DETERMINATION OF DOSEMETER RESPONSE IN TERMS OF ICRU 95 OPERATIONAL QUANTITIES

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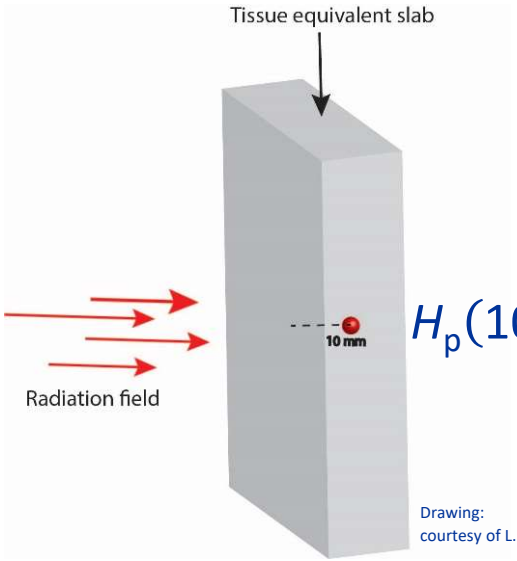
OUTLINE

- Comparison of old and new quantities
- Conversion coefficients
- Assessment/determination? of dosemeter response in terms of ICRU 95 operational quantities
- Literature

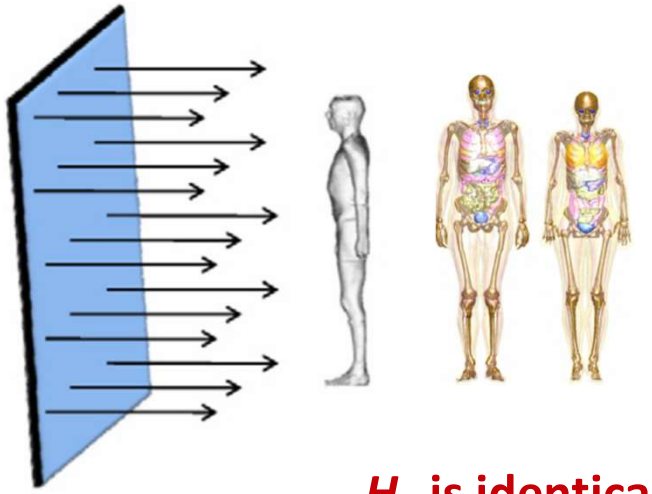
DEFINITIONS OF THE OPERATIONAL QUANTITIES

ICRU Report 39/51 Personal dose equivalent, $H_p(10)$	ICRU Report 95 Personal dose, H_p
$H_p(10)$ is defined below a specific point in the body or on a calibration phantom.	H_p is defined at a point on the body.
$H_p(10)$ is defined in ICRU 4-element soft tissue.	H_p is the product of the fluence and the appropriate conversion coefficient.
d = 10 mm for penetrating radiations d = 0.07 mm for the skin d = 3 mm for the eye	No fixed depth of a maximum (energy dependent).



Drawing:
courtesy of L. Bossin

$H_p(10) = Q \,.\, D$ (d = 10 mm)



$H_p = \Phi . h_\Phi$

$h_E = \frac{E}{\Phi}$

AP **H_p is identical to E (by definition)**

CONVERSION COEFFICIENTS

ICRU Report 57 / ICRP Report 74 Personal dose equivalent, $H_p(10)$	ICRU Report 95 Personal dose, H_p
Conversion coefficients have been calculated in ICRU slab in kerma approximation.	Conversion coefficients have been calculated considering the E/ϕ for the reference adult voxel phantoms at different incident angles with secondary charged particle transport.
Conversion coefficients maximum energies: **10 MeV for photons and electrons 20 MeV for neutrons**	Conversion coefficients maximum energies: **1 GeV for photons, neutrons, electrons, positrons, protons, negative muons, positive muons, negative pions, positive pions, ^{4}He ions**

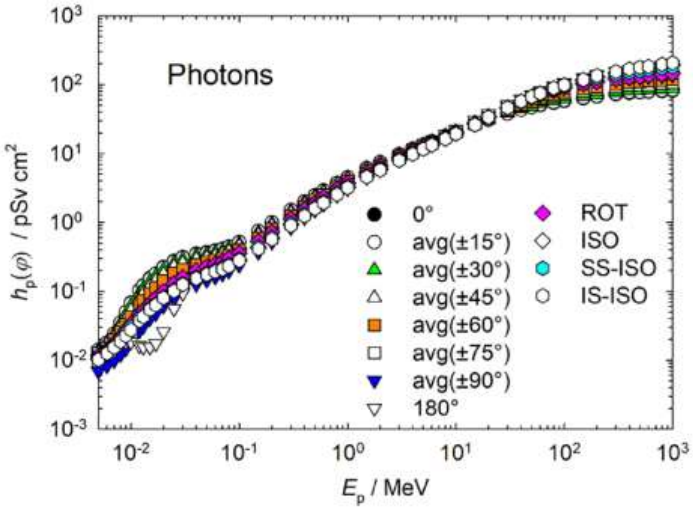


Figure A.2.1a Conversion coefficients from photon fluence to personal dose (Endo[5], 2017; ICRP, 2010).

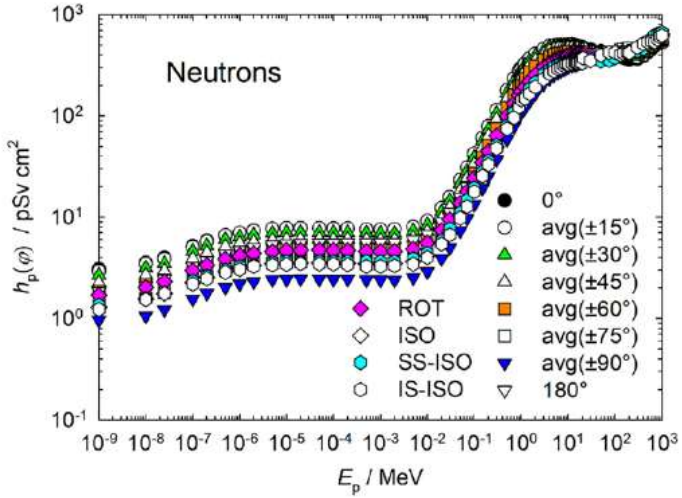


Figure A.2.2 Conversion coefficients from neutron fluence to personal dose (Endo, 2017; ICRP, 2010).

CONVERSION COEFFICIENTS: COMPARISON

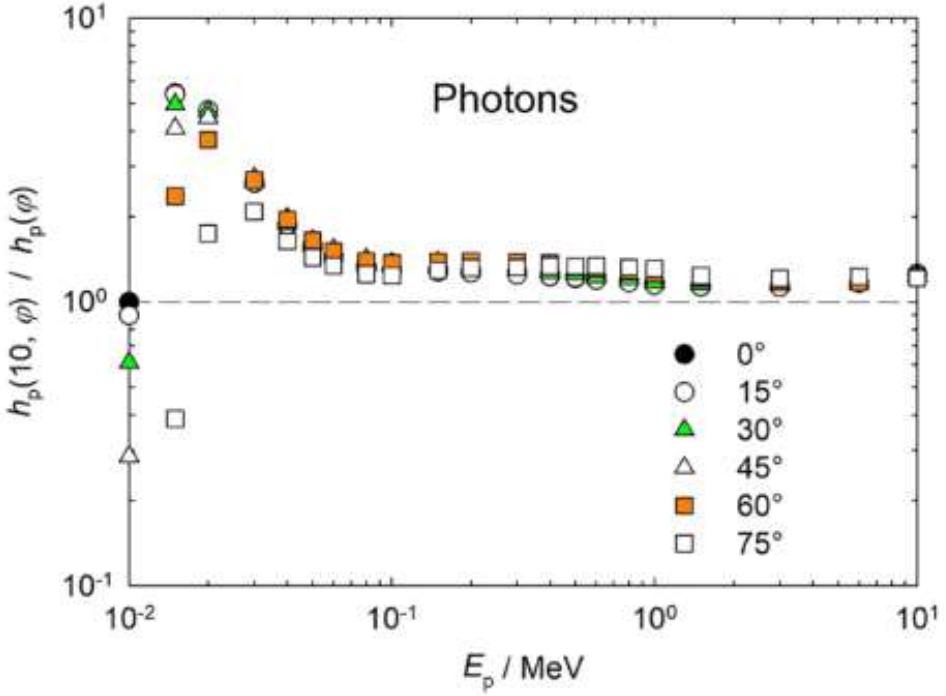


Figure 4.3 Comparison of incident photons of conversion coefficients from fluence to personal dose equivalent at 10 mm depth, $h_p(10,\varphi)$, taken from ICRU Report 57 (1998) which used the kerma approximation method, shown as a ratio to the recommended values of $h_p(\varphi)$ (Endo, 2017).

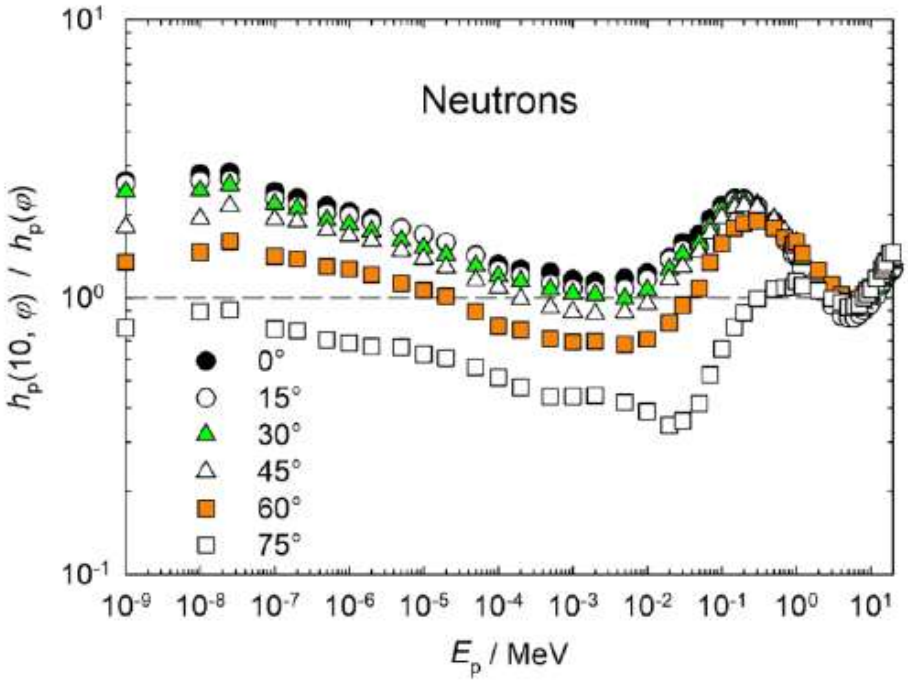


Figure 4.5 Comparison of incident neutrons of conversion coefficients from fluence to personal dose equivalent at 10 mm depth, $h_p(10,\varphi)$, taken from ICRU Report 57 (1998), shown as a ratio to the recommended values of $h_p(\varphi)$ (Endo, 2017).

CONVERSION COEFFICIENTS: COMPARISON AT 0° INCIDENCE

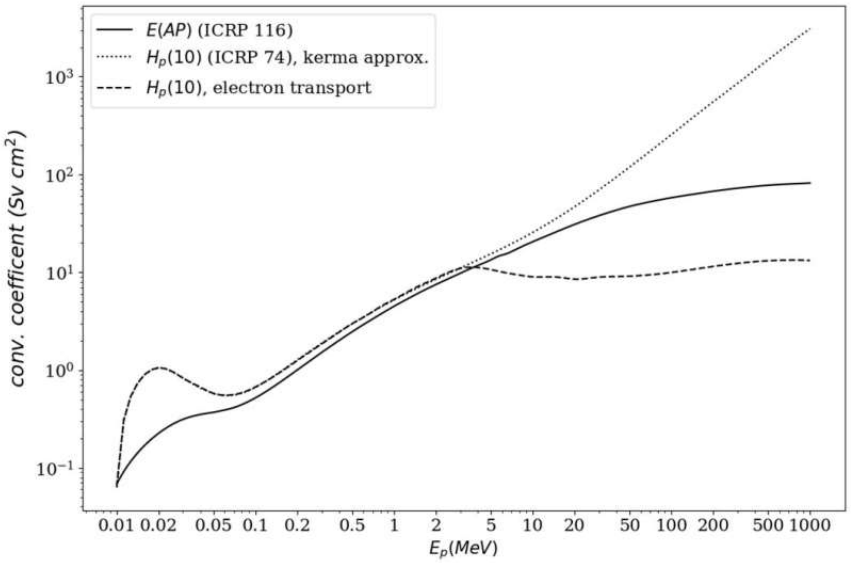


Figure 1. Effective dose per unit fluence in AP orientation E(AP) (continuous line), personal dose equivalent $H_p(10,0^0)$ per unit fluence as published, calculated in kerma-approximation (dotted line), personal dose equivalent $H_p(10,0^0)$ per unit fluence calculated with full electron transport (dashed line). On this scale, the corresponding curves for ambient dose equivalent $H^*(10)$ are indistinguishable from the ones for $H_p(10,0^0)$.

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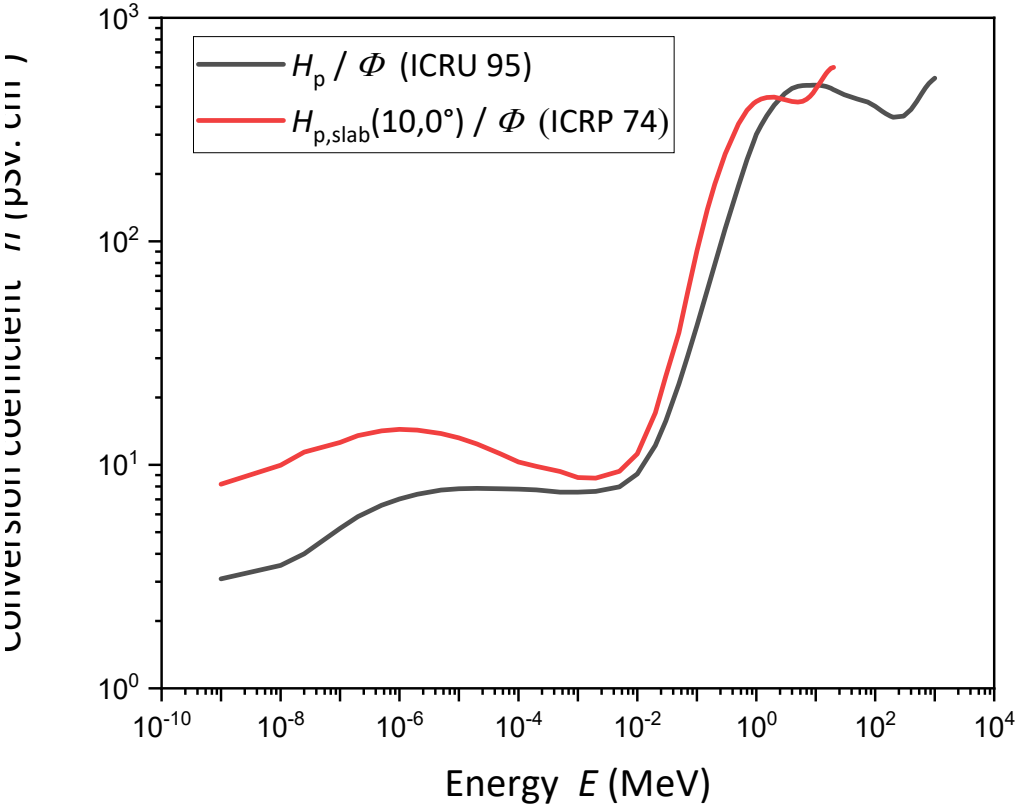


ASSESSMENT OF DOSEMETER RESPONSE IN TERMS OF ICRU 95 OPERATIONAL QUANTITIES

The response of the dosimeter is the ratio of the value indicated by the dosimeter, G, over the conventional quantity value, C.

$$R = \frac{G}{C}$$

Provided that the method of irradiations for the old and the recommended quantities is unchanged and the response of the dosimeter to the previous quantity $H_p(10)$ is known, R can be calculated as:

$$R = \frac{G}{C_{old}} \frac{C_{old}}{C} = R_{old} \frac{C_{old}}{C} = R_{old} \frac{h_{old}}{h} = R_{old} \frac{h_p(10)_{, ISO\ 8529\text{–}3}}{h_{p,\ ICRU\ 95}}$$

Reciprocal is listed for neutron radionuclide sources in EURADOS report – *Evaluation of the Impact of the New ICRU Operational Quantities and Recommendations for their Practical Application*

CONVERSION COEFFICIENTS FOR IC2022 PHOTON IRRADIATIONS CONDITIONS

No.	Radiation quality	$H_p(10)$ of IC2022n [mSv]	$h_{p\ ICRU\ 95}$ / $h_p(10)_{ISO\ 4037\text{-}3}$	$h_p(10)_{ISO\ 4037\text{-}3}$/ $h_{p\ ICRU\ 95}$
1	S-Cs 0°	2.4 - 9.0	0.840	1.191
2	S-Co 0°	8 - 360	0.838	1.193
3	N-40 0°	3.7 – 6.0	0.432	2.317
4	W-80 0°	4.8 – 7.2	0.665	1.503
5	W-80 60°	4.8 – 7.2	0.614	1.628
6	Mixed N-40 / S-Cs 0°: N-40	1.4 – 2.4	0.432	1.193
7	Mixed N-40 / S-Cs 0°: S-Cs	1.2 – 1.8	0.840	1.191

For true $H_p(10)$ values, see your certificate by the irradiation lab

Rolf Behrens and Thomas Otto, *Conversion coefficients from total air kerma to the newly proposed ICRU/ICRP operational quantities for radiation protection for photon reference radiation qualities* 2022 *J. Radiol. Prot.* **42** 011519

CONVERSION COEFFICIENTS FOR IC2022 NEUTRON IRRADIATIONS CONDITIONS

No.	Radiation quality	$H_p(10)$ of IC2022n [mSv]	$h_{p,\ ICRU\ 95}$ / $h_p(10)_{\ ISO\ 8529\text{-}3}$	$h_p(10)_{\ ISO\ 8529\text{-}3}$/ $h_{p,\ ICRU\ 95}$
1	Bare ^{252}Cf source at 0°	0.3 5.0	0.880	1.214
2	Bare ^{252}Cf source at 30°	0.5	0.824	1.259
3	Bare ^{252}Cf source at 45°	0.5	0.794	1.203
4	D_2O-moderated ^{252}Cf source at 0° & 1 mm Cd	0.8	0.831	1.136
5	Bare ^{252}Cf source (0.45 mSv) & thermal neutron field (0.15 mSv)	0.6	0.880 (0.45 mSv) & 0.531*	1.214 & 2.85*
6	Bare ^{241}Am-Be at 0°	1.0	1.039	0.962
7	Bare ^{241}Am-Be at 30°	0.5	0.972	1.029

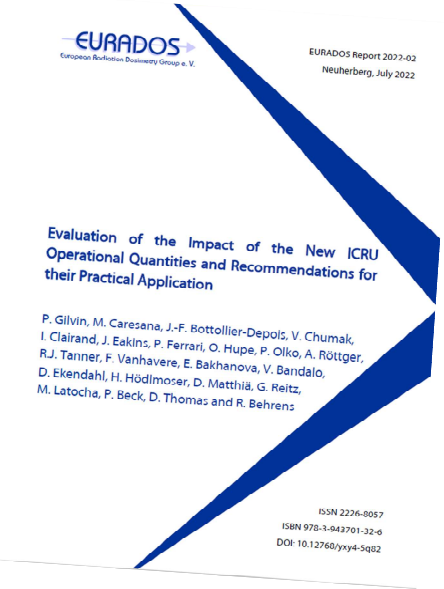
listed in EURADOS report – *Evaluation of the Impact of the New ICRU Operational Quantities and Recommendations for their Practical Application*

*Calculated ratio for E_n=2.53E-8 MeV

LITERATURE

- ICRU Report 95
  Operational Quantities for External Radiation Exposure
  Journal of the ICRU, 2020, Vol. 20(1) 14–16

- P. Gilvin, M. Caresana, J.-F. Bottollier-Depois, V. Chumak, I. Clairand, J. Eakins, P. Ferrari, O. Hupe, P. Olko, A. Röttger, R.J. Tanner, F. Vanhavere, E. Bakhanova, V. Bandalo, D. Ekendahl, H. Hödlmoser, D. Matthiä, G. Reitz, M. Latocha, P. Beck, D. Thomas and R. Behrens. "Evaluation of the Impact of the New ICRU Operational Quantities and Recommendations for their Practical Application", EURADOS, July 2022.



ENEA
Italian National Agency for New Technologies, Energy and Sustainable Economic Development

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

PAUL SCHERRER INSTITUT
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thank you!

Please let us know your suggestions

or comments by e-mail to:

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