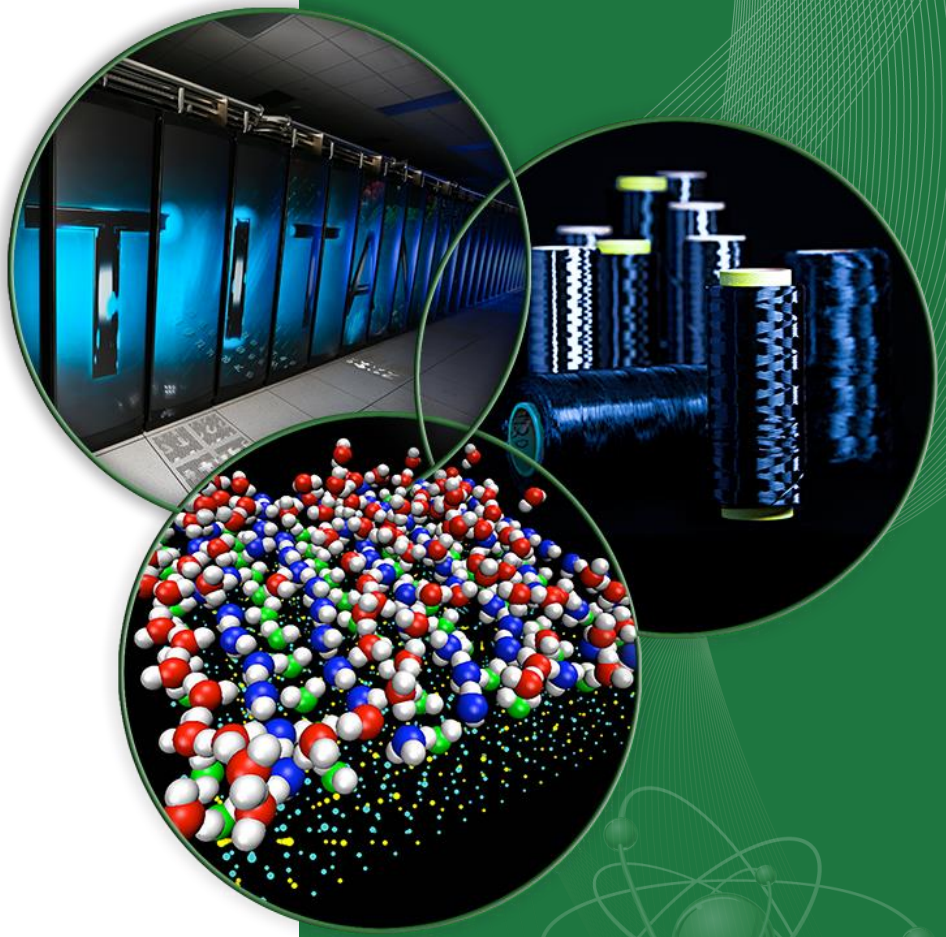
Data Challenges in Radiation Protection Research



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USNC CODATA

Data Citation Workshop:
Developing Policy and Practice

July 12, 2016

ORNL is managed by UT-Battelle
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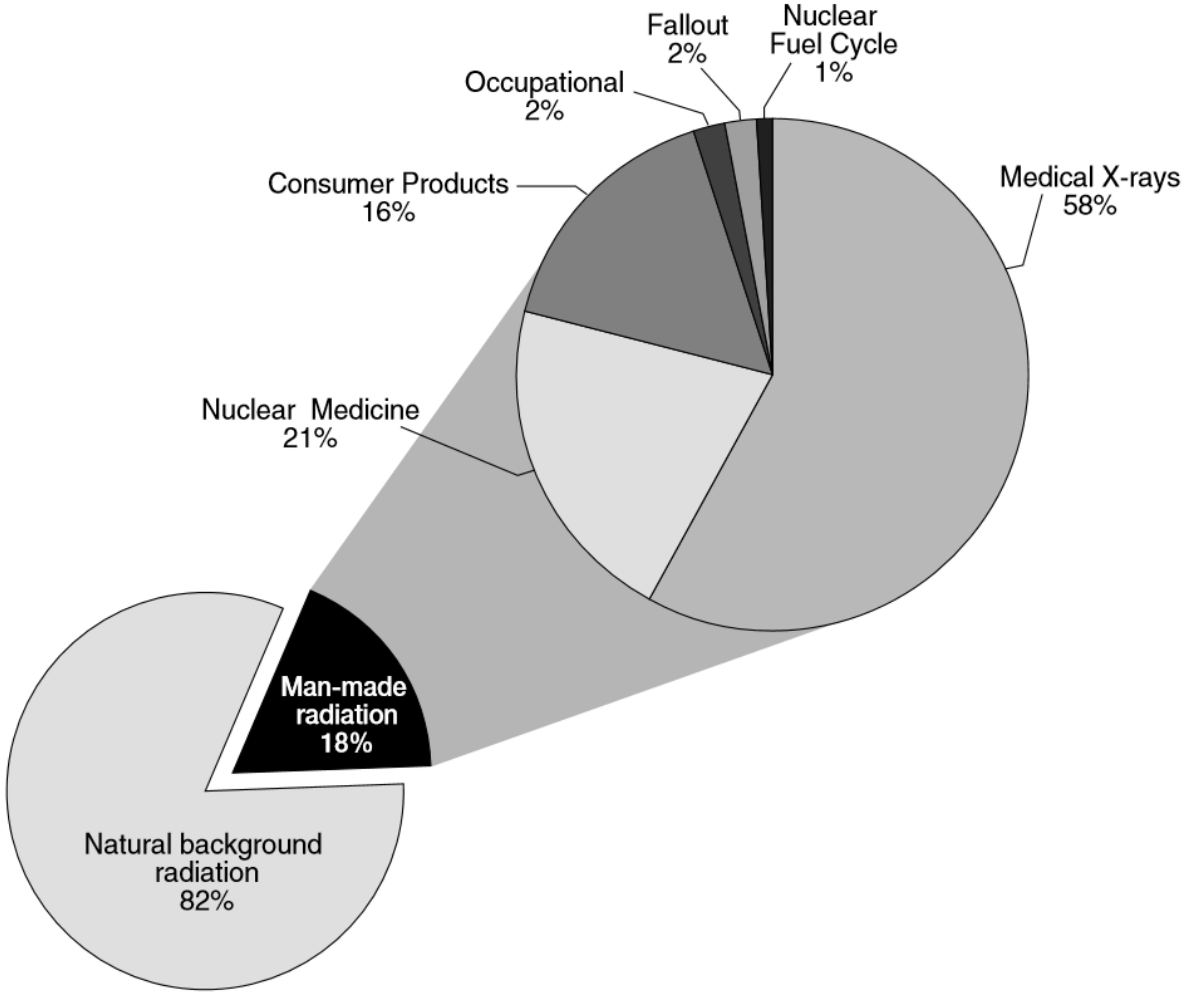
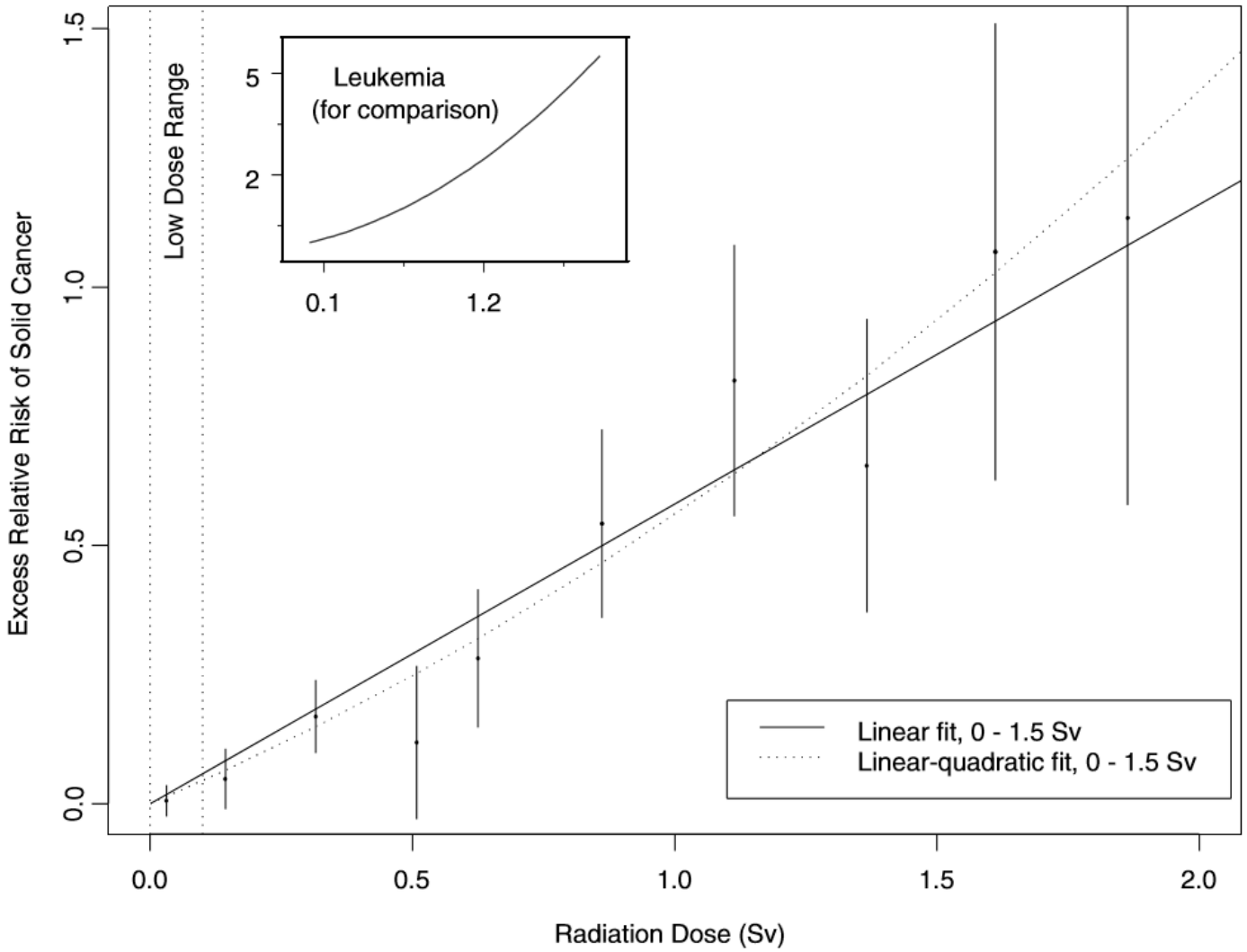
Background



Contribution from man-made radiation sources *(NCRP, 1987).*

Background



Excess relative risks of solid cancer for Japanese atomic bomb survivors.

Radiation Protection Objectives

Fundamental principles

- Goals are the same as for protection against chemical hazards
  - Avoid acute/deterministic effects
  - Limit long-term/stochastic effects to as low as reasonably achievable (ALARA)

Definition of Radiation Dose

- In contrast to other types of hazardous material, radiation dose does not refer to the quantity of intake
- Rather, it refers to the amount of energy deposited per unit mass of tissue
- A unique aspect of radiation protection is that one must consider dose delivered by radionuclides in the nearby environment (called external exposure) in addition to intake or skin contact

Unique Methodology for Evaluation of Hazards of Exposure to Radionuclides

- Also, in contrast to chemical toxins, one does not need material-specific information to assess the risk (presumed to be proportional to dose) of exposure to a radionuclide
- Rather the methodology is based on two main factors:
  - Physical properties of the radionuclide as condensed into *dosimetric* models
  - For intake, its behavior in the body as condensed into *biokinetic* models

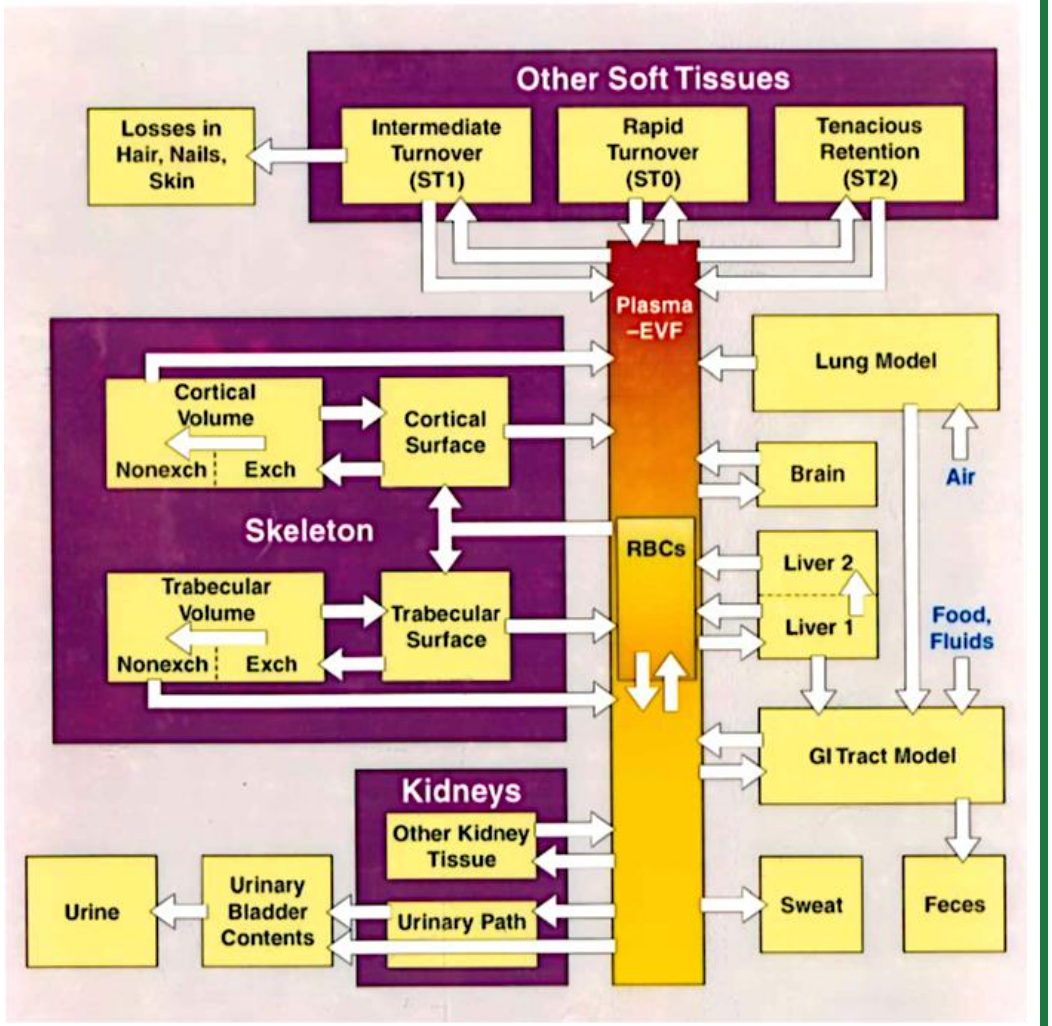
10CFR20 Support – Inhalation and Ingestion of Radionuclides

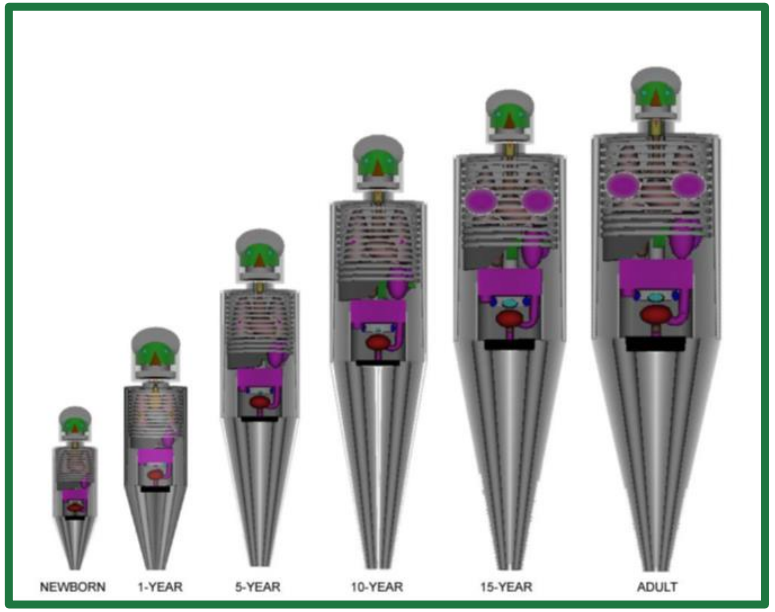
Biological (biokinetic)

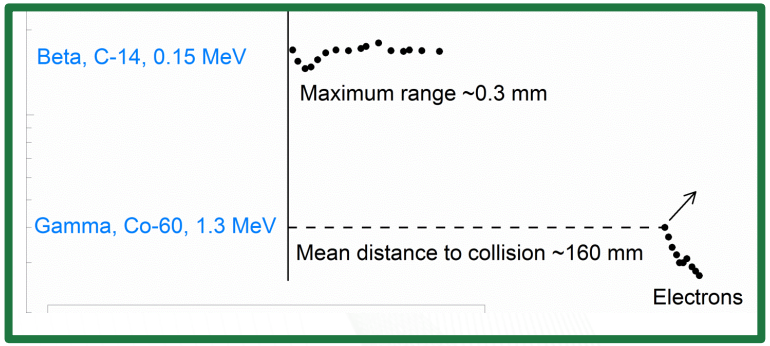
- Breathing and ingestion rates
- Excretion
- Time varying distribution
- Retention

Physical (dosimetric)

- Radiological Half-life
- Types and energies of emitted radiation
- Radiation interaction cross-sections
- Tissue mass, composition and density
- Dimensions of reference humans







(Leggett 1980, Cristy, 1980; Leggett, 1993)

Dose Coefficients: A simple tool for estimating radiation doses

- The link between radionuclide intake and radiation dose depends on many factors and is a complex calculation
- Make dose assessment available throughout the radiation protection community by creating a set of multiplicative factors called dose coefficients, with each dose coefficient being specific to
  - a radionuclide,
  - a physical and chemical form of that radionuclide, and
  - an intake mode.
- The estimated dose to an organ is then just the product of a dose coefficient and an estimated amount of intake of a radionuclide

Internal Dose Coefficients

$$h(r_T, \tau) = \sum_{r_S} \tilde{a}(r_S, \tau)\, S_w(r_T \leftarrow r_S)$$

Biological (ã)

- Activity in source tissue

Physical (S_w)

- Dose in target tissue per nuclear decay

Dose per Intake

Sv/Bq

Radiation Dose Limits

- Public 1 mSv
- Occupational 50 mSv

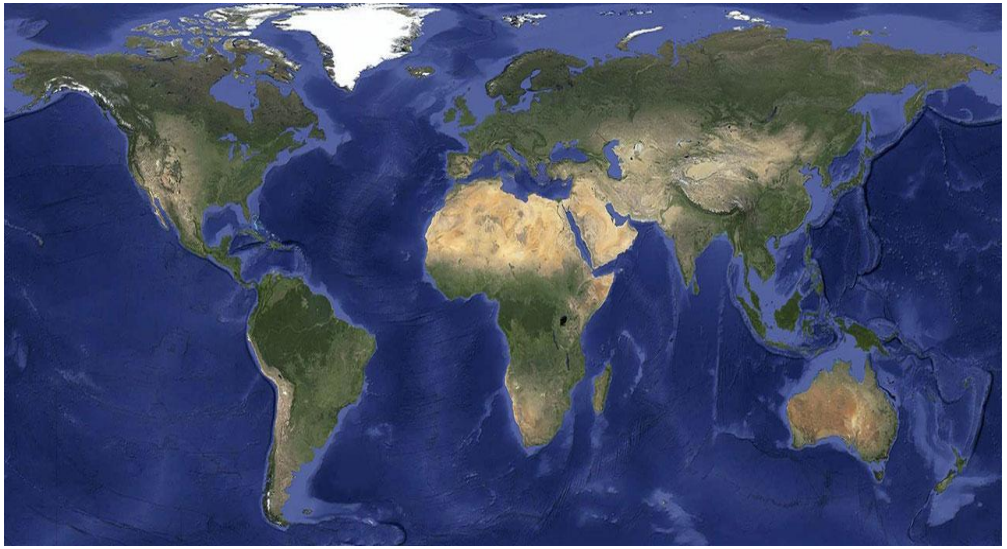
(NCRP 116, 1993)

Carbon-14

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table 2 Effluent Concentrations		Table 3 Releases to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
6	Carbon-14	Monoxide	-	2E+6	7E-4	2E-6	-	-
		Dioxide	-	2E+5	9E-5	3E-7	-	-
		Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4

(NRC 10CFR20 Appendix B)

Global Impact



Software:

- CAP88
- IMBA
- COMPLY
- DCFPAK
- Turbo FRMAC
- RASCAL
- RESRAD
- EPA-PRGS

International Organizations:

- International Commission on Radiological Protection (ICRP)
- International Commission on Radiation Units and Measurements (ICRU)

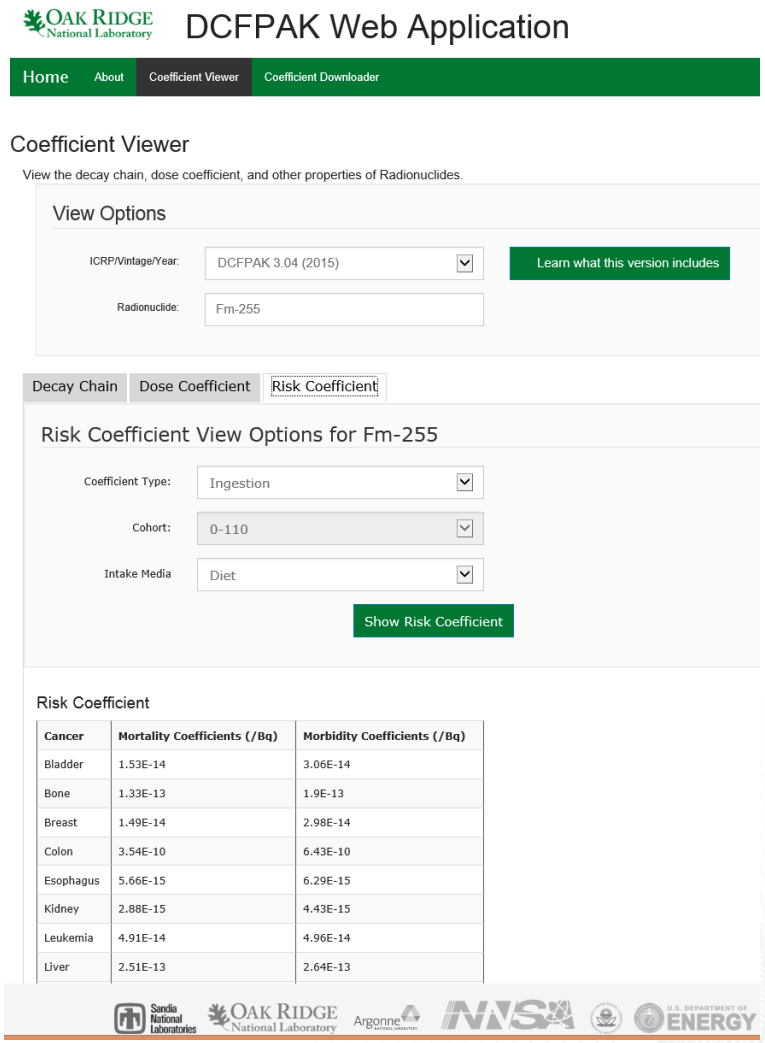
Domestic Organizations:

- Environmental Protection Agency (EPA): Federal Guidance Reports (FGR)
- Nuclear Regulatory Commission: Code of Federal Regulations (CFR)
- National Council on Radiation Protection and Measurements (NCRP)

and more!

Distributing Datasets

- Journal Articles
- Reports with DVDs
- Dropbox
- Email
- GIT server
- Online database portal



https://www.dcfpak.org

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Database challenges

- Who are our users?
- How do we publish “intermediate” datasets?
- How do we notify users of updates?
- How do we get cited for our work?

Give me a generalized platform so I spend minimal time on IT.

Center for Radiation Protection Knowledge





http://crpk.ornl.gov/

Top:
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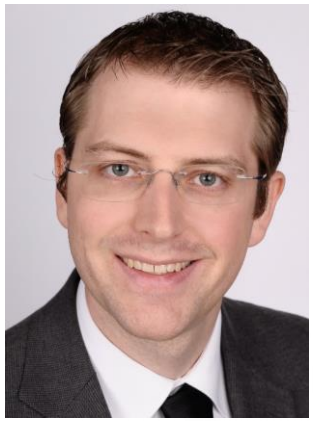
Keith Eckerman (Emeritus)
Rich Leggett (R&D Scientist)
Clay Easterly (Consultant)
Richard Ward (Consultant)






Middle: Michael Bellamy (ORNL, R&D Engineer)
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