### Updates on the National Radiation Bioassay Program at CDC

### Robert L. Jones, PhD

Inorganic and Radiation Analytical Toxicology Branch

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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









## **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.

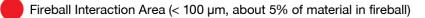
Both 'exposure' and 'contamination' results in an exposure <u>dose</u>.

## The Boston Marathon 2013

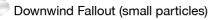
## What if,

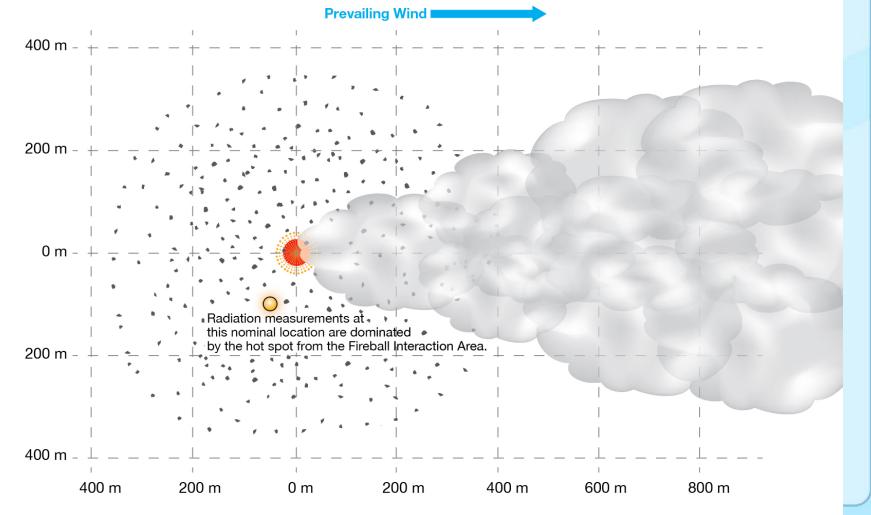
# It had been an RDD ("Dirty Bomb")?

#### **Dispersal Pattern**



- Large Particles (≈ 100 500 µm)
- Ballistic Fragments (> 1 cm)

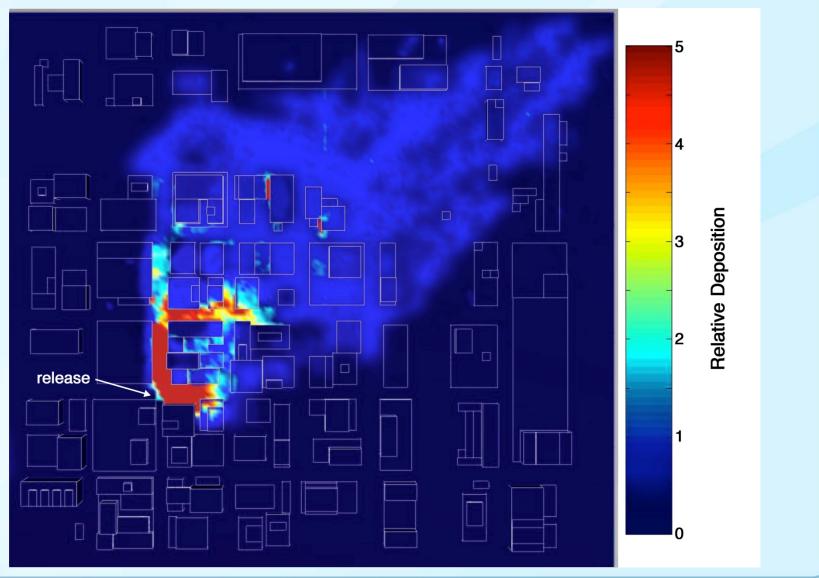




Musolino, et.al., Health Physics, 2013, Volume 105, pages 65-73.

Michael Brown, LANL

## Was it a Widespread Dispersal?



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

Michael Brown, LANL7

### Examples of Mass Screening/Analysis

- 1987 Goiania <sup>137</sup>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 <sup>210</sup>Po **800** tested

### **Concerned Citizen Multiplier**

- 1987 Goiania <sup>137</sup>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**

## **CDC Guidance on Population Monitoring**

April 2014

- 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

**Population Monitoring in Radiation Emergencies** A Guide for State and Local Public Health Planners *Second Edition* 







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

### Bioassay: Key Issue Detection of <u>Internal</u> Contamination

Radionuclides	Urine bioassay detection	Primary radiation detection	
Uranium ( <sup>235</sup> U, <sup>238</sup> U), Thorium	yes		
Strontium, Plutonium ( <sup>238</sup> Pu, <sup>239</sup> Pu) yes		alpha and	
Americium, Californium, Neptunium,	yes	beta	
Phosphorus, Curium, Polonium	yes		
Cesium, Cobalt ( <sup>57</sup> Co, <sup>60</sup> Co), Radium	yes		
lodine ( <sup>125</sup> I, <sup>131</sup> I), Technetium-99m	yes	Gamma	
Selenium, Molybdenum, Iridium	yes	rays	
Internal radiation screening via hand held detectors or portals is only applicable for gamma emitting radionuclides. adionuclides 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

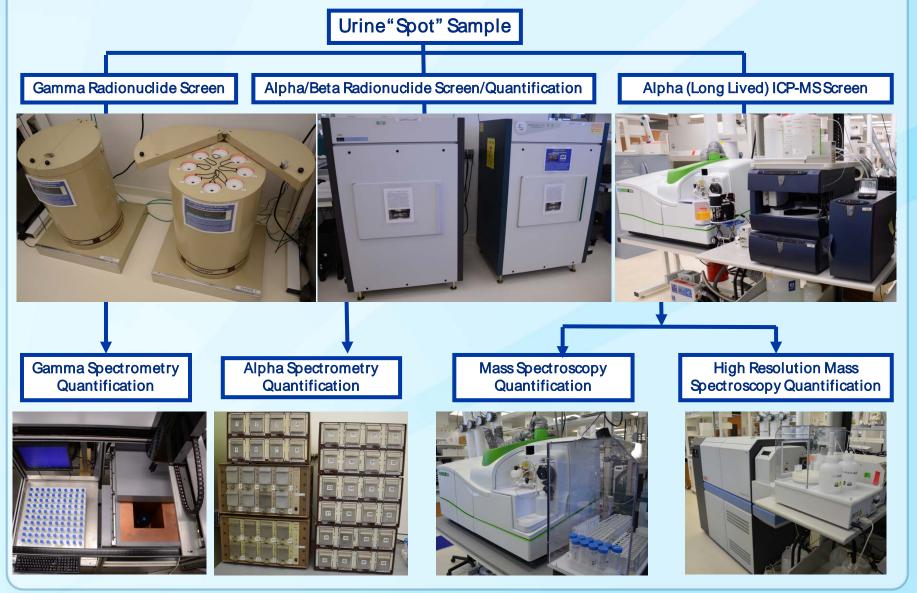


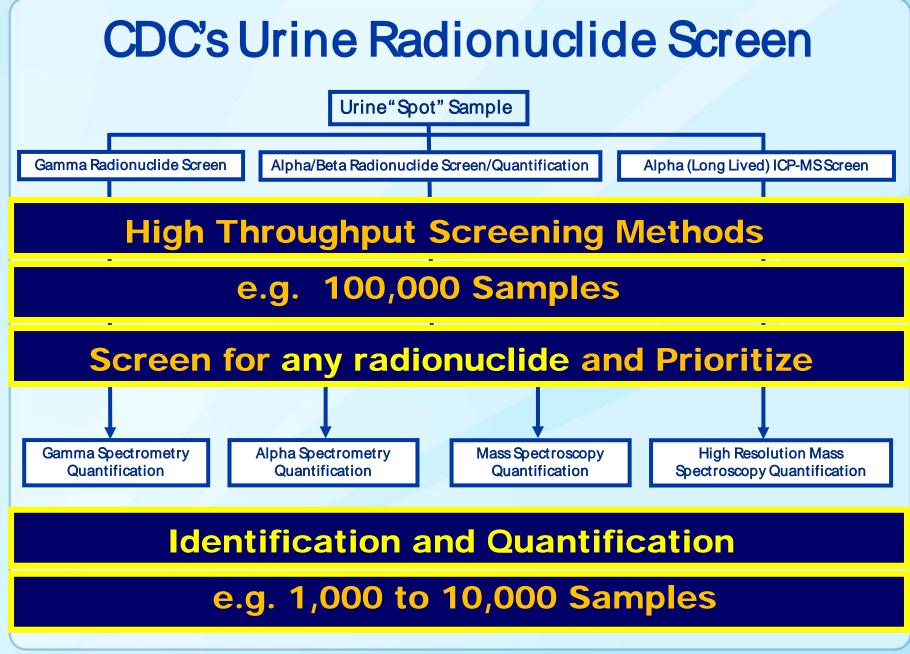
External (Alpha/Beta/Gamma) Testing



External/Internal (Gamma only) Testing

### CDC's Urine Radionuclide Screen





## **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

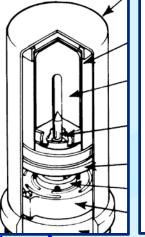
## CDC Radiation Lab Updates Automation for Nal Gamma Spec method:

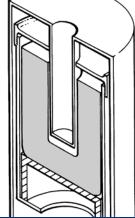
425 - 10mL vials

Automation for HPGe Autosamplers:

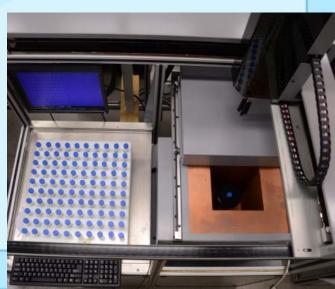
100 - 10mL vials (well detector)

49 - 50mL urine cups (coaxial detector)









## **HPGe Detector LODs**

Detector Type	<b>Co-57</b>	Cs-137	<b>Co-60</b>	lr-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

Centers for Disease Control and Prevention CDC 24/7: Saving lives, protecting people, reducing health costs

#### A-Z Index A B C D E F G H I J K L M N O P Q R S T U V W X Y Z #

#### **Emergency Preparedness and Response**

Emergency Preparedness & Response

#### Emergency Preparedness & Response > Specific Hazards

Specific Hazards

Bioterrorism

#### Radiation Emergencies

If a radiation emergency occurs, you can take actions to protect yourself, your loved ones, and your pets.

2014 West Virginia Chemical Release

Chemical Emergencies

Gulf Oil Spill 2010

Radiation Emergencies

Mass Casualties

Natural Disasters & Severe Weather

Recent Outbreaks & Incidents

Preparedness for All Hazards

What CDC Is Doing

What You Can Do

Blog: Public Health Matters

What's New

A - Z Index







Learn more »



#### **Radiation Emergencies and Your** Health

Radiation can affect the body in a number of ways, and the adverse health effects of exposure may not be apparent for many years.

Learn about:

- Possible Health Effects of Radiation Exposure and Contamination
- Treatments for Radiation Exposure and Contamination
- Health Information for Specific Groups



#### Information for Professionals

Resources for professionals in making an informed decision during a radiation emergency.

Learn about:

- Public Health Preparedness Capabilities
- Resource Library -- Additional CDC webpages, documents, and videos on radiation emergencies, organized by topic
- Radiation Emergency Toolkits -- FREE toolkits available.
- Learn more »

 Radiation Emergency Training and http://emergency.cdc.gov/radiation

#### CDC Web site for Radiation Emergency Preparedness and Response



Centers for Disease Control and Prevention CDC 24/7: Saving lives, protecting people, reducing health costs

#### A-Z Index ABCDEFGHIJKLMNOPQRSTUVWXYZ#

#### **Emergency Preparedness and Response**

Emergency Preparedness & Response	Emergency Preparedness & Response > Specific Hazard	ds > <u>Radiation Emergencies</u>	
Specific Hazards	Information for Professional	s	
Radiation Emergencies			
What Should I Do?	<ul> <li>The Nuclear Radiological Incident Annex (a part of the National Response Framework) outlines the response activities for a radiation emergency.</li> </ul>		
Questions About Radiation (FAQ)	<ul> <li>Public Health Professionals will conduct population monitoring operations (identifying people contaminated with radioactive materials or exposed to radiation).</li> </ul>		
Radiation Dictionary	Managing medical surge in a radiation emergency will include facility preparation, surge     constitute hashes provider cafety, patient decentermination, triage and the medical		
Radiation Emergencies & Your Health	capacity, health care provider safety, patient decontamination, triage and the medical management of life threatening injuries. The <b>Radiation Emergency Medical Management</b> ( <b>REMM</b> ) website provides clinicians with information on medical management of radiation		
Types of Radiation Emergencies	<ul> <li>injuries.</li> <li>Radiation emergency preparation and response guidance is a reflection of the CDC's Public Health Preparedness Capabilities standards.</li> </ul>		
Information for Professionals	See all of CDC's Public Health Preparedness Capabilities »		
CDC Response, Japan 2011			
Preparedness for All Hazards	Resource Library	Free toolkits for Clinicians and Public Health Professionals	
What CDC Is Doing	Search Resource Library by Topic:		
What You Can Do	Population Monitoring     Patient Management		
Blog: Public Health Matters	Countermeasures		
What's New	Communications and Public Information     Mass Fatalities	Naciological ferroren	
A - Z Index	Mass Care/Sheltering	Clinicians Public Health Professionals	
	Laboratory     Law Enforcement     Radiation Basics	To order, contact us through CDC-INFO or call 1- 800-CDC-INFO (1-800-232-4636); TTY: (888 - 232-6348)	
	Infographics     or - Browse the entire library	More information can be found on additional Radiation Emergency Training and Education here.	
	•		

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

#### CDC Web site for Radiation Emergency Preparedness and Response

Prepar Hazard What ( What ) Blog: I Matter What's A - Z I

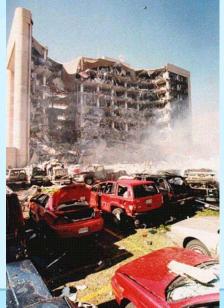
redness for All rds	Decision Guide (CDG) for each radionuclide. The application can be downloaded here.ස්				
CDC Is Doing You Can Do Public Health rs 's New Index	The United States Nuclear Regulatory Commission: Multi-Agency Radiological Laboratory Analytical Protocols Manual? The Multi-Agency Radiological 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 <u>specific</u> 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 preplanning
- 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

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- Carl Verdon, PhD

## 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: <u>cdcinfo@cdc.gov</u> Web: <u>http://www.cdc.gov</u>

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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.

National Center for Environmental Health Division of Laboratory Science



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### Contact

### Robert L. Jones, PhD

Centers for Disease Control and Prevention 4770 Buford Hwy Mailstop F-50 Atlanta, GA 30341-3724 RLJones@cdc.gov

"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 <u>dose</u> received after radiation exposure. (**BARDA method R&D**) *Most effective for estimating injury due to <u>irradiation</u> [shine] (IND, RED or NPP).*
- <u>**Bioassay</u>**: 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 <u>dose</u>. *Most effective for estimating injury due to inhalation or ingestion* after a RDD, IND or NPP fallout.</u>

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 <b>days</b>	Less than <b>24 <i>hours</i></b>
Sample Requirements	24 hour collection	" <i>spot</i> " 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 MHON HED STA

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AGENCY

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

www.wipp.energy.gov/namp/linkitems/Rad\_Screening\_for\_Unknown\_Samples\_2012\_04\_12.pdf 32