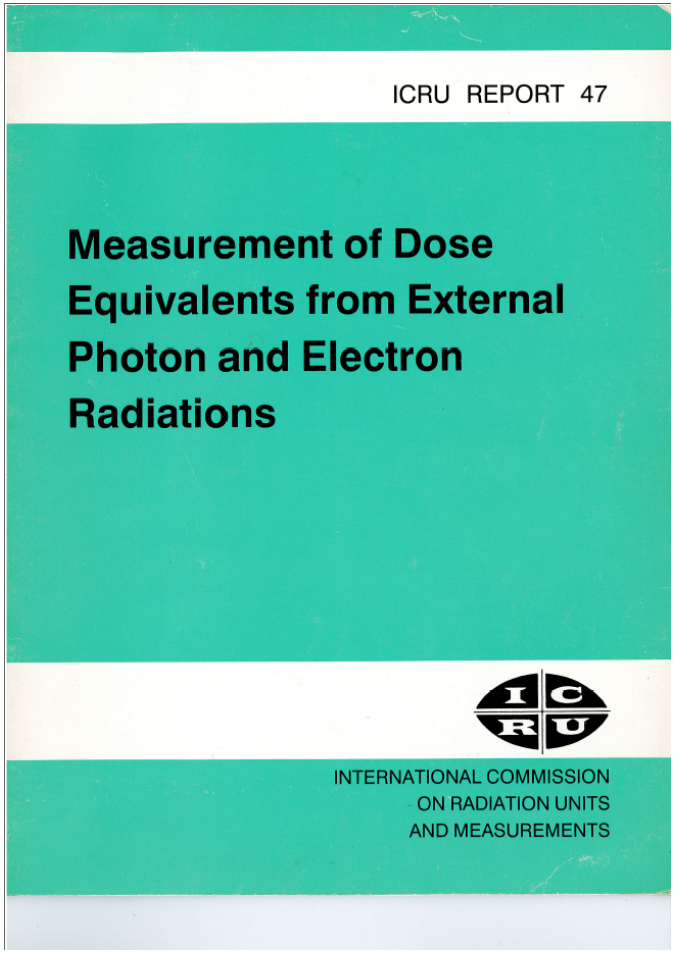
Operational quantities

- To provide measurable estimates for limiting quantities E and H_T
- For external radiation exposure
- Based on “dose equivalent”, H
  - taking into account biological effectiveness different types of radiation
- Different definitions for
  - Monitoring workplaces and environment
  - Monitoring individuals



Personal dose equivalent $H_p(d)$

- Definition (ICRU 47):
  - Equivalent dose *H* *in* a person at an appropriate depth of *d* (mm) below a specified point on the body
- Measurement:
  - With a suitable dosemeter *on* a person at the specified point



Appropriate depth *d*

d (mm)	H_p(d) is a good estimator for:	Annual limit A-worker (mSv)
10	Effective dose, *E*	20
3	Equivalent eye lens dose, H_{lens}	150
0.07	Equivalent skin dose, H_{skin}	500

Suitable dosemeter

- Type tested
  - Energy and angular response
- Calibrated
  - Traceable to primary measurement standard

- Appropriate phantoms are needed, because
  - dosemeters are intended to be worn at a specified point on the body
  - dosemeter will be exposed to backscattered radiation

Guidance type testing and calibration

ISO 4037 ".. calibrating dosemeters … and determining their response"

- Definition phantoms

Position of dosemeter on the body	*ISO phantom*
Trunk	Water slab
Wrist, ankle	Pillar
Finger	Rod

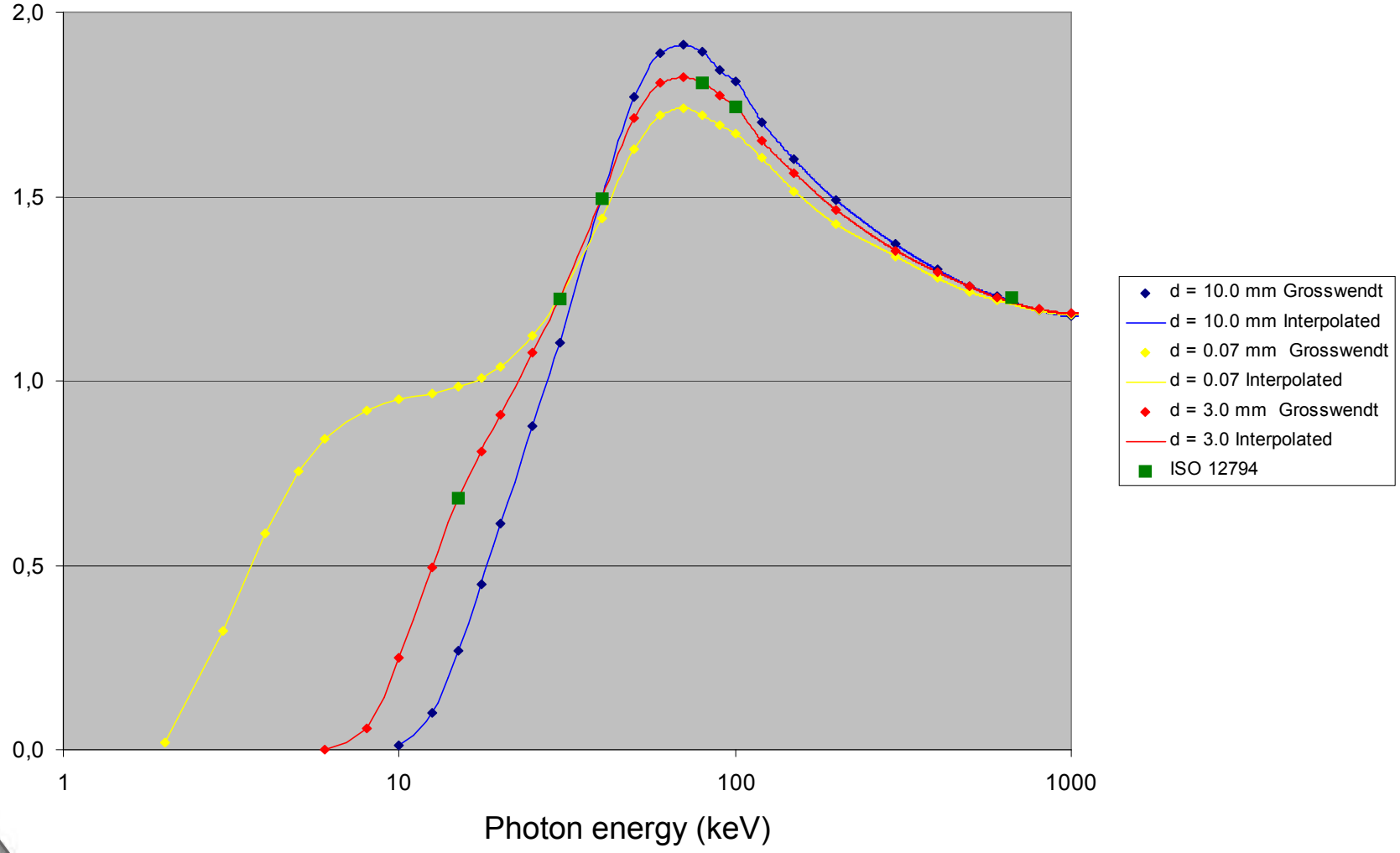
- Traceability
  - No primary measurement standards for $H_p(d)$ available
  - Traceability to air kerma standard by use of conversion factors

Lack of specific guidance for $H_p(3)$

- ISO 4037
  - No specific phantom for dosemeters worn on the head
  - No conversion factors $H_p(3)/K_a$
- ISO 12794:2000
  - Individual thermoluminescence dosemeters for extremities and eyes
  - No specific phantom (use slab…)
  - Limited set of conversion factors $H_p(3)/K_a$ for slab

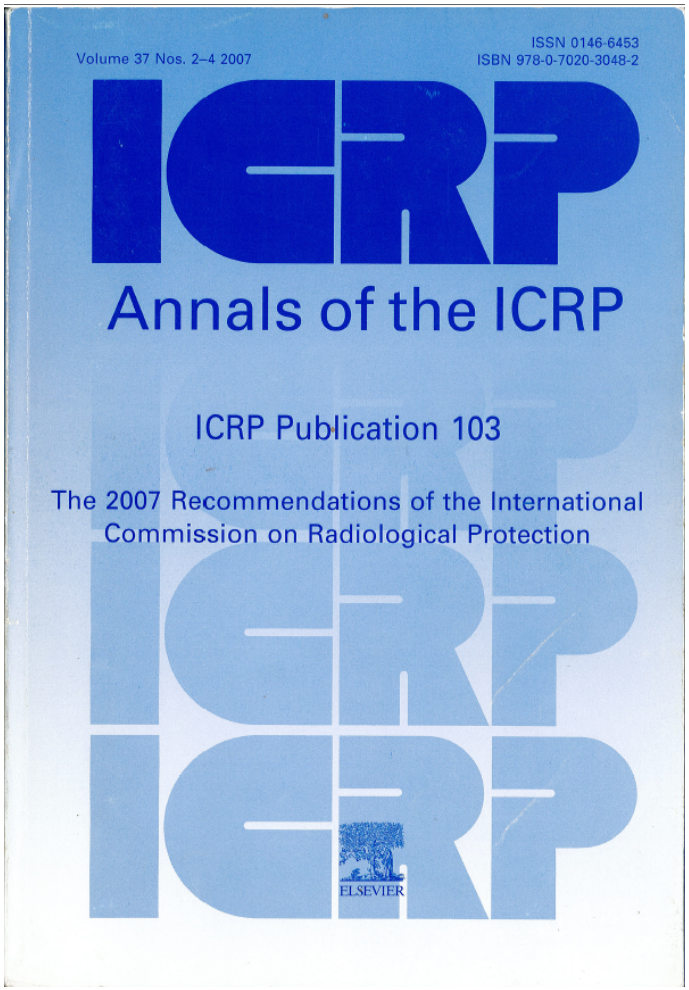
$H_p(d)/K_a$ conversion coefficients (Sv/Gy)

- ISO water slab phantom



$H_p(3)$ barely used in practice

- "monitoring of $H_p(3)$ will be required only in unusual circumstances" (ICRU 39, 1985)
- "… $H_p(3)$ has rarely been used in practice and very few instruments exist for measuring this quantity. It is suggested that its use is discontinued…" (ICRP 103, 2007)
- Main arguments:
  - Eye lens will be protected sufficiently if E and H_{skin} are below limits
  - $H_p(0.07)$ can be used to estimate H_{lens} with sufficient accuracy.



On the other hand…

- "… further information is needed and revised judgements may be required particularly in respect of the eye" (ICRP 103, 2007)

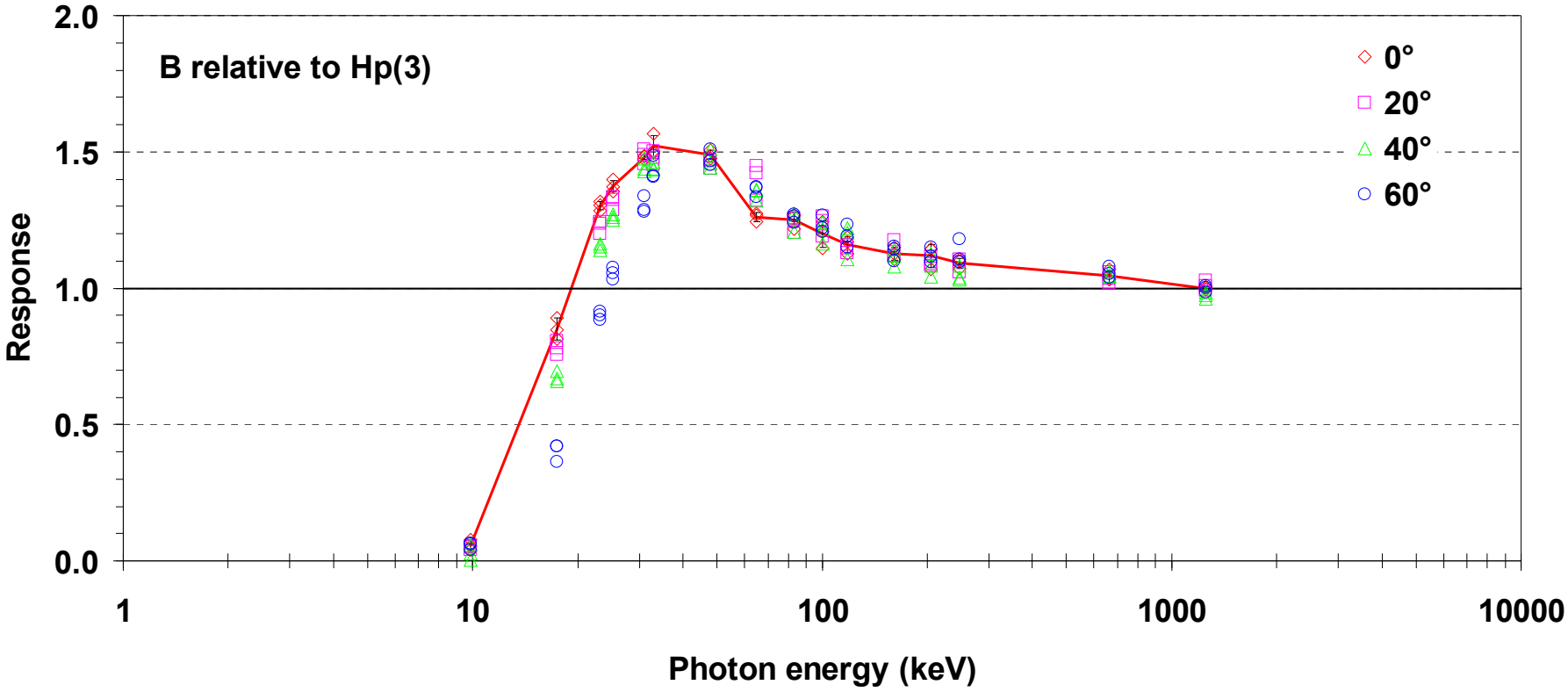
- "The Commission has now reviewed recent epidemiological evidence suggesting that there are some tissue reaction effects, particularly those with very late manifestation, where threshold doses are or might be lower than previously considered … the Commission now recommends an equivalent dose limit for the lens of the eye of 20 mSv in a year" (ICRP, 2011)

- " With this new proposed limit, 45% of the operators have annual eye doses above 3/10th of the annual limit of which 24% exceed the new proposed annual limit" (Oramed, Eurados, 2012)

Test NRG whole body dosemeter

- Data used from previous type test (1991)
- NRG dosemeter tested for:
  - 16 photon energies, 10 keV to 1250 keV
  - 4 angles of incidence, 0° to 60°
- Dosemeter on 30 x 30 x 15 cm^3 PMMA slab
- Re-evaluation with $H_{p,\,slab}(3)$ conversion coefficients

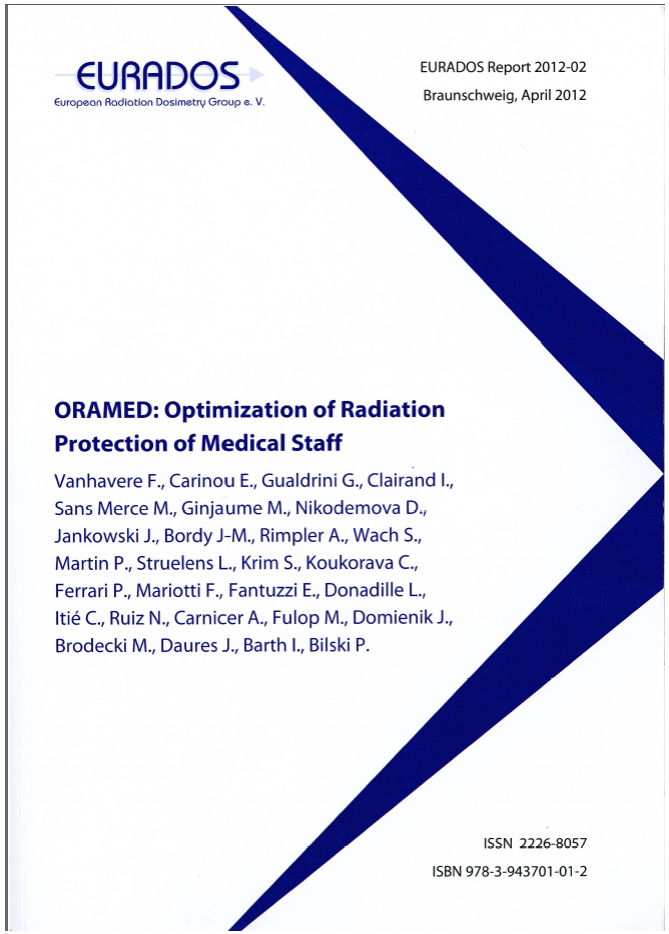
$H_p(3)$ reponse of the NRG dosemeter



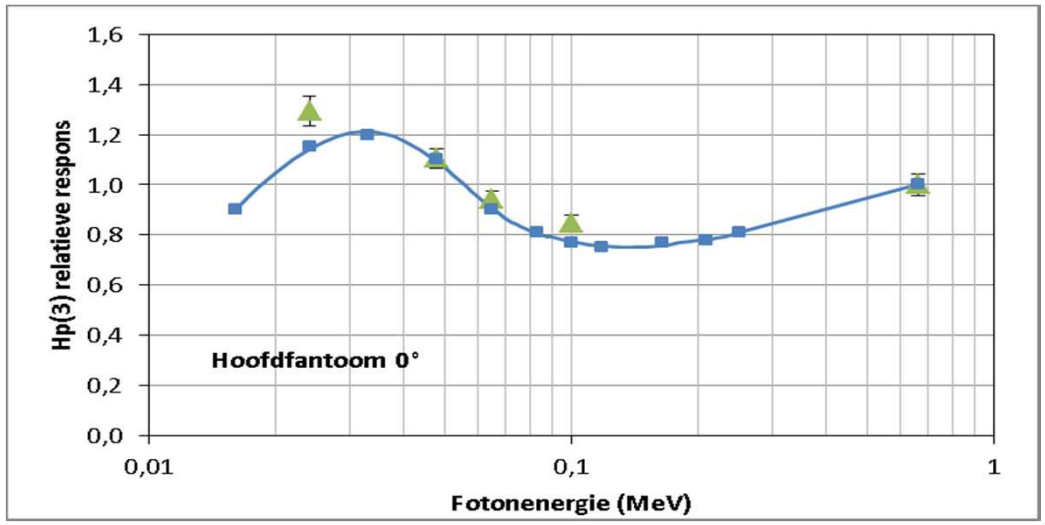
- Detector at position B passes criteria ISO 12794

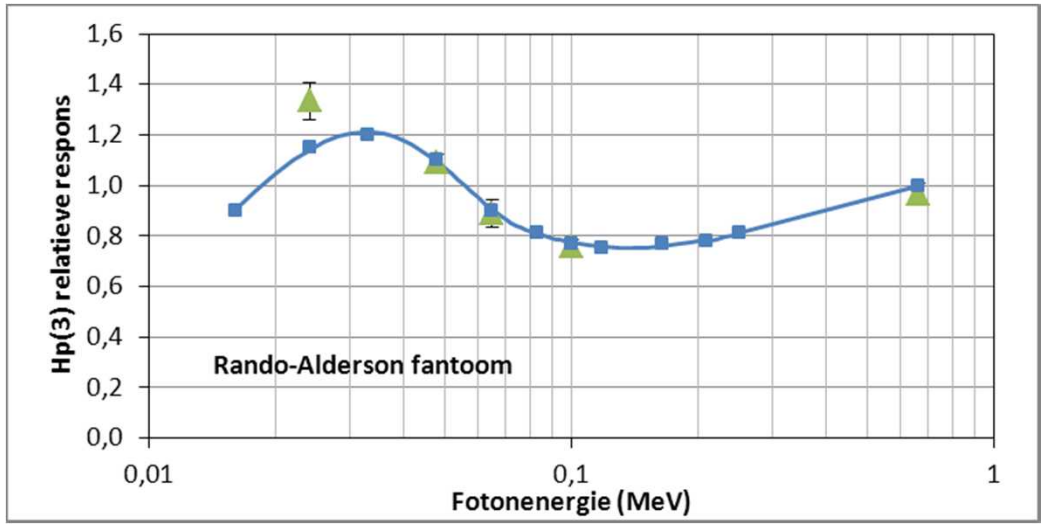
EU initiative: Oramed

- Optimization of radiation Protection of Medical Staff (Eurados Report 2012-02)
- Filled in a number of gabs
  - Proposal for suitable head phantom
  - Conversion factors
  - Design dedicated dosemeter



Type test eye lens dosemeter at NRG





Neighbour countries: UK

Newsletter of the HPA Personal Dosimetry Service

Monitor

April 2012 Issue 41

Health Protection Agency

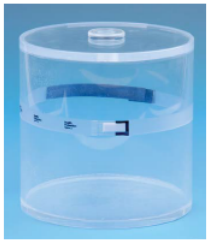
Eye Dosemeter: Update

In *Monitor* No. 40, we reported on the work we are doing on a new dosemeter for measuring the dose to the lens of the eye, in the context of a probable reduction in the eye lens dose limit.

This will only be of direct interest to employers where individuals' eyes are subject to significantly non-uniform fields: a prime example is in interventional radiology, where a surgeon's body is well protected by a lead apron, but where the eyes may be less so. Other examples are where beta radiations are encountered, eg in nuclear medicine or in some applications in the nuclear industry.

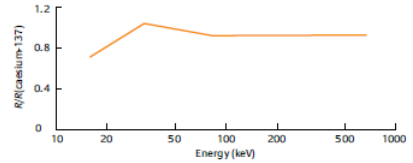
It may be that, in the long run, not many more workers will require routine monitoring. However, we have developed the new headband to help meet the need for assessing, over the next few years, the scope and magnitude of the problem. On the design, we have consulted with customers and colleagues and believe we have struck a balance between usability and affordability.

The type testing of the dosemeter – when we assess its generic radiation detection characteristics – is almost complete. We have constructed a new phantom* according to the recommendations



Headband eye dosemeter on phantom

of ORAMED (Optimization of RAdiation protection for MEDical staff, www.oramed-fp7.eu/), and have established how the response varies with the energy of beta, gamma and X-radiations. The results so far have been as expected, and we are completing the type tests by looking at the directional dependence of the response.



Photon energy dependence of relative response for $H_p(3)$

* A 'phantom' is a standard body which scatters the radiation in the same way as a human body (in this case, the head), making the radiation field more realistic.

How Not to Do Things ...

You may remember that a few years ago we ran a number of articles in *Monitor* that were taken from the UK Ionising Radiation Incident Database (IRID). IRID contained anonymised details of incidents that had resulted in elevated levels of radiation exposure, or had been 'near misses'. The object was to learn lessons so that other people's mistakes could be avoided.

Together with a number of other organisations, the HPA has established an international online database, known as OTHEA, that fulfils a similar function. The latest incident entries include:

- Contamination of persons and equipment by a damaged level gauge source in a food factory
- Incident involving radiation injury from gamma non-destructive testing source exchange
- Rupture of a package containing iodine-131
- Search for a lost laboratory source found elsewhere on same premises
- Historical thorium contamination in a research facility.

The reports make instructive reading – see www.othea.net/

Also in this issue:

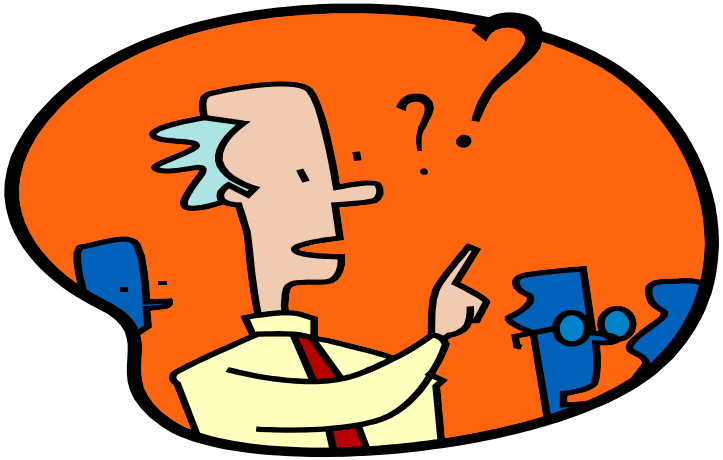
Neighbour countries: Germany

- In photon radiation fields, the personal dose equivalent quantity Hp(0.07) adequately estimates the eye lens dose (…) there is therefore no need to introduce the additional personal dose equivalent quantity Hp(3) (…) for the specific case of lens monitoring.
- For the dose equivalent quantity Hp(0.07), the personal dosimeter used must, however, be calibrated on an ISO water slab phantom (slab phantom), like a whole-body dosimeter, not on an ISO rod phantom as in the case of a extremity dosimeter.
- Beta fields: maybe better to use Hp(3)?

SSK, *Monitoring the Eye lens Dose, Statement of the German Commission on Radiological protection with Scientific Reasoning* (2010)

Wrap-up

- Considerable amount of debate concerning $H_p(3)$ still going on
- A lot of work is needed for robust metrology of $H_p(3)$
- There may be work-arounds, avoiding the need for $H_p(3)$
- Meanwhile, a lot of information and guidance has become available
- So, why not make use of it?



or…