Radiation Protection Computer Code Analysis and Maintenance Program (RAMP)
User Group Virtual Meeting, Internal Dosimetry Session, October 28, 2020

Internal Dosimetry for Radiation Emergency Response

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Radiation Studies Section
Division of Environmental Health Science and Practice

Radiation Studies Section: Emergency Roles

- Member of the Federal Advisory Team for Environment, Food, and Health

- Support state and local health partners
  - Technical assistance on a range of public health issues
    - Population monitoring

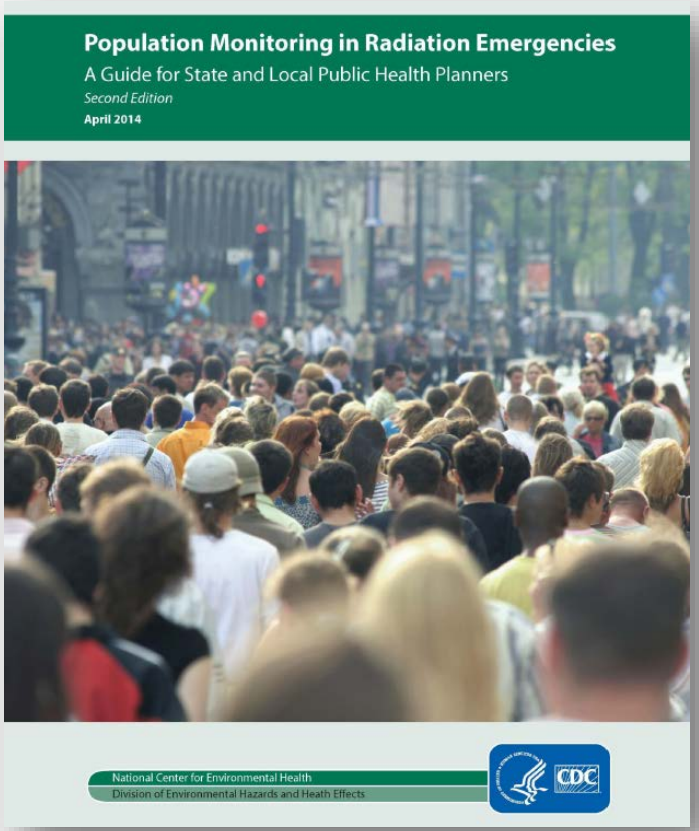
Nuclear/Radiological Incidents

Impact on People

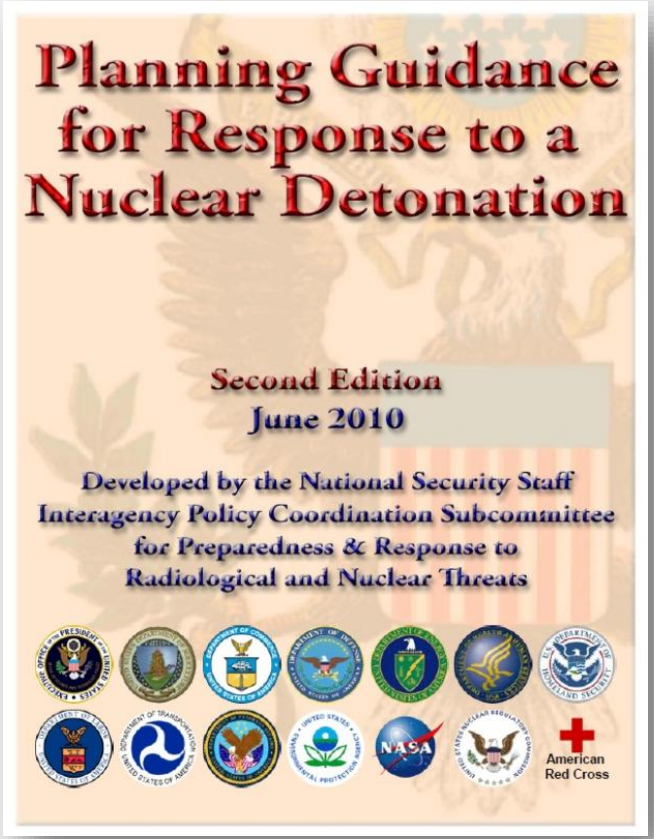
- Fatality
- Injury
- Exposure to radiation
- Contamination with radioactive material
- Anxiety
- Displacement

Population Monitoring

Population Monitoring Guidance

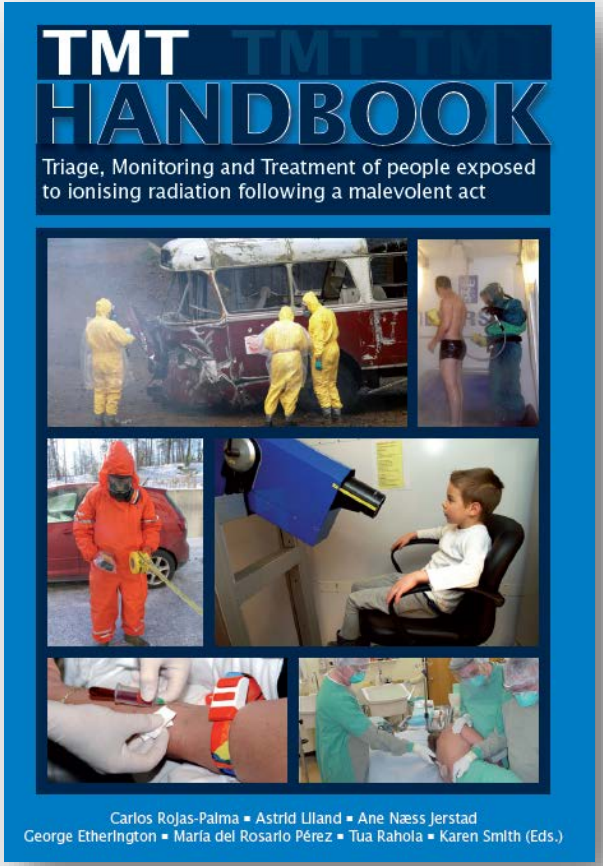


http://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf

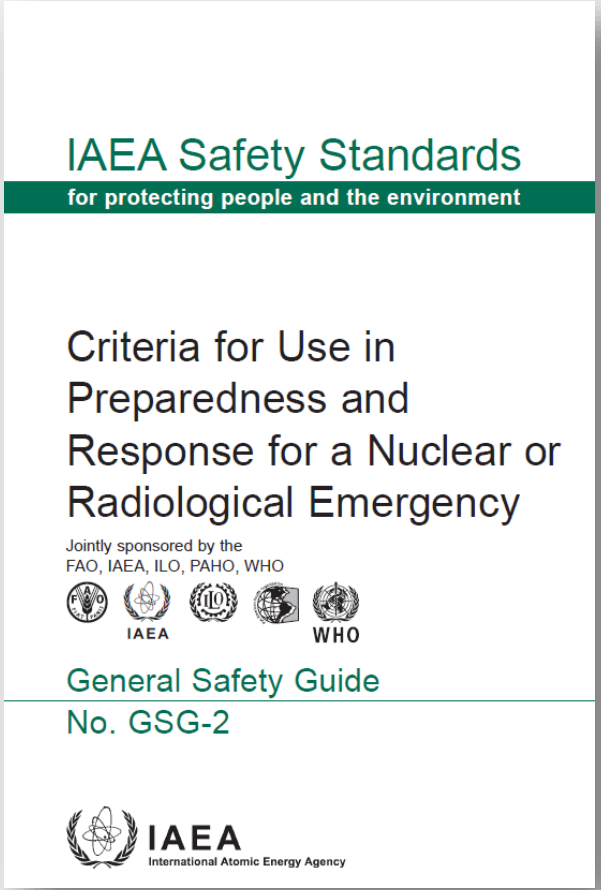


http://www.remm.nlm.gov/PlanningGuidanceNuclearDetonation.pdf

Guidance



www.tmthandbook.org/



www-pub.iaea.org/MTCD/publications/PDF/Pub1467_web.pdf

Guidance

Commentary No. 19

Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism

Report 161

Management of Persons Contaminated With Radionuclides

Report 165

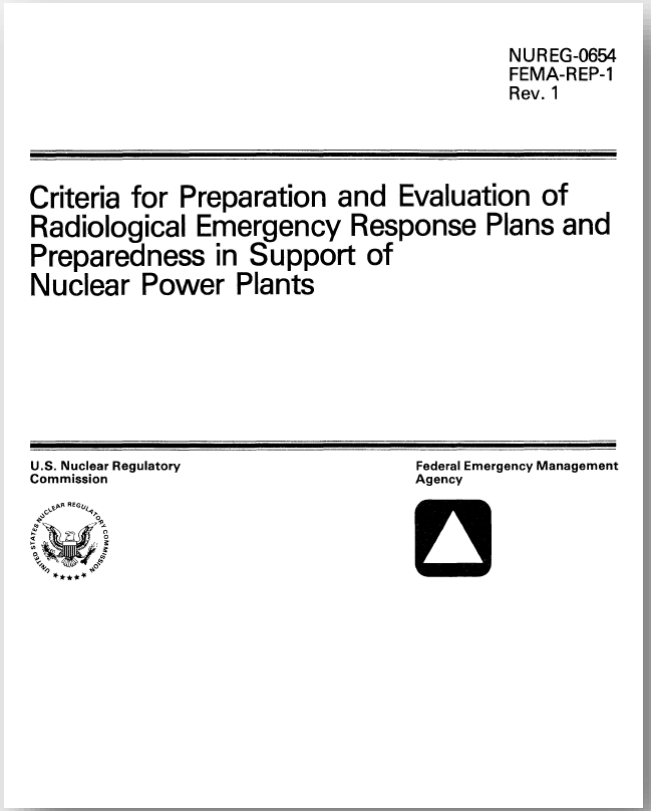
Responding to a Radiological or Nuclear Terrorism Incident: A Guide for Decision Makers

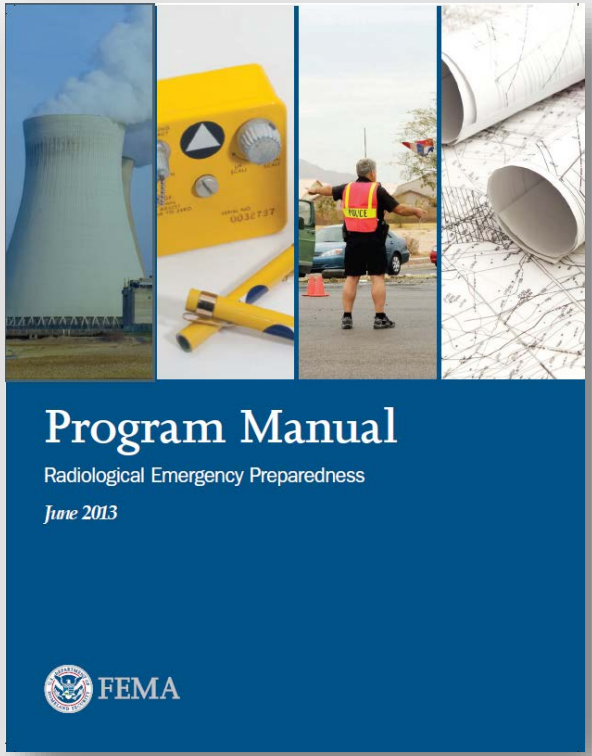
Report 166

Population Monitoring and Radionuclide Decorporation Following a Radiological or Nuclear Incident

www.ncrponline.org

Guidance Specifically for Nuclear Power Plants Off-site Response

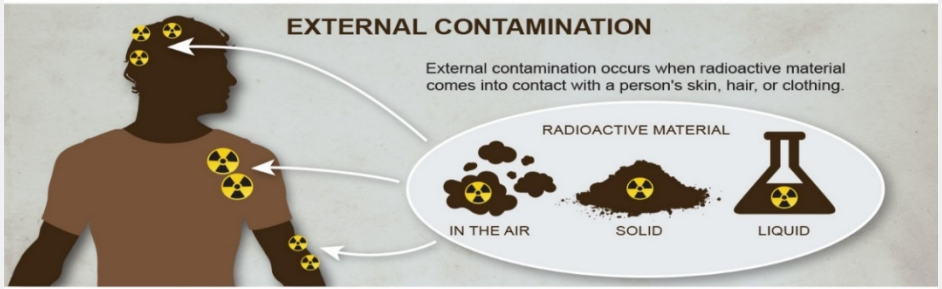


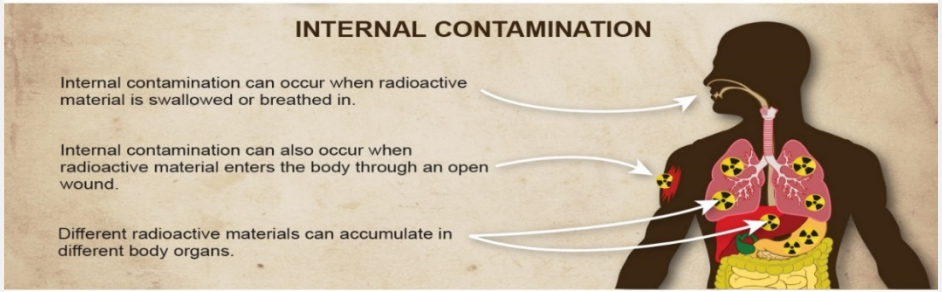


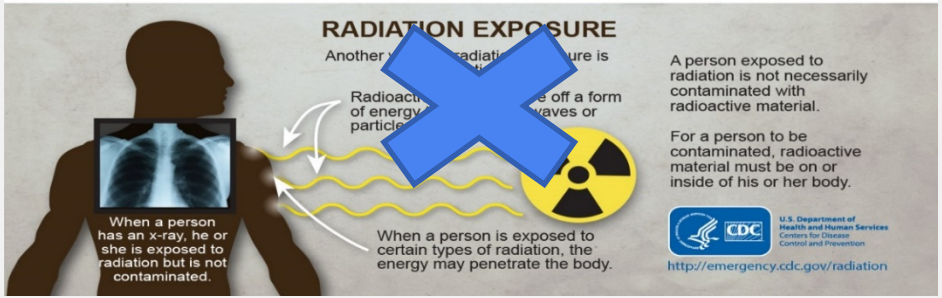
www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0654/

www.fema.gov/media-library/assets/documents/32780

RADIATION CONTAMINATION VERSUS EXPOSURE



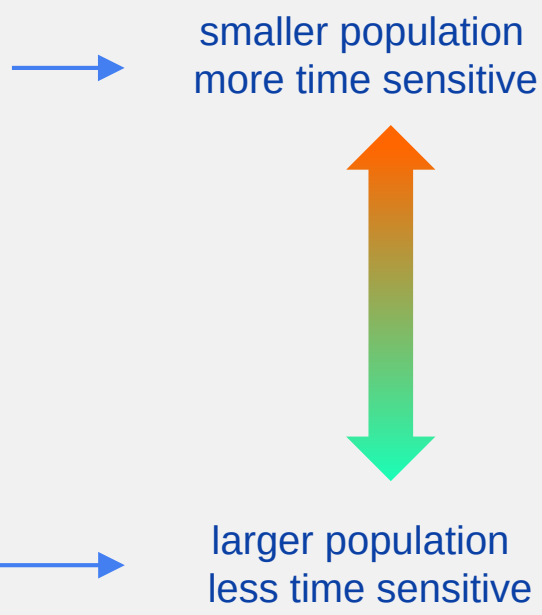




https://www.cdc.gov/nceh/radiation/emergencies/resourcelibrary/infographics.htm

Screening for Internal Contamination

- To identify people who could benefit from medical intervention (e.g., decorporation therapy)
- To identify people for long-term health monitoring
- To provide reassurance



Clinical Decision Guide (CDG)

To help physicians make clinical decisions about individuals with internal contamination who may need treatment.

For Adults* (use the most limiting value):

- **0.25 Sv (50-year effective dose) whole body**
- 0.25 Gy-Eq (30-day RBE-weighted absorbed dose) to the bone marrow
- 1 Gy-Eq (30-day RBE-weighted absorbed dose) to the lung

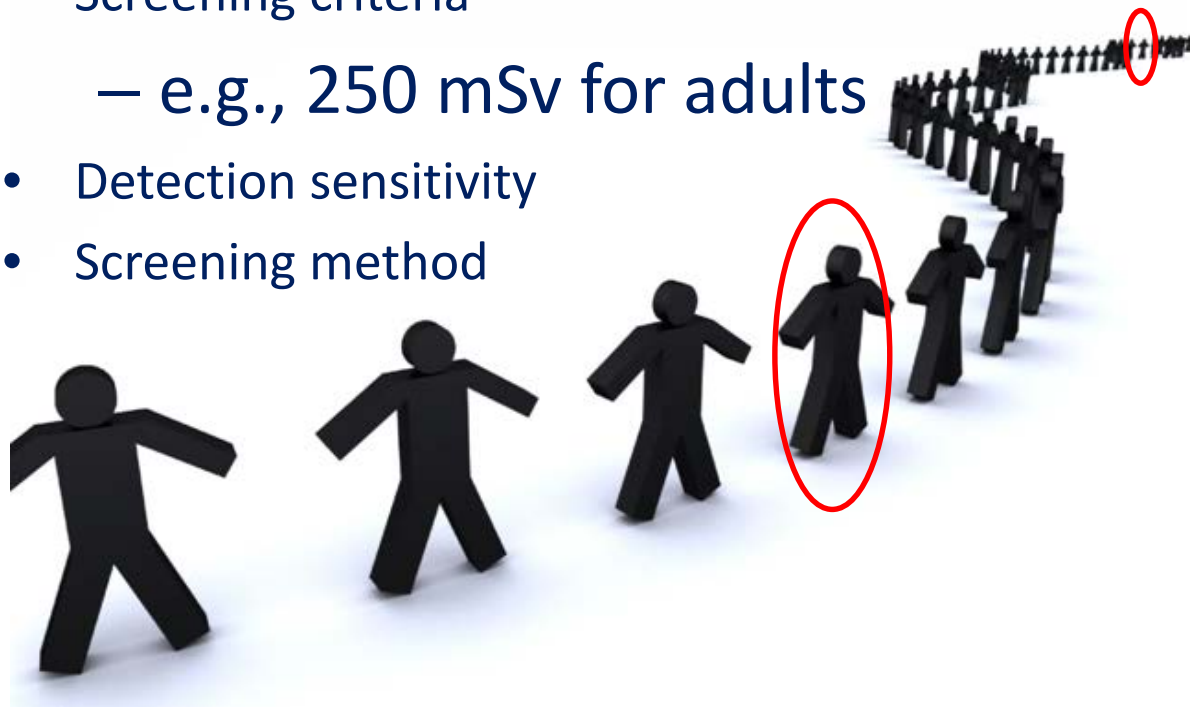
For children and pregnant/nursing women: 1/5th of the Adult CDG

* Except for iodine

NCRP Report 161 (2008) *Management of Persons Accidentally Contaminated with Radionuclides*

Screening a Large Population

- Screening criteria
  - e.g., 250 mSv for adults
- Detection sensitivity
- Screening method



Laboratory Analyses

- Conventional methodology
  - 24-hr urine sample (1-2 Liter sample)
  - 3-6 days turnaround time
  - 10-20 samples/day/lab

- Improved methodology (for population screening)
  - One 15-70 ml “spot” urine sample
  - < 24 hours turnaround time (multiple radionuclides)
  - 250-3000 samples/day
  - CLIA certified

Field screening and prioritization important

Direct Bioassay

- Feasible only when contaminants are gamma emitters (with some exceptions)
- Detection sensitivity does NOT have to be as low as routine occupational bioassays
- Allows for rapid prioritization of individuals for further analysis
- Needs characterization of instrument response

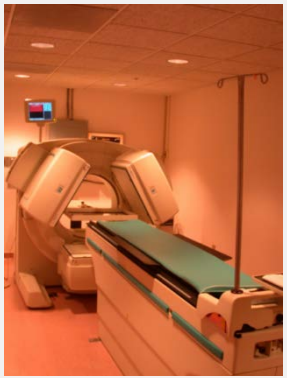
Examples of Instruments for Use in Direct Bioassay

- **Field Instruments**
  - **Portable Hand-held instruments**
  - **Portal monitors**



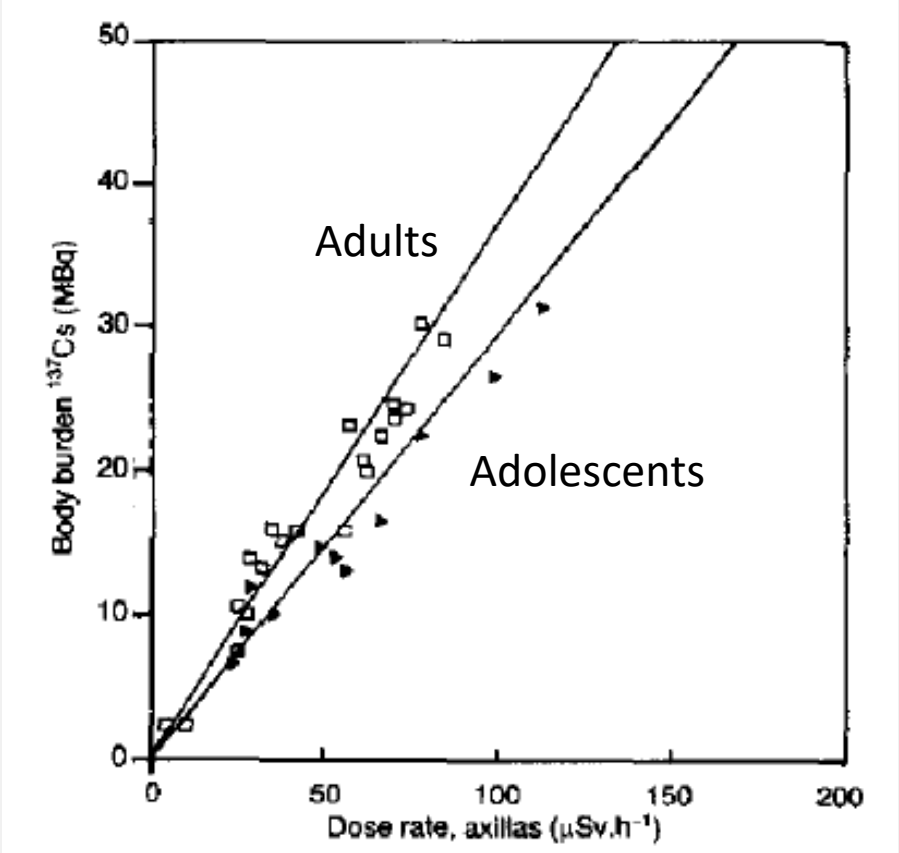


- **Hospital instruments**
  - **Thyroid Scanners**
  - **Gamma Cameras**




Example of Direct Bioassay: Goiania Patients

- Correlation for axilla measurements
- Adults
  - 20-60 years
  - 66 kg average weight
- Adolescents
  - 13-15 years
  - 41 kg average weight

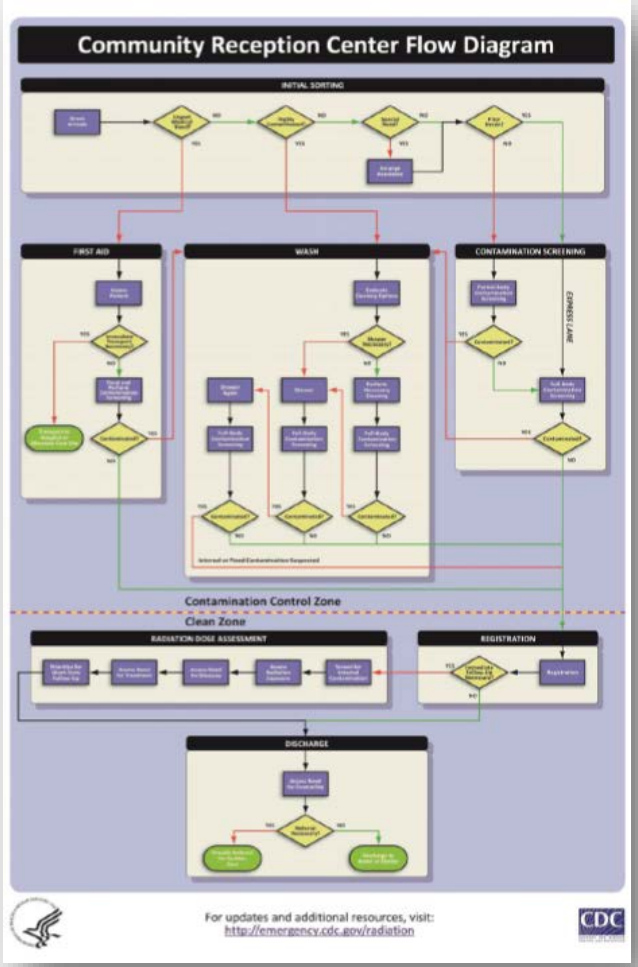


Hunt and Nogueira de Oliveira, 1990. *Radiat Prot Dosimetry* 30(4):275-77

Community Reception Center (CRC)

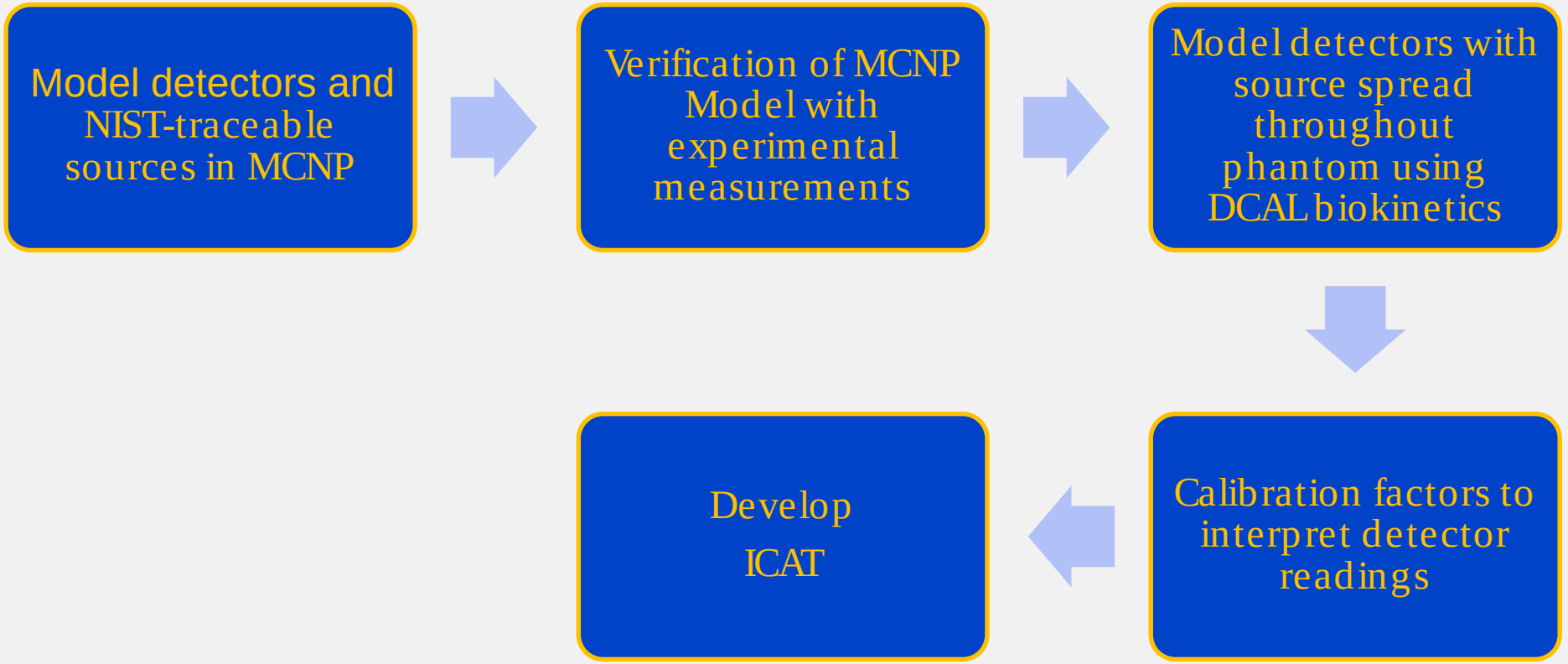
- Place where population is directed after a radiological incident to receive screening, decontamination, and other services

- Services include:
  - First Aid
  - Contamination screening
  - Wash (Decon)
  - **Dose Assessment**
    - includes triage for internal contamination
  - Registration



Population Monitoring in Radiation Emergencies: A Guide for State and Local Public Health Planners, Second Edition. 2014, 10 May. 2016 http://emergency.cdc.gov/radiation/pdf/population-monitoring-guide.pdf

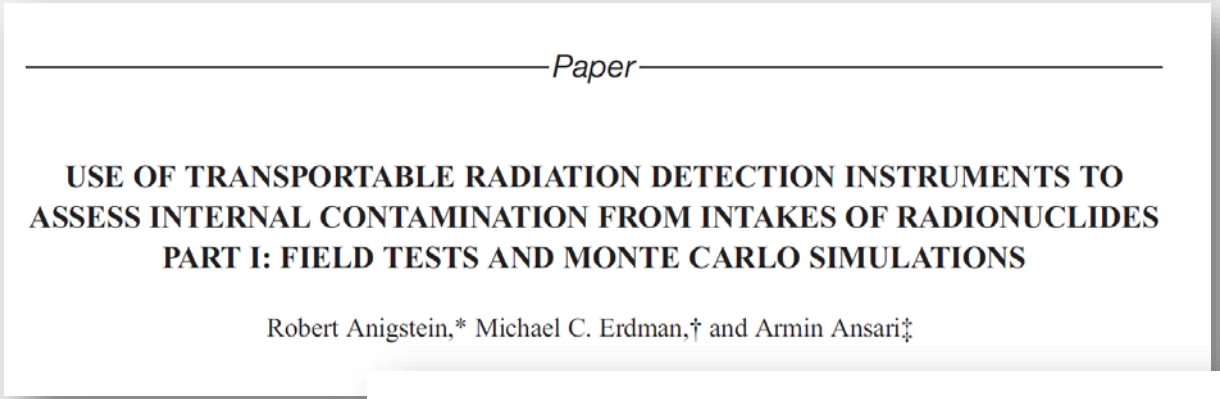
Overview of Methodology



Motivation for Developing ICAT (Internal Contamination Assessment Tool)

- **Need for simple, readily available way for rapid triage and prioritization of individuals suspected of internal contamination using field deployable instruments**

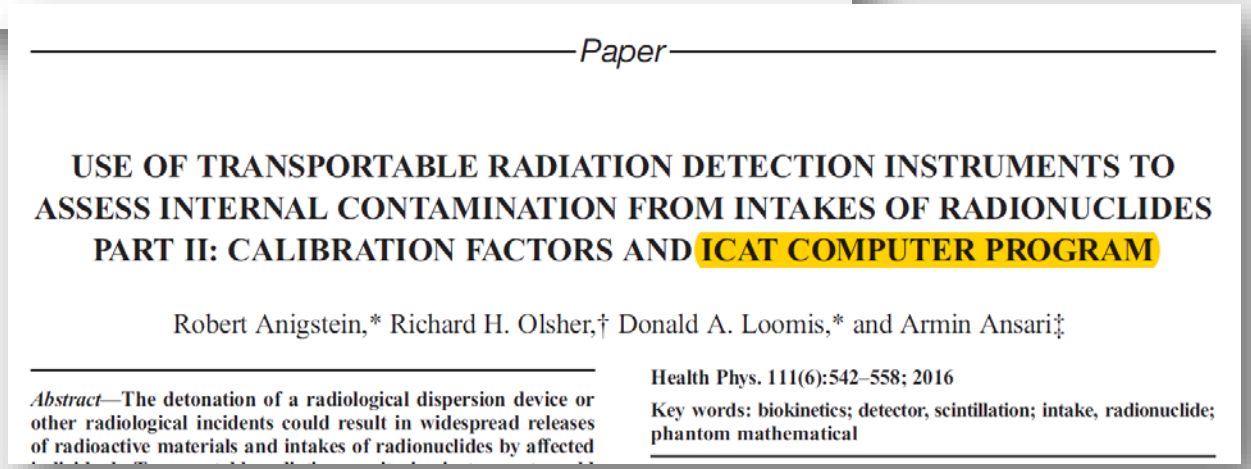
- **Create software that incorporates instrumentation data for easy use by responders**
  - Only applicable for gamma-emitters
  - Not a substitute for laboratory bioassay



Paper

USE OF TRANSPORTABLE RADIATION DETECTION INSTRUMENTS TO ASSESS INTERNAL CONTAMINATION FROM INTAKES OF RADIONUCLIDES PART I: FIELD TESTS AND MONTE CARLO SIMULATIONS

Robert Anigstein,* Michael C. Erdman,† and Armin Ansari‡



Paper

USE OF TRANSPORTABLE RADIATION DETECTION INSTRUMENTS TO ASSESS INTERNAL CONTAMINATION FROM INTAKES OF RADIONUCLIDES PART II: CALIBRATION FACTORS AND ICAT COMPUTER PROGRAM

Robert Anigstein,* Richard H. Olsher,† Donald A. Loomis,* and Armin Ansari‡

Abstract—The detonation of a radiological dispersion device or other radiological incidents could result in widespread releases of radioactive materials and intakes of radionuclides by affected

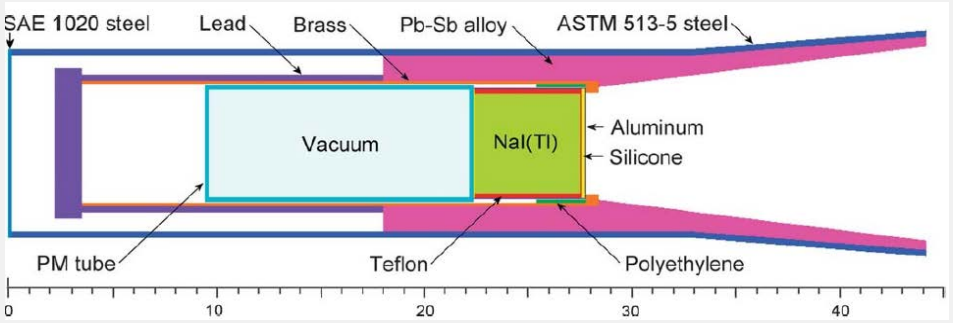
Health Phys. 111(6):542–558; 2016

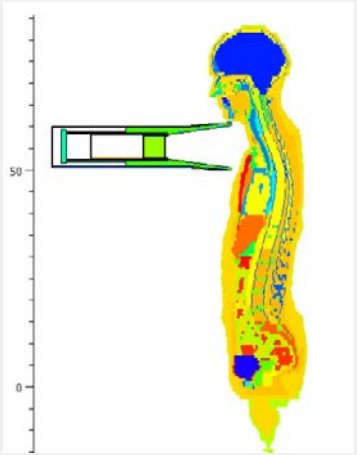
Key words: biokinetics; detector, scintillation; intake, radionuclide; phantom mathematical

Anigstein, R, Erdman MC, Ansari A, Use of transportable radiation detection instruments to assess internal contamination from intakes of radionuclides Part I: field tests and Monte Carlo simulations. *Health Phys* 110 (6):612-22, 2016.

Anigstein, R, Olsher RH, Loomis DA, Ansari A, Use of transportable radiation detection instruments to assess internal contamination from intakes of radionuclides Part II: calibration factors and ICAT computer program. *Health Phys* 111 (6):542-558, 2016.

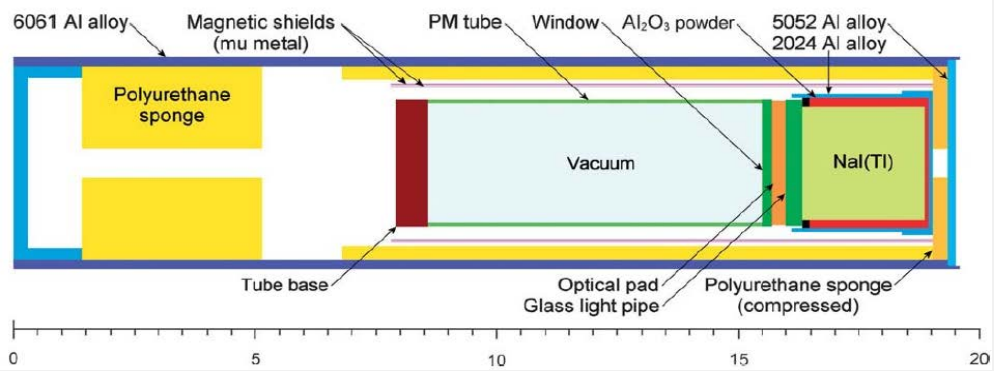
CAPTUS 3000 Model

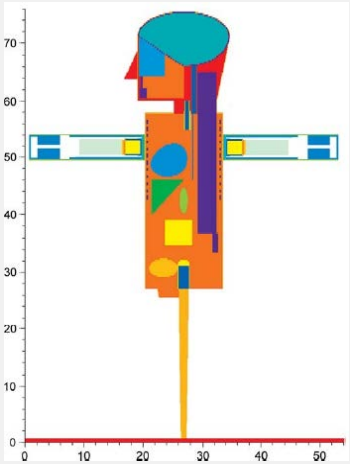




*Capintec, Inc. Captus 3000 Uptake Thyroid System. 2015. http://www.capintec.com/product/captus-3000-thyroid-uptake-system/. Accessed 19 June 2017.

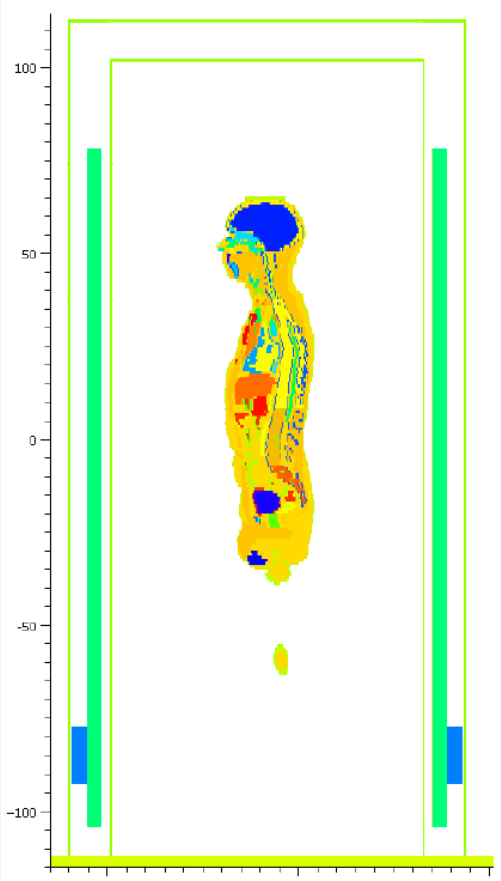
Ludlum 44-2 Model

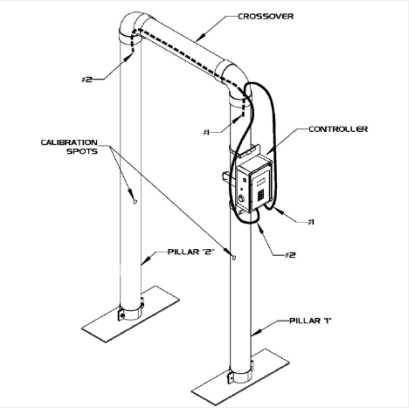


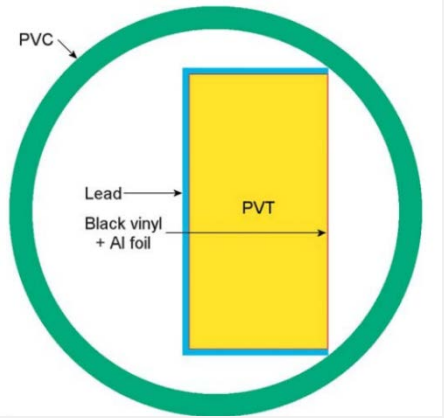


*Ludlum Measurements, Inc. Ludlum Model 44-2 gamma scintillator[online]. 2014. http://ludlums.com/images/stories/Product_manuals/M44-2.pdf. Accessed 19 June 2017.

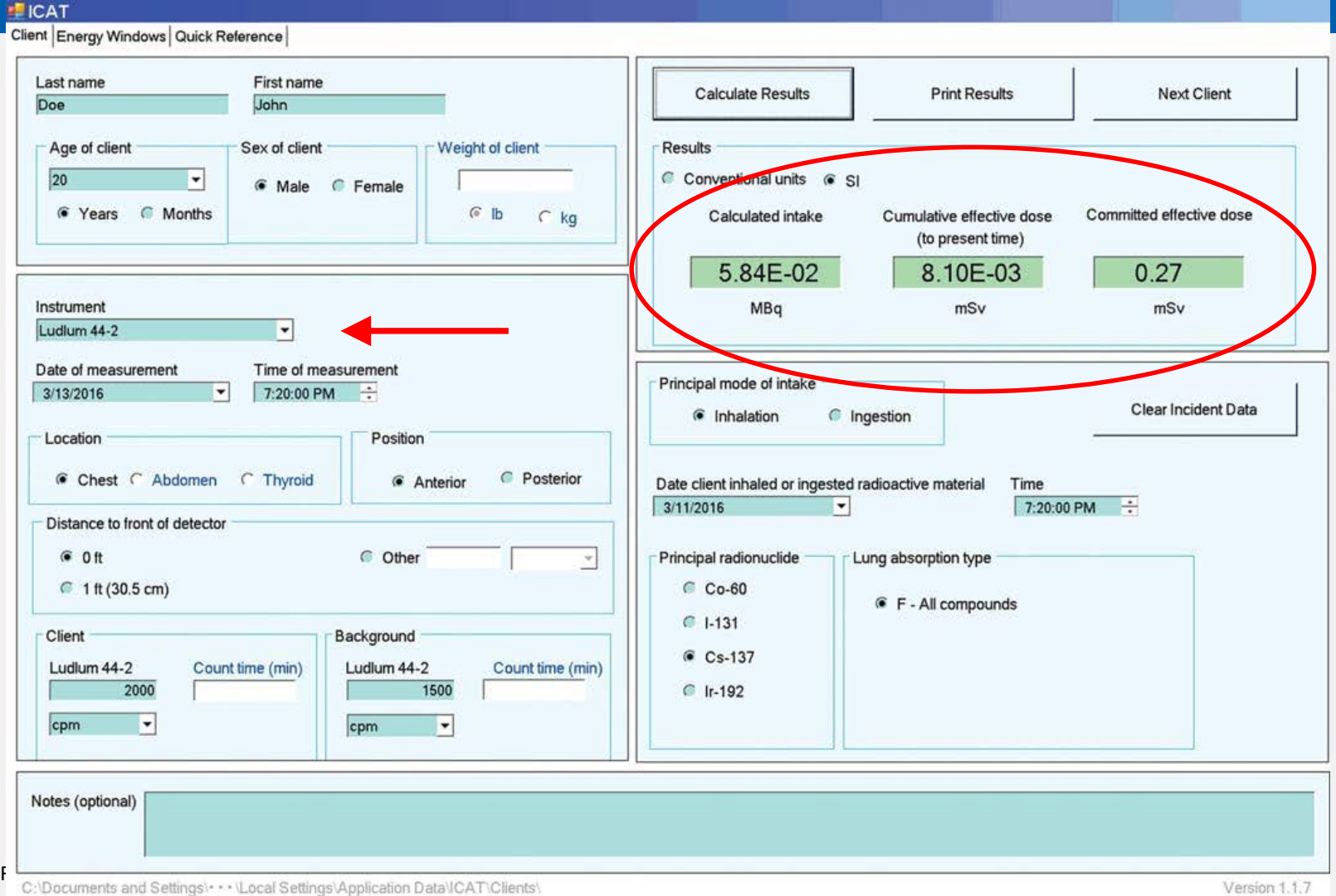
TPM-903B Model





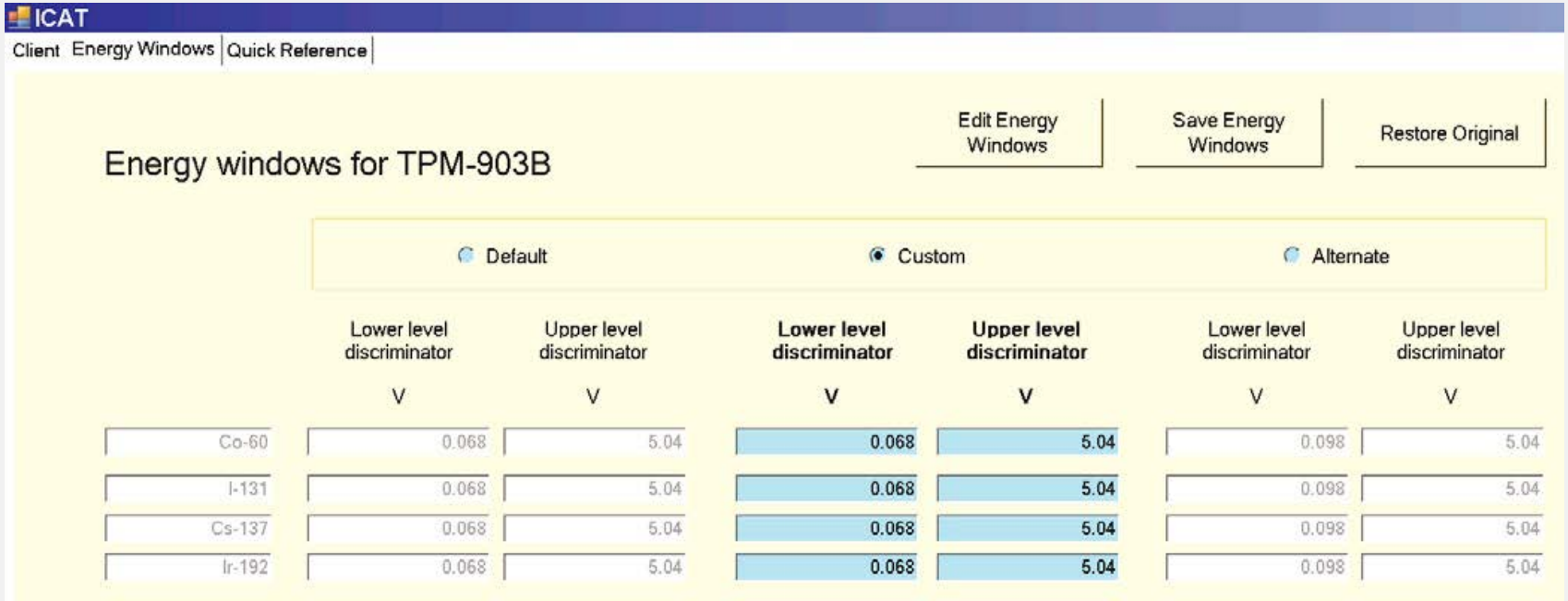


*TSA Systems, Ltd. Transportable portal monitor model TPM-903B: operating and service manual, Doc. #5003 Rev. A [online]. 2006. www.laurussystems.com/Service/TPM-903BUser-Guide092009.pdf. Accessed 19 June 2017.



Anigstein et al. *Health Phys* 111 (6):542-558, 2016.

Anigstein et al. *Health Phys* 111 (6):542-558, 2016.



https://emergency.cdc.gov/radiation/clinicians/evaluation/index.asp

CDC's Urine Radionuclide Screen

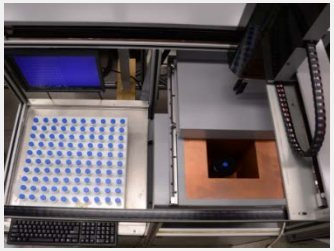
Urine "Spot" Sample

Gamma Radionuclide Screen

Alpha/Beta Radionuclide Screen/Quantification

Alpha (Long Lived) ICP-MS Screen

Gamma Spectroscopy Quantification



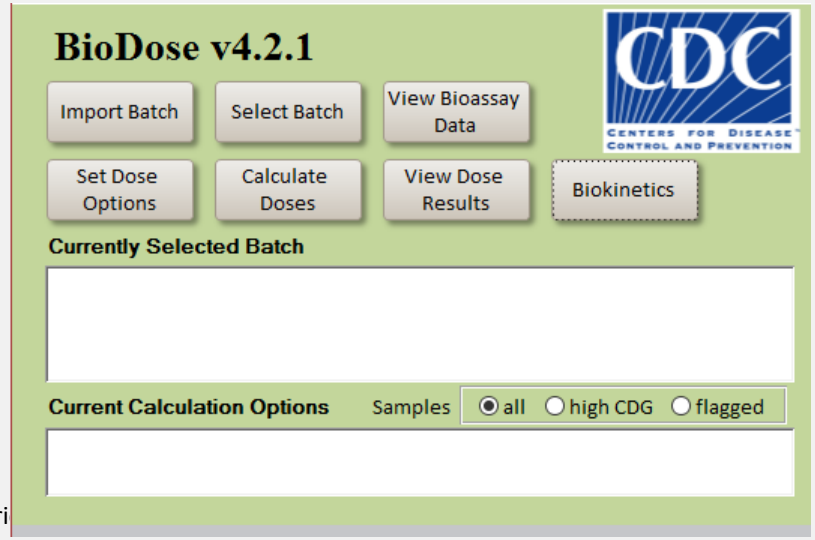
Alpha Spectroscopy Quantification

Mass Spectrometry Quantification

High Resolution Mass Spectrometry Quantification

Internal Dose Calculation for Large Batch of Urine Bioassay Results

Sample Matrix	Matrix Qualifier	Sample Volume (ml)	Laboratory Sample ID	Local Sample ID	Analytical Result	Units	Creatinine Corrected Result	Creatinine Corrected Units	LOD (pCi/L)	Uncertainty	Volume Corr	Volume-Corrected units	First Name	Last Name	DOB MM/DD/YYYY	Age (years)	Gender	Height (cm)	Weight (Kg)
Urine	Spot	200	08-901-000001-4RA	CHE2018000001	3.39E+01	Bq/L	3.39E+01	Bq/gCr	4.20E+04			Bq/L				10	M		
Urine	Spot	200	08-901-000002-4RA	CHE2018000012	3.39E+01	Bq/L	3.39E+01	Bq/gCr	4.20E+04			Bq/L				10	M		
Urine	Spot	200	08-901-000003-4RA	CHE2018000022	3.54E+01	Bq/L	3.54E+01	Bq/gCr	4.20E+04			Bq/L				10	M		
Urine	Spot	200	08-901-000004-4RA	CHE2018000032	3.54E+01	Bq/L	3.54E+01	Bq/gCr	4.20E+04			Bq/L				10	M		
Urine	Spot	200	08-901-000005-4RA	CHE2018000042	3.39E+01	Bq/L	3.39E+01	Bq/gCr	4.20E+04			Bq/L				10	M		
Urine	Spot	200	08-901-000006-4RA	CHE2018000052	3.54E+01	Bq/L	3.54E+01	Bq/gCr	4.20E+04			Bq/L				10	M		



Laboratory Sample Id 08-901-000006-4RA
BioDose - 8/8/2018 6:53:02 AM

Intake

Intake Date	7/8/2018 10:15:00 AM
Route	wound
I131 activity	100%

Person involved

Sex	M
Weight	not given
Height	not given
Age Group	10y (reported age 10 years)

Bioassay Data

Sample Date	7/10/2018 10:15:00 AM
Time from Intake	2 days
Nuclide	I131
Type	Spot Urine
Reported Result	3.535E+01 Bq/L
Result (Urine24H)	2.475E+01 Bq (see calculation details at end)
CDG	5.020E+04 Bq (Model used=WIN)

Definition of Dose

Type	Equivalent Dose (H)
Tissue	Thyroid
Time Period	60 years (21915 days) after intake

Dose Result

Intake	*Default dose (Sv)(model)*	*Min dose (Sv)(model)*	*Max dose (Sv)(model)*
I131	5.471E-04 (WIN)	5.471E-04 (WIN)	5.471E-04 (WIN)

Definitions In Calculation Section

IRF	Intake retention fraction for bioassay type (from Biokinetic table)
dose coefficient	Coefficient from Biokinetic table for dose type, tissue and time period * See end of Comments section (Biokinetic Tables Used) for values
const extrapolate	#days exceeds max days in table, use value for max days

Detail Calculation

Thank you!

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For more information, contact NCEH
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov
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