

ETSU College of Public Health

Public Health Implications of Radiation Emergencies

Kyle T. Colvett, M.D., M.S.
November 21, 2013



Kyle T. Colvett, M.D.



Fundamentals

PERIODIC TABLE OF THE ELEMENTS

<http://www.periodni.com>

Legend:

- Metal
- Alkali metal
- Alkaline earth metal
- Transition metals
- Lanthanide
- Actinide
- Semimetal
- Nonmetal
- Chalcogens element
- Halogens element
- Noble gas

STANDARD STATE (25 °C; 101 kPa):
■ Ne - gas ■ Fe - solid
■ Hg - liquid ■ Tc - synthetic

LANTHANIDE

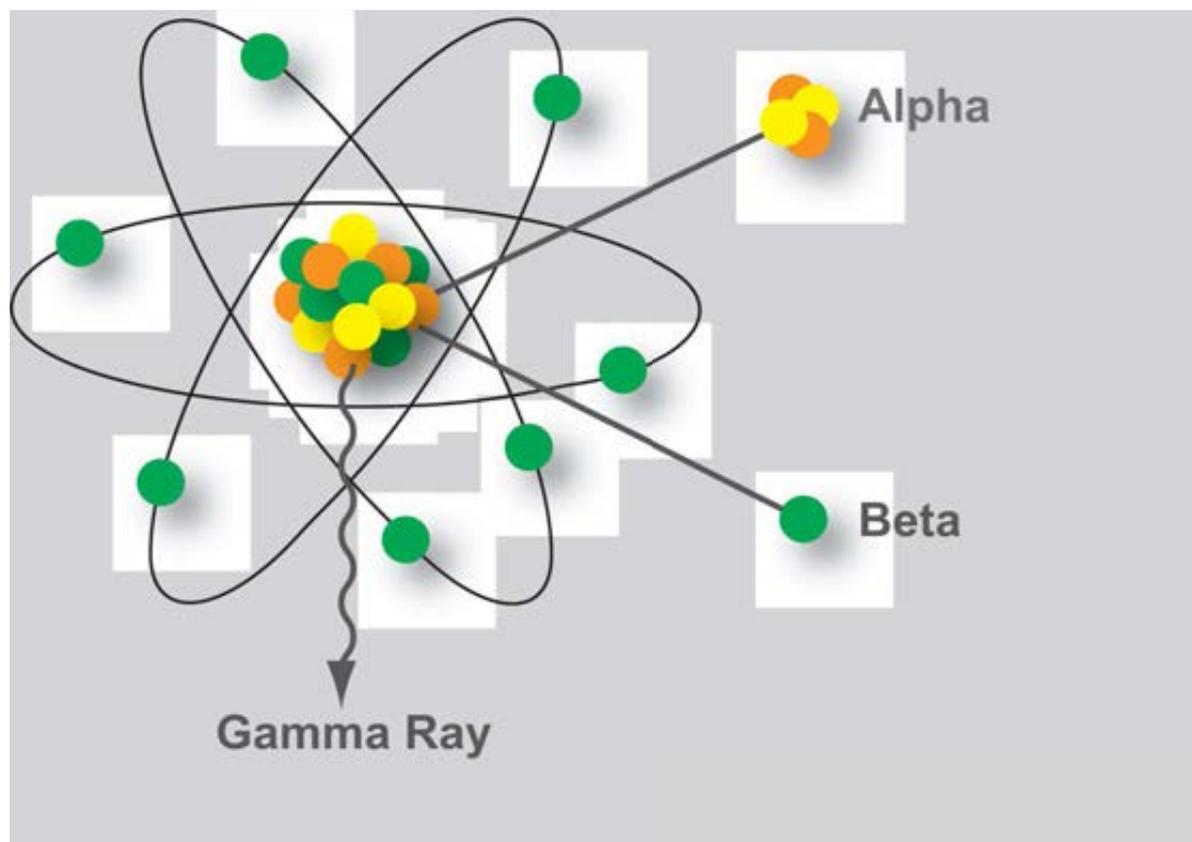
57 138.91 La LANTHANUM	58 140.12 Ce CERUM	59 140.91 Pr PRASEODYMIUM	60 144.24 Nd NEODYMIUM	61 (145) Pm PRIMUM	62 150.36 Sm SAMARIUM	63 151.96 Eu EUROPIUM	64 157.25 Gd GADOLINIUM	65 158.93 Tb TERBIUM	66 162.50 Dy DYSPRODIUM	67 164.93 Ho HOLMIUM	68 167.26 Er ERBIUM	69 168.93 Tm THULIUM	70 173.05 Yb YTTERIUM	71 174.97 Lu LUTETIUM
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ACTINIDE

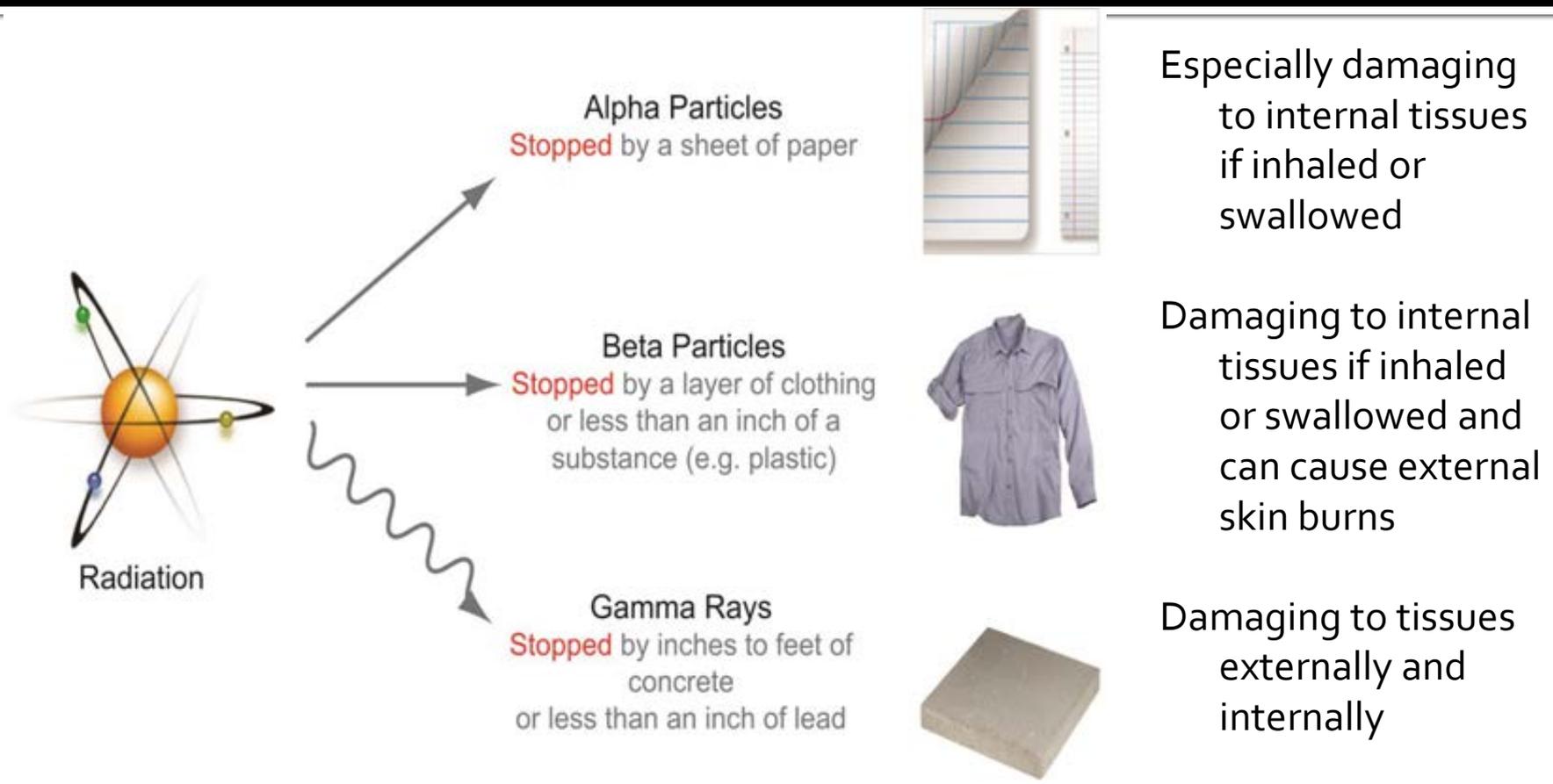
89 (227) Ac ACTINIUM	90 232.04 Th THORIUM	91 231.04 Pa PROTACTINIUM	92 238.03 U URANIUM	93 (237) Np NEPTUNIUM	94 (244) Pu PLUTONIUM	95 (243) Am AMERICIUM	96 (247) Cm CURIUM	97 (247) Bk BERKELIUM	98 (251) Cf CALIFORNIUM	99 (252) Es EINSTEINIUM	100 (257) Fm FERMIUM	101 (258) Md MENDELEVIUM	102 (259) No NOBELIUM	103 (262) Lr LAWRENCIUM
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(1) Pure Appl. Chem., 81, No. 11, 2131-2156 (2009)
 Relative atomic masses are expressed with five significant figures. For elements that have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element. However for these elements (Tc, Pm and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

Radioactivity

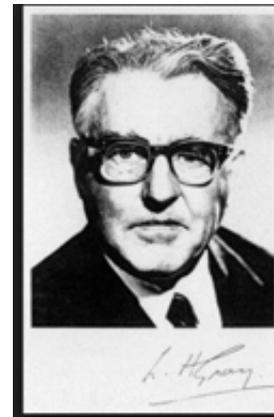


Penetration Abilities



Radiation Units

- Amount of radioactivity
 - Curie (Ci), Becquerel (Bq)
- Ambient radiation levels
 - Roentgen (R) per hour, rem per hour, Sievert (Sv) per hour
- Radiation dose
 - Rad, rem, Gray (Gy), Sievert (Sv)



Comparing Units of Curie (Ci) and Becquerel (Bq)



■ Ci

1 Ci = 37 billion dps



• Bq



1 Bq = 1 dps

More Radiation Units

- U.S.: rem, rad, Roentgen (R)
- International: Sievert (Sv) and Gray (Gy)
- Most common unit (U.S.) for health effect: rem

$$1 \text{ rem} = 0.01 \text{ Sv}$$

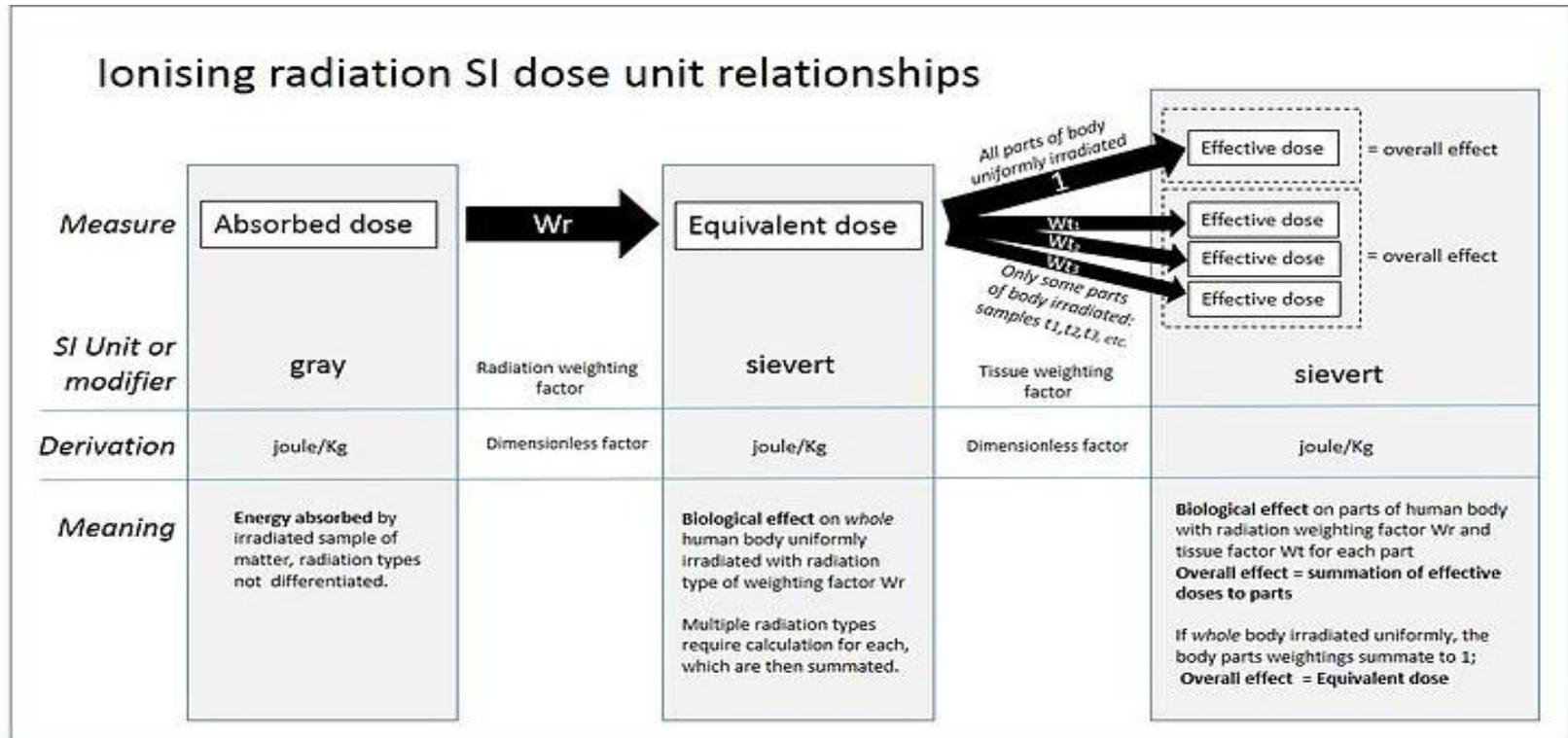
$$1 \text{ mrem} = 10 \mu\text{Sv}$$

$$1 \text{ Sv} = 100 \text{ rem}$$

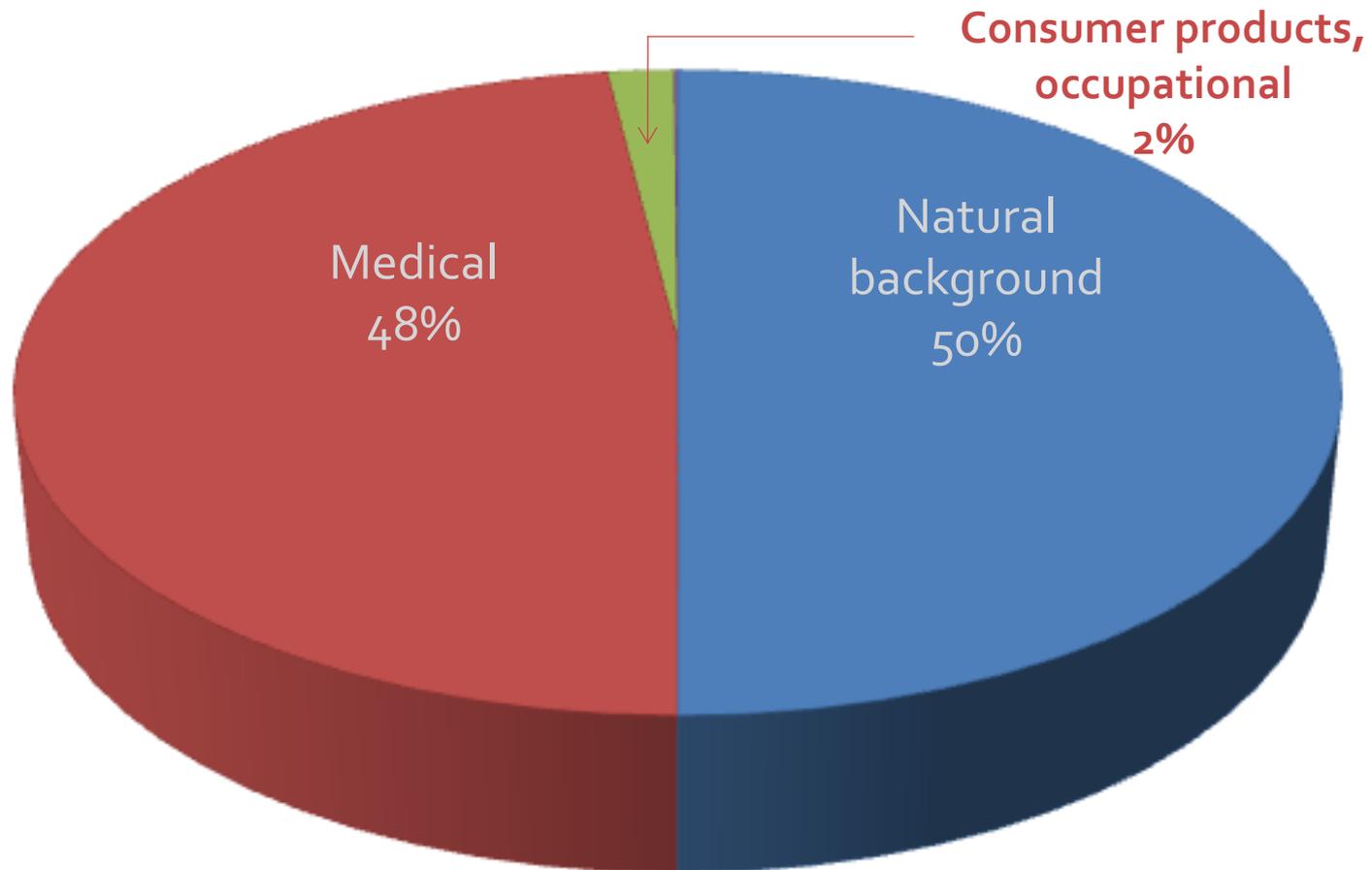
$$1 \text{ mSv} = 100 \text{ mrem}$$

$$1 \mu\text{Sv} = 100 \mu\text{rem}$$

Ionising radiation SI dose unit relationships

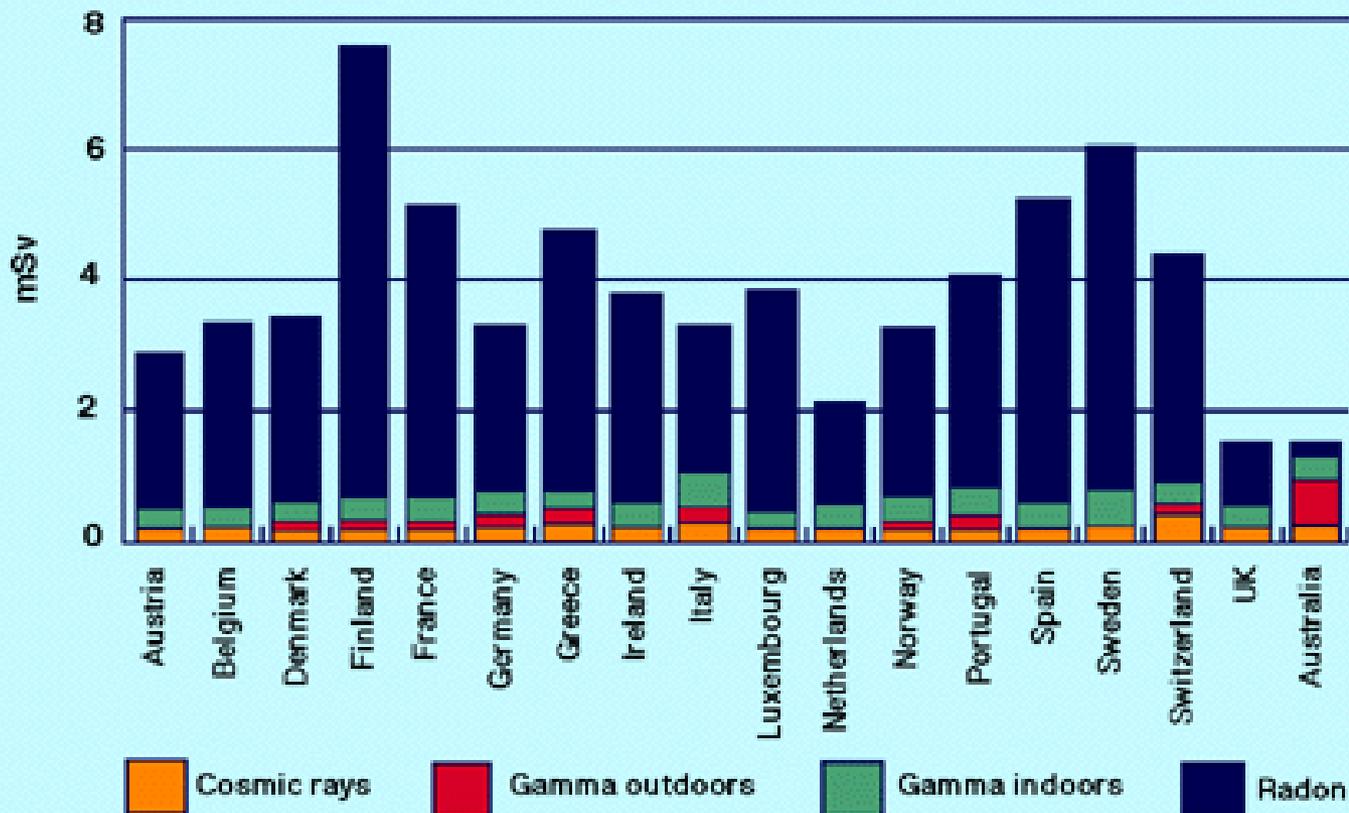


Average Annual Radiation Exposures: 6.2 mSv = 620 mrem



Source: NCRP Report No. 160, *Ionizing Radiation Exposure of the Population of the United States* (2009)

AVERAGE ANNUAL DOSES FROM NATURAL RADIATION SOURCES



Typical Doses (mrem)

Airport Screening	0.010
NY to London by air	5
Chest x-ray	10
Natural (annual)	300
CT Scan -Abdomen	1,000
Occupational annual limit	5,000
50% survival (whole body)	400,000
Radiation therapy (tumor)	8,000,000

$$1 \text{ mrem} = 10 \mu\text{Sv}$$

Radiation Protection

- Time
- Distance
- Shielding

Guiding principle for controlling exposures:

ALARA

As Low As Reasonably Achievable

Human Health Effects

Depending on radiation dose, dose rate, and other parameters (e.g., age):

- Acute effects (acute radiation syndrome)
- Late effects (cancer)
- No observable effects

Late Effects (cancer)

- Most cancers can be induced by radiation
- Clear evidence for leukemia, breast, thyroid, salivary glands, stomach, colon, lung
- Young age at exposure increases risk
- Risk persists throughout life, but temporal patterns are suggested

Physics Key Points

- Radiation types: alpha, beta, gamma
- Radiation and radioactivity are part of our natural environment
- Radioactive contamination is not immediately life threatening.
- Decontamination is relatively simple.

Physics Key Points

- Radiation can be readily detected.
- Dose Units: rem (U.S.)
- Radiation *can* kill in short term or cause cancer in long term
- It is all about the dose

Acute radiation syndromes

Table 1. Acute Radiation Syndromes

Whole Body Radiation from External Radiation or Internal Absorption

Phase	Feature	Subclinical range		Sublethal range		Lethal range	
		0-100 rad (cGy)	100-200 rad (cGy)	200-600 rad (cGy)	600-800 rad (cGy)	600-3000 rad (cGy)	>3000 rad (cGy)
Prodromal Phase	Nausea and Vomiting	none	5-50%	50-100%	75-100%	90-100%	100%
	Onset		3-6 hrs	2-4 hrs	1-2 hrs	<1 hr	<1 hr
	Duration		<24 hrs	<24 hrs	<48 hrs	<48 hrs	<48 hrs
	Lymphocytes			<100 @24 hr	<500 @24 hr	<500 @ 24 hr	<500 @ 24 hr
Latent Phase	Duration	>2 wks	7-15 days	0-7 days	0-2 days	None	
Illness Phase	Sign and Symptoms	none	moderate leukopenia	severe leukopenia, purpura, hemorrhage, infection		diarrhea, fever, electrolyte disturbance	convulsions, ataxia, tremor, lethargy
	Onset		>2 wks	2 days - 2 wks		2-3 days	1-48 hrs
	Organ System	none		hematopoietic and respiratory (mucosal) systems		GI tract, mucosal systems	CNS
	Hospitalization	0	<5% 45-60 days	90% 60-90 days		100% 90+ days	100% 2 weeks
	Fatality	0%	0%	0-80%	90-100%	90-100%	
	Time of Death			3 wks-3 months		1-2 wks	1-2 days

Radiation in the public mind

- Radiation and radioactivity occupy a vivid region of the human imagination
- The general public derives its understanding from key historic events and from popular media
- Both science and science fiction influence cultural response and emotions

Hiroshima August 6, 1945

first deployment of an atomic weapon



Nagasaki August 9, 1945



Aftermath of A-bombs



Bikini Atoll

Baker test July 25, 1946



Hydrogen bomb

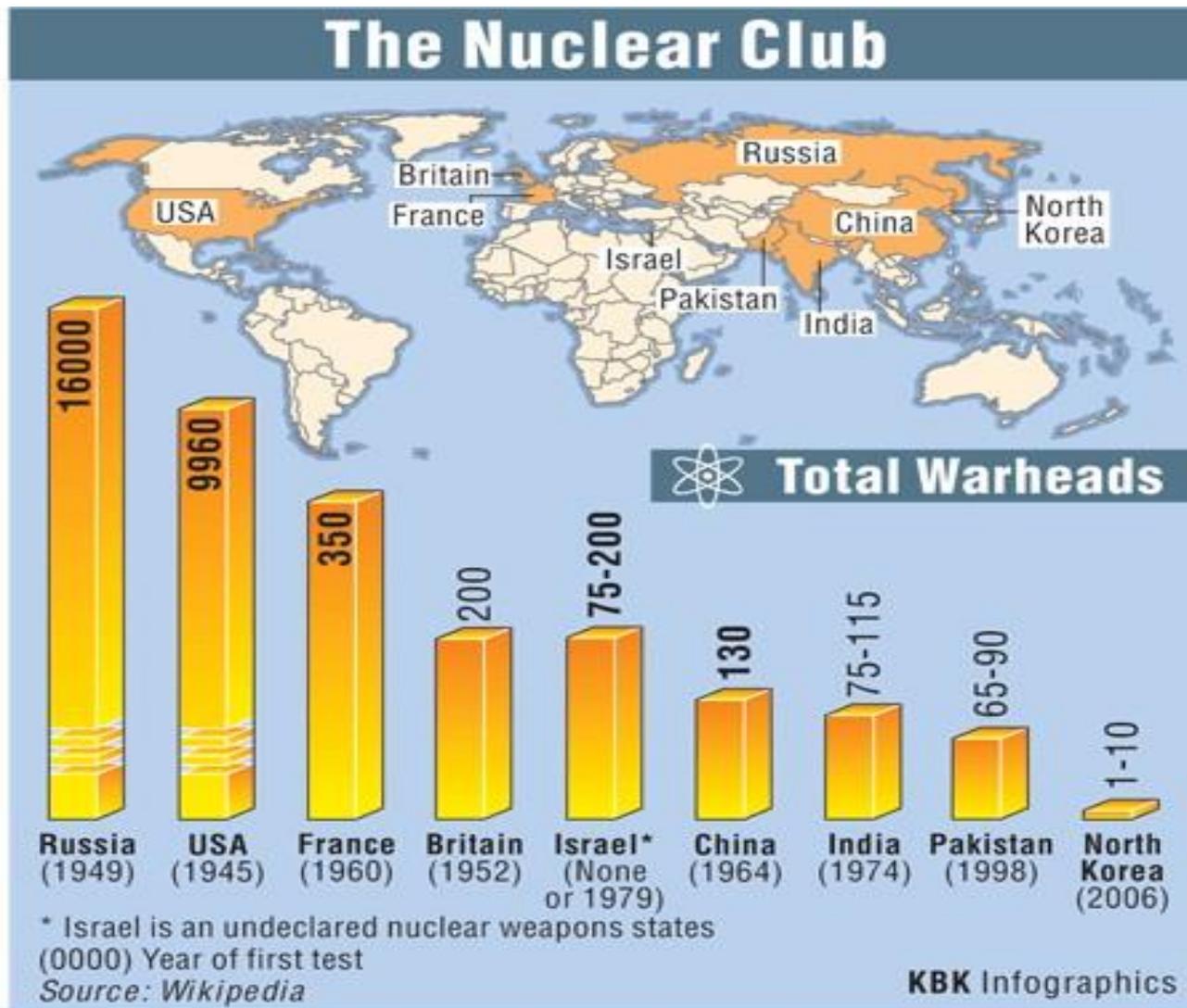
First Hydrogen bomb "Ivy Mike"
Castle Bravo test

November 1, 1952
March 1, 1954

Eniwetok Atoll
Bikini Atoll



The exclusive nuclear club

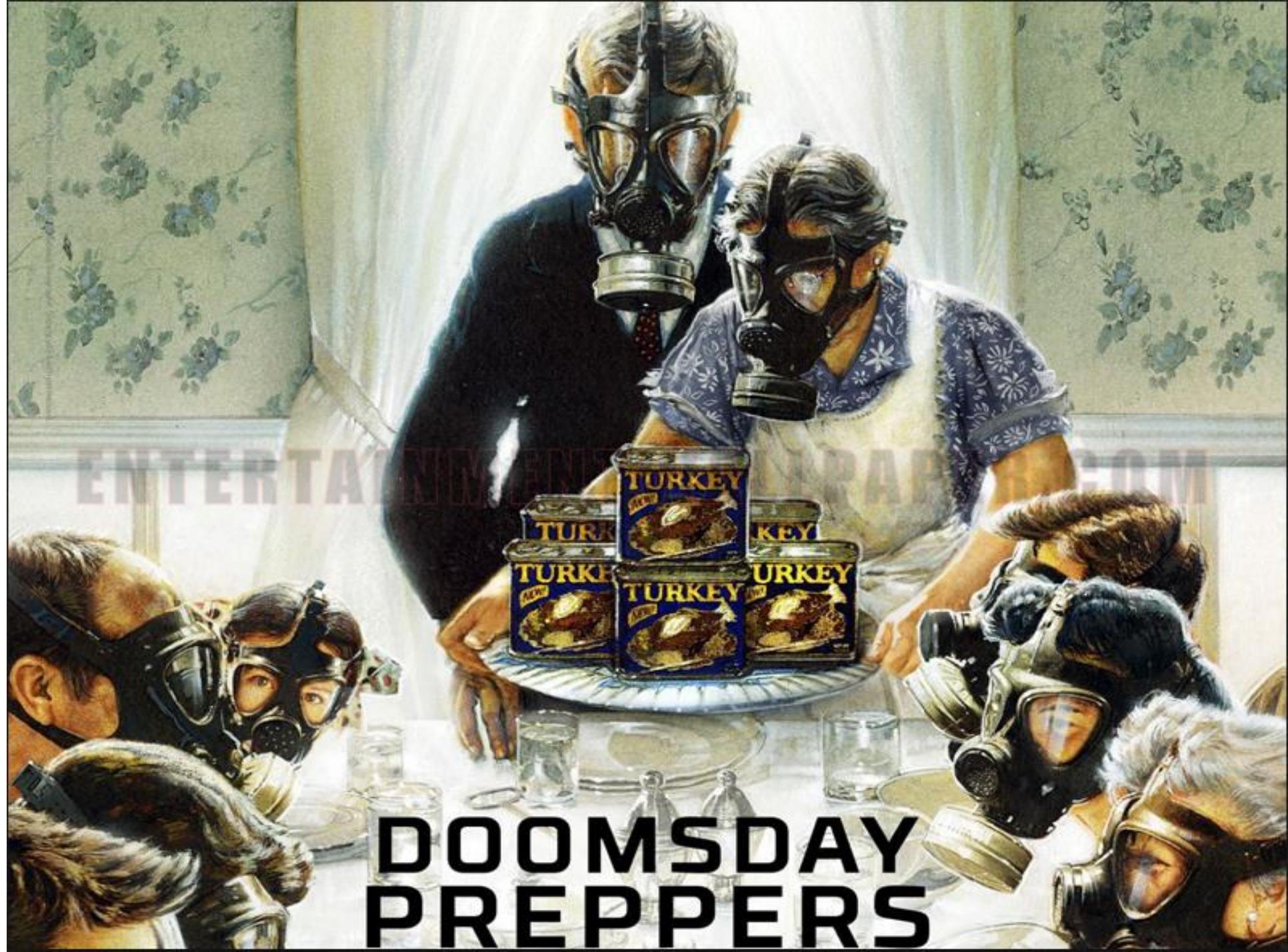






Dr. Strangelove

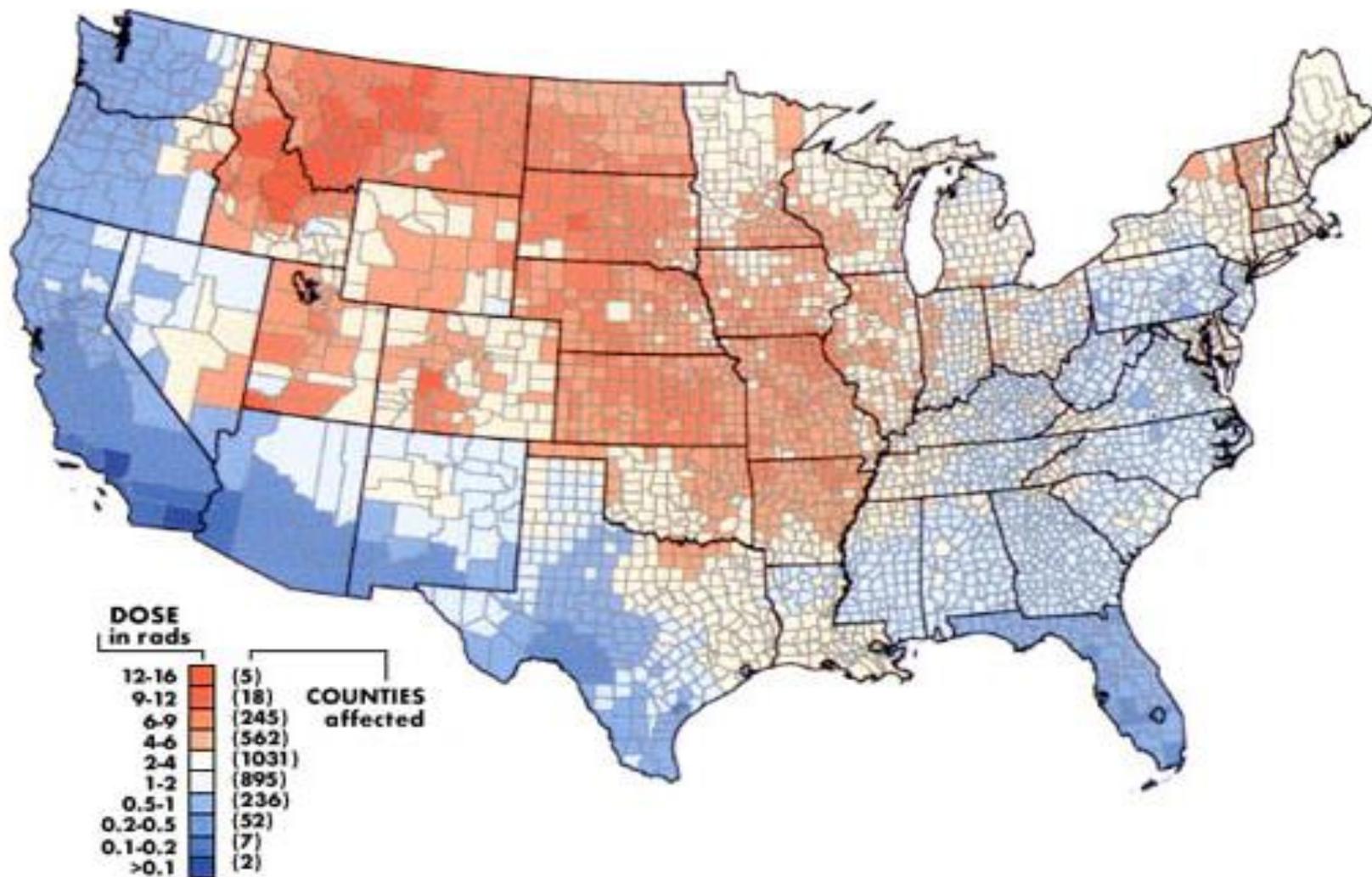




ENTERTAINMENT WEEKLY.COM

DOOMSDAY PREPPERS

Exposure of American People to I-131 (Radioactive Iodine) from Nevada Nuclear Bomb Tests in the 1950s and 1960s



U.S. Commercial Nuclear Power Reactors— Years of Operation by the End of 2010



**Years of Commercial
Operation**

- △ 0-9
- ▲ 10-19
- ▲ 20-29
- ▲ 30-39
- ▲ 40 plus

**Number of
Reactors**

- 0
- 3
- 48
- 46
- 7

Note: Ages have been rounded up to the end of the year.

Source: U.S. Nuclear Regulatory Commission



Watts Bar

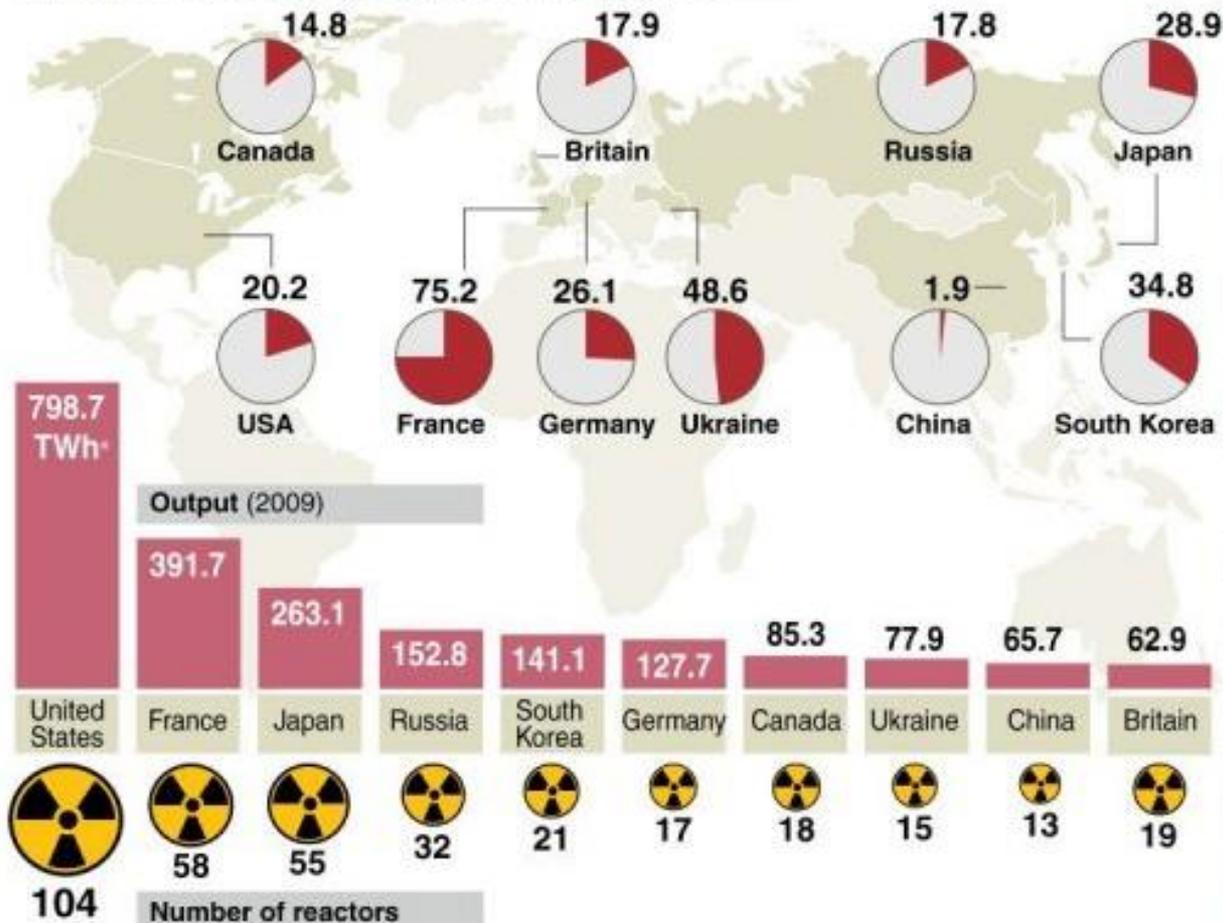
Sequoyah



Nuclear power around the world

World's biggest users of nuclear energy

Nuclear's percentage of national electricity production



GUESS WHO'S BUILDING NUCLEAR POWER PLANTS.



The Shah of Iran is sitting on top of one of the largest reservoirs of oil in the world.

Yet he's building two nuclear plants and planning two more to provide electricity for his country.

He knows the oil is running out — and time with it.

But he wouldn't build the plants now if he doubted their safety. He'd wait. As many Americans want to do.

The Shah knows that nuclear energy is not only economical, it has enjoyed a remarkable 30-year safety record. A record that was good enough for the citizens of Plymouth, Massachusetts, too. They've approved their second nuclear plant by a vote of almost 4 to 1. Which shows you don't have to go as far as Iran for an endorsement of nuclear power.

NUCLEAR ENERGY. TODAY'S ANSWER.

BOSTON EDISON, EASTERN UTILITIES ASSOCIATES, NEW ENGLAND POWER COMPANY,
PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE, NEW ENGLAND GAS AND ELECTRIC COMPANIES.

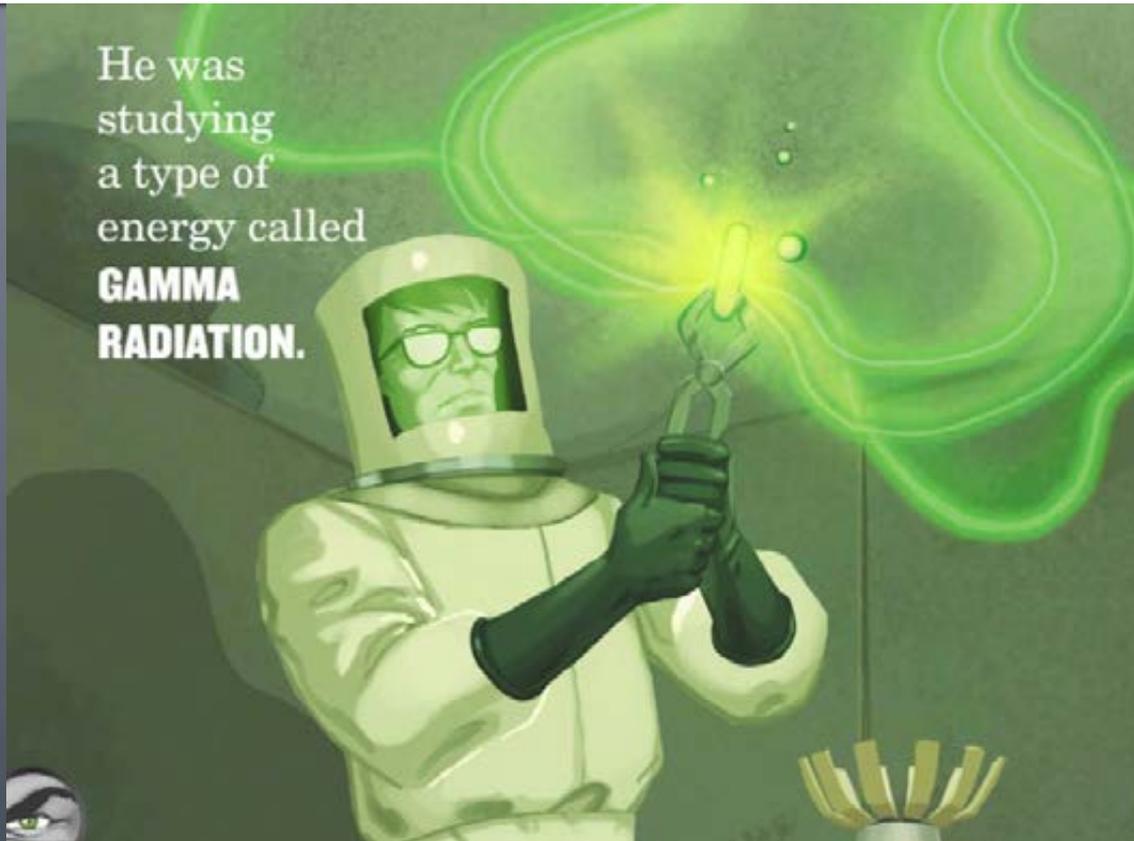
Science fiction builds upon fact

Gojira!



Dr. Bruce Banner - The Incredible Hulk

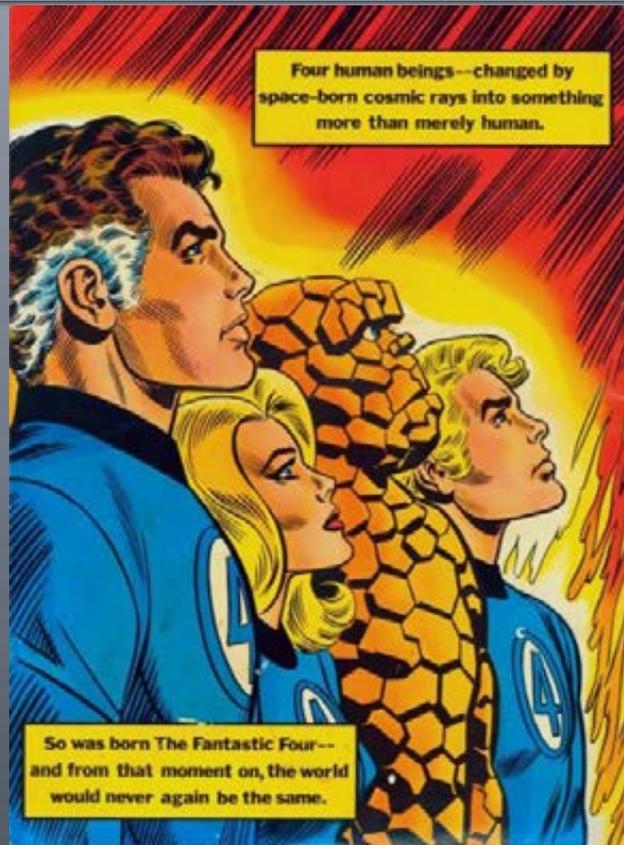
He was studying a type of energy called **GAMMA RADIATION.**



Peter Parker - Spiderman



The Fantastic Four



Dr. Jonathan Osterman – Dr. Manhattan





BART SIMPSON'S FAVORITE COMIC BOOK!

#1

RADIOACTIVE MAN™

suporak.com



MATT GREENING



INTRODUCING THE GREATEST HERO OF THEM ALL! DON'T MISS...
"THE ORIGIN OF RADIOACTIVE MAN!"

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Three Mile Island

March 1979





NUCLEAR ACCIDENT AT THREE MILE ISLAND

On March 28, 1979, and for several days thereafter -- as a result of technical malfunctions and human error -- Three Mile Island's Unit 2 Nuclear Generating Station was the scene of the nation's worst commercial nuclear accident. Radiation was released, a part of the nuclear core was damaged, and thousands of residents evacuated the area. Events here would cause basic changes throughout the world's nuclear power industry.

PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION

1999

The China Syndrome March 1979



Chernobyl



Fukushima

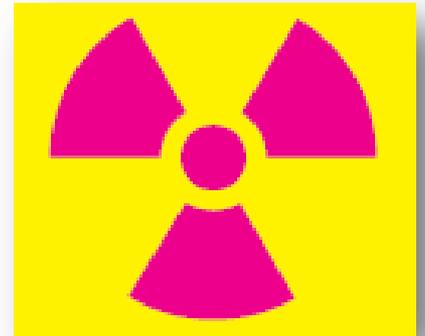




CBRNE

(Chemical, Biological, Radiological, Nuclear, Explosive)

- A nuclear incident involves a nuclear detonation
- A radiological incident does NOT involve a nuclear detonation



Radiation emergency

Obvious in Real Time

- Information from local, State, Federal authorities
- News report
- Routine, real time radiation monitoring of
 - Industrial radiation sources
 - Planned transport of radiation sources
 - Medical facility radiation sources
- Personal observation

Examples

- Nuclear explosion
- Transportation incident
- Medical facility incident
- Nuclear power plant / reactor incident or sabotage
- Industrial radiation source incident

Radiation emergency

Not Obvious in Real Time

- Evaluating an explosive incident, HAZMAT team tests for and finds radiation.
- Monitoring of water, soil, food, air reveals unexpected radiation.
- Recognizing over time a cluster of victims with radiation-linked clinical signs and symptoms
- Locating a radiation source outside of expected places, e.g., subway, sports field

Examples

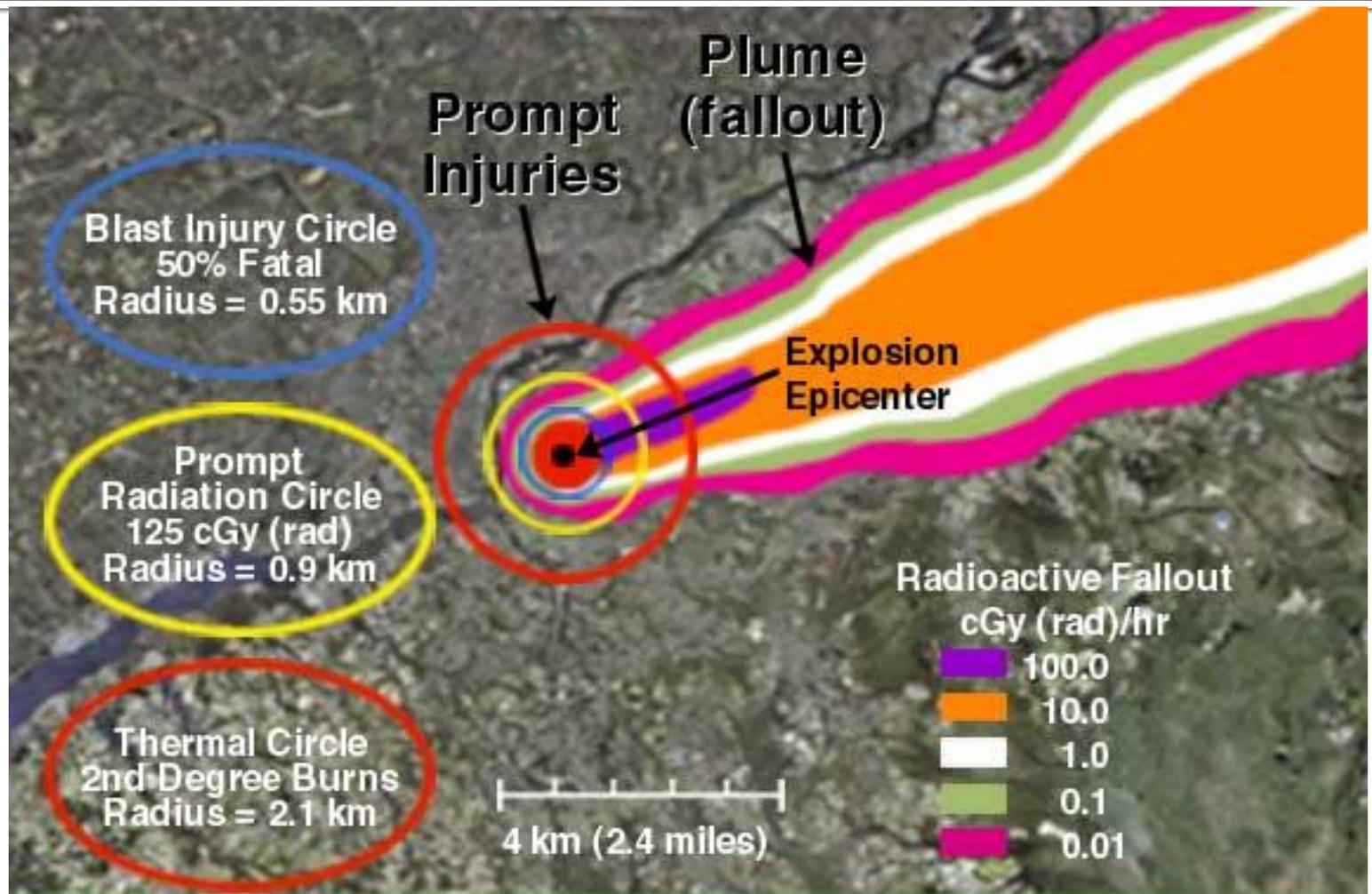
- Radiological Dispersal Device
 - Explosive incident subsequently found to have radiation
 - Non-explosive incident: radiation dispersion into food, water, soil, air
 - Hidden radiological source:
Radiological Exposure Device
- Malicious or unintentional industrial, nuclear reactor, medical facility, or transportation incident discovered after the fact

Examples of Nuclear Incidents

- Strategic Nuclear Weapons
 - Think Cold War (megaton range)
 - Not considered a likely threat today
- Improvised Nuclear Device (IND)
 - Think Hiroshima “Little Boy”
 - Low-yield kiloton range
 - Possible tool of terrorism
 - No warning

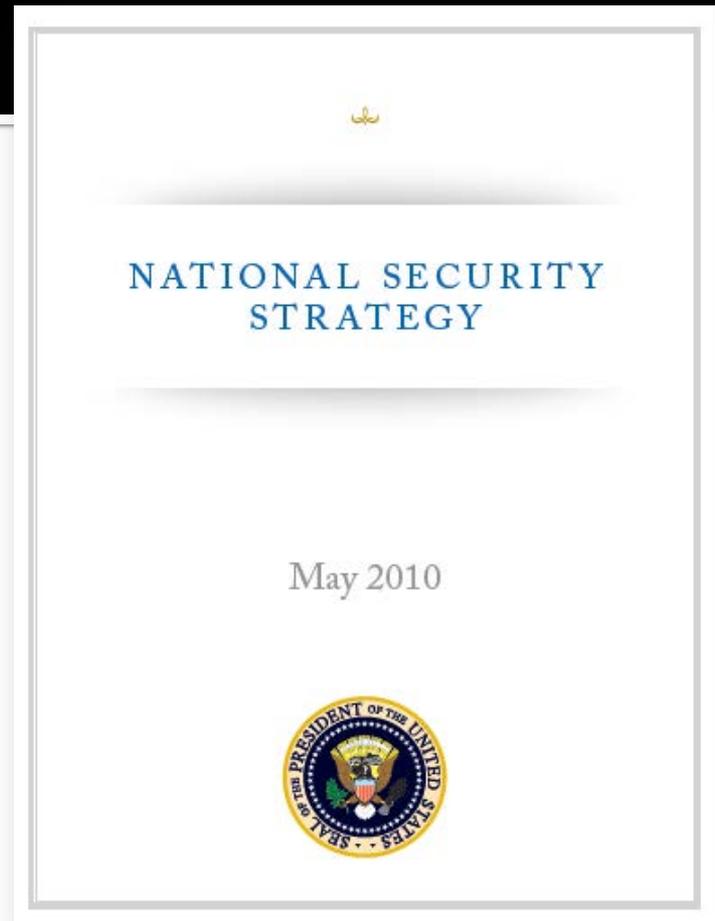


10 Kiloton Nuclear Detonation



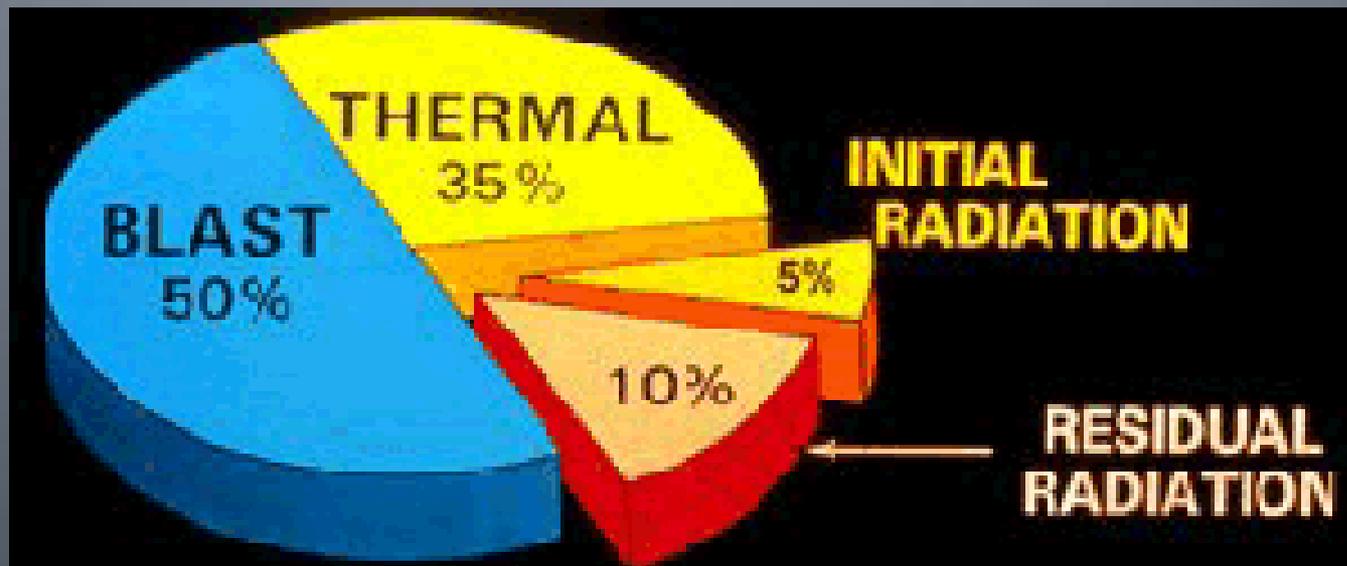
The Threat

“The American people face no greater or more urgent danger than a terrorist attack with a nuclear weapon.”



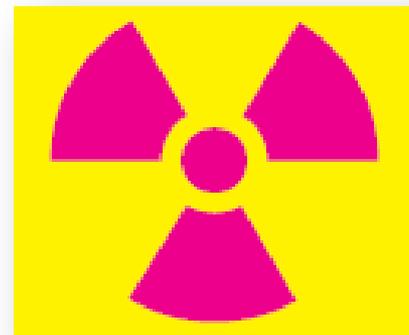
http://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf

Immediate and massive destruction of by a nuclear bomb is NOT caused by radiation!



Examples of Radiological Incidents

- Transportation accidents
- Nuclear power plant accidents
- Spent fuel storage leaks/spills
- Space vehicle accidents
- Gas explosion/fire at any licensed facility
- Explosive RDD (dirty bomb) – National Planning Scenario #11
- Non-explosive RDD (Cesium Chloride [CsCl] solution spray)
- Radiation Exposure Device – (hidden source)



Intentional release of radioactive material:

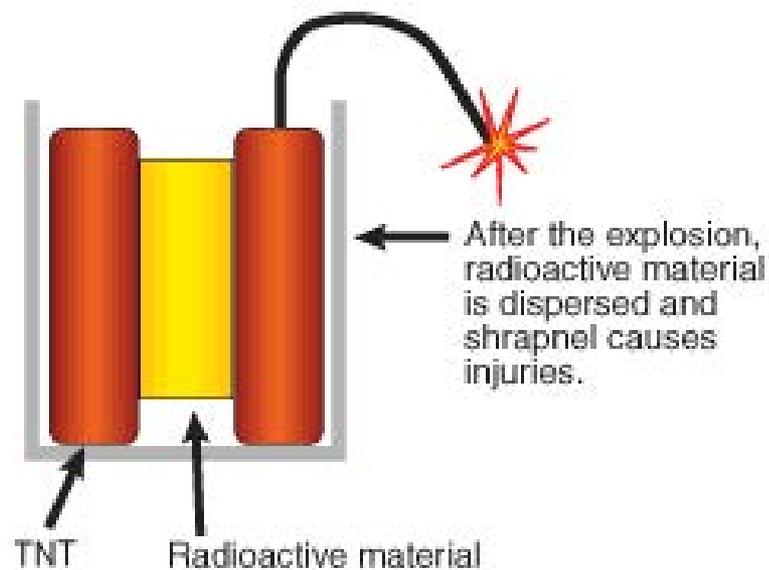
- Contamination of food or water
- Importation or planting of material
- Spreading radioactive material (RDD)
- Dirty bomb
- Bombing or destroying a nuclear reactor
- Railway/Highway vulnerability spill
- Exploding a nuclear weapon

Radiological Dispersal Device (RDD)

- A device that disperses radioactive material by conventional explosive (dirty bomb) or other mechanical means, such as a spray.



Figure 1. Dirty Bomb: Radiological Dispersal Device Using Explosive



Adapted from:
Armed Forces Radiobiology Research
Institute

Explosion disseminates radioactive and non-
radioactive shrapnel and radioactive dust

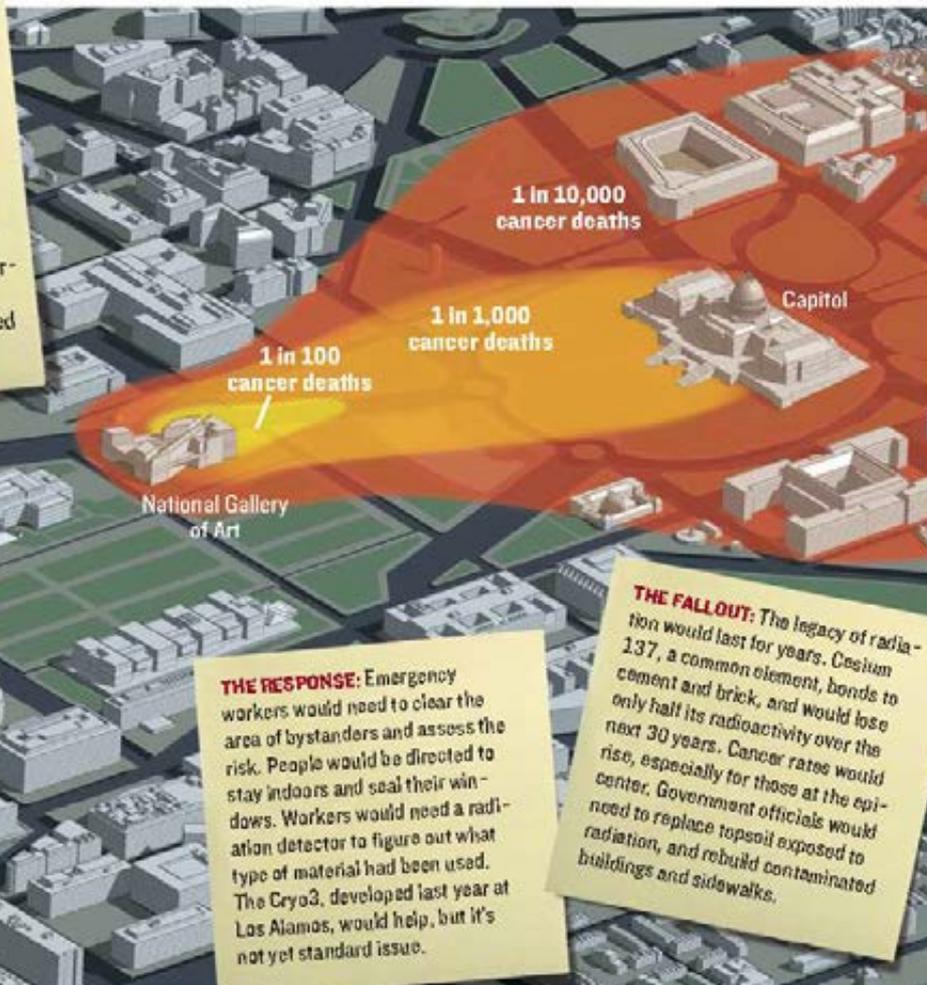
'Dirty Bombs': A Cheap Way To Sow Panic

The body count wouldn't be high, but a vast area could be rendered uninhabitable if a dirty bomb went off. The Federation of American Scientists conducted a simulation of what it would look like if terrorists detonated a device on the Mall in Washington, D.C.

MOMENT OF IMPACT: You would hear a blast. Some buildings would be damaged. And fires might break out. But there would be no mushroom clouds or giant orange fireballs. At its core, the dirty bomb contains only a few pounds of conventional explosives, but it would spew radiation in all directions, contaminating the immediate vicinity.

THE RESPONSE: Emergency workers would need to clear the area of bystanders and assess the risk. People would be directed to stay indoors and seal their windows. Workers would need a radiation detector to figure out what type of material had been used. The Cryo3, developed last year at Los Alamos, would help, but it's not yet standard issue.

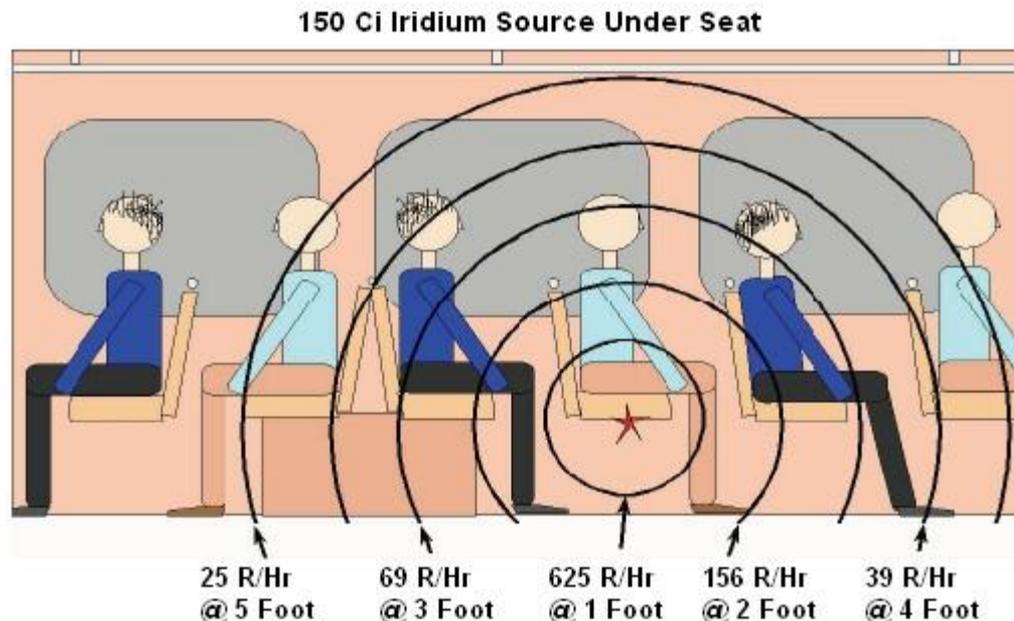
THE FALLOUT: The legacy of radiation would last for years. Cesium 137, a common element, bonds to cement and brick, and would lose only half its radioactivity over the next 30 years. Cancer rates would rise, especially for those at the epicenter. Government officials would need to replace topsoil exposed to radiation, and rebuild contaminated buildings and sidewalks.





Radiological Exposure Device (RED)

- A device whose purpose is to expose people to radiation, rather than to disperse radioactive material.
“silent source”





**SPRINGFIELD
NUCLEAR
POWER PLANT**



FOX41
WDRB

Japan Disasters: March 11, 2011



9.0 magnitude earthquake

Tsunami

Nuclear power plant damage
and radiation release

Fukushima 2011



Fukushima

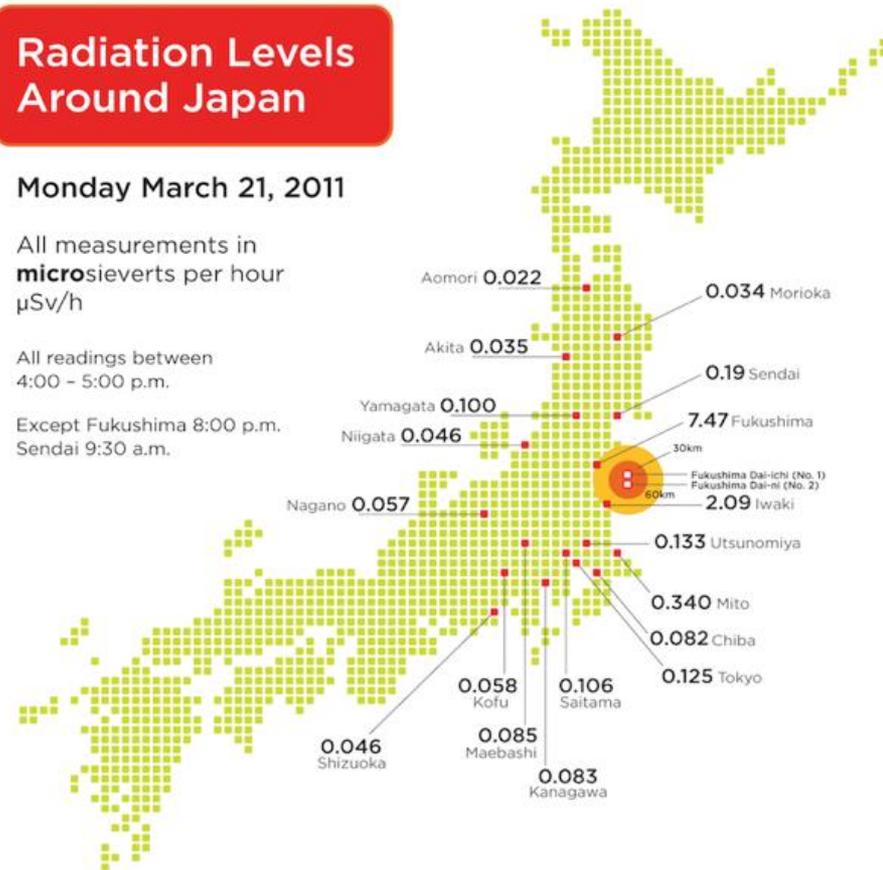
Radiation Levels Around Japan

Monday March 21, 2011

All measurements in
microsieverts per hour
 $\mu\text{Sv/h}$

All readings between
4:00 - 5:00 p.m.

Except Fukushima 8:00 p.m.
Sendai 9:30 a.m.



Measurements taken by Yomiuri Shimbun

CDC Response to Japan Disasters

- CDC Emergency Operations Center activated
- 3 persons deployed by CDC
- Travel health precaution posted on CDC website



Chernobyl, April 1986

- The world's worst nuclear reactor disaster
- 10 km radius uninhabitable indefinitely
- 30 km radius controlled entry indefinitely
- Impacting towns and large rural areas

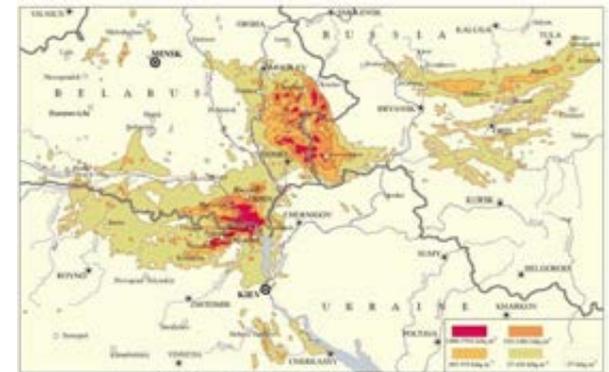
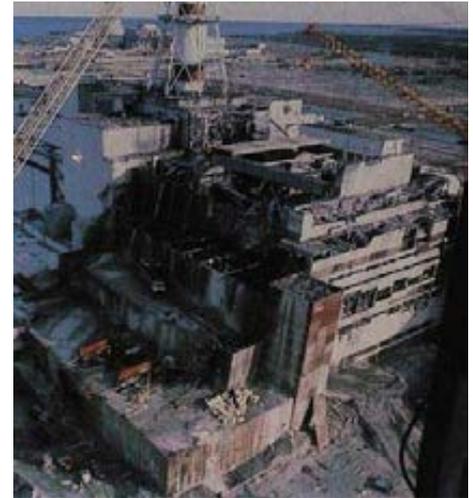
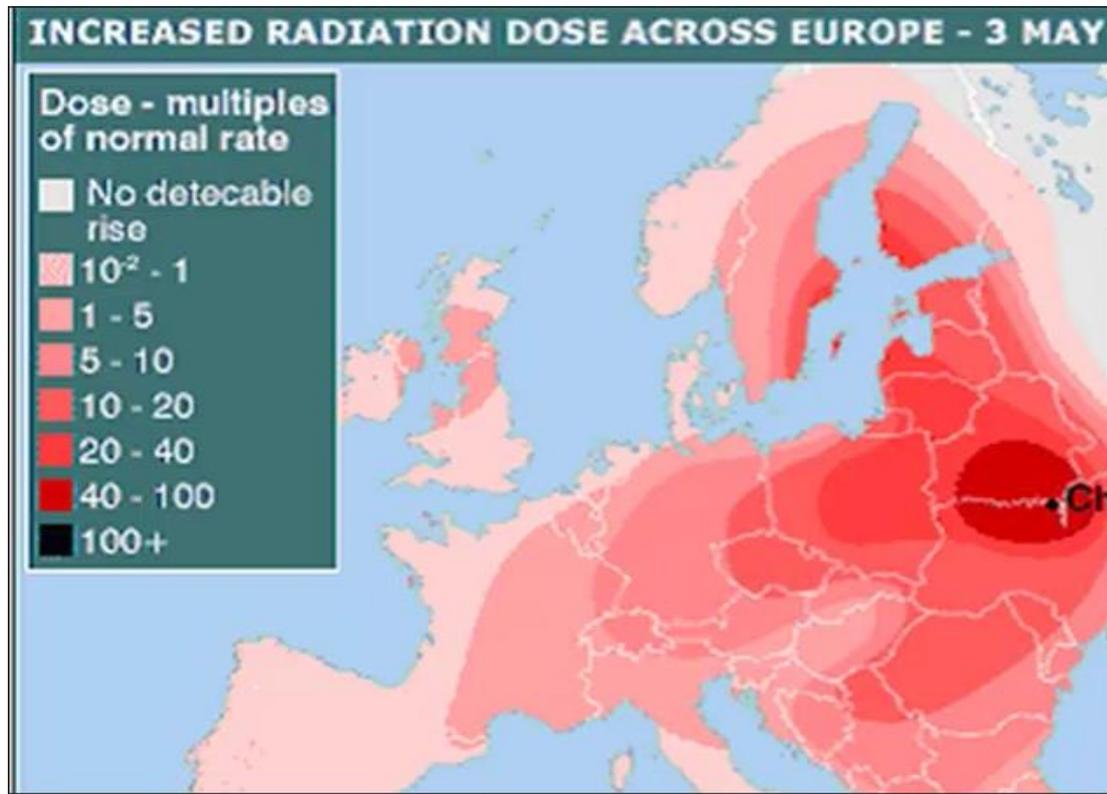


Figure 15. Surface ground deposition of cesium-137 released in the Chernobyl accident [9, 10]



Chernobyl range



Three Mile Island, March 1979

- No one was physically harmed.
- Radiation doses were miniscule.
- Tremendous social and economic impact.



Goiânia, September 1987

- 249 exposed; 54 hospitalized
- Eight with ARS
- Four people died
- 112,000 people monitored (>10% of total population)
- Psychosocial Impact



Learning From Past Events

Three Mile Island, Middletown, PA (1979)

- Nuclear Reactor
 - Mechanical problem & operator-induced error
 - 144,000 individuals within 15 mile radius evacuated
 - Initial official communication was confusing
 - Schools closed
 - Public perceptions of term health effects
- Radiation exposure to public minimal
 - The only detectable effect was psychological stress during and shortly after the incident.
 - Pennsylvania DOH maintained registry of 30,000 individuals x 18 years

ZERO measured health effects

Learning From Past Events

Goiana, Brazil (1987)

- Discarded radioactive medical equipment
 - 249 individuals contaminated
 - 4 related deaths
 - Public concern spread throughout the city and outlying regions
 - Government screened about 125,000 persons for possible exposure.
 - Of the first 60,000 screened, 5,000 individuals had psychosomatic symptoms that mimicked those of radiological exposure.
 - None of them had actually been exposed to the radioactive materials
 - 112,000 sought medical evaluation (11% of population)

Radiation emergencies interim summary

- Incidents involving radiation cover a wide range of scenarios.
- A nuclear detonation creates by far the greatest amount of damage and loss of life.
- Radiological incidents can involve exposure and/or contamination. They may be limited in scope or cover wide geographical areas.
- Both present many public health challenges, even at communities far removed from the scene.

Key Planning Questions

- ① **Could our community be affected by a nuclear or radiological emergency?**

Department of Health and Human Services

**OFFICE OF
INSPECTOR GENERAL**

**LOCAL PUBLIC HEALTH
PREPAREDNESS FOR
RADIOLOGICAL AND
NUCLEAR INCIDENTS**



Daniel R. Levinson
Inspector General

January 2012
OEI-04-10-00250

HHS Office of Inspector General Study

- *Radiological and Nuclear Preparedness: Assessing Selected State and Local Public Health Emergency Response Plans*
- Ongoing survey will determine the extent to which selected states and/or localities have developed and exercised radiological and nuclear public health emergency response plans.

OIG Report

Local Public Health Preparedness for Radiological and Nuclear Incidents OEI-04-10-00250

WHY WE DID THIS STUDY

According to the 2010 National Security Strategy, the American people face no greater or more urgent danger than a terrorist attack with a nuclear weapon. If State and local public health officials do not plan for such incidents, local public health departments will not be adequately prepared to quickly respond and protect the public. Although the Nuclear Regulatory Commission requires nuclear powerplants to have emergency plans for their facilities and the immediate surrounding area, no Federal entity requires States or localities to have public health emergency plans for nonpowerplant radiological and/or nuclear (RN) incidents, such as a terrorist attack.

OIG Report

HOW WE DID THIS STUDY

Using information requests and conducting document reviews, we determined the extent to which 40 localities from the Nation's most populous metropolitan statistical areas (referred to as the "selected localities") used local risk assessments to prioritize planning for RN incidents. We also determined whether the selected localities planned for RN incidents by engaging in five RN-specific public health planning areas; coordinating with Federal, State, and local partners; and using Federal guidance sources.

OIG Report

WHAT WE FOUND

Thirty-six of the forty selected localities had conducted risk assessments, but RN-specific public health planning did not always correspond to localities' prioritized threats. For example, of the four localities that categorized RN incidents as a high-priority threat, only one had RN-specific plans. Twenty-one of the forty selected localities conducted RN-specific public health planning in at least one of the five public health areas of responsibility we examined, but planning in the five areas varied. Localities also varied in the extent to which they coordinated with Federal, State, and local partners for RN-specific public health planning. Most State and local officials were aware of Federal guidance sources available to aid RN-specific public health planning, but requested more comprehensive and specific planning tools.

2010 CSTE Assessment of State-level Radiation Emergency Preparedness

Conclusion: In nearly every measure of public health capacity and capability, the nation is poorly prepared to respond to a major radiation event.

Average subjective preparedness score for a radiation emergency was 4.54 on a scale of 1 to 10.

Recommendations from the CSTE Survey

- Explore with CDC how to incorporate radiation preparedness as a priority in all hazards capabilities development.
- Promote strategic planning between state public health emergency preparedness and traditional radiation personnel to increase collaboration.

Public Health Preparedness:

Strengthening the Nation's Emergency Response State by State

A Report on CDC-funded Preparedness and Response Activities
in 50 States, 4 Cities, and 8 U.S. Insular Areas

September 2010



INDIANA

KANSAS

NEW JERSEY

OHIO

PENNSYLVANIA

ALABAMA

NEW MEXICO

MICHIGAN

GEORGIA

KENTUCKY

ARKANSAS

CALIFORNIA

SOUTH CAROLINA

OKLAHOMA

COLORADO

VIRGINIA

LOUISIANA

MARYLAND

FLORIDA

MISSISSIPPI

NORTH CAROLINA



Centers for Disease Control and Prevention
Office of Public Health Preparedness and Response

NEBRASKA

TEXAS

TENNESSEE



Tennessee
Emergency
Medical Services
for Children

Responding to Radiation Disasters



EXIT



TEXT
OFF



Please click the screen to continue.

Tennessee Disaster Support Network



**Pre-Disaster
Planning**



**During a
Disaster**



**Recovery
from Disaster**



**Resources for
Providers**

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Managed by ORAU for DOE

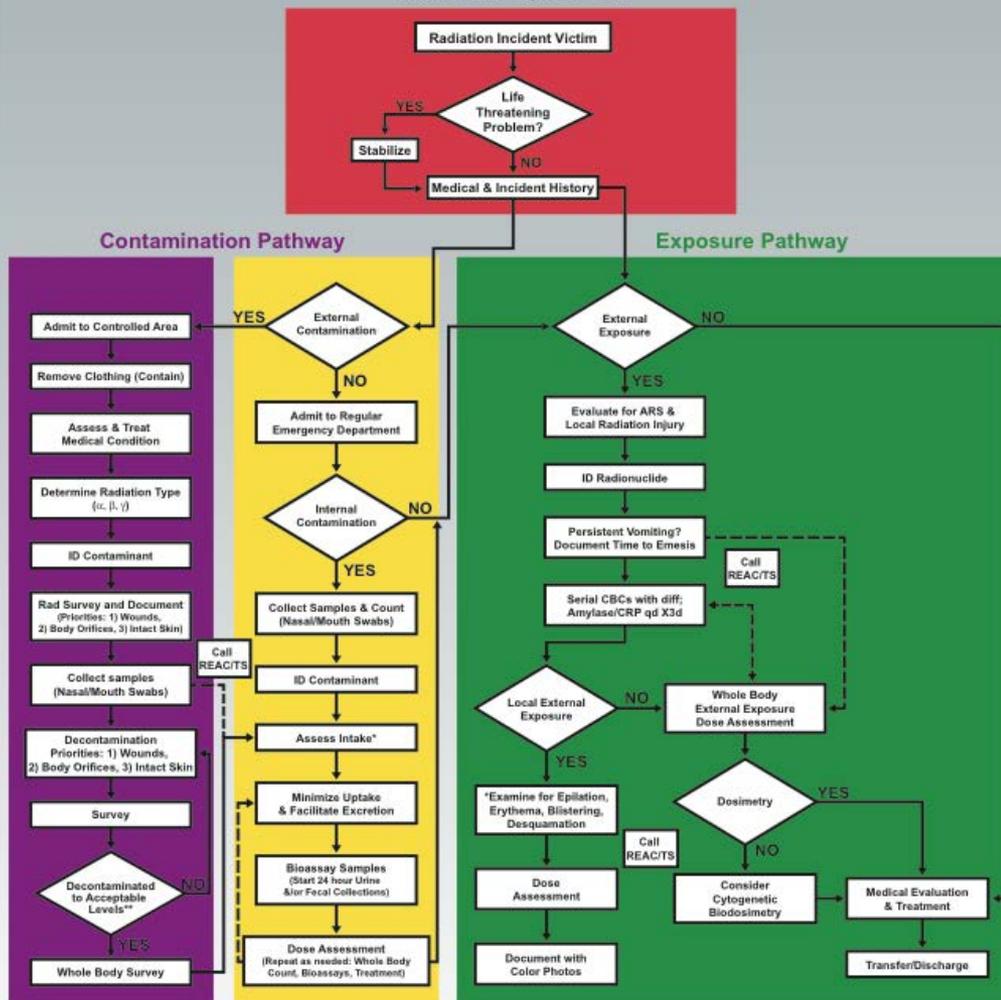


reacts

The Radiation Emergency Assistance Center/Training Site

Radiation Patient Treatment

Version 2, August 2012



Radiation Emergency Assistance Center/Training Site (REAC/TS)

24-Hour Emergency Phone: 865-576-1005

Routine Work Phone: 865-576-3131

On the Web: orise.orau.gov/reacts



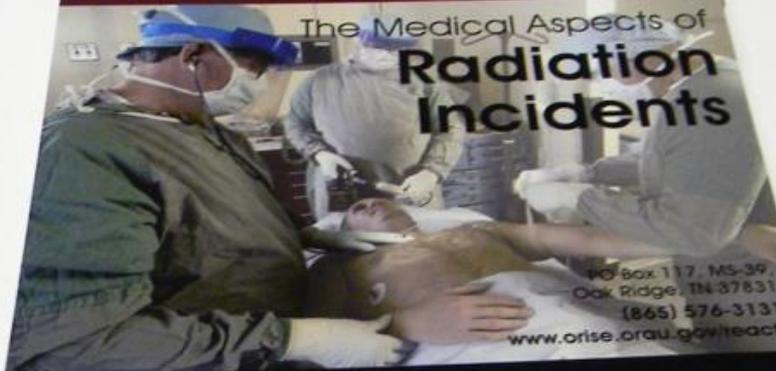
* See REACTS Pocket Guide <http://orise.orau.gov/reacts/resources/radiation-accident-management.aspx>

** <2>.3X Natural Background or No Reduction in Counts, Medical Priorities Dictate Stopping Decontamination, Health Physics Consultation Warranted

reacts

RADIATION EMERGENCY ASSISTANCE CENTER/TRAINING SITE

The Medical Aspects of
**Radiation
Incidents**



PO Box 117, MS-39,
Oak Ridge, TN 37831
(865) 576-3131
www.orise.orau.gov/reacts

ORISE



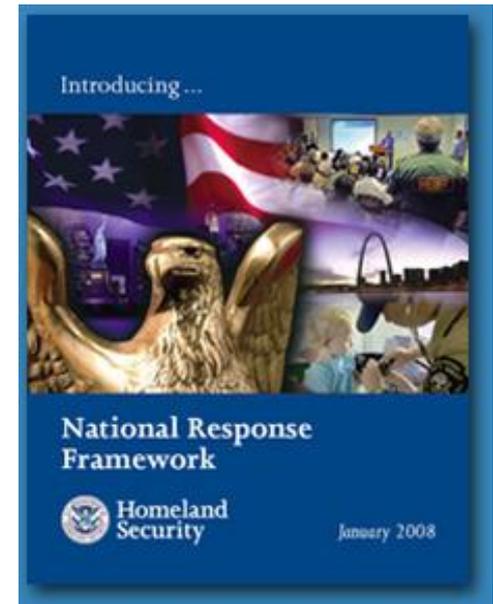
U.S. DEPARTMENT OF
ENERGY

The National Response Framework and CDC's Role

The Department of Homeland Security has overall authority for emergency response activities as laid out in the National Response Framework (NRF)

The Department of Health and Human Services under the NRF has responsibility for public health and medical services (Emergency Support Function 8)

The Centers for Disease Control and Prevention executes public health response activities



Catastrophic Preparedness & Planning

Incorporating the Whole Community Approach

- Improving the nation's preparedness for catastrophic events in continuous collaboration with ALL members of the community
- Plan for the "Maximum of the Maximums" catastrophic event : the real, not the manageable
- Consistent with and expands upon existing emergency preparedness and response systems and doctrine
- Focus: Stabilize catastrophic effects with emphasis on the first 72 hours
- Requires a new planning framework and targeted preparedness campaign.



Whole Community Principles

- Leverage the whole community vs a “government-centric” approach
View public as an asset, not a liability
- Think “community” in terms of resources, concepts of operations, etc.
- Focus on outcomes, with *acute emphasis on* increasing the number of people who survive
- Response is a push event; recovery is a pull event
- Think bigger – engage “atypical partners and collaborators” and train and exercise to reduce impediments to cooperation



FEMA

Potential Solutions/Courses of Action

New ways of thinking and/or conducting business will need to be explored in order to recover from catastrophic disaster events.

Working groups will examine:

- New partners
- New concepts of operation
- Authorities: More effective use of existing authorities, or identification of new requirements
- New or enhanced pre-scripted mission assignments
- Pre-incident preparedness programs
- Implications for academic, R&D, and other communities
- Implications for physical, programmatic and effective communications accessibility



FEMA



FEMA

Short-Term Goals

Fully involve States, cities and the public in the “Maximum of Maximums” planning initiative

Stand-up Stakeholder Engagement Working Groups

Assess courses of action across the “Core Capabilities”

Refine existing Pre-scripted Mission Assignments (PSMAs)

Pilot “Maximum of Maximums” draft products through NLE 2011 (NMSZ)

Long-Term Goals

Implement non-traditional (atypical) solutions to minimize response deltas

Incorporate “Whole Community” framework throughout the nation

Key Planning Questions

- ① Could our community be affected by a nuclear or radiological emergency?
- ② What are the public health roles in radiation emergencies?

Public Health Functions After Any Disaster

- Rapid assessment of health and medical needs
- Sheltering and housing, mass care safety
- Injury and illness surveillance
- Potable water, safe food, sanitation and hygiene
- Vector control
- Solid waste, waste water management
- Hazardous material disposal
- Registry
- Handling of the deceased
- Rumor control
- Public service announcements



In a radiation emergency:

Public health practitioners need to work closely with radiation safety professionals

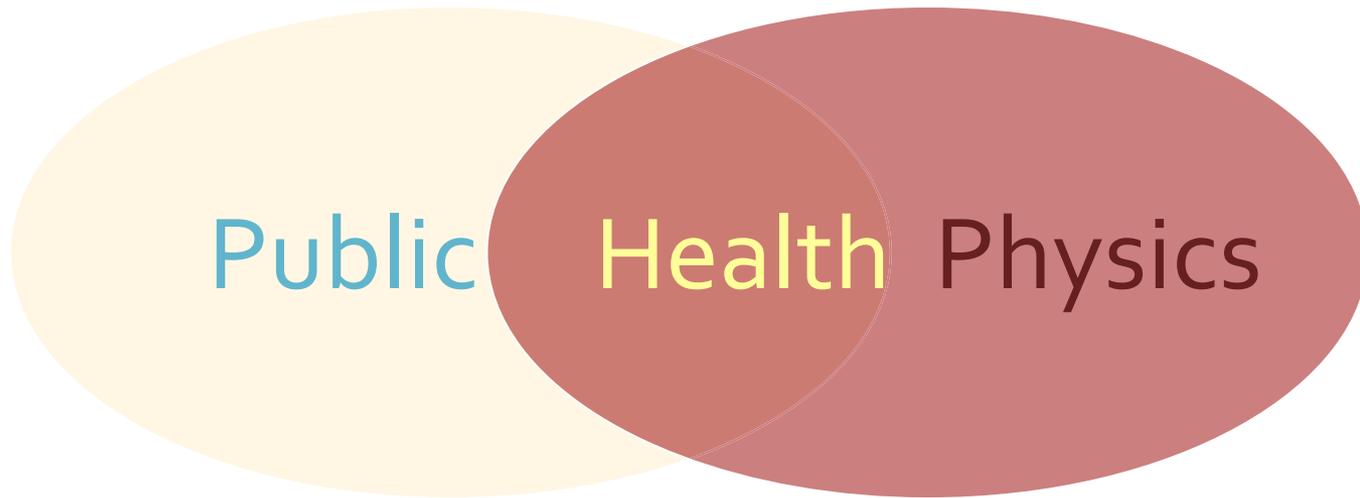


Table 2.1
Core and Essential Public Health Functions

Core Function	Essential Function
Assessment	Monitor health Diagnose and investigate
Assurance	Enforce safety and health laws Link to/provide health care Assure competent workforce Evaluate health services
Policy development	Inform, educate, empower Mobilize community partnerships Develop policies
All	Research

SOURCES: Core functions from Institute of Medicine (1988); essential functions and their relationship to core functions from CDC (2008b).

CDC Focuses on Public Health Strengths

- Laboratory and epidemiological detection and characterization of events
- Clinical and self-help guidance
- Countermeasures for medical and population response (where appropriate)
- Linkage across the health system from the local to state, national, and even international levels

Public Health Preparedness Capabilities

- Public Health Laboratory Testing
- Public Health Surveillance and Epidemiological Investigation
- Community Preparedness
- Community Recovery
- Medical Countermeasure Dispensing
- Medical Material Management and Distribution
- Non-Pharmaceutical Interventions
- Emergency Operations Coordination
- Emergency Public Information and Warning
- Information Sharing
- Fatality Management
- Mass Care
- Medical Surge
- Volunteer Management
- Responder Safety and Health

Response principles

- The first priority is to save lives: respond to and treat the injured first
- Contamination with radioactive materials is not immediately life threatening
- Initial population activities should focus on preventing acute radiation health effects
- Fear of radiation may dominate response and management
- Radiological decontamination recommendations differ from those for chemical or biological agents
- Law enforcement resources may be simultaneously engaged in the investigative and criminal aspects of the event

U.S. Department of Justice
Federal Bureau of Investigation



RADIOLOGICAL/NUCLEAR

LAW ENFORCEMENT AND PUBLIC HEALTH

INVESTIGATION HANDBOOK



September 2011 Edition



U.S. Department of Health & Human Services
Centers for Disease Control and Prevention



Control Incident Perimeter

- Establishing the incident perimeter is critical for a successful and safe response and recovery
- Perimeter location depends on many factors including
 - Physical issues
 - The nature and severity of the radiation incident, e.g. RDD, IND, RED, nuclear reactor incident
 - The nature of co-existing threats like chemical and biological threats explosions, fires etc.
 - Likelihood of subsequent dangers or incidents in the area
 - Protecting critical infrastructure locations in the area
 - Managing risks from physical damage that has already occurred
 - Medical Issues
 - Responder safety
 - Public safety
 - Security issues
 - Using existing roads/structures/topography to help enforce security perimeters
 - Protecting/ gathering forensic information
 - Establishing/maintaining incident control locations
 - Protecting government and private institutions
- Boundaries reflecting levels of radiation from the incident may change over time as radiation decays

International Atomic Energy Agency Zone System

Agency	Zone Designation	Perimeter Designation	Exposure Levels	Activities and Guidelines
IAEA⁺ (See diagram)	Inside the inner cordoned area	---	Areas with > 100 mSv/h	<ul style="list-style-type: none"> • Only lifesaving actions should be performed in this area • Limit staying time to <30 minutes, or less, depending on measured level of radiation.
	Inner Cordoned Area ("Hot zone")	Safety Perimeter	>0.1 mSv/h	<ul style="list-style-type: none"> • Area around dangerous radioactive source where precautions should be taken to protect the responders and the public from potential external exposure and contamination.
	Outer Cordoned Area	Security Perimeter	---	<ul style="list-style-type: none"> • Access controlled, secure zone around the inner cordoned area. • Ambient dose rates in this area need to be at levels very close to background levels. • See diagram for response activities in this zone.

Local Response

Plan to receive a large population

- Potential for contamination
- Potential for injuries
- Some may need immediate medical care
- Most may need shelter/temporary housing
- All would be stressed

Local Response

- People need to be screened and triaged, preferably at locations other than area hospitals (more on this later)
- Response and recovery from detection to site decontamination could extend for months or years
- Biomonitoring might be performed for years

Planning Challenges in Response to Radiation Disasters

Public/Responder Reactions

- Plan for how people will respond, not how you want them to respond!
- Radiation effects are not clearly understood by the public
- Concern, anxiety, fear and panic
- Concerns about short and long term health effects
- Concerns about contamination/contagion
- Social stigma

Reactions Following Radiation Incidents

“When people are confused about their actual health risks, some will assume incorrectly that they have been exposed and will develop physical reactions.”

National Child Traumatic Stress Network (NCTSN) 2010

Planning Challenges in Response to Radiation Disasters

Surge on the Healthcare Sector

- Medical “home” may or may not be available
- Traditional places for seeking care (e.g. hospitals, clinics) may be overcrowded
- Staffing shortages
- Personnel Training
- Mental health vs. physical health triage
- Availability of prophylaxis or treatment medications
- Alternate care system and standards of care

Planning Challenges in Response to Radiation Disasters

Communication with the Public

- Information sharing-What? When? How?
- Social media
- Trusted informants
- Messaging to special needs populations, risk groups

Conceptual issues:

- Progressive radiation exposure
vs
- Sudden radiation exposure



WHERE TO GO IN A RADIATION EMERGENCY



GET INSIDE



STAY INSIDE



STAY TUNED



If a radiation emergency happens in your area, you should get inside immediately.

No matter where you are, the safest action to take is to: **GET INSIDE. STAY INSIDE. STAY TUNED.**

- Close and lock all windows and doors.
- Go to the basement or the middle of the building. Radioactive material settles on the outside of buildings; so the best thing to do is stay as far away from the walls and roof of the building as you can.
- If possible, turn off fans, air conditioners, and forced-air heating units that bring air in from the outside. Close fireplace dampers.
- Bring pets inside.
- Stay tuned for updated instructions from emergency response officials.



Adapted from Ventura
County Public Health,
Ventura County, CA



U.S. Department of
Health and Human Services
Centers for Disease
Control and Prevention

<http://emergency.cdc.gov/radiation>

BE INFORMED. BE PREPARED.

Know what to do in a radiation emergency.



GET INSIDE



STAY INSIDE



STAY TUNED

emergency.cdc.gov/radiation



Types of Contamination



Internal Contamination

Internal contamination occurs when people swallow or breathe in radioactive materials, or when radioactive materials enter the body through an open wound or are absorbed through the skin. Some types of radioactive materials stay in the body and are deposited in different body organs. Other types are eliminated from the body in blood, sweat, urine, and feces.



Radioactive Contamination

Radioactive contamination occurs when radioactive material is deposited on or in an object or a person. Radioactive materials released into the environment can cause air, water, surfaces, soil, plants, buildings, people, or animals to become contaminated. A contaminated person has radioactive materials on or inside their body.



External Contamination

External contamination occurs when radioactive material, in the form of dust, powder, or liquid, comes into contact with a person's skin, hair, or clothing. In other words, the contact is external to a person's body. People who are externally contaminated can become internally contaminated if radioactive material gets into their bodies.



Radiation Exposure

Radioactive materials give off a form of energy that travels in waves or particles. This energy is called radiation. When a person is exposed to radiation, the energy penetrates the body. For example, when a person has an x-ray, he or she is exposed to radiation.



Internal Contamination

Internal contamination occurs when people swallow or breathe in radioactive materials, or when radioactive materials enter the body through an open wound or are absorbed through the skin. Some types of radioactive materials stay in the body and are deposited in different body organs. Other types are eliminated from the body in blood, sweat, urine, and feces.



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Radiation Exposure

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How You Can Limit Contamination

Since radiation cannot be seen, smelled, felt, or tasted, people at the site of an incident will not know whether radioactive materials were involved. You can take the following steps to limit your contamination.

1. Get out of the immediate area quickly. Go inside the nearest safe building or to an area to which you are directed by law enforcement or health officials.
2. Remove the outer layer of your clothing. If radioactive material is on your clothes, getting it away from you will reduce the external contamination and decrease the risk of internal contamination. It will also reduce the length of time that you are exposed to radiation.
3. If possible, place the clothing in a plastic bag or leave it in an out-of-the-way area, such as the corner of a room. Keep people away from it to reduce their exposure to radiation. Keep cuts and abrasions covered when handling contaminated items to avoid getting radioactive material in them.
4. Wash all of the exposed parts of your body using lots of soap and lukewarm water to remove contamination. This process is called decontamination. Try to avoid spreading contamination to parts of the body that may not be contaminated, such as areas that were clothed.
5. After authorities determine that internal contamination may have occurred, you may be able to take medication to reduce the radioactive material in your body.

Public health response issues:

- Limited availability of medications
 - Potassium Iodide (KI)
 - Prussian Blue
 - Diethylene Triamine Pentaacetate (DTPA)
 - Neupogen and related cytokine /CSF drugs

Radiation Medical Countermeasures

- Potassium Iodide (KI) tablets
- Prussian Blue
- Ca-DTPA, Zn-DTPA
- Neupogen®

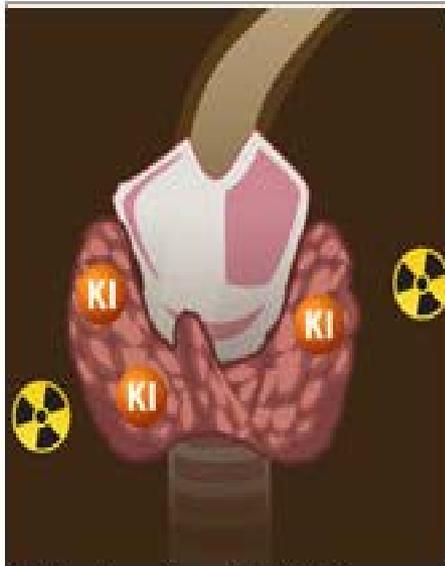


www.remm.nlm.gov

www.fda.gov/Drugs/EmergencyPreparedness/default.htm

Table 2. Countermeasures in Strategic National Stockpile

Name	Symbol or Brand Name	Targeted Radionuclide(s)	Benefit to Patients
Potassium iodide	KI	Iodine-131	Blocks radioactive iodine absorption in the thyroid
Prussian blue	$Fe_7(CN)_{18}$	Cesium-137 Thallium-201	Traps radioactive cesium and thallium in the intestines, keeping them from being reabsorbed by the body so that they are excreted
Calcium and zinc diethylenetriaminepentaacetic acid (DTPA)	Ca DTPA and Zn DTPA	Plutonium-239 Americium-241 Curium-244	Removes radioactive plutonium, americium, and curium by binding onto the materials so that they will be eliminated by the body
Cytokines	Neupogen, Neulasta, and Leukine	N/A	Stimulates growth of white blood cells to help recovery of the bone marrow



How does KI (potassium iodide) work?

The thyroid gland cannot tell the difference between stable and radioactive iodine. It will absorb both.

KI (potassium iodide) blocks radioactive iodine from entering the thyroid. When a person takes KI, the stable iodine in the medicine gets absorbed by the thyroid. Because KI contains so much stable iodine, the thyroid gland becomes “full” and cannot absorb any more iodine—either stable or radioactive—for the next 24 hours.

KI (potassium iodide) may not give a person 100% protection against radioactive iodine. Protection will increase depending on three factors.

- **Time after contamination:** The sooner a person takes KI, the more time the thyroid will have to “fill up” with stable iodine.
- **Absorption:** The amount of stable iodine that gets to the thyroid depends on how fast KI is absorbed into the blood.
- **Dose of radioactive iodine:** Minimizing the total amount of radioactive iodine a person is exposed to will lower the amount of harmful radioactive iodine the thyroid can absorb.

What is DTPA (Diethylenetriamine pentaacetate)?

DTPA (Diethylenetriamine pentaacetate) is a medicine that can bind to radioactive plutonium, americium, and curium to decrease the amount of time it takes to get radioactive plutonium, americium, and curium out of the body.

DTPA cannot bind all of the radioactive plutonium, americium, and curium that might get into a person's body after a radiation emergency.

DTPA cannot prevent radioactive plutonium, americium, and curium from entering the body.

How does DTPA work?

DTPA comes in two forms: calcium (Ca-DTPA) and zinc (Zn-DTPA). Both forms work by tightly binding to radioactive plutonium, americium, and curium. These radioactive materials (bound to DTPA) are then passed from the body in the urine.

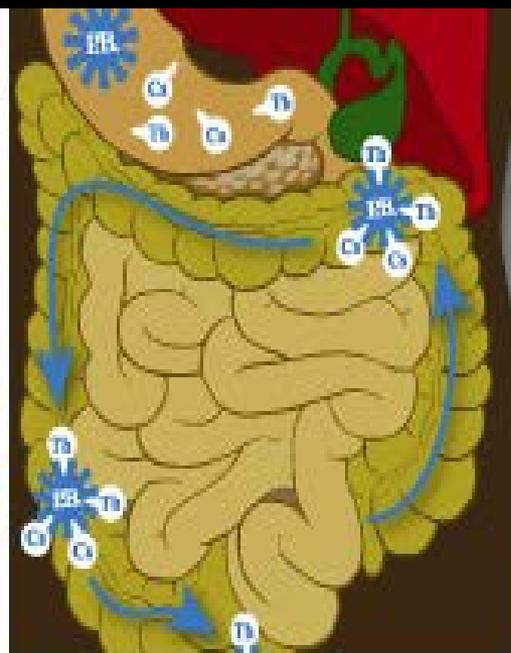
DTPA works best when given shortly after radioactive plutonium, americium, and curium have entered the body. The more quickly radioactive material is removed from the body, the fewer and less serious the health effects will be.

When given within the first day after internal contamination has occurred, Ca-DTPA is more effective than Zn-DTPA. After 24 hours have passed, Ca-DTPA and Zn-DTPA are equally effective.

After 24 hours, DTPA binds less effectively to radioactive plutonium, americium, and curium. However, DTPA can still work to remove these radioactive materials from the body several days or even weeks after a person has been internally contaminated

Cytokine	Adult Dose	Pregnant Women
G-CSF: filgrastim (Neupogen®)	<ul style="list-style-type: none"> • Subcutaneous administration • 5 ug/kg/day via single daily injection • Continued until absolute neutrophil count > 1.0×10^9 cells/L 	Class C (Same as adults)
Pegylated G-CSF: pegfilgrastim (Neulasta®)	<ul style="list-style-type: none"> • 1 subcutaneous dose, 6 mg • Consider second 6 mg dose 7 or more days after initial dose, if significant neutropenia persists 	Class C (Same as adults)
GM-CSF: sargramostim (Leukine®)	<ul style="list-style-type: none"> • Subcutaneous administration • 250 ug/m²/day • Continued until absolute neutrophil count > 1.0×10^9 cells/L 	Class C (Same as adults)

G-CSF = granulocyte colony-stimulating factor; GM-CSF = granulocyte-macrophage colony-stimulating factor.



How does Prussian blue work?

Prussian blue traps radioactive cesium and thallium in the intestines and keeps them from being re-absorbed by the body.

The radioactive materials then move through the intestines and are passed (excreted) in bowel movements.

Because Prussian blue reduces the time that radioactive cesium and thallium stay in the body, it helps limit the amount of time the body is exposed to radiation.

Prussian blue reduces the **biological half-life** of cesium from about 110 days to about 30 days.

- Prussian blue reduces the biological half-life of thallium from about 8 days to about 3 days.

Prussian blue binds cesium and thorium





Where can I get Prussian blue?

Prussian blue is available only by prescription.

People **SHOULD NOT** take Prussian blue artist's dye in an attempt to treat themselves. This type of Prussian blue is not designed to treat radioactive contamination and can be harmful.

More detailed information on Prussian Blue can be found at the [FDA Website](#) 

Protocols at hospitals

Prototype for Adult and Pediatric Medical Orders During a Radiation Incident

 [View/Print as PDF](#) (PDF - 565 KB)

CAUTIONS



- Authored by [REMM](#) and [RITN](#) physicians, this set of orders is a prototype only.
 - **Orders must be customized for each patient and incident.**
 - Specific drugs are suggested for function only. Patients may not need any/every category of drug listed.
 - No HHS, CDC, FDA, or other US government entity endorsement of specific drugs or drug doses is intended or implied by inclusion in this order set.
 - Consult the notes at the end of this document for additional, key information.
-

Internal contamination (decorporation treatments)

- This **Adult and Pediatric Orders Prototype** lists only FDA-approved medications as radioisotope countermeasures.
 - Some, but not all of these drugs are currently in the [Strategic National Stockpile](#).
 - Prescribers should consult the FDA drug label for complete prescribing information.
 - Decorporation drugs should be used in children with great caution.
 - The online version of REMM has additional recommendations about [additional countermeasure drugs that may be considered](#).
 - This prototype does **not** address threshold levels of [internal contamination](#) that would trigger initiation, continuation, or discontinuation of decorporation treatment. See [REMM Countermeasures Caution and Comment](#), which discusses this issue.
-

Public health and medication response

- Logistical Issues:
 - Delivery
 - Time is of the essence
 - Transportation
 - Public safety vehicles
 - Courier
 - Locations
 - Hospitals
 - Homes
 - Community Reception Centers



Home

Potassium Iodide

Emergency Kits

Radiation Detector

Radiation Filtration Straw

Emergency Preparedness

Nuclear vs Dirty Bombs

Nuclear Reactor Maps

ALL PRODUCTS

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STORE



1,803 people like this. Be the first of your friends.



FDA and DHS Approved RADIATION PROTECTION



DETECT: A back-up to the reliance of government officials, such as FEMA, would be the possession of a small, discreet, personal radiation detector. Instant detection of dirty bomb and nuclear radiation. First to know - First to escape.



BLOCK: Saturate the thyroid with FDA Approved **Iosat Potassium Iodide** so it won't absorb cancer-causing radioactive iodine, the predominate radioisotope released from a nuclear reactor accident or nuclear weapon detonation.



DECONTAMINATE: Decontamination of yourself or your environment may be necessary. We offer radiation decontamination kits for dirty bomb, nuclear, and medical facility radiation.

What's potassium iodide?

Stockpiling of potassium iodide (KI) is highly recommended by health officials worldwide to prevent thyroid cancer of those exposed to radioactive iodine. Radioactive iodine is the predominant radioisotope released from a nuclear reactor accident or detonation of a nuclear weapon (due to nuclear fission) and can travel hundreds of miles downwind, such as it did after the Chernobyl accident.

BLOCK



FDA Approved in 1982
Made in the U.S.A.

Buy 10, get 1 free
Buy 20, get 2 free, etc.

IOSAT™ Potassium Iodide

- 14 130mg tablet
- Individually foilsealed for single unit dosing
- No prescription - OTC
- Exp date: January 2020

[More info](#)



\$34.99

Radiation Water Filtration Straw

- Removes radiological contaminants from up to 25 gallons of fresh water.

[More info](#)

BLOCK | DECONTAMINATE



Nukepills™ Family Emergency Kit

- Family-pack supply of Potassium Iodide

BLOCK

Fruit flavored for kids

ThyroShield™ Liquid Potassium Iodide

- 30ml liquid w/ dropper
- Exp. Date: Feb 2016

Decontamination as a Response Issue

- Department of Defense supports transport of injured
 - Current protocols: injured must be stable and decontaminated before they will be accepted for transport

- American Red Cross supports public shelters
 - Current protocols: Before entering a shelter, evacuees need to be free of radioactive contamination



Default Thinking on Dealing with "Contaminated" Public

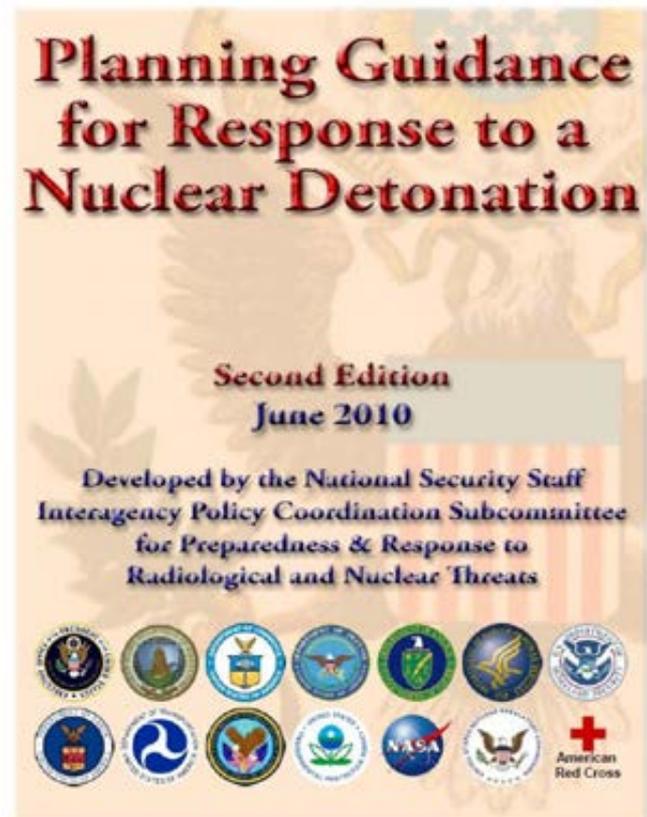
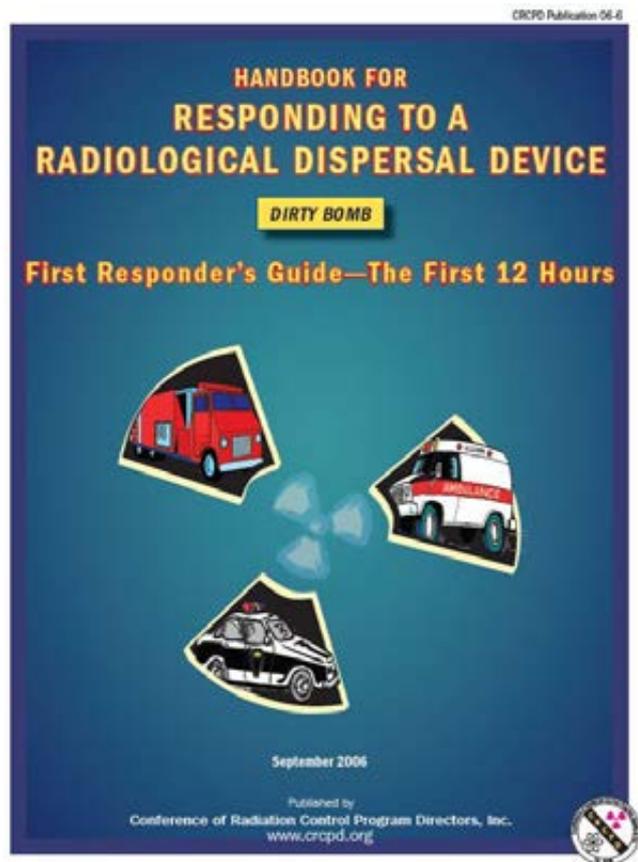


Decontamination





References



www.crcpd.org/RDD.htm
www.rehnm.nlm.gov/PlanningGuidanceNuclearDetonation.pdf

Guidelines for Handling Decedents Contaminated with Radioactive Materials



Prepared by Charles M. Wood,¹ Frank DePaolo,² R. Doggett Whitaker³

¹Radiation Studies Branch, Division of Environmental Hazards and Health Effects, National Center for Environmental Health,
Centers for Disease Control and Prevention, Atlanta, Georgia
²Office of Chief Medical Examiner, New York, New York
³National Funeral Directors' Association



Planning Challenges in Response to Radiation Disasters

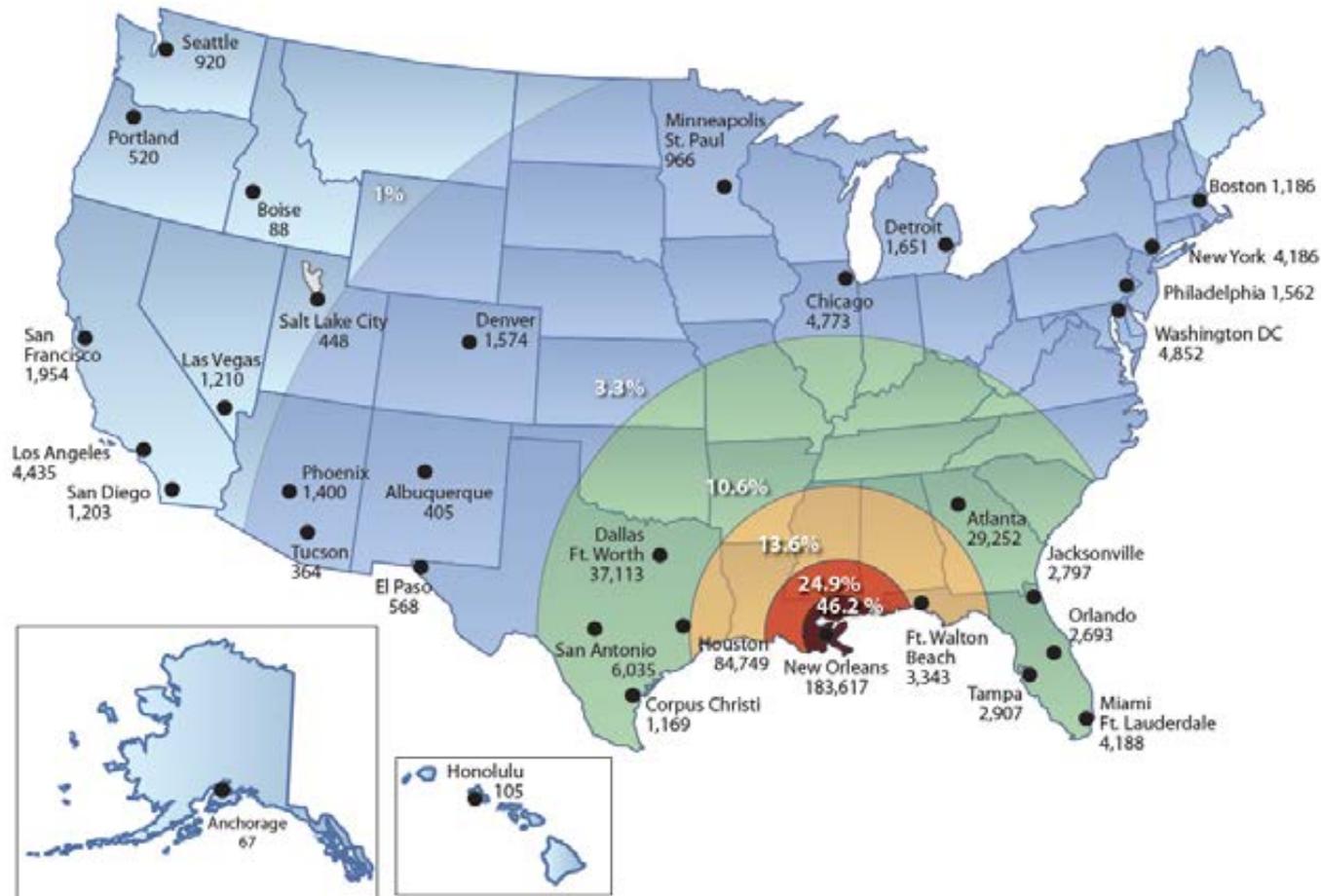
Evacuation

- Determining when, who, where, and how
- Addressing special needs populations
- Setting up evacuee receiving sites
- Determining the services offered at these sites
- Population monitoring (short/long term) and decontamination
- Pets

Example: Displaced Population

- **Chernobyl (1986)**
 - 116,000 initially from the 30-km radius
 - 210,000 additional from Ukraine, Belarus, and Russia
- **Fukushima (2011)**
 - 170,000 from the 20-km radius
 - 450,000 people occupy 2600 evacuation centers
- **Our National Planning Scenarios**
 - IND (scenario 1) – One million + self evacuate
 - RDD (scenario 11) – Hundreds of thousands self evacuate

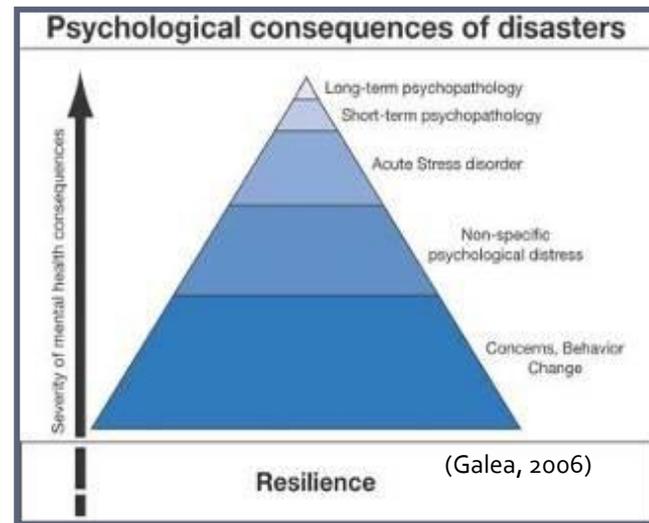
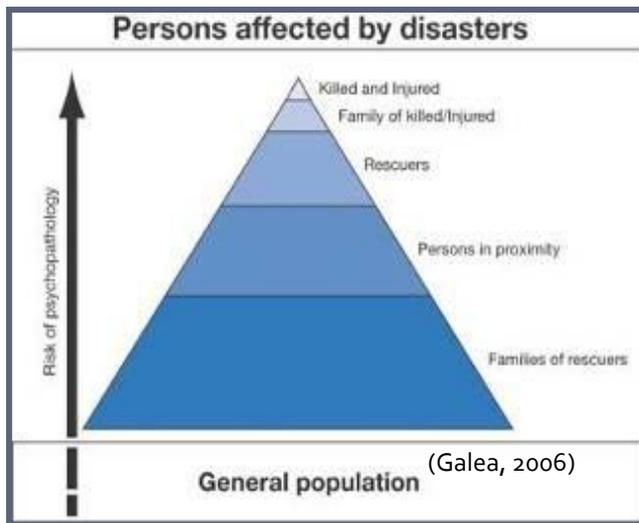
Displaced Population - Katrina (2005)



Sources: The Times-Picayune, October 13, 2005; FEMA, Census Bureau, Queens College Sociology Dept.

Psychological response principles

- Most disaster survivors experience 'expectable' reactions and are generally capable of functioning effectively in the aftermath of a disaster.
- The vast **majority** of survivors do not develop long term psychiatric disorders.
- However, some will go on to develop both short and long term mental health problems.



Disaster Reactions Over Time

- 20-50% of individuals exposed to disasters experience psychological responses that are:
 - Immediate (onset within one month of trauma)
 - Mild (fewer symptoms than needed for full diagnosis)
 - Transient (symptoms are less than 1 year in duration)
- Majority recover fully from any psychological effects within 12-18 months
- May be longer for human-caused disasters



RESPONSE CHARACTERISTICS



Reactions Following Radiation Incidents

- Radiation emergencies may cause psychological traumatic stress, with both short and long-term effects
- Extend beyond the individuals directly affected.
- Situations with a high degree of uncertainty, regarding potential future health effects, may be more psychologically traumatic than others.

Reactions Following Radiation Incidents

Medical Professionals and First Responders

- Have limited experience in managing casualties from radiation events.
- May experience fear, shock, anger, helplessness and worry
- May be concerned about exposing family/friends

Psychological support services, education and training may mitigate potential staff shortages during these incidents

Example: Planning for Public Shelters

- Public shelter locations
- Radiation screening staff and equipment



Public Shelters & Reception Centers



what is population monitoring?_____

Population monitoring is a process that begins soon after a radiation incident is reported continues until all potentially affected people have been monitored and evaluated for

- *Needed medical treatment.*
- *The presence of radioactive contamination on the body or clothing.*
- *The intake of radioactive materials into the body.*
- *The removal of external or internal contamination (decontamination).*
- *The radiation dose received and the resulting health risk from the exposure.*
- *Long-term health effects.*

Population monitoring

The Objectives of Population Monitoring

With these key objectives in mind, you may use this guide to work through your planning process for population monitoring.

- *Identify individuals whose health is in immediate danger and who need immediate care, medical attention (whether radiation-related or not), or decontamination.*
- *Identify people who may need medical treatment for contamination or exposure, further evaluation, or short-term health monitoring.*
- *Recommend (and to the extent possible, facilitate) practical steps to minimize risk of future health consequences (e.g., cancer).*
- *Register potentially affected populations for long-term health monitoring.*

Population Monitoring



population monitoring in radiation emergencies:
a guide for state and local public health planners



Developed by the Radiation Studies Branch
Division of Environmental Hazards and Health Effects
National Center for Environmental Health
Centers for Disease Control and Prevention
U.S. Department of Health and Human Services
August 2007

PREDECISIONAL DRAFT





Epidemiology

Evaluation of subjects, gathering samples,
and recording of data is a serial process
Any step can be rate-limiting
Public health agencies must maximize
efficiency of data collection during disasters
Little evidence comparing efficiency and
utility of data collection tools in a disaster

Community Reception Centers

Local response strategy for conducting population monitoring

- Multi-agency effort, public health lead
- Staffed by government officials and organized volunteers
- Opened 24-48 hours post event
- Located outside of hot zone
- Comparable to PODs, NEHCs



Community Reception Centers

- Services include:
 - Contamination screening
 - Decontamination
 - Information
 - Limited medical care
- Main purpose is to prioritize people for further care
 - Ease burden on hospitals
 - Manage scarce medical resources
 - Registry



Origin



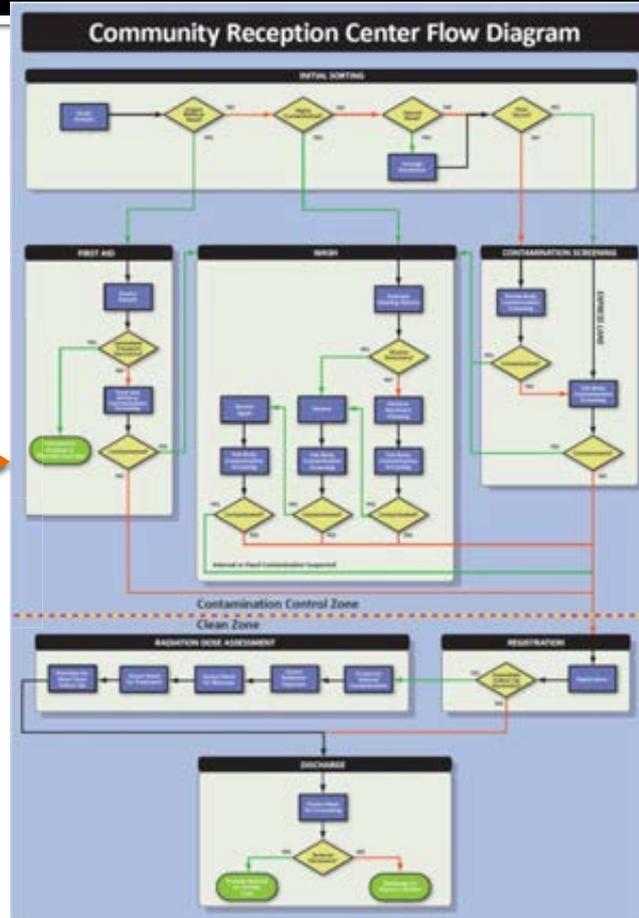
CRC



Endpoint

Affected Area

Surrounding Community

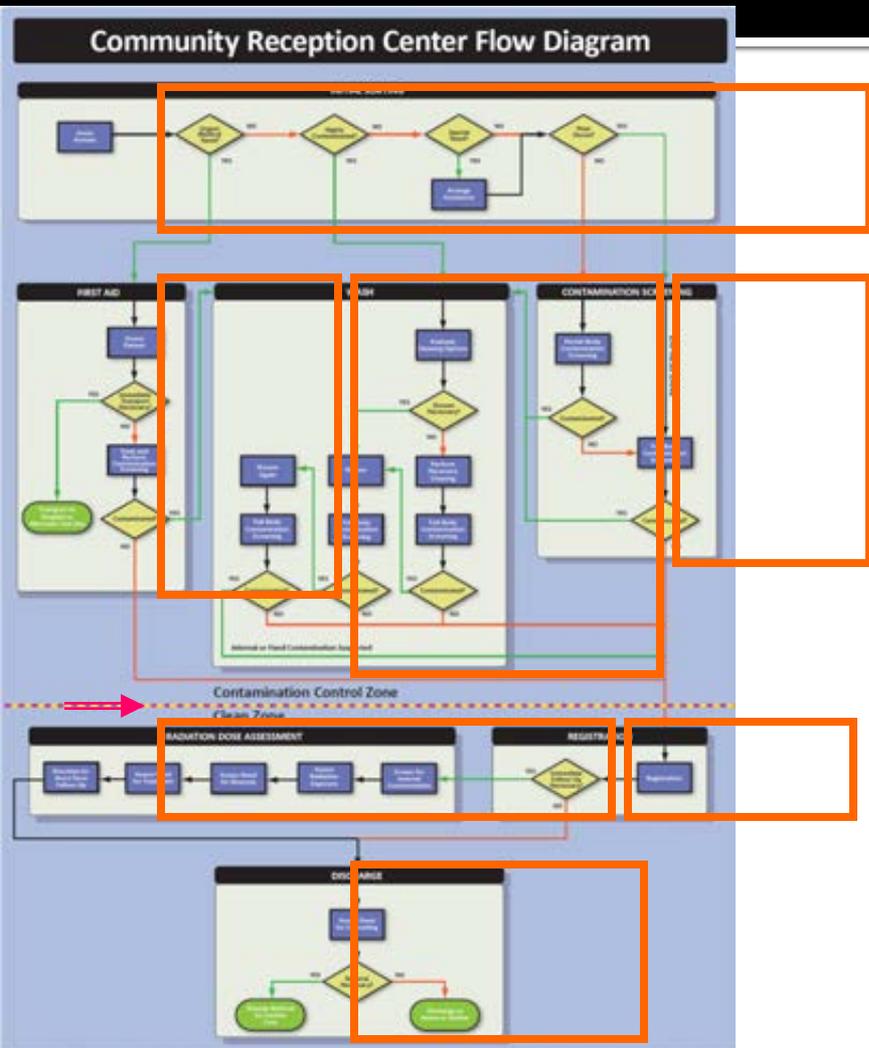


Home

Public Shelter

Hospital or Alternate Care Site

Community Reception Center Process Flow



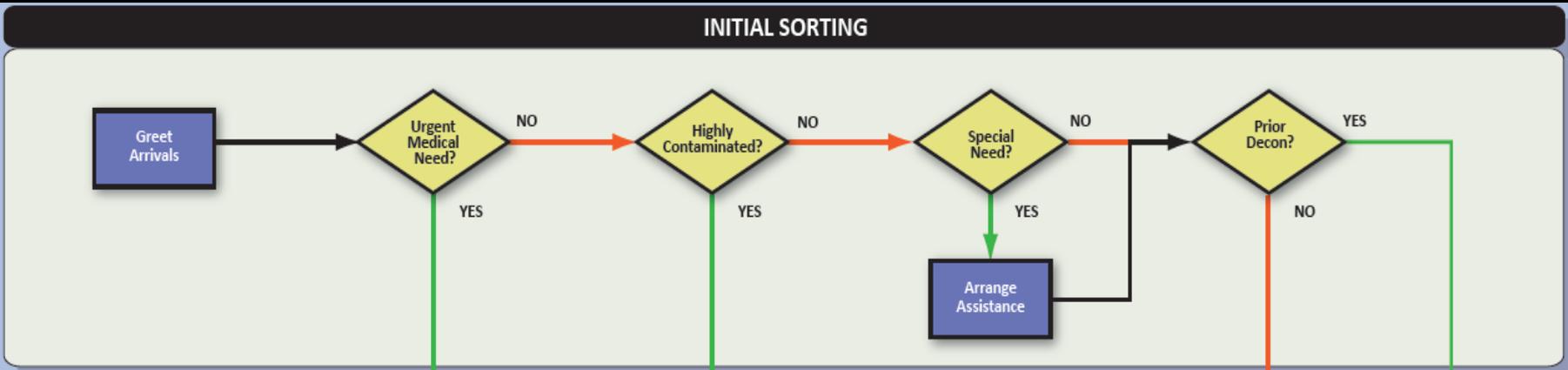
7 Stations:

- Initial Sorting
- First Aid
- Contamination Screening
- Wash

Contamination Control Zone
Clean Zone

- Registration
- Radiation Dose Assessment
- Discharge

Initial Sorting

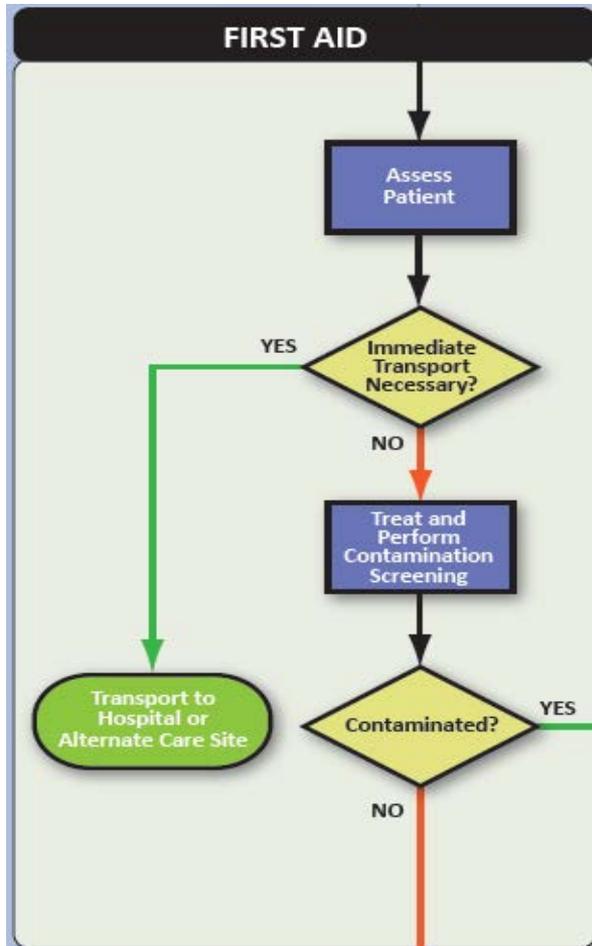


Staff identify people who have :

- Urgent medical needs
- High levels of contamination
- Special needs
- Decontaminated before coming to the CRC



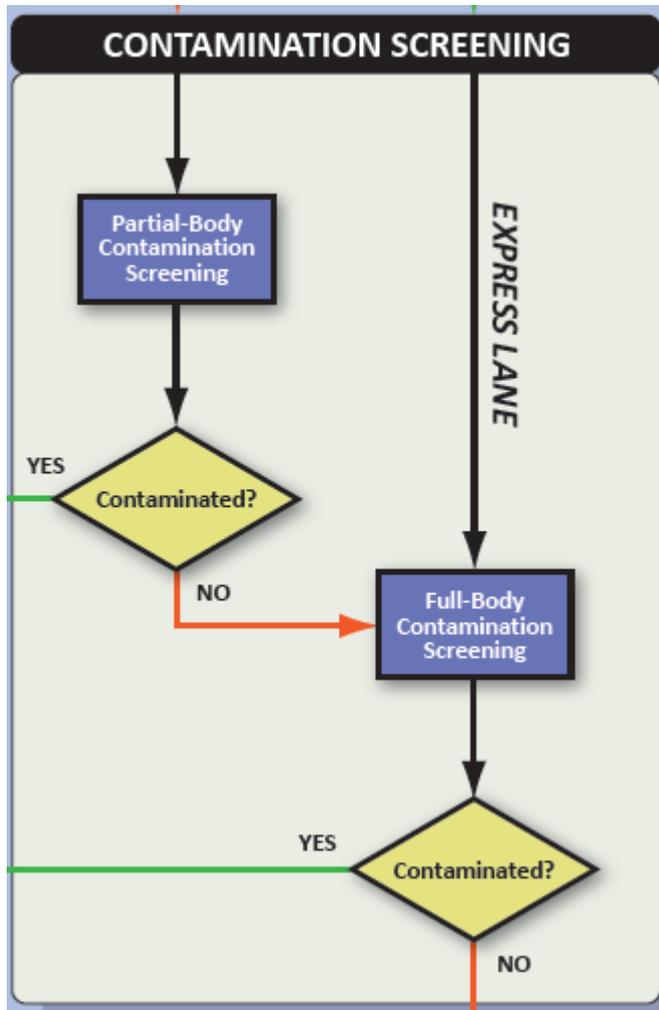
First Aid



- Medical staff care for and/or transport patients with urgent medical needs
- Life saving care takes priority!
 - Do not delay transport for decontamination!



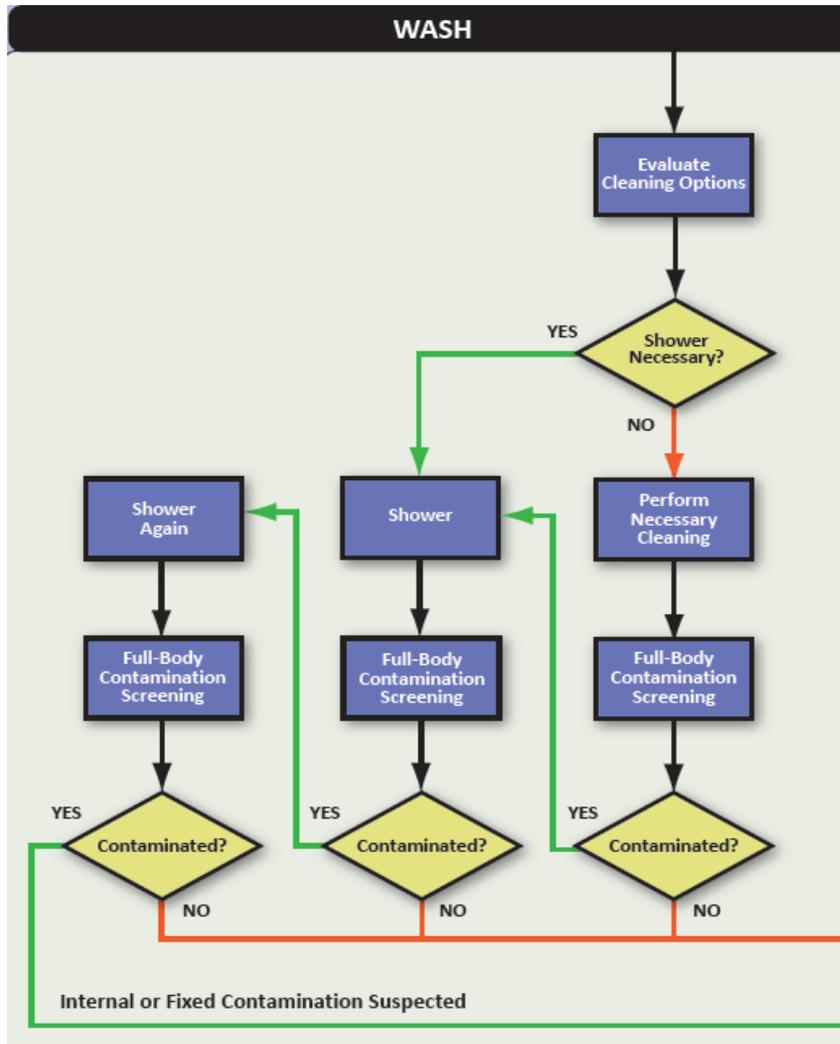
Contamination Screening



- Staff screen people for external contamination
- Radiation detection equipment
 - Consult your state or local radiation control authority for assistance



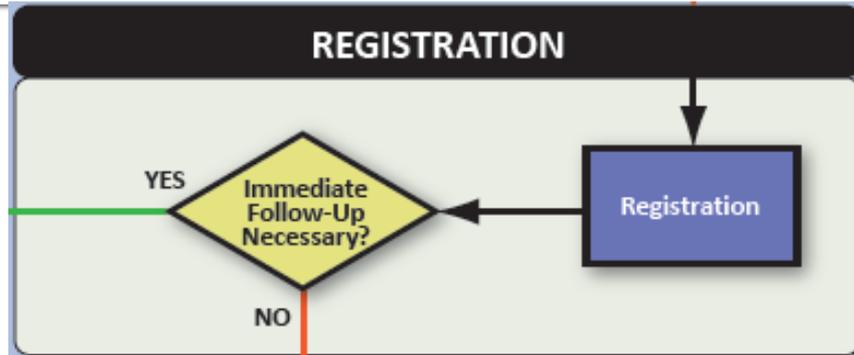
Wash



- Staff monitor and facilitate showering
- People wash themselves
- People with special needs may require additional assistance



Registration

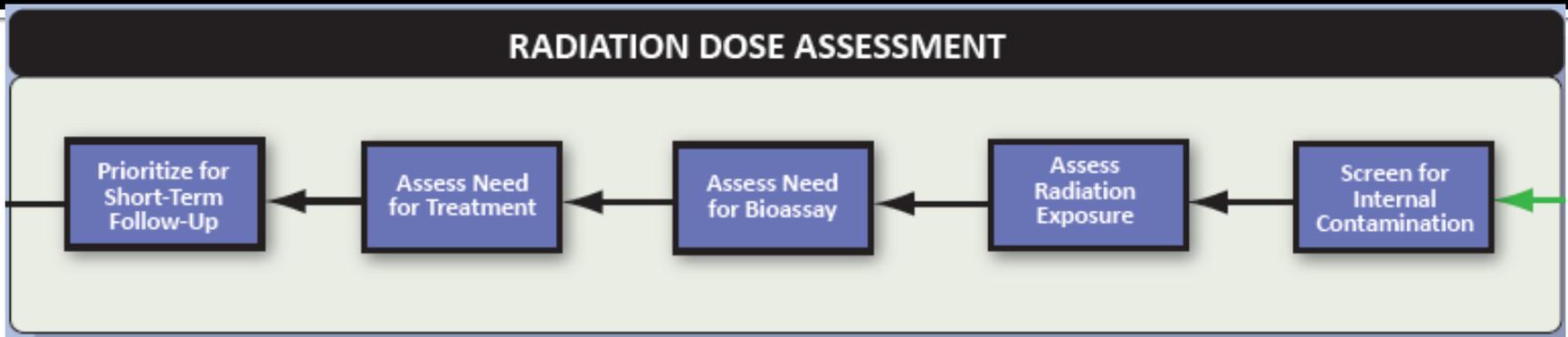


Staff collect information for registry and long-term follow-up:

- Patient name
- Contact information
- Destination
- Proximity to event
- Time in affected area



Radiation Dose Assessment

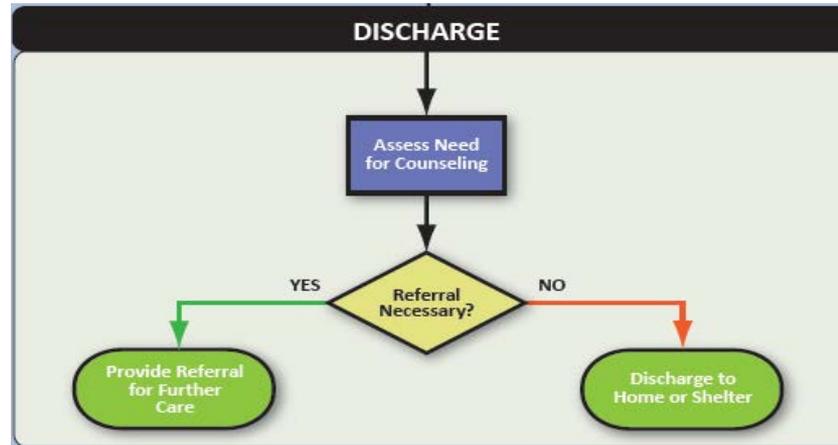


Clinical and health physics staff:

- Screen for internal contamination
- Assess radiation exposure
- Assess need for bioassay
- Assess need for treatment
- Prioritize for short-term follow-up



Discharge

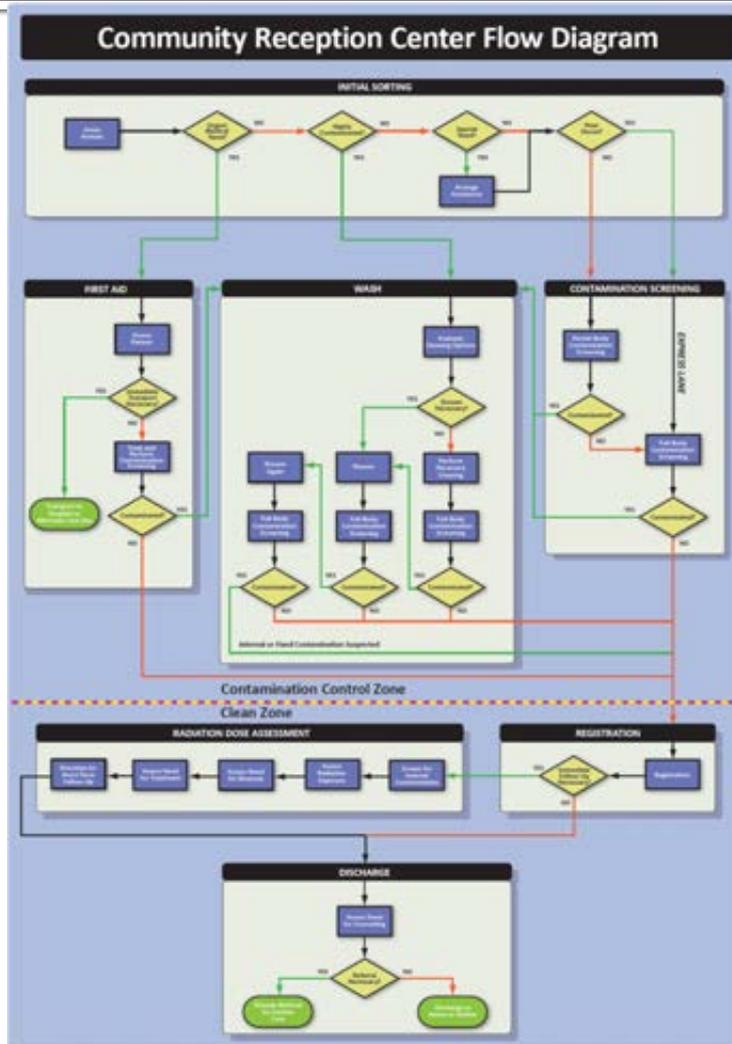


Staff provide information for people discharged:

- Assess need for counseling
- Discharge to home or shelter
- Provide referral for further care



Community Reception Center Process Flow



- Process can be adjusted to meet capabilities
 - Instrumentation
 - Personnel
- Additional processes can be added as needed or as possible
 - Pets
 - Relocation services

vCRC Demo

Virtual Community Reception Center

INTRODUCTION | RESOURCES | GLOSSARY | HELP

My View: Initial Sorting



Information

Area Description

Initial Sorting

The Initial Sorting Station is where people enter the community reception center (CRC). Staff here welcome and direct people where they need to go in the CRC.

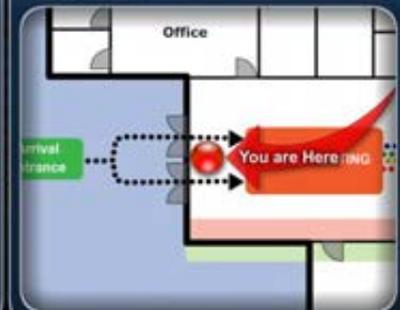
Info Spots

Resources

Flow Chart



Floor Plan



Key Planning Questions

- ① Could your community be affected by a nuclear or radiological emergency?
- ② What are the public health roles in radiation emergencies?
- ③ **Is “radiation” included in your All-Hazards planning?**

Resources: CDC/ORISE/REACTS





BRIDGING THE GAPS:

Public Health and Radiation Emergency Preparedness



CDC Radiation Emergencies | Information for Public Health Professionals

http://www.bt.cdc.gov/radiation/publichealth.asp

CDC Home



Centers for Disease Control and Prevention

CDC 24/7: Saving lives, protecting people, reducing health costs

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Emergency Preparedness and Response



http://www.remm.nlm.gov/remm_PublicHealth.htm

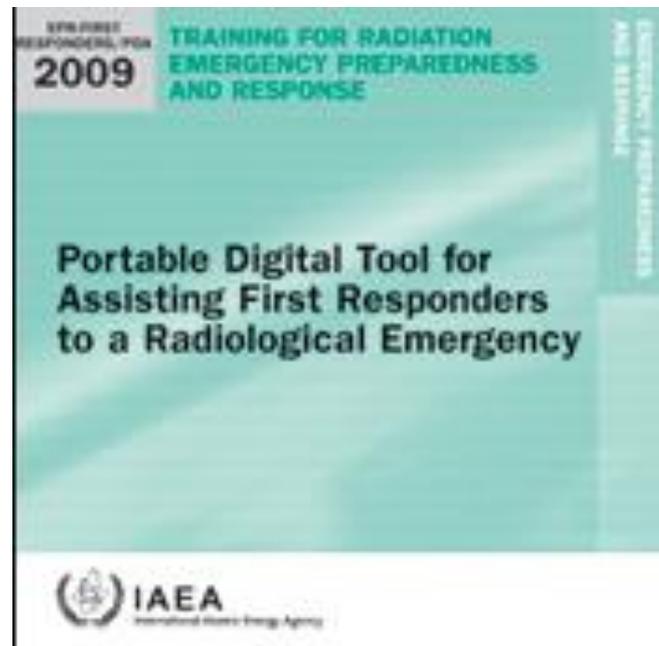
U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES

REMM

RADIATION EMERGENCY MEDICAL MANAGEMENT

Guidance on Diagnosis & Treatment for Health Care Providers

Smartphone apps and web resources are expanding



A lagniappe on late radiation effects

Federal Standards, Permissible Levels Of Radiation Exposure to Whole Body (1994 unless noted otherwise)

Millirems above natural background levels (average 300) and medical radiation:

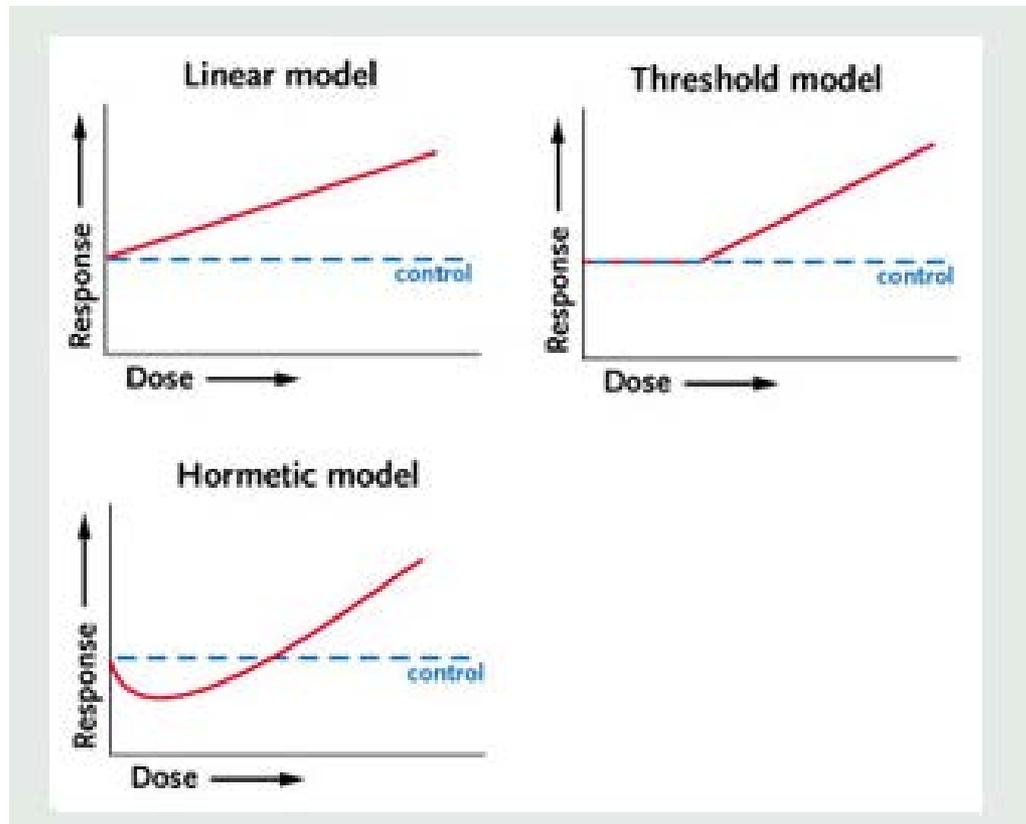
25,000-Astronauts, per Space Shuttle mission. This also was the annual occupational limit for adults from World War II through 1950.

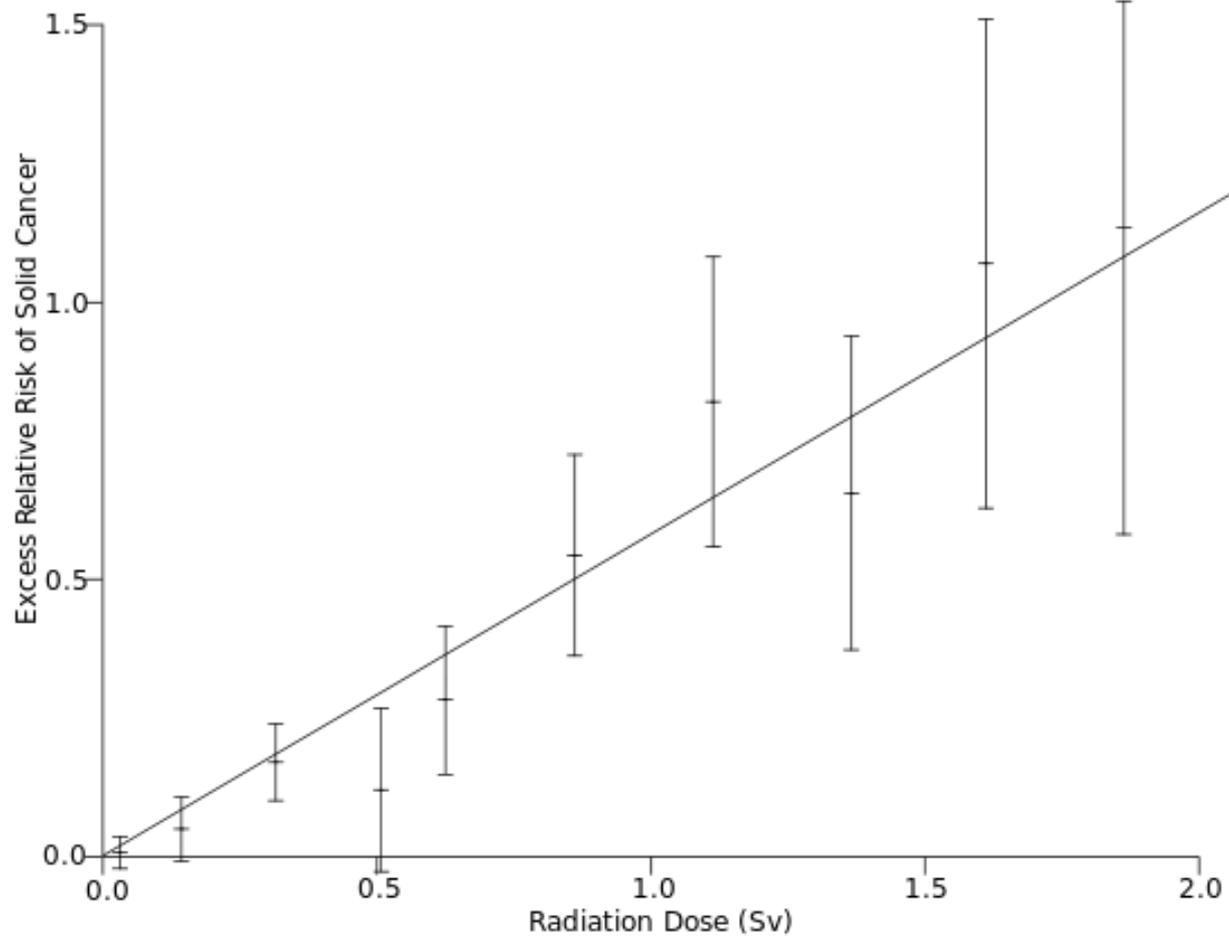
15,000-1950 to 1957 occupational limit per year for adults, including radiation workers and soldiers. Limit changed in 1957 to 5,000 millirems.

5,000-(Since 1957) Occupational limit per year for adult radiation workers, including soldiers exposed to radiation. It is "as low as reasonably achievable; however, not to exceed 5,000 millirems." It is recommended that lifetime cumulative exposure is not to exceed the age multiplied by 1,000 millirems.

500-Occupational limit per year for a minor under 18 exposed to radiation. An embryo or a fetus of a pregnant worker exposed to radiation (a new regulation as of Jan. 1, 1994) is not to exceed more than 500 cumulated total millirems before birth, and it is recommended that the exposure of a fetus be limited to no more than about 50 millirems above background levels per month.

Models of cellular response to radiation injury





Linear, no threshold model

The LNT model was introduced as a concept to facilitate radiation protection.

The use of this model has led to the claim that even the smallest imaginable dose has the potential to be carcinogenic. This concept is highly hypothetical and is not presently supported by epidemiological or laboratory data.

There are medical, economic, and societal dynamics of our present risk application. These have tremendous influence on the public health response to a radiation emergency.

Japanese atomic survivor cancer patterns

Of the 200,000 registered Japanese survivors who received radiation exposure, over 40% are still alive

The radiation exposures were essentially full body, single dose

Leukemia risks began to appear at about five years after the bombings

Solid tumor risks were much slower to appear

Both leukemia and solid tumor risks seemed to be dose dependant

Japanese atomic survivor cancer patterns

Of one study cohort of 120,000 people, there were 219 deaths from leukemia between 1950-2002

45% (98 people) had leukemias which could be statistically attributed to the radiation exposure

The ratio of radiation induced leukemias varied with dose. At over 100 rem, 86% of leukemias could be attributed to radiation exposure. At dose of 10-50 rem, 36%; and at dose 0.5 rem to 10 rem, 5% could be attributed.

Japanese atomic survivor cancer patterns

In a cohort of 100,000 Japanese people from Hiroshima and Nagasaki followed until 2002, there were 7,851 deaths from cancer. 11% of these could be attributed to the radiation exposure.

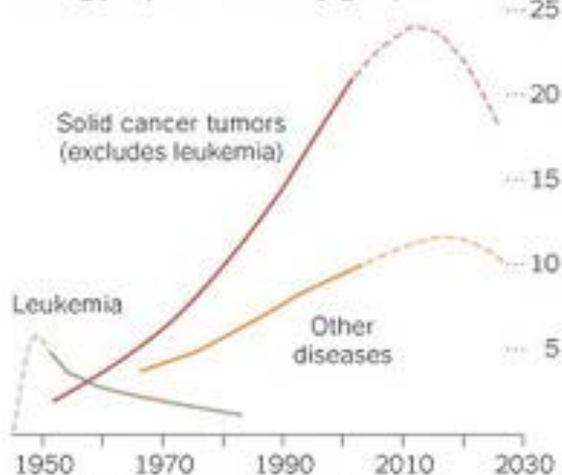
As was seen in leukemia, risk increased with dose.

Potential carcinogenic confounders such as burn injury, inflammation events, altered health habits, blast/dust effects can't be parsed easily

After Hiroshima and Nagasaki

A study of 120,000 atomic bomb survivors and unexposed residents of Hiroshima and Nagasaki found that excess deaths from leukemia peaked within five years, while other cancers took longer to develop. Cancer risk increased with radiation dose.

Excess deaths attributed to atomic bomb radiation
Among people in the study group



Note: dashed lines are estimates

Source: Disaster Medicine and Public Health Preparedness

THE NEW YORK TIMES

Chernobyl event

**Average 20 yr cumulative excess radiation dose 1986-2005
10-30 mSv**

**In highest contaminated areas (exclusion zone) average
20 yr effective dose
50 mSv**

**Compare to many world areas where background radiation is
much higher than Ukraine, on the order of excess over world
average of 200 mSv in 20 years**

Chernobyl WHO surveys

NO increase in

Leukemias

Solid tumors (other than thyroid cancers)

Stillbirths

Miscarriages

Mental retardation

INCONCLUSIVE data

Birth defects

Chernobyl and thyroid cancers

- Aggressive thyroid cancers in children began to appear at 5 yrs
 - Baseline iodine insufficiency in region
 - Diet with significant caloric percentage from cow's milk
- Dose threshold for thyroid cancer seems to be about 200mSv
- City of Pripyat received iodine 6 to 30 hrs after event began—rate of thyroid cancer 1/6 of surrounding region
- Model suggests that if iodine had been made available and if warnings communicated regarding milk and leafy vegetables , thyroid cancer rate would have been ~5% of observed

Radiation health risks in nuclear industry

Among 400,000 U.S. workers with lifetime exposures of 150 mSv or less, the health outcomes are indistinguishable from matched cohorts

There has been no established increased risk for solid tumor incidence up to a threshold of 400 mSv

Leukemia threshold seems to be about 200 mSv, but at magnitude of a 1.08 risk factor.

A large scale Canadian database study found cancer incidence risk for nuclear workers to be 0.7x of matched controls.

Radiation hormesis in humans?

Life on earth evolved in a bath of ionizing radiation at levels much higher than present.

Aerobic organisms developed defenses against metabolically induced reactive oxygen species while evolving sophisticated means of DNA repair and elimination of damaged cells.

Many lines of data show that these defenses are upregulated at low level of radiation, and are more pronounced in fractionated or continuous low-level exposures.

Radiation hormesis in humans?

Kerala region of India has high background radiation due to sandy soil rich in thorium. Lifetime background exposure to gamma radiation can be 70 to 80 X that received in London.

Kerala has no excess cancer incidence or mortality compared to remainder of India. Leukemia rates are lower than expected.

Radiation hormesis in humans?

In Taiwan in the 1950s, Co 60 was inadvertently incorporated into tons of steel destined for construction. For residents in those buildings the lifetime excess radiation can approach 1,000 times background radiation.

Yet, overall cancer incidence is 40% of expected and mortality is less than 50% of that of matched national cohorts.

Only leukemia in men (6 : 1.9 o:e) and thyroid cancer in women (6 : 2.8 o:e) were noted.

Overestimating radiation risks can have severe detrimental effect

Misinformation and faulty risk models led to likely unnecessary traumatic evacuations of about 200,000 Ukrainian and Belarussian people.

An estimated 1,250 excess suicides occurred in distraught people, many of whom had false impressions of risk for health outcomes.

Between 100,000 and 200,000 elective abortions were performed in anxious women concerned over birth defect risks. Many were documented in western Europe.

Epidemiologists have identified elevated patterns of risky behaviors and increased substance abuse patterns in survivors.

Use of terms like “victims” and “afflicted” have created personal and social barriers to good health