

Clearance levels for surface-contaminated objects leaving a nuclear facility: Preliminary results

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and the Environment
Ministry of Health, Welfare and Sport

BEL ✓

Outline

- Introduction
- Objectives and methodology
- Results
- Benchmarking study
- Conclusions

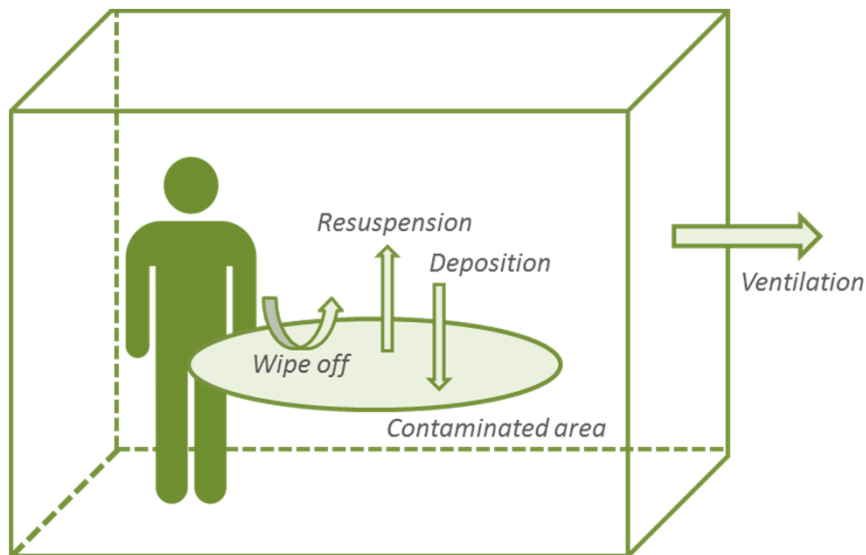
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Introduction – *SUDOQU* methodology

S	U	D
R	Q	O
I	V	M

Assumes a **non-constant surface-contamination level**, affected by removal (radioactive decay, resuspension, wipe-off) and deposition mechanisms



- Allows dose assessment for **public** exposure scenarios
- Potentially suitable for derivation of **surface-clearance** levels

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Objectives and methodology

- Test suitability of SUDOQU for clearance calculations
- Deterministic calculation of annual effective dose from use of a surface-contaminated office item: **Bookcase**

Geometry: *Circular shape*

Dimensions: 6 m^2

Contamination: 1 Bq/cm^2 (only front panel)

Receptor: *Office worker (5d/w, 8h/d)*

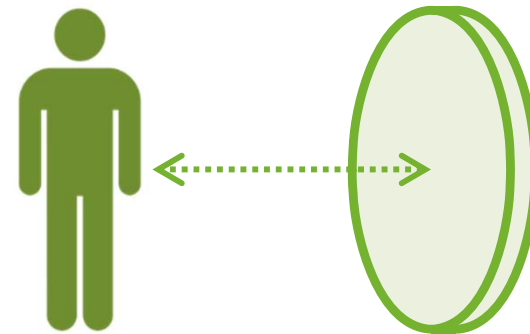
Exposure pathways: *External irradiation*

Inhalation

Skin dose (wipe off)

(Indirect) Ingestion

Several radionuclides considered



Objectives and methodology

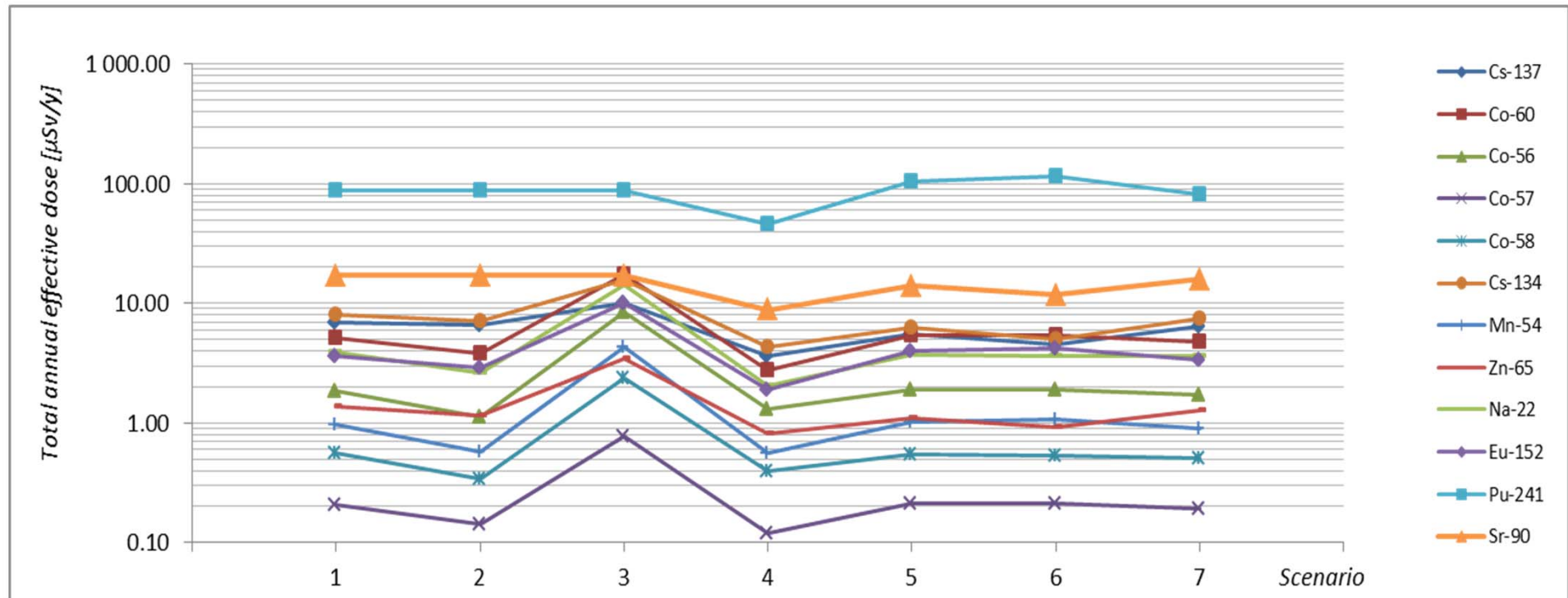
- Considered scenarios

Scenario #	Varied Parameter (wrt ref. Scenario 1)
01	<i>Reference scenario</i>
02	<i>Distance ↗</i>
03	<i>Distance ↘</i>
04	<i>Wipe frequency ↗</i>
05	<i>Transfer efficiency ↘</i>
06	<i>Transfer efficiency ↘↘</i>
07	<i>Time ↘</i>

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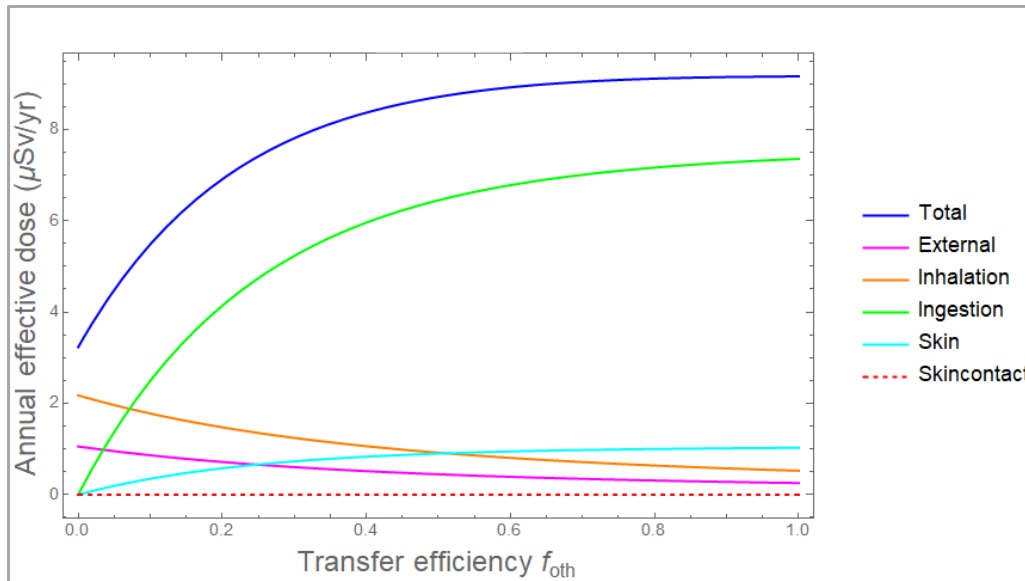
Results – Total annual effective dose



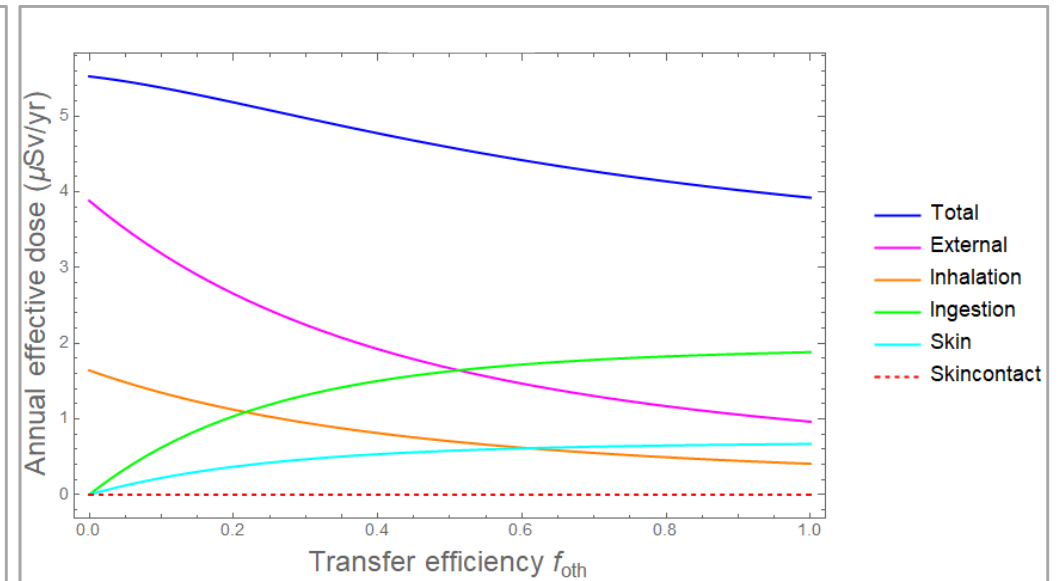
- Absolute dose values ranging from 10^{-1} $\mu\text{Sv/y}$ (Co-57) to 10^2 $\mu\text{Sv/y}$ (Pu-241)
- Heterogeneous behaviour of the considered nuclides
- Parameter variation has different (sometimes opposite) effects on the considered dose contributions → The net result depends on which effect prevails

Results – Influence of the transfer efficiency (from object to hands)

Bookcase, **Cs-137**



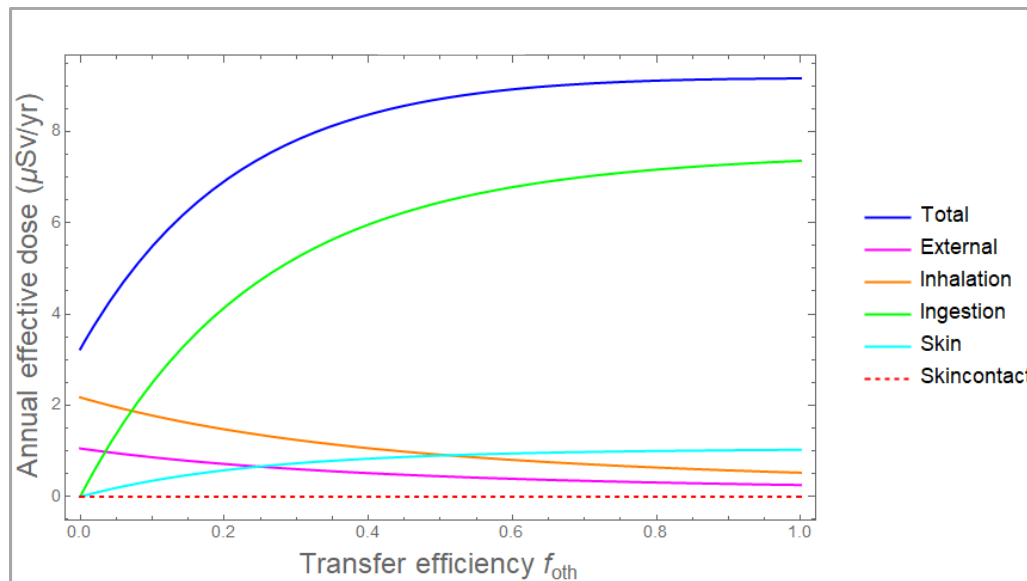
Bookcase, **Co-60**



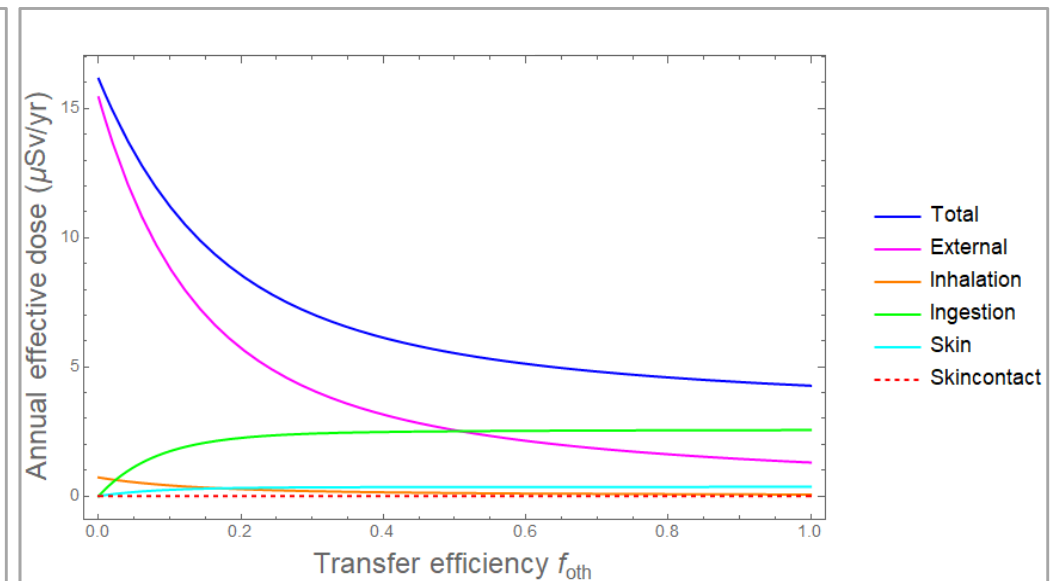
Results are **isotope-specific**

Results – Influence of the object

Bookcase, Cs-137



Desk, Cs-137



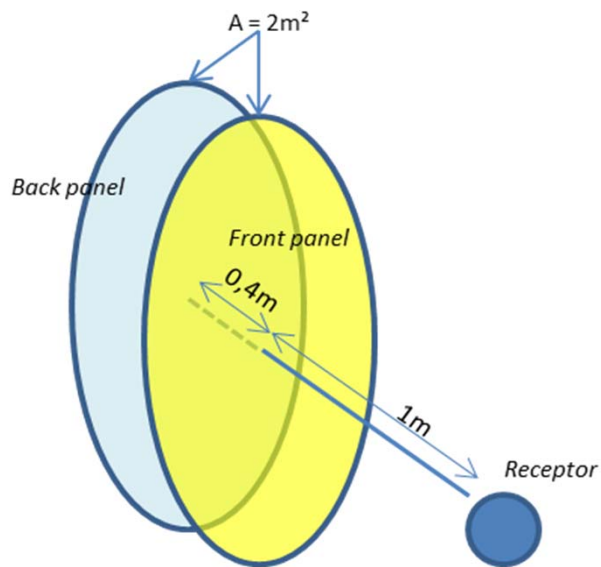
Results are **specific for the considered type of object**

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Benchmarking study – *Bookcase*

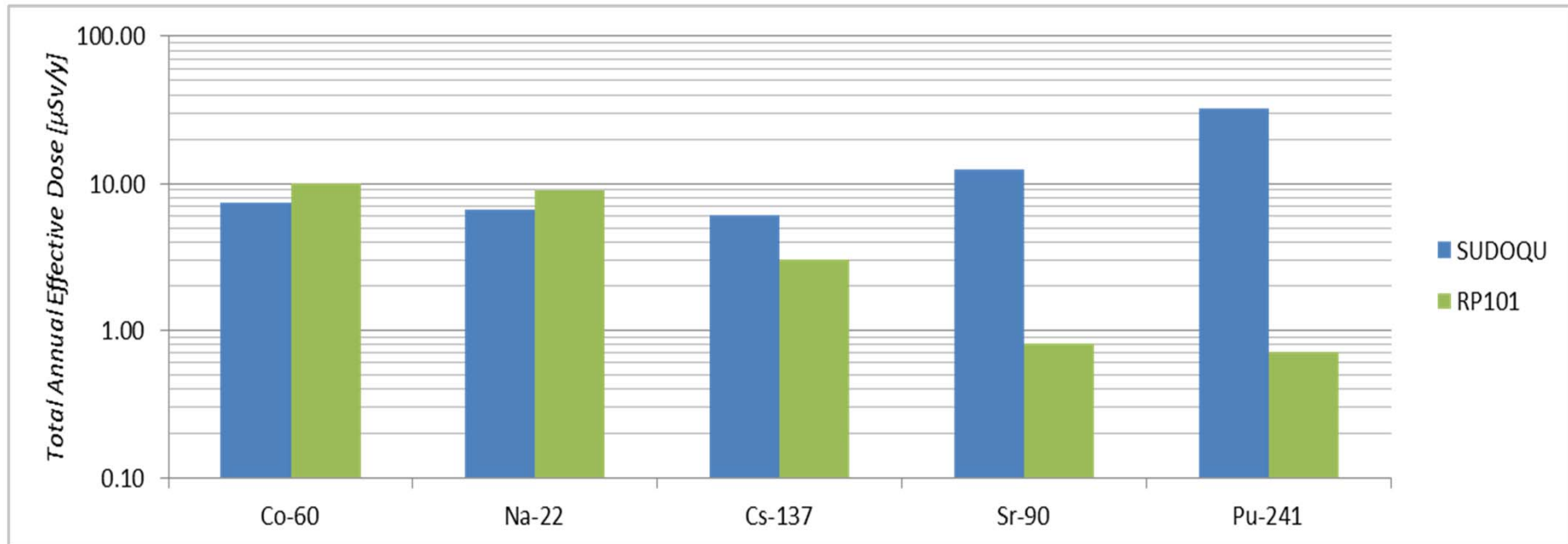
- Results benchmarked against RP 101
- Main assumptions:



	RP 101	SUDOQU
<i>Mechanisms affecting activity</i>	Radioactive decay	Radioactive decay, wipe off, resuspension, deposition
<i>Removable fraction</i>	10%	100%
<i>Transfer efficiency</i>	10%	20%

Source: Bel V publication
http://www.belv.be/images/pdf/SUDOQU_report.pdf

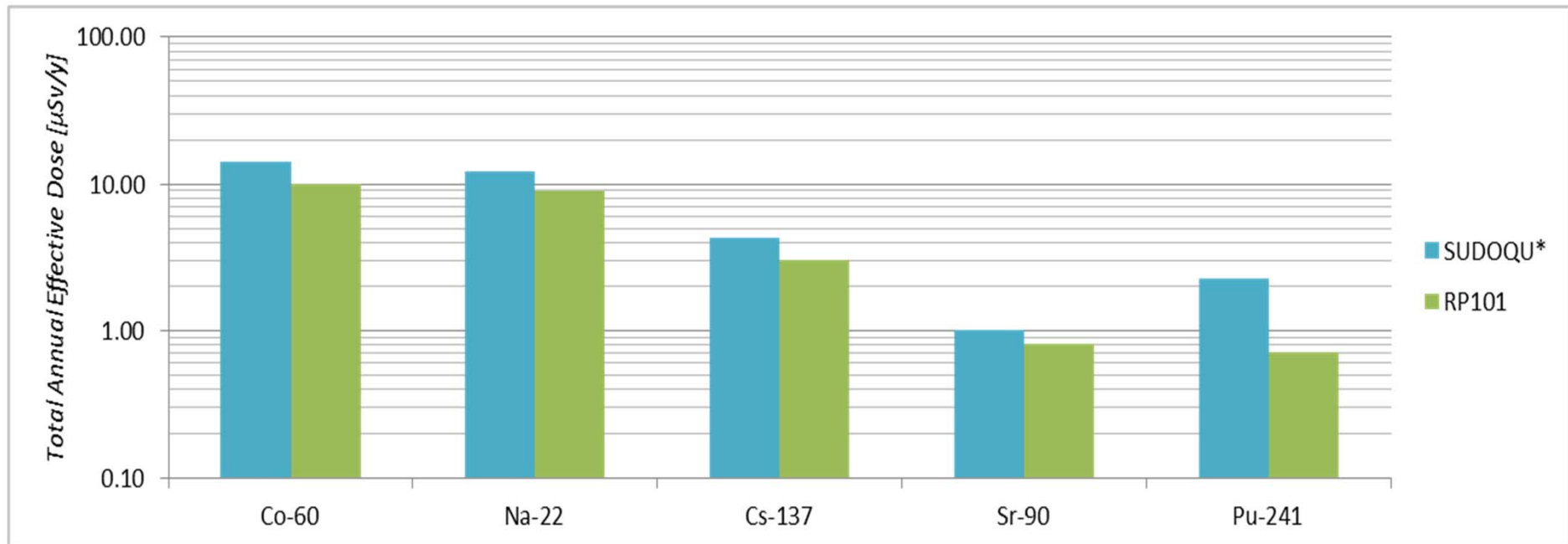
Benchmarking study – *Bookcase*



First benchmarking: SUDOQU assumptions unchanged

- Contributions linked to removal (skin + ingestion + inhalation) emphasised in SUDOQU with respect to RP101
→ effect visible for Cs-137, Sr-90, Pu-241
- External-irradiation contribution emphasised in RP101 with respect to SUDOQU
→ effect visible for Co-60, Na-22

Benchmarking study – *Bookcase*



Second benchmarking: SUDOQU assumptions conform to RP101 (SUDOQU*)

- Contributions linked to removal (skin + ingestion dose) decrease in SUDOQU*
 - Dose for Cs-137, Sr-90, Pu-241 decreases (although still conservative)
- External-irradiation contribution increases in SUDOQU*
 - Dose for Co-60, Na-22 increases (now more conservative)

SUDOQU in good agreement with RP101

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Conclusion

- In SUDOQU, contamination level is affected by several mechanisms (resuspension, wipe-off, radioactive decay, deposition)
- The variation of one parameter may cause opposite effects on the various dose contributions. The net outcome depends on the relative importance of each dose contribution → isotope- and scenario-specific.

Conservatism of assumptions difficult to predict



Ongoing:

Performance of statistical calculations to identify more general trends and dependencies, and to develop probabilistic and conservative dose assessments

Thank you for your attention.

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