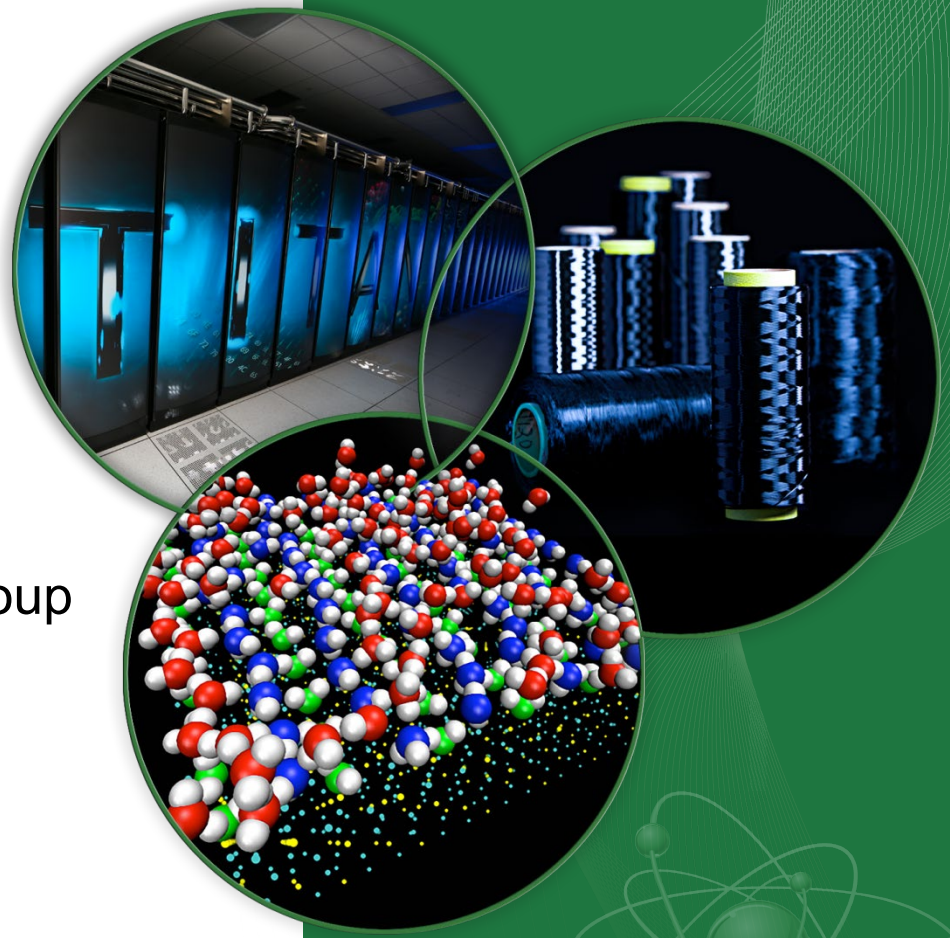
Oak Ridge National Laboratory's Center for Radiation Protection Knowledge



Nolan E. Hertel

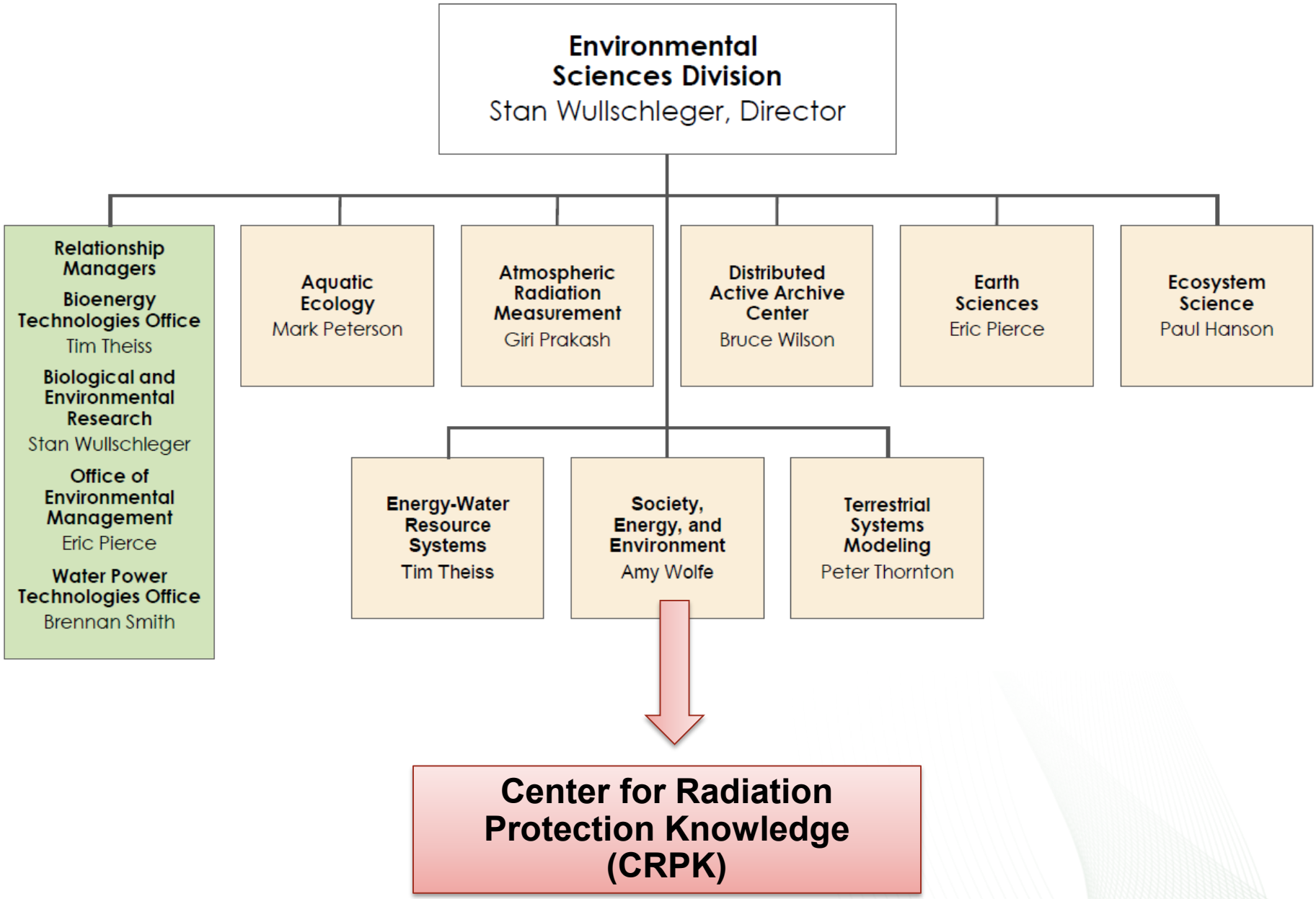
Society, Energy and Environment Group
Environmental Sciences Division

hertelne@ornl.gov

(nolan.hertel@me.gatech.edu)

www.ornl.gov/crpk

December 6, 2018



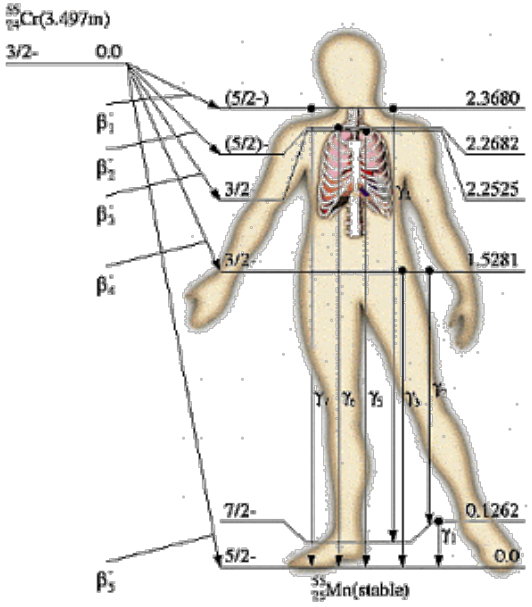
Society, Energy, and Environment (SEE) Group

Analyzes human health, environmental, economic, and societal implications of emerging science and technology

Expertise includes:

- Human health risk assessment
- Dosimetry and radiation protection
- Toxicology (human, animal, and environmental)
- Regulatory analysis
- Energy and economic modeling and analysis
- Sustainable technology modeling
- Assessment, analysis, evaluation, and deployment
- Environmental analysis; and social, institutional, and behavioral analysis

Relevant SEE Group Projects and Initiatives



- Development of EPA-published dose conversion factors for human exposure to over 1200 radionuclides
- Million worker study (retrospective evaluation of the dose-exposure of over 1 million U.S. radiation workers and veterans)
- Development of National Academy of Science-published acute exposure guideline levels (AEGLs) for airborne chemicals
- Development of clean-up and re-entry criteria for a hypothetical terrorist attack at a large U.S. airport
- Large-scale bioremediation of subsurface contaminants at Dover Air Force Base, DE
- Environmental impact assessment of U.S. Army's Chemical Weapons Disposal Program
- Energy efficiency and conservation at Fort Campbell, KY (data collection and analysis of building-by-building energy and water usage)
- Studies for FDA on human health effects of food additives
- Computational toxicology

Center for Radiation Protection Knowledge

- Established at ORNL per MOU 2010
  - Current Signatories: DOE, DoD, EPA, NRC, OSHA, DHHS, DHS
  - Maintaining/Preserving U.S. expertise and leadership
  - Development/Application of Radiation Dosimetry and Risk Assessment Methodologies/Models
  - Ensure the best scientifically available knowledge in regulatory processes and decision making

Center for Radiation Protection Knowledge

CRPK Objectives

1. Maintain state-of-the-art biokinetic and dosimetric methodologies
2. Make methodologies available to stakeholders in Federal agencies and to the scientific community
3. Provide technical assistance to stakeholders
4. Provide technical analyses and documentation to support Federal Guidance Technical Reports
5. Provide training material and courses for stakeholders

Center for Radiation Protection Knowledge

Web: *https://ornl.gov/crpk* E-mail: *crpk@ornl.gov*

Permanent, Full-time Staff

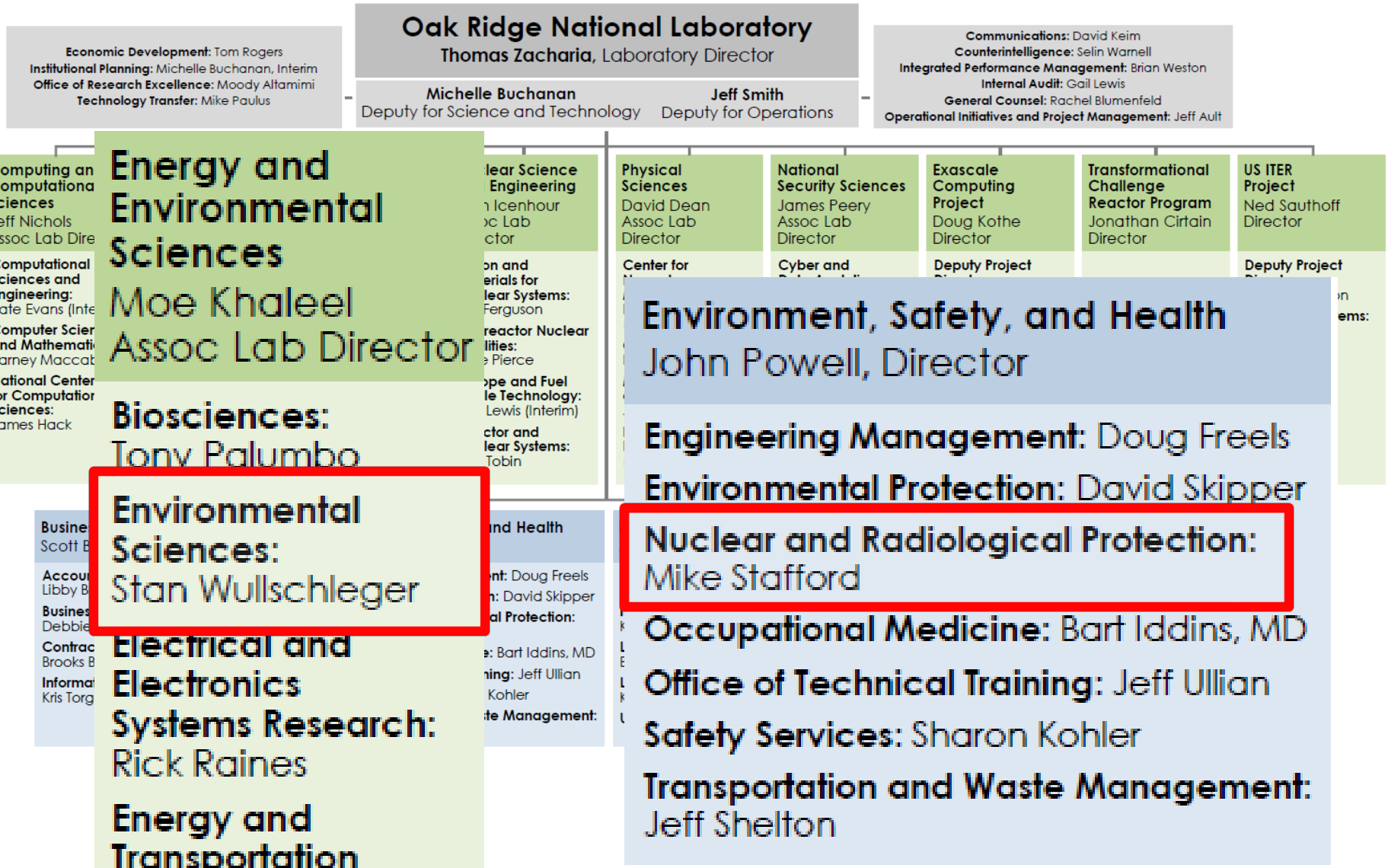
Rich Leggett (ORNL, Senior R&D Scientist)
Pat Scofield (ORNL)
Scott Schwahn (ORNL)
Michael Bellamy (ORNL)

Nolan Hertel - Director (JFA, GaTech)
Derek Jokisch (JFA, Francis Marion U)
Nicole Martinez (JFA, Clemson U)
Rob Hayes (JFA, NCSU)

Consultants:
Clay Easterly
Ken Veinot
Keith Eckerman

Consultants

OAK RIDGE National Laboratory

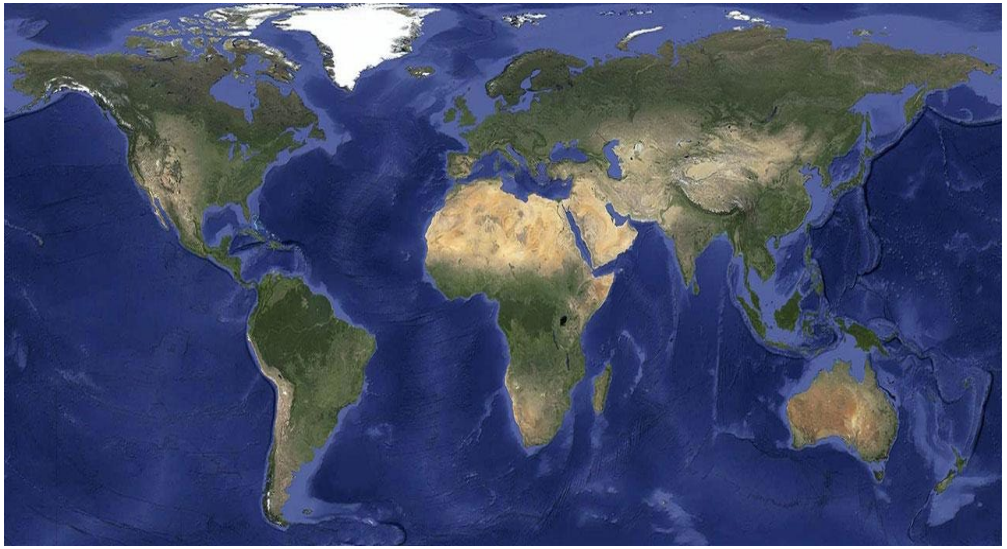


ORNL CRPK Fundamental Capabilities

Estimation of Radiation Doses to Humans Requires Biokinetic and Dosimetric Models

- **Biokinetic Models -** Time-dependent distribution, retention, and excretion of radionuclides entering the body through inhalation, ingestion, wounds, or injection.
- **Dosimetric Models (radiation transport)**
  - **Internal Dosimetry** – Compute dose in "target organs" due to radiation emitted from "source organs" of the body.
  - **External Dosimetry** - Dosimetric models are also used to estimate tissue/organ doses from external sources of ionizing radiation.
- **Nuclear Decay**
  - State of the art decay data must be used in these models.

Dose Coefficients: 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!

CRPK Application Areas

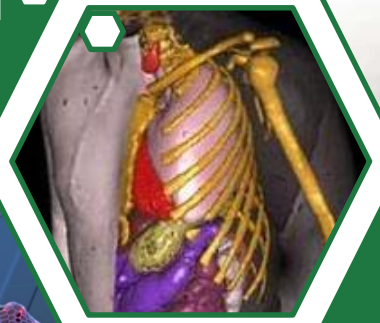
Emergency Preparedness and Response

Biological Effects to Exposures at Low Doses

Medical Radiation Dosimetry

Next Generation Computational Dosimetry

Instrumentation Optimization



Knowledge Management

CRPK's parallel work for US Federal Agencies and ICRP (Main sponsors – EPA and CDC)

- Biokinetic modeling
  - 2016: Completed suite of systemic biokinetic models for adult member of public or worker – used in ICRP's OIR (Occupational Intake of Radionuclides) series
  - Completed provisional set of age-specific biokinetic models for members of the public in 2017 for use in FGR16 and ICRP's EIR (Environmental Intake of Radionuclide) series
- **"Final" set of age-specific SAFs delivered to ICRP –** now being reviewed and tested.
- **Age-specific external dose** (contributions to related ICRP report in progress)

Million Worker Study (CRPK sponsors: CDC, DOE, EPA)

- Dose reconstructions for internal emitters completed for
  - Rocketdyne (U and many other radionuclides)
  - Mound (Po-210, Pu-238, Pu-239)
  - Mallinckrodt (U, Ra-226, Rn-222 and progeny
- **Dose reconstruction in progress for LANL (Pu-238, Pu-239)**
- **Upcoming - Dose reconstruction for Rocky Flats and Fernald**

Status of ICRP OIR and EIR Reports

- OIR Part 1 (2015): Summary of methods, assumptions, and generic models
- OIR Part 2 (2016): Dose coefficients and reference bioassay data for isotopes of H, C, P, S, Ca, Fe, Co, Zn, Sr, Y, Zr, Nb, Mo, Tc
- OIR Part 3 (2017): Ru, Sb, Te, I, Cs, Ba, Ir, Pb, Bi, Po, Rn, Ra, Th, U
- **OIR Part 4 (at publisher): Lanthanides and Actinides (other than Th and U)**
- **Some preliminary calculations for the IER Public Series.**
  - Full production mode once the SAFs are available in final form.
  - Biokinetic models are same as used in FGR16.

Other EPA Related Efforts

- FGR 16 in review at EPA
  - Final version awaits the ICRP approved SAFs
- Conducting study with UFL, OECD, and ORNL-CRPK on organ dose variability looking at variance of reference dose coefficients for variations in body morphometry (BMI 5th and 95th percentile) for all ages for external irradiation by contaminated ground

NRC Activities

- **Regulatory Guide 8.36: Initiating update of Reg. Guide 8.36, "Dose to Embryo/Fetus"**
- **RAMP support of software**
  - PIMAL
  - RadToolbox
  - Migration of DCFPAK to RAMP
- **Advanced Radiation Protection Dosimetry book in press**
  - Page proofs being checked.

SERIES IN MEDICAL PHYSICS AND BIOMEDICAL ENGINEERING
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ADVANCED RADIATION PROTECTION DOSIMETRY

Although many radiation protection scientists and engineers use dose coefficients, few know the origin of those dose coefficients. This is the first book in over 40 years to address the topic of radiation protection dosimetry in intimate detail.

It covers all methods used in radiation protection dosimetry, including advanced external and internal radiation dosimetry concepts and regulatory applications. It is an ideal reference for both scientists and practitioners in radiation protection and students in graduate health physics and medical physics courses.

Features:

- A much-needed book filling a gap in the market in a rapidly expanding area
- Contains the history, evolution, and the most up-to-date computational dosimetry models
- Authored and edited by internationally recognized authorities and subject area specialists
- Interrogates both the origins and methodologies of dose coefficient calculation
- Incorporates the latest international guidance for radiation dosimetry and protection

Dr. Shaheen A. Dewji is an Assistant Professor in the Department of Nuclear Engineering at Texas A&M University. Prior, Dr. Dewji was a staff scientist at Oak Ridge National Laboratory as part of the Center for Radiation Protection Knowledge. Her research and expertise has focused on developing computational models for the development of internal and external radiation dose coefficients for federal and international stakeholders in health and medical physics, radiation protection, nuclear security, and emergency response.

Dr. Nolan E. Hertel is a Professor of Nuclear and Radiological Engineering at Georgia Institute of Technology and holds a Joint Faculty Appointment in the Center for Radiation Protection Knowledge at the Oak Ridge National Laboratory. He received the Distinguished Scientific Achievement Award from the Health Physics Society in 2016 and the Rockwell Lifetime Achievement Award from the Radiation Protection and Shielding Division of the American Nuclear Society in 2018. Dr. Hertel is a recognized expert in radiation protection, shielding, detection, transport and dosimetry and has been actively engaged in nuclear engineering education and research as a university professor and private consultant for 39 years.

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ISBN 978-1-4987-8543-3
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SERIES IN MEDICAL PHYSICS AND BIOMEDICAL ENGINEERING

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RADIATION PROTECTION
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Edited by
Shaheen Dewji & Nolan E. Hertel

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OAK RIDGE National Laboratory

Contents

Page Proofs Now in Review and early 2019 publication date is anticipated.

OAK RIDGE National Laboratory

Additional Ongoing

- Characterizations of fallout from nuclear explosions, including IND (CDC)
  - Analyze data in the context of various external contamination screening criteria
  - Resuspension of radioactive material from contaminated people (due to routine human movement and activity) as a potential inhalation hazard to other people or staff at public shelters and community reception centers
- Age-dependent dose coefficients (DOE) for revision to DOE-STD-1196-2011

Risks to CRPK Capabilities/Mission

- ORNL believes that the Center for Radiation Protection Knowledge fulfills a critical national need.
- ORNL is the only national lab that has taken steps recently to bolster this capability.
- ORNL operates on a full-cost recovery business model.
- Most ORNL projects are multiyear; the CRKP work mostly isn't.
- Budget uncertainty/instability is the biggest near-term risk to CRPK capabilities.
- A longer-term risk is rebuilding the professional workforce in radiation protection.