Updates on the National Radiation Bioassay Program at CDC

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June 2, 2014

APHL 2104 National Meeting

National Center for Environmental Health

Division of Laboratory Sciences

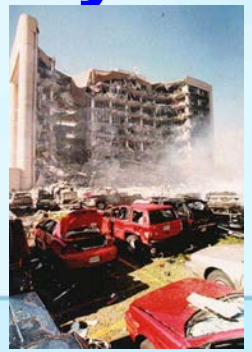
Disclosure

Mention of company or product names does not constitute endorsement by the National Center for Environmental Health (NCEH), Centers for Disease Control (CDC), or the Public Health Service.

Potential Radiological or Nuclear Incidents

- Nuclear
  - Damaged nuclear facility
  - Improvised nuclear device
  - Nuclear weapon

- Radiological
  - Radiological dispersion device (RDD); e.g.,“Dirty bomb”



Radiation Diagnostics

- Radiation **Exposure**: A person is "exposed" to radioactive materials through
  - gamma irritation (external only e.g. IND blast)
  - "exposure" to alpha, beta or gamma radiation from external or internal contamination (RDD or IND fallout).

- Radiation **Contamination**: A person is "contaminated" **internally** with **radioactive materials** via inhalation or ingestion.

Both "exposure" and "contamination" results in an exposure dose.

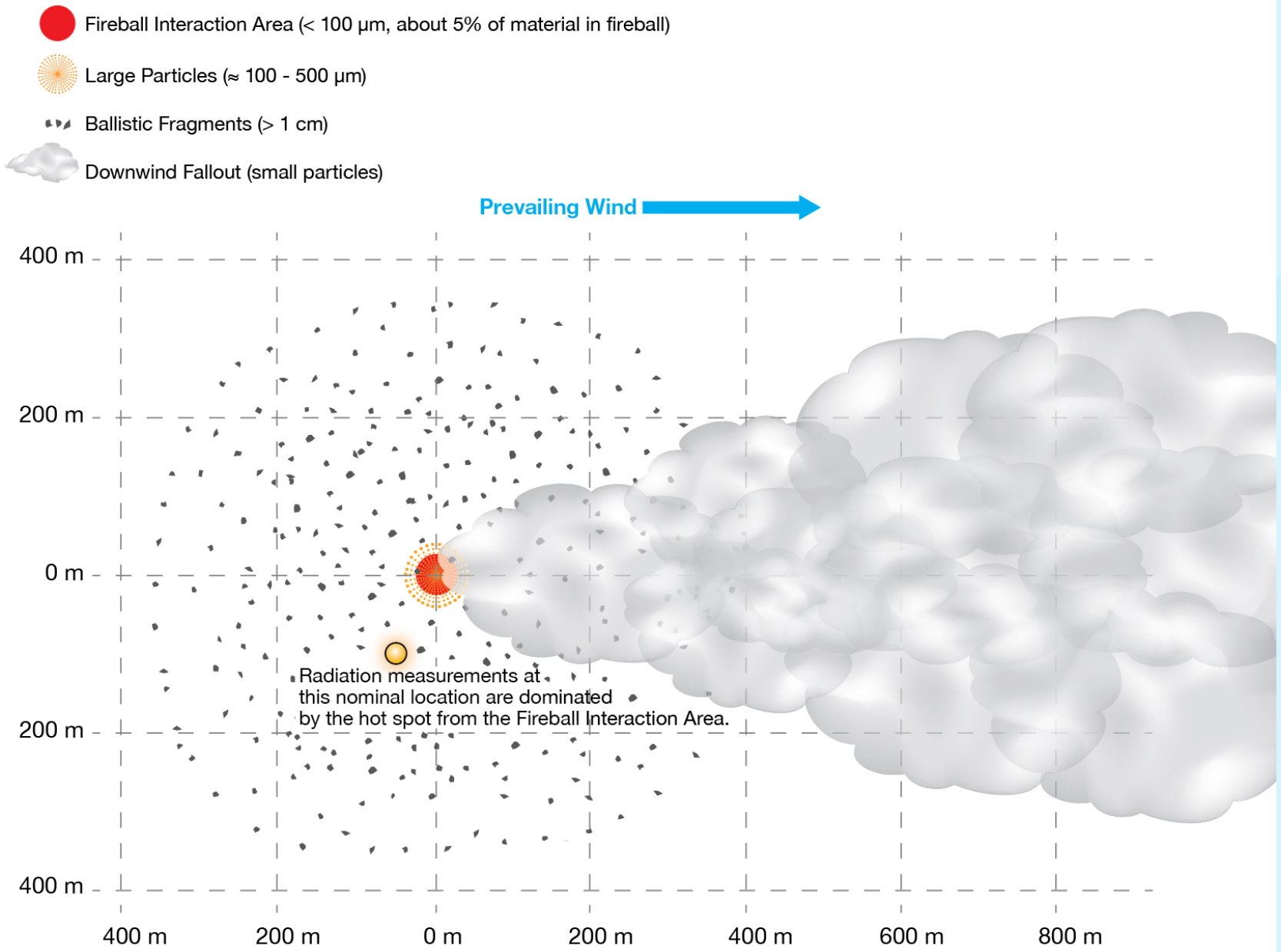
The Boston Marathon 2013

What if,

It had been an RDD

("Dirty Bomb")?

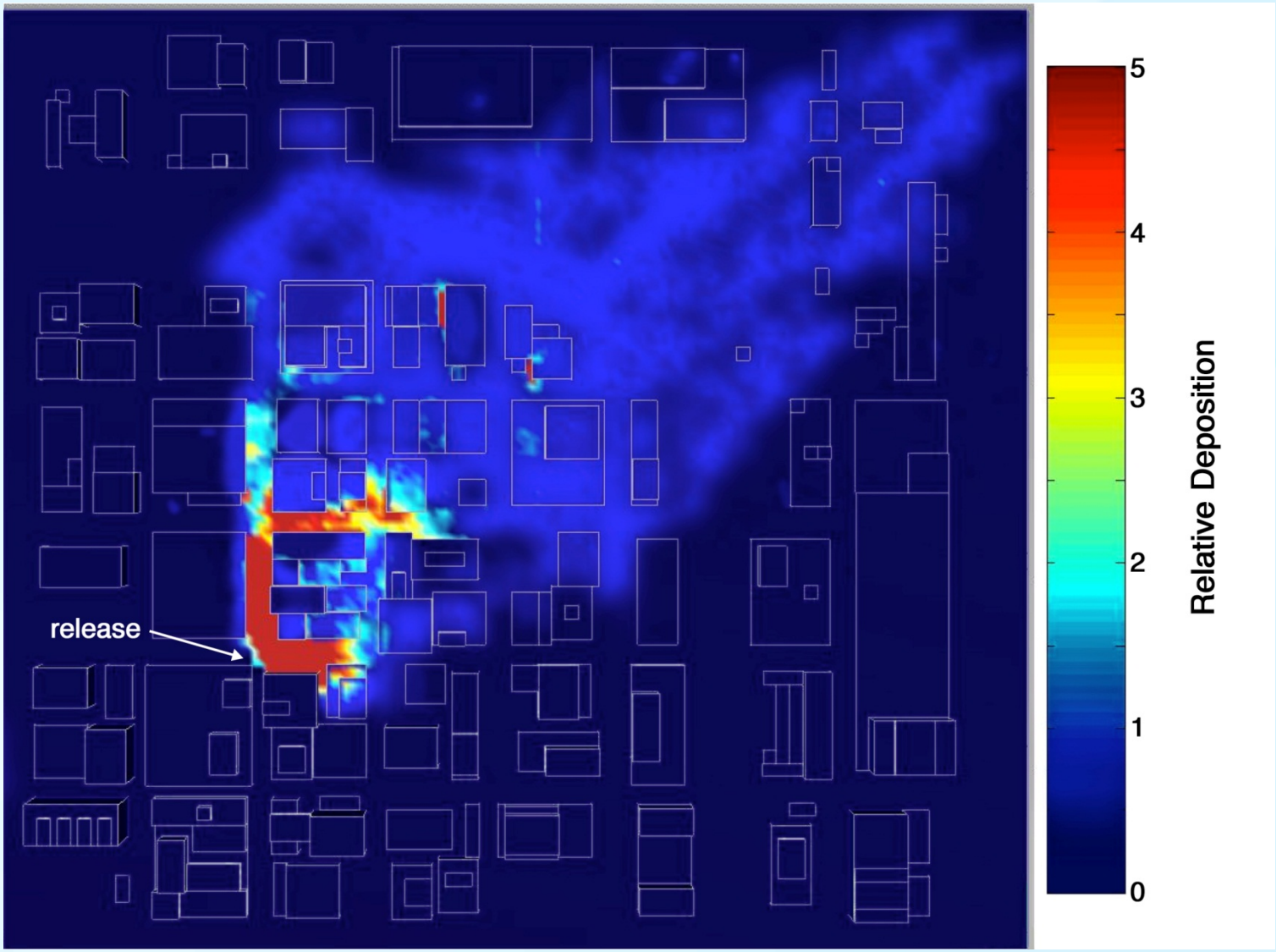
Dispersal Pattern



Musolino, et.al., Health Physics, 2013, Volume 105, pages 65-73.

Michael Brown, LANL

Was it a Widespread Dispersal?



Musolino, et.al., Health Physics, 2013, Volume 105, pages 65-73.

Examples of Mass Screening/Analysis

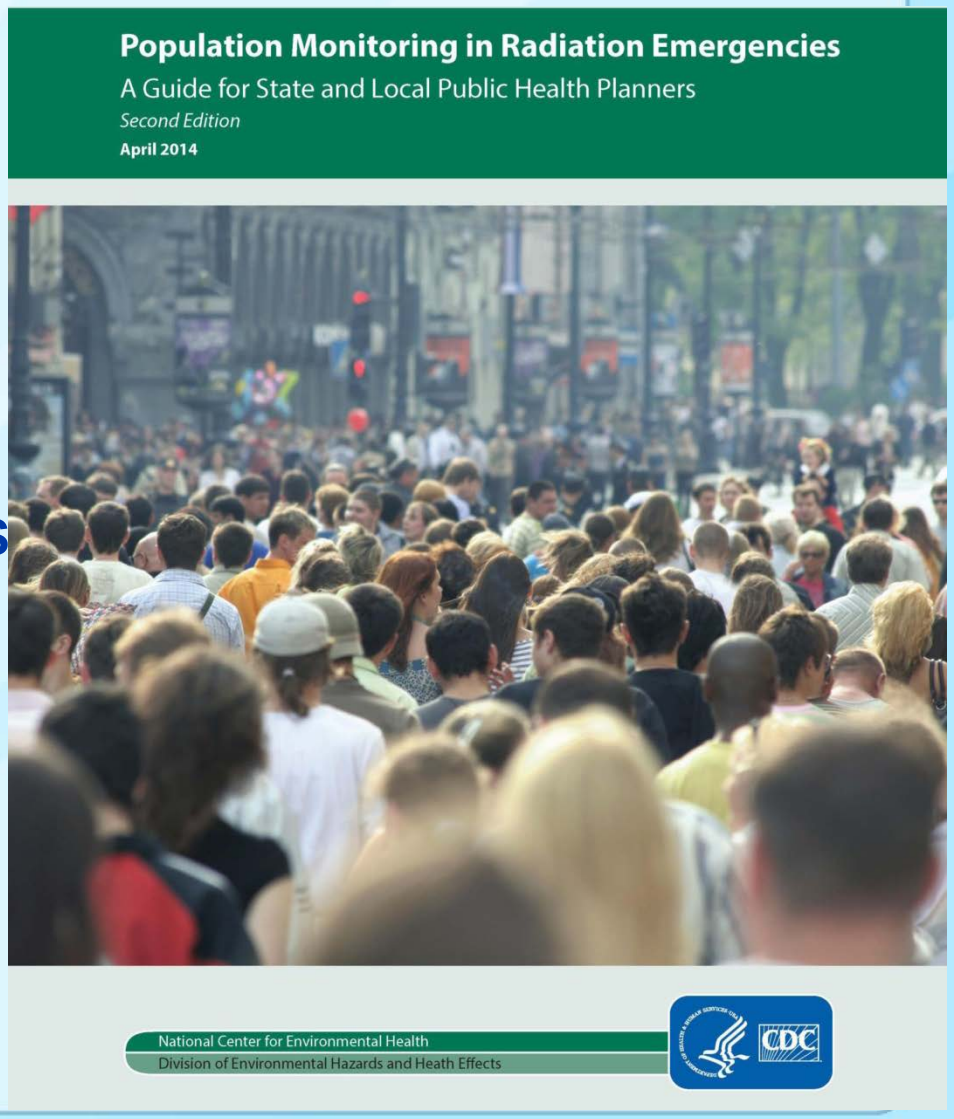
- 1987 Goiania – ^{137}Cs - **112,000** tests
- 1995-1996 U.S. Methyl parathion – **16,000** tests
- 2001-2002 U.S. Anthrax (clinical) - **250,000** tests
- 2001-2002 U.S. Anthrax (environmental) – **1,000,000**
- 2005 NV Mercury exposure – **280** tested
- 2006 London - ^{210}Po - **800** tested

Concerned Citizen Multiplier

- 1987 Goiania – ^{137}Cs – 50 treated / 112,000 tested = **2240 "concerned citizen multiplier" (CCM)**
- 1995-1996 U.S. Methyl parathion – **16,000 CCM**
- 2001-2002 U.S. Anthrax (clinical) – 30 casualties or infected / 250,000 tests = **8,500 CCM**
- 2005 NV Mercury exposure – 1 contaminated /280 tested = **280 CCM**
- 2006 London - ^{210}Po –1 casualty / 800 tested = **800 CCM**

CDC Guidance on Population Monitoring

- Target audience:
  - State and local public health and emergency preparedness personnel
- Focus:
  - Terrorism incidents involving mass casualties
- Scope:
  - Assumes local infrastructure is intact
  - Principles apply to all radiation incidents
- Updated April 2014



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

Bioassay: Key Issue
Detection of Internal Contamination

Radionuclides	Urine bioassay detection	Primary radiation detection
Uranium (^{235}U, ^{238}U), Thorium	yes	alpha and beta
Strontium, Plutonium (^{238}Pu, ^{239}Pu)	yes	
Americium, Californium, Neptunium,	yes	
Phosphorus, Curium, Polonium	yes	
Cesium, Cobalt (^{57}Co, ^{60}Co), Radium	yes	Gamma rays
Iodine (^{125}I, ^{131}I), Technetium-99m	yes	
Selenium, Molybdenum, Iridium	yes	

Internal radiation screening via hand held detectors or portals is only applicable for gamma emitting radionuclides.

Radionuclides of concern can be found at:
www-pub.iaea.org/MTCD/publications/PDF/Pub1309_web.pdf
www.energy.gov/media/RDDRPTF14MAYa.pdfc

The "Grand Rounds" presentation and slides can be found at:
www.cdc.gov/about/grand-rounds/archives/2010/03-March.htm

Examples of Contamination Triage Testing for Alpha Emitters

External Testing:
Alpha/Beta/Gamma Emitters
Pre-Decon

External
(Alpha/Beta/Gamma)
Internal
(Gamma only)
Testing:
Post-Decon

External
(Alpha/Beta/Gamma)
Testing

External/Internal
(Gamma only)
Testing

CDC's Urine Radionuclide Screen

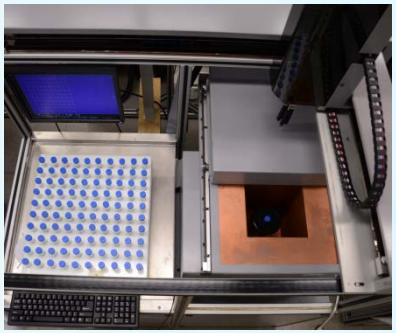
Urine "Spot" Sample

Gamma Radionuclide Screen

Alpha/Beta Radionuclide Screen/Quantification

Alpha (Long Lived) ICP-MS Screen

Gamma Spectrometry Quantification

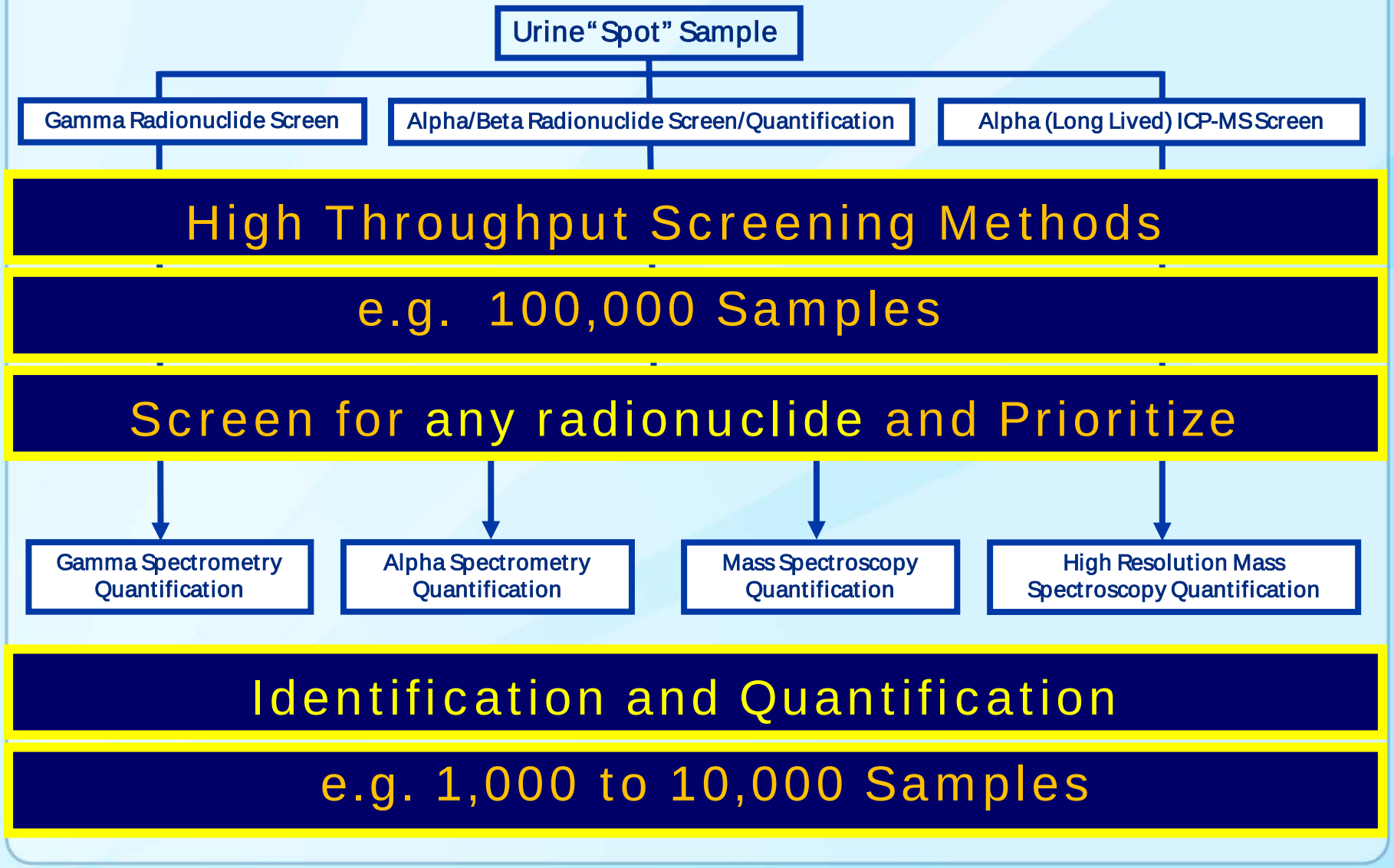


Alpha Spectrometry Quantification

Mass Spectroscopy Quantification

High Resolution Mass Spectroscopy Quantification

CDC's Urine Radionuclide Screen



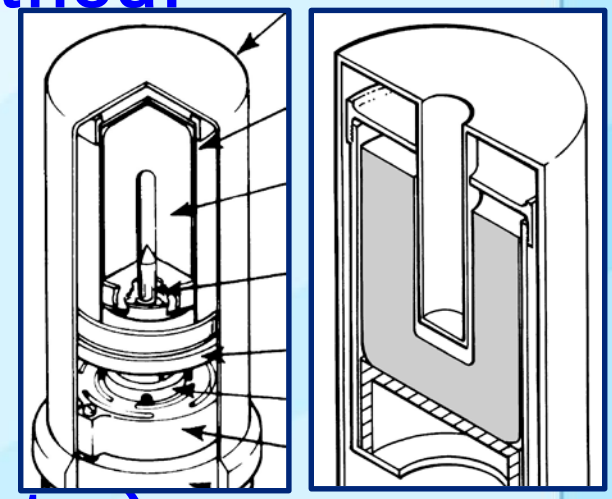
CDC Radiation Lab Updates

- Analytical methods for 14 of the 22 Priority radionuclides have been developed
- Refining and enhancing current methods
  (e.g. Sr-90, Pu-239)
- Additional methods being developed for:
  - Np-237 via Q-ICP-MS
  - Ra-226 via HR-ICP-MS
  - Se-75 via Gamma Spec. (HPGe)
  - Po-210 via Alpha Spec

CDC Radiation Lab Updates

Automation for NaI Gamma Spec method:

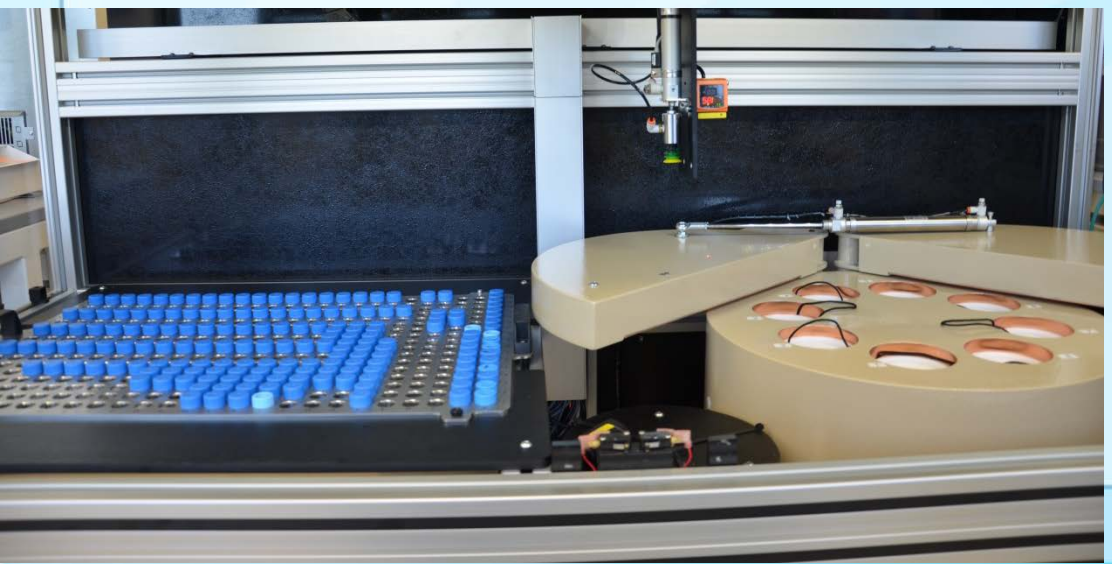
425 - 10mL vials

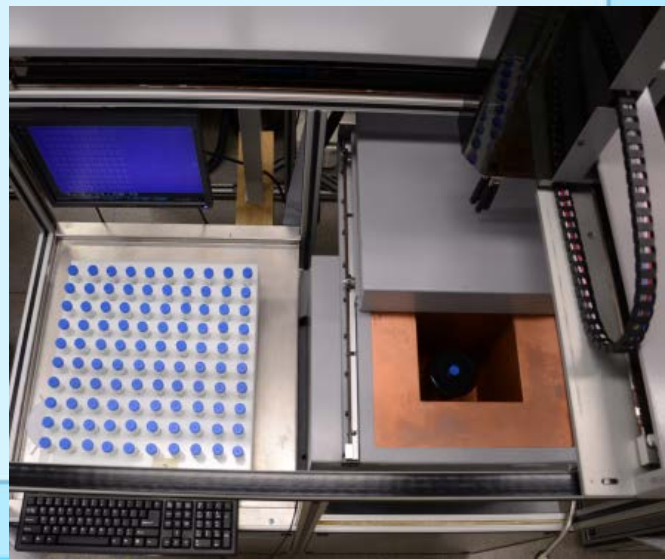


Automation for HPGe Autosamplers:

100 - 10mL vials (well detector)

49 - 50mL urine cups (coaxial detector)





HPGe Detector LODs

Detector Type	Co-57	Cs-137	Co-60	Ir-192
Small Coaxial*	36	35	41	66
Large Coaxial*	44	28	28	58
Well**	31	16	17	59

All LODs are in Bq/L

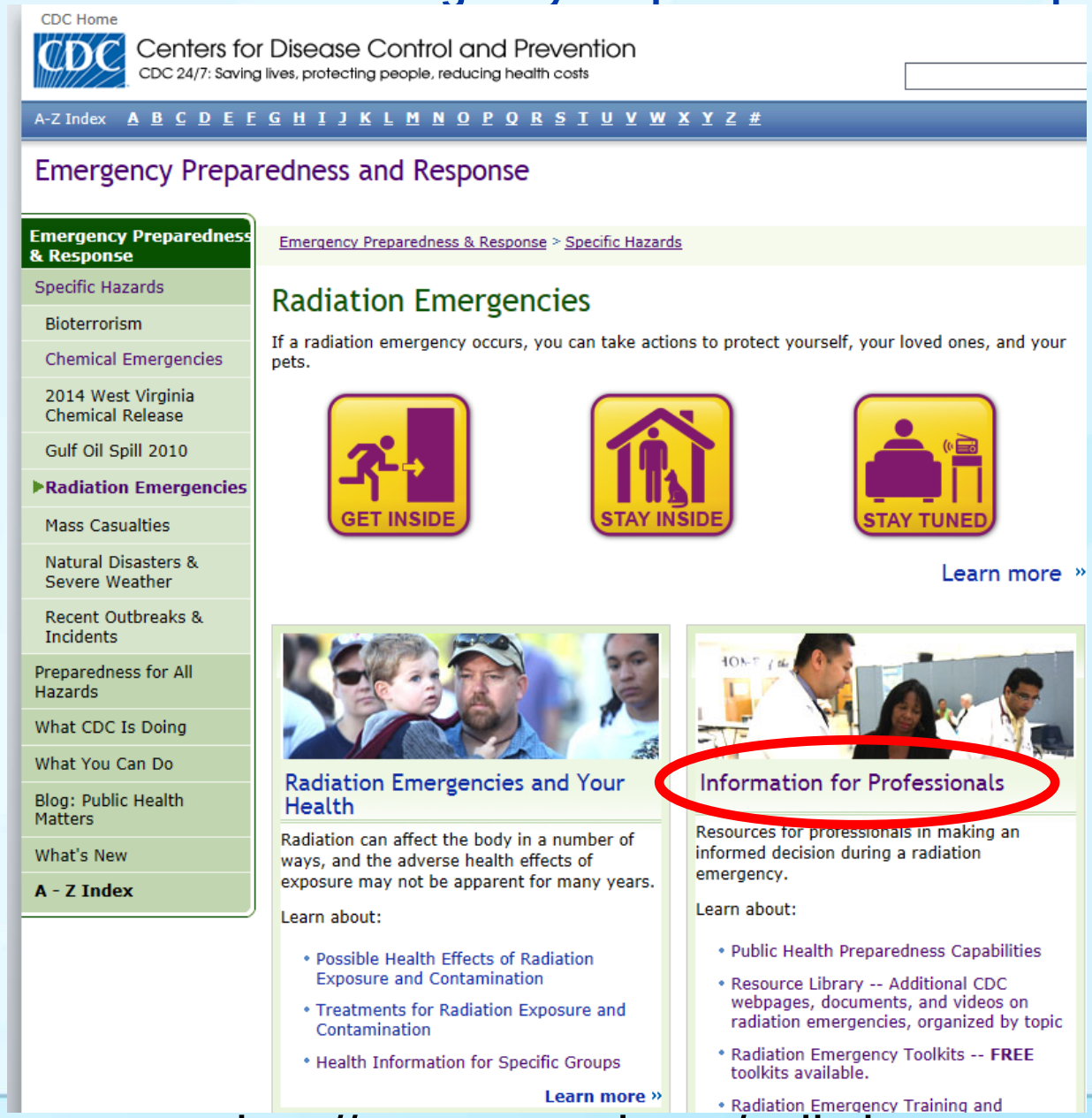
10 mL geometries: * 10mL in a 120mL urine cup

** 10mL in a 15mL tube

Small = ~85%, Large = ~180%, Well ~ 130% relative efficiency (based on size)

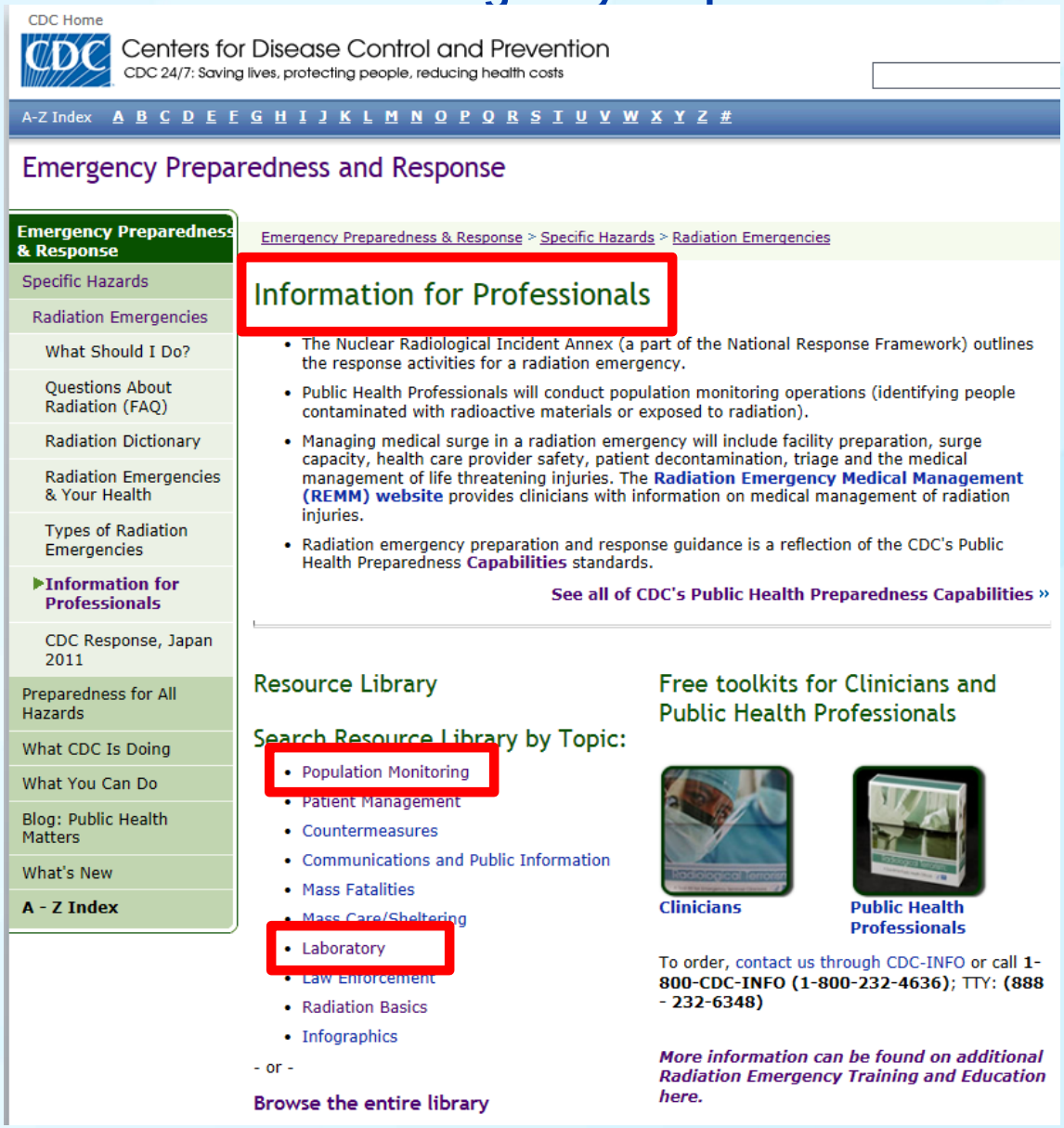
Small: 330cc, Large: 730cc, Well: 520 cc (with 4 pi collection geometry)

CDC Web site for Emergency Preparedness and Response



http://emergency.cdc.gov/radiation

CDC Web site for Radiation Emergency Preparedness and Response



http://emergency.cdc.gov/radiation/professionals.asp

CDC Web site for Radiation Emergency Preparedness and Response

- Preparedness for All Hazards
- What CDC Is Doing
- What You Can Do
- Blog: Public Health Matters
- What's New
- **A - Z Index**

Decision Guide (CDG) for each radionuclide. The application can be downloaded here.			
The United States Nuclear Regulatory Commission: Multi-Agency Radiological Laboratory Analytical Protocols Manual The Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) manual provides guidance for the planning, implementation, and assessment of projects that require the laboratory analysis of radionuclides. MARLAP's basic goal is to provide guidance for project planners, managers, and laboratory personnel to ensure that radioanalytical laboratory data will meet a project's or program's data requirements.	NRC	Website	Clinicians, Public Health Professionals, Medical examiners
Radiological/Nuclear Law Enforcement and Public Health Investigation Handbook - September, 2011 This handbook serves to introduce RN LE and PH investigations , identify potential barriers and solutions that LE and PH personnel will encounter during their investigations and enhance appreciation across each discipline.	CDC	PDF	Public Health Professionals
Centers for Disease Control and Prevention (CDC) Shipping Instructions for Specimens Collected from People Who May Have Been Exposed to Radiological/Nuclear Terrorism Agents Instructions detailing how to ship specimens to the CDC of those who may have been exposed to radiological/nuclear terrorism agents.	CDC	PDF	Clinicians, Public health professionals
Flowchart: Instructions for Shipping Urine Specimens to Centers for Disease Control and Prevention (CDC) After a Radiological/Nuclear Exposure Event A flowchart detailing how to ship urine specimens to the CDC after a radiological/nuclear emergency.	CDC	PDF	Clinicians, Public health professionals
Flowchart: Centers for Disease Control and Prevention Specimen-Collection Protocol for a Radiological/Nuclear-Exposure Event A flowchart detailing how to collect urine specimens after a radiological/nuclear emergency.	CDC	PDF	Clinicians, Public health professionals
Radiological/Nuclear Terrorism Urine Specimen Collection and Shipping Manifest A form for specimen collection and shipping to the Centers for Disease Control and Prevention after a radiological/nuclear emergency.	CDC	PDF	Clinicians, Public health professionals

http://emergency.cdc.gov/radiation/resourcelibrary/lab.asp

Radiological Incident Impact

- Loss of life
- Acute radiation exposure
- Potential future cancer risk
- Psychosocial issues
- Economic impact, including area denial (due to contamination)
- Increased anxiety among citizens

Summary

- Radiation Laboratory Methods (bioassay): rapidly identify and quantify specific radionuclides in people potentially contaminated in a radiological or nuclear event.
- Provides critical information for effective medical management of individuals by assessing risk for medical management and follow-up
- Provides information for population monitoring (populations and population sub-groups)
- Provides "negative" results for people who think that they may be contaminated, but, are not truly contaminated.

What can you do to be prepared and respond to a radiological incident?

- Be prepared for a radiological or nuclear incident with pre-planning
- People's contamination to radionuclides (or radiation) can be minimized (time, distance, shielding, PPE, etc.)
- People's external contamination can be reduced via decontamination procedures
- People's contamination can be rapidly evaluated for external and internal contamination
- Medical management guidelines and some medical countermeasures for the treatment of internal contamination of people are available for the medical community to use
- Prepare for the people's psychosocial and anxiety issues
- Have a communications plan

Acknowledgements

- David Saunders, PhD
- Olga Piraner, PhD
- Ge Xiao, PhD
- Shannon Sullivan, MS
- Kathleen Caldwell, PhD
- Kameswara Voleti, PhD
- Youngzhong Liu, PhD
- Rebecca Hunt, MS
- Carl Verdon, PhD

- Los Alamos National Labs
- Sandia National Labs
- Savannah River National Labs
- Argonne National Labs
- FDA, EPA, NIST, DOD, DOE

Questions and Discussions

Thank you

For more information please contact
Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA 30333
Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov Web: http://www.cdc.gov

For more information please contact Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA 30333
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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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"The findings and conclusions in this presentation have not been formally disseminated by the Centers for Disease Control and Prevention/the Agency for Toxic Substances and Disease Registry and should not be construed to represent any agency determination or policy."

Supplemental

and

Backup slides

Radiation Diagnostics

- **Biodosimetry**: Use of clinical and laboratory observations to estimate radiation dose received after radiation exposure. (**BARDA method R&D**) *Most effective for estimating injury due to **irradiation** [shine] (IND, RED or NPP).*
- **Bioassay**: Any procedure used to determine the nature, location or retention of radionuclides in the body (*contamination*) by direct (*in vivo*) measurement or by **indirect (*in vitro*) analysis of material excreted or otherwise removed from the body (CDC methods)**. Generally used for the purpose of estimating intake and committed dose. *Most effective for estimating injury due to **inhalation or ingestion** after a RDD, IND or NPP fallout.*

NCRP 166: Population Monitoring and Radionuclide Decorporation Following a Radiological or Nuclear Incident

Rapid Radionuclide Bioassay analytical methods: traditional versus new methods

	"Traditional" Radionuclide methods: DOE	New "Rapid" methods: CDC
Time to first analytical results for 40 samples	About 3-6 ***days***	Less than **24 *hours***
Sample Requirements	***24 hour*** collection	"***spot***" collection
Sample Size Requirement	1 -2 **L**	70 **mL**
Number of radionuclides with validated clinical methods	Limited to contract with DOE Bioassay lab	22 + "fission products" (14 current)
Sample throughput	**10-20** samples per day	**250 -3000 samples** per day
CLIA Certified Methods	no	yes
Scalable for "Surge Capacity"	minimal	yes

Integrated Consortium of Laboratory Networks (ICLN)

National Radioanalytical Laboratory Incident Response

Radiological Laboratory Response- Limiting Issues

http://www.aphl.org/MRC/Documents/EH_2011Oct_Laboratory-Logistics-Limiting-Issues.pdf

Guidance for Gross Radioactivity Screening of "Unknown" Samples

for Non-Radiological Laboratories