Ukrainian Situation Brief: Rad Hazard Response

1Q22
Jeff Semancik
Radiation Director, CT DEEP
Type 1 ROSS

No specific threat but…

Ukraine invasion: Would Putin press the nuclear button?

By Steve Rosenberg
BBC News, Moscow

1 day ago

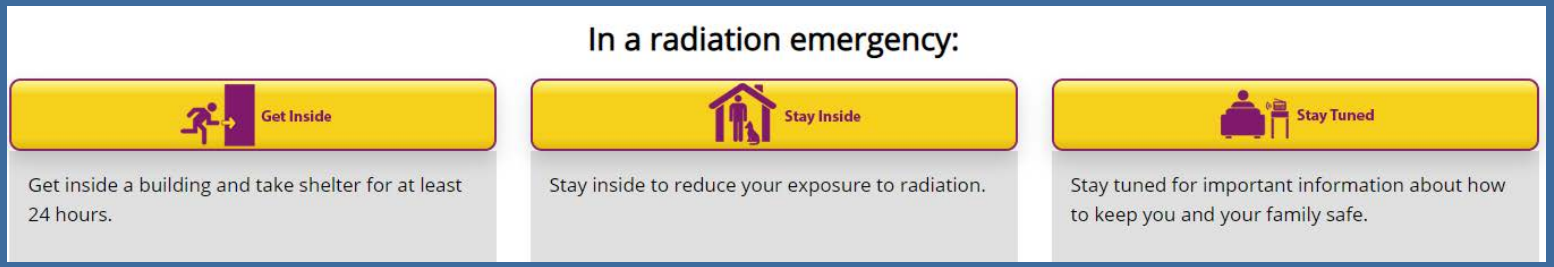
'Putin might do the unthinkable': Former intelligence chief warns that the conflict in Ukraine has increased the risk of nuclear war.

Russia attacks Ukraine nuclear plant as invasion advances

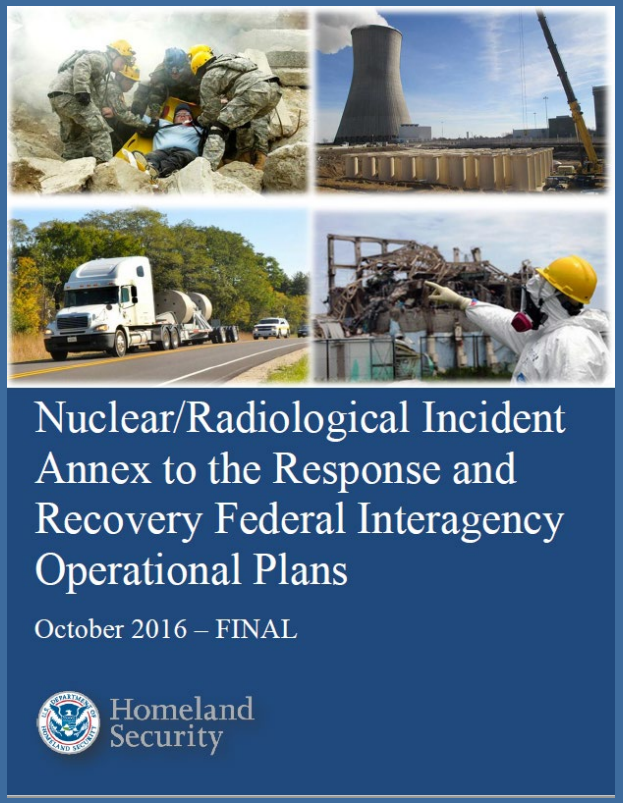
By JIM HEINTZ, YURAS KARMANAU and MSTYSLAV CHERNOV March 3, 2022

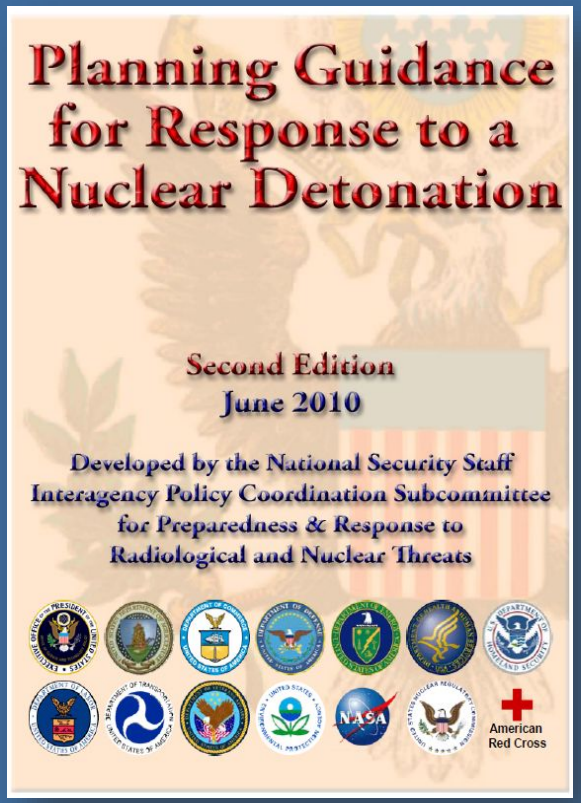
Response

- We have national response plans and protocols
- Local actions in the first hours can save lives
- Break the nuclear power plant paradigm
- We have trained ROSS to support decision makers



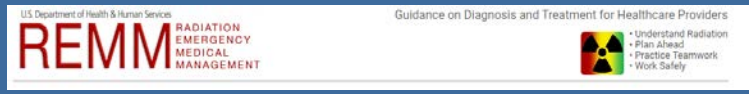
Playbook for DEMHS REP and DEEP Radiation



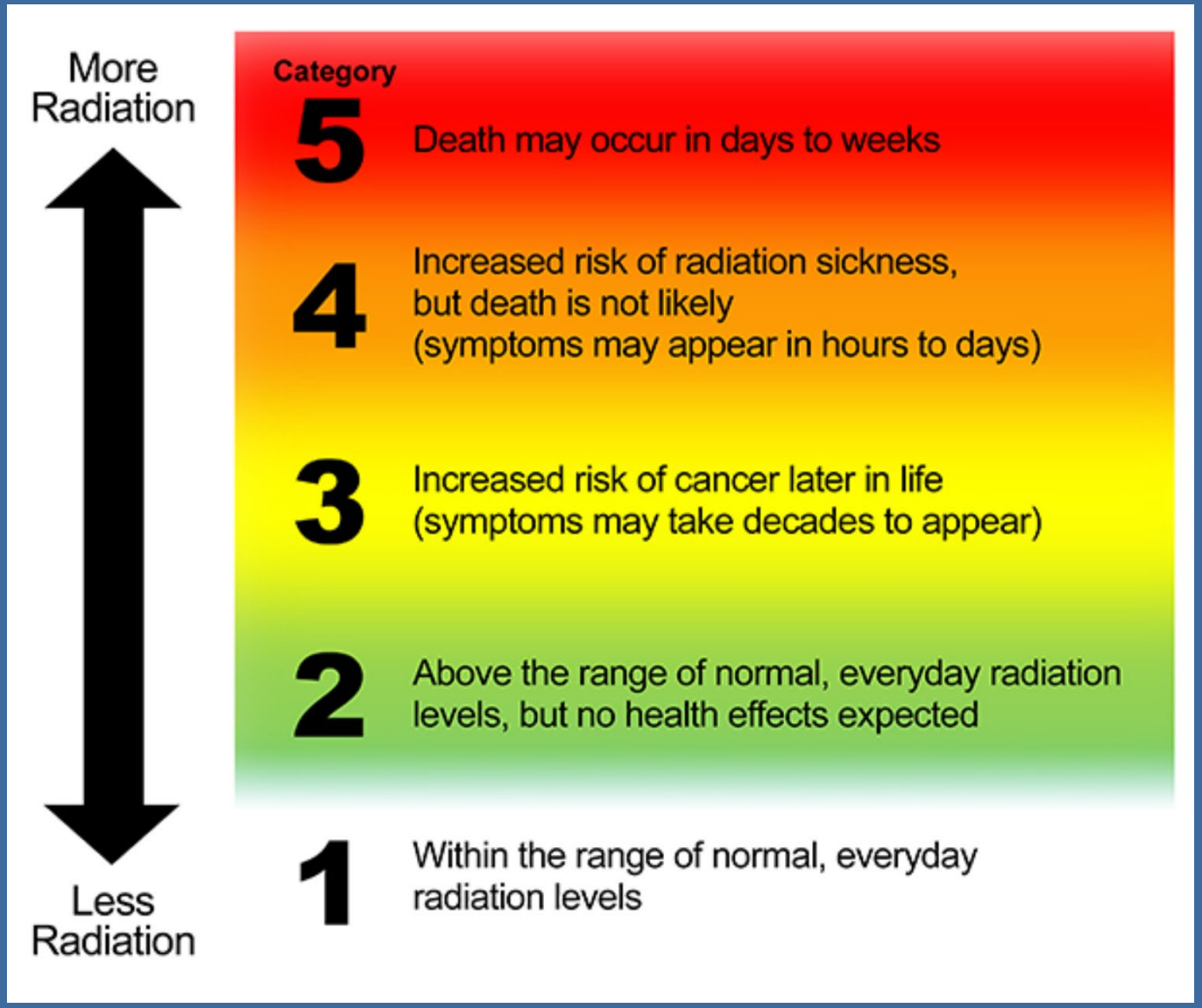


Resources

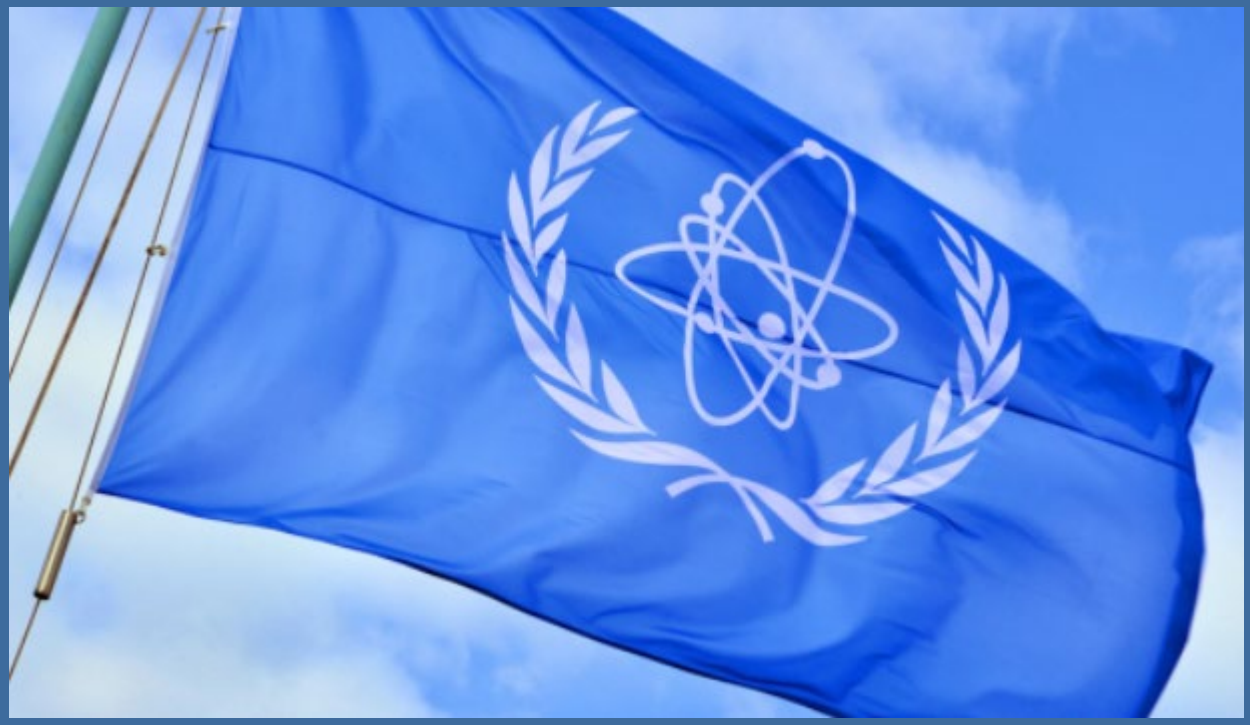
- For LPAC
  - Radiation Emergencies | NCEH | CDC
    - Myths of Radiation: Communicating in Radiation Emergencies (cdc.gov)
  - REMM - Radiation Emergency Medical Management (hhs.gov)
  - Radiation Emergencies | FDA
  - Resources for Medical Professionals - ORISE (orau.gov)



Review - Rad Hazard Scale



Potential Reactor Incidents

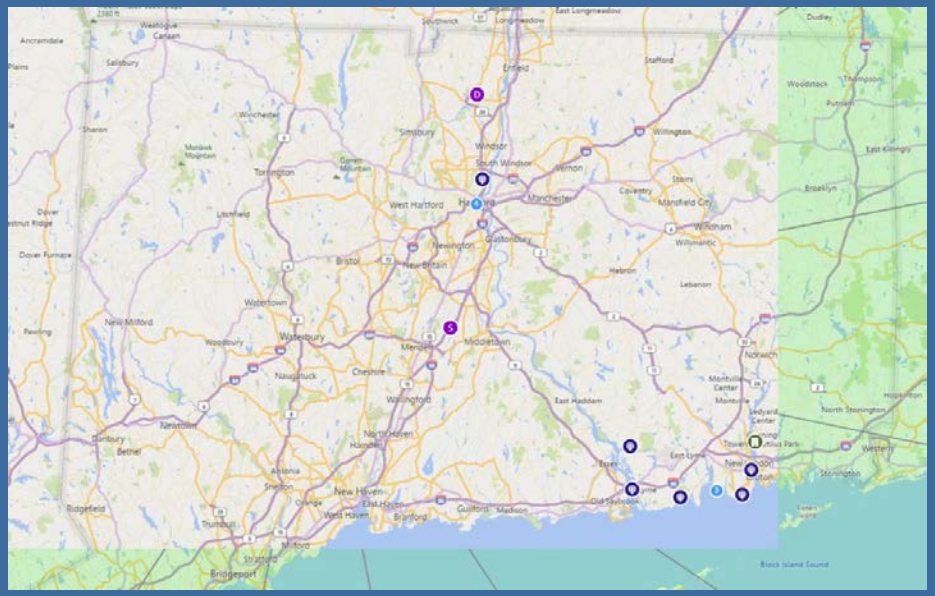


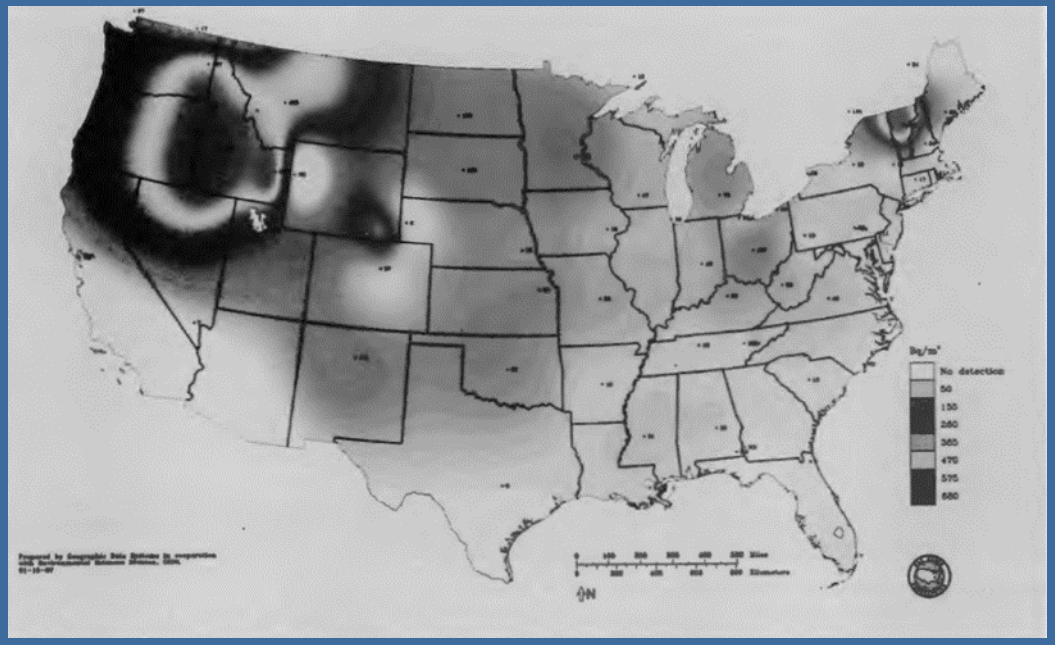
“Tense” Situation

- NPPs Under Russian Control
  - Chornobyl
    - No shift changes
    - Email coms only
  - Zaporizhzhya
    - Ukrainian Operators (3 shifts)
    - All actions must be approved by Russian Military Commander
    - 2 Units operating, other 4 units are shutdown
    - Communications/Data shutoff
    - No indications of radiation release or damage
- Other 6 of 9 NPPs at remaining 3 sites are operating under Ukrainian Control

Environmental Monitoring

- DEEP Actively Monitoring
  - Fixed gamma detectors
  - Air samplers
  - Rain Water
- Communication with EPA and other state programs





- Would expect any large release to be detectable but below concern
  - < DILs
  - Typically, 1 to 2 week transport time
- No public protective or precautionary measures expected

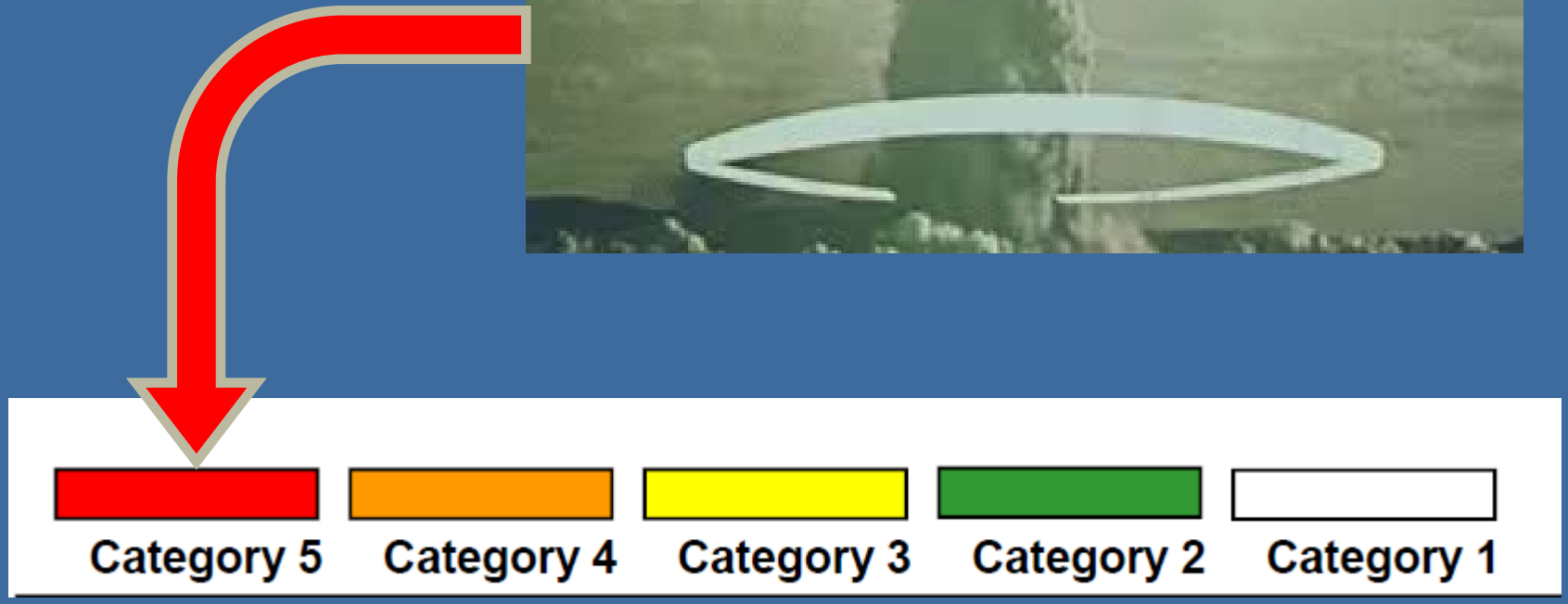
Nuclear Weapons Effects & Response Protocols

Prompt Effects

- Blast and Overpressure
- Thermal radiation (Heat)
- Ionizing Radiation
- Optical
- EMP

Peak Overpressure (psi)	Approximate Distance from Ground Zero (miles) [km]	Maximum Wind Speed (mph) [km/h]
50	0.18 [0.29]	934 [1503]
30	0.24 [0.39]	669 [1077]
20	0.30 [0.48]	502 [808]
10	0.44 [0.71]	294 [473]
5	0.6 [0.97]	163 [262]
2	1.1 [1.8]	70 [113]

Delayed Fallout Effects



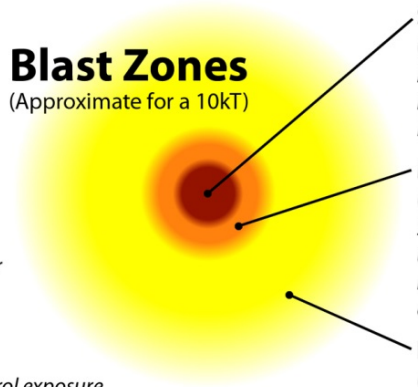
Defined of 5 Key Response Zones

Fallout Zones
(Approximate for a 10kT)

Dangerous Fallout Zone (DFZ)
- *Bounded by radiation levels of 10R/hr*
- *Acute Radiation Injury possible within the DFZ*
- *Could reach 10-20 miles downwind*
- *The decay of the radiation causes this zone to shrink after about 1 hour*

Hot Zone
- *Bounded by radiation levels of 0.01 R/h (10 mR/h)*
- *Acute radiation effects unlikely, however steps should be taken to control exposure*
- *For a 10 KT detonation, the Hot Zone could extend in a number of directions for 100s of miles*
- *The decay of the radiation causes this zone to shrink after about 12-24 hours*
- *After ~ 1 week the Hot Zone will be the size of the maximum extent of the DFZ (10-20 miles)*

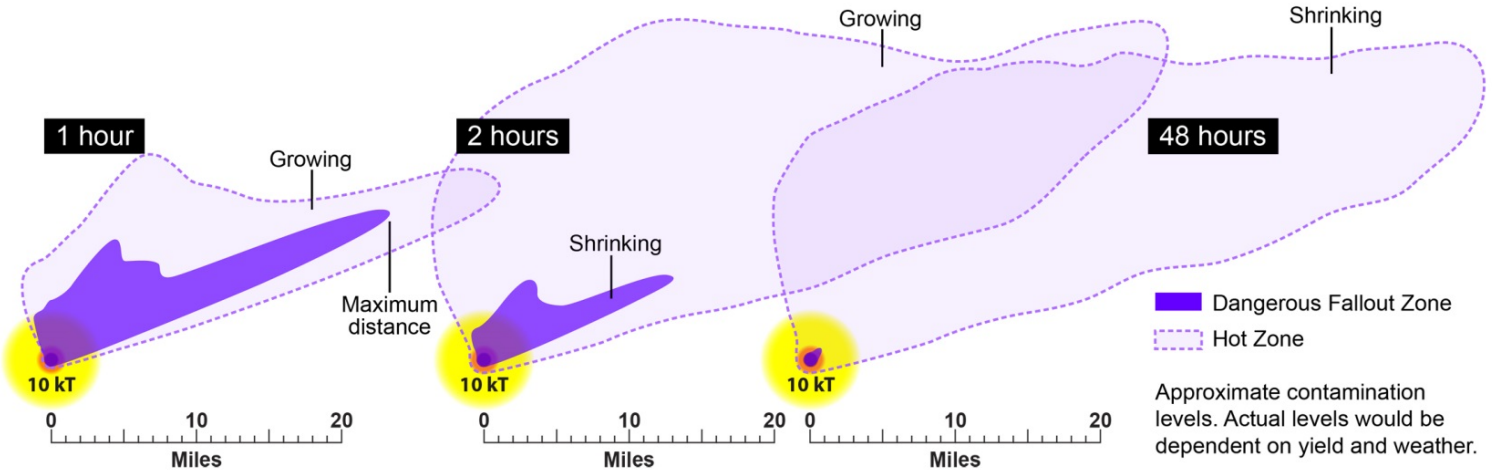
Blast Zones
(Approximate for a 10kT)

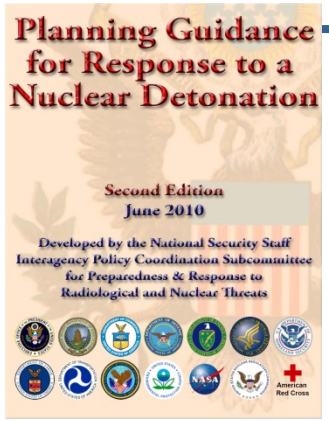


Severe Damage Zone
(half-mile radius)
Most buildings destroyed, hazards and radiation initially prevents entry into the area; low survival likelihood.

Moderate Damage Zone
(half- to 1-mile radius)
Significant building damage and rubble, downed utility poles, overturned automobiles, fires, and many serious injuries. Early medical assistance can significantly improve the number of survivors.

Light Damage Zone
(1- to 3-mile radius)
Windows broken, mostly minor injuries that are highly survivable even without immediate medical care.



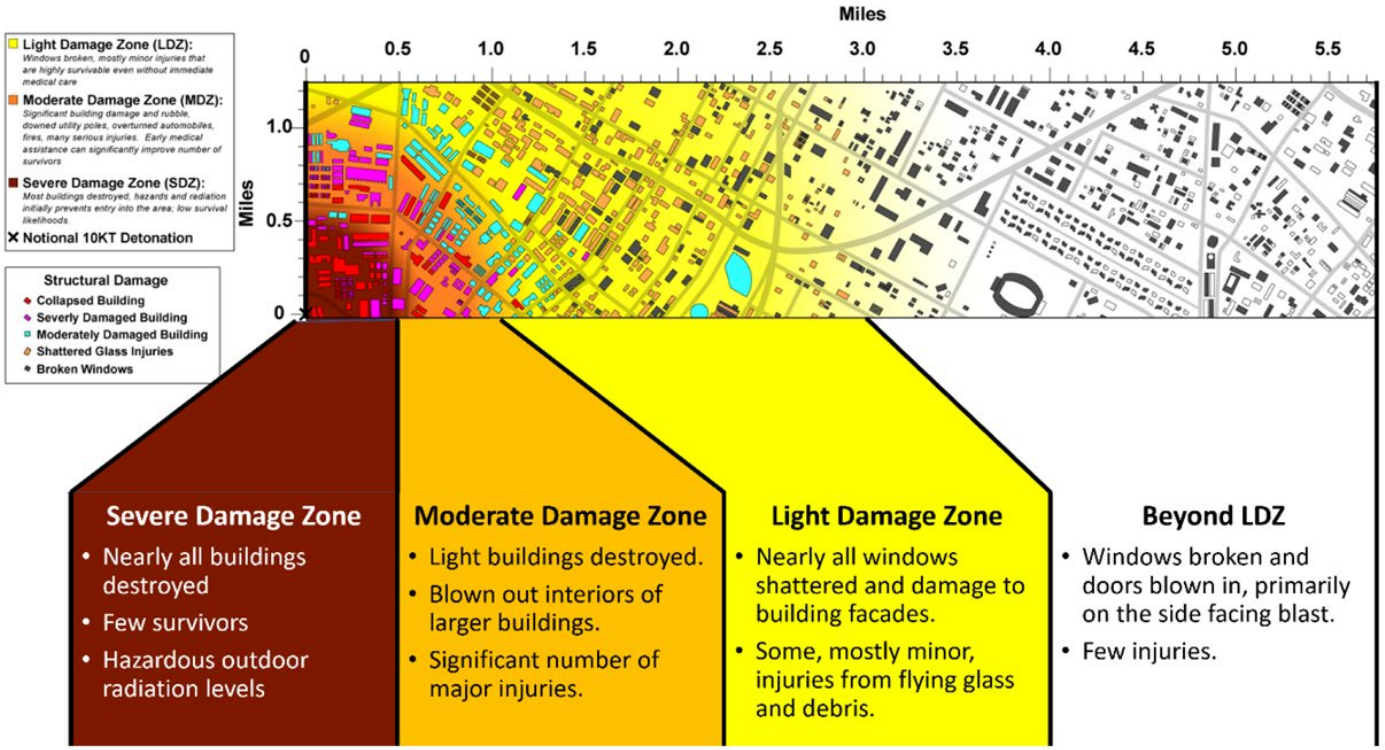


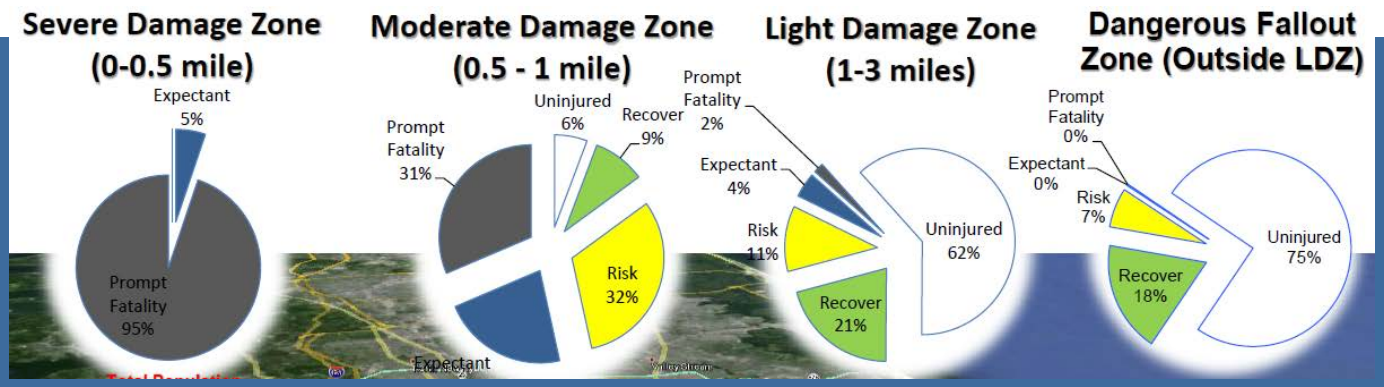
NCRP REPORT No. 165

RESPONDING TO A RADIOLOGICAL OR NUCLEAR TERRORISM INCIDENT: A GUIDE FOR DECISION MAKERS

Damage Zones

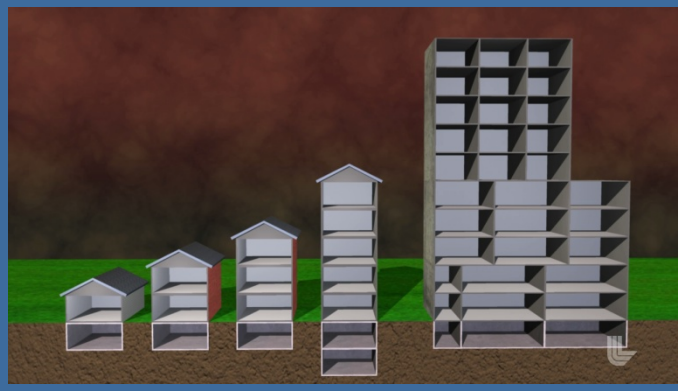
Blast Effect Range



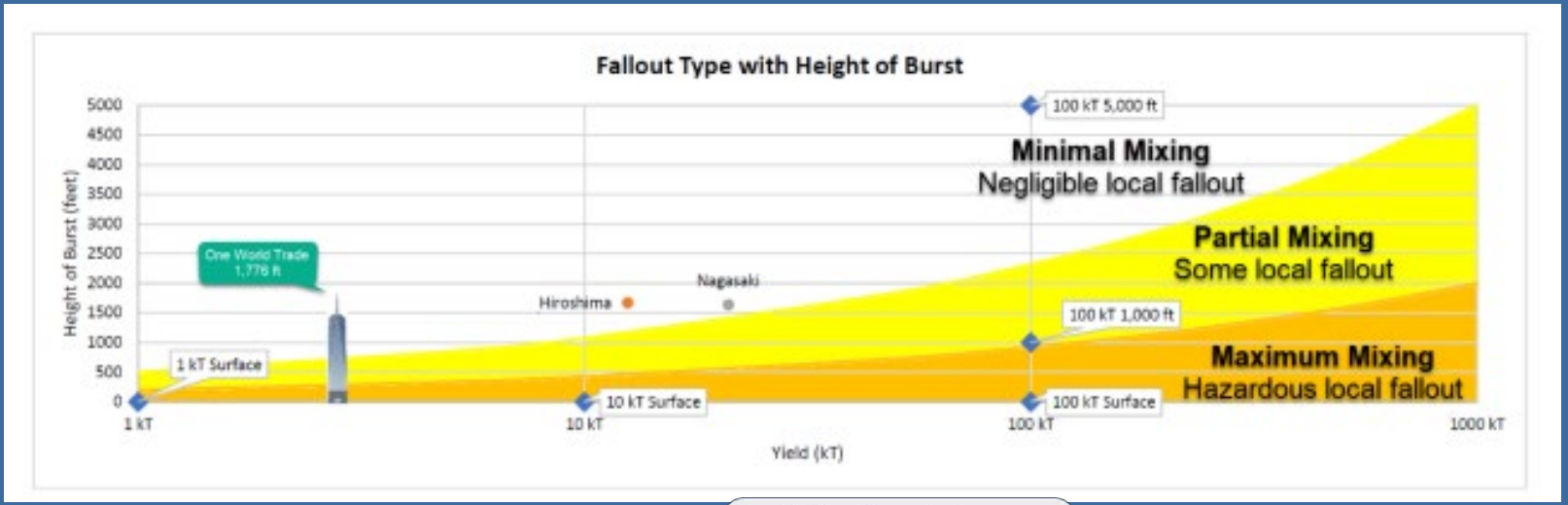


Key Fallout Considerations

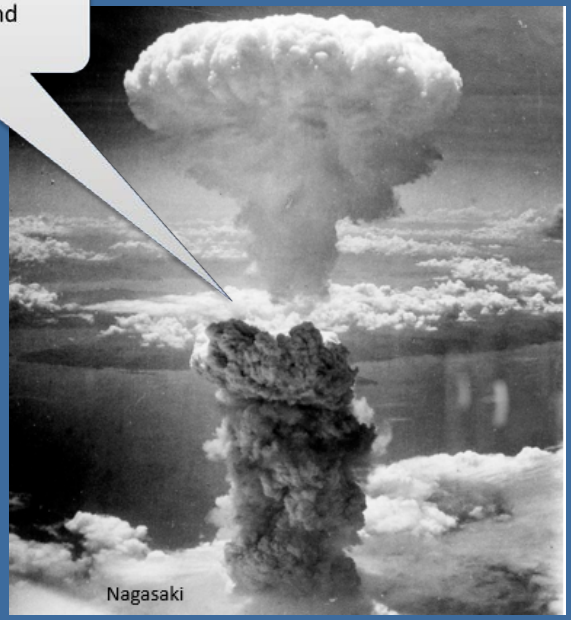
- ***Fallout Decays Rapidly*** (releasing more than half of its energy in the first hour)
- The primary hazard from fallout is being is exposure to penetrating radiation from the particles
- Dangerous levels of fallout is readily visible as it falls
- Plot v. Plume
- Fallout is not a significant inhalation hazard
- The radiation penetrates through windows and walls, but exposure decreases with distance and intervening materials.



Fallout Depends on Yield and HOB

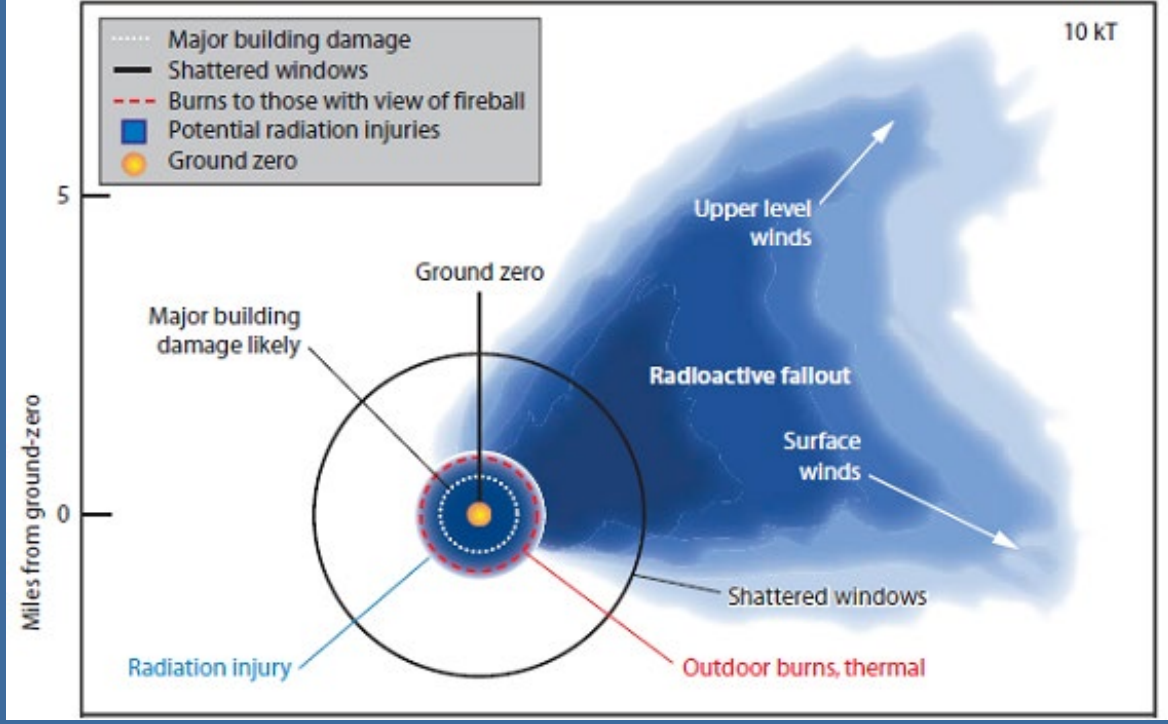


Notice air gap between fission products and dirt/debris stem

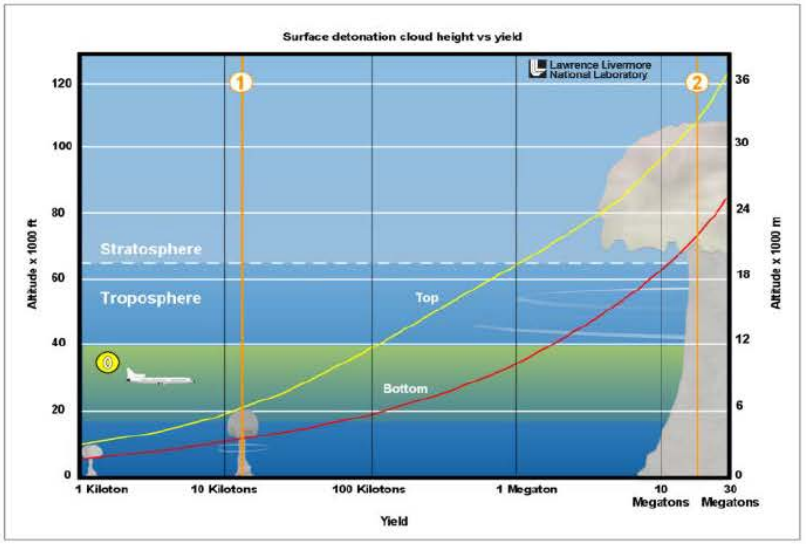


Break the NPP Paradigm

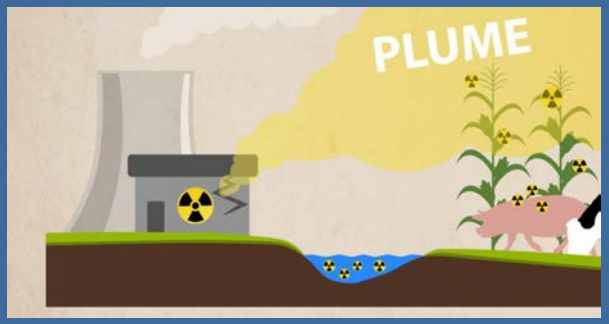
Higher and Further



Yield Estimate	Height (ft)	Height (miles)	Height (km)
1,000 kT	> 58,000 ft	> 11 miles	> 18 km
100 kT	38,000 ft to 58,000 ft	7 miles to 11 miles	12 km to 18 km
10 kT	17,000 ft to 38,000 ft	3 miles to 7 miles	5 km to 12 km
1 kT	< 17,000	< 3 miles	< 5 km



Immediate Health Risk v. Cancer Risk



Evacuation

Fallout

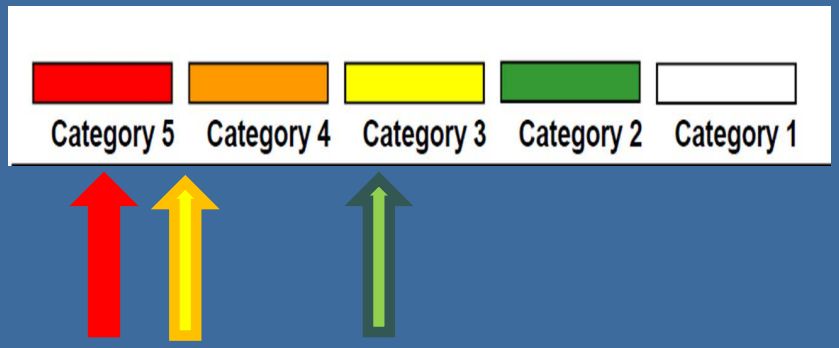
Evacuate

Reduces risk to..

Category	
5	Death may occur in days to weeks
4	Increased risk of radiation sickness, but death is not likely (symptoms may appear in hours to days)
3	Increased risk of cancer later in life (symptoms may take decades to appear)
2	Above the range of normal, everyday radiation levels, but no health effects expected
1	Within the range of normal, everyday radiation levels

Get Inside
Stay nside

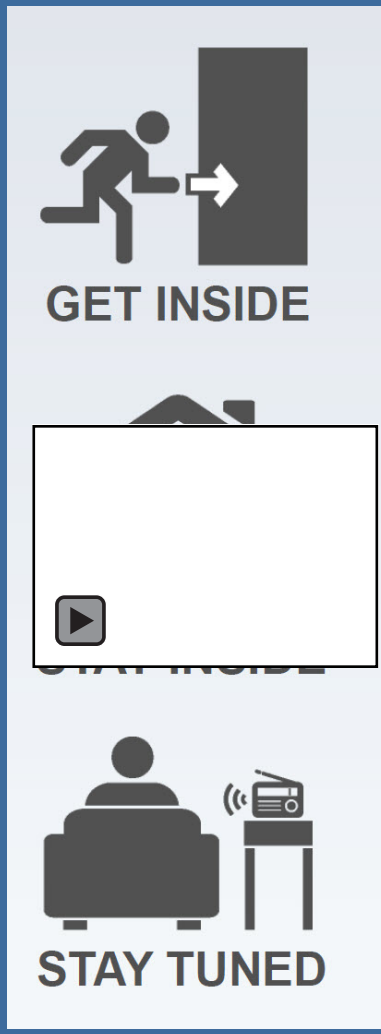
Prompt Action can Save Lives



Duck and Cover 2.0:
Addressing our Expanded Threat Base

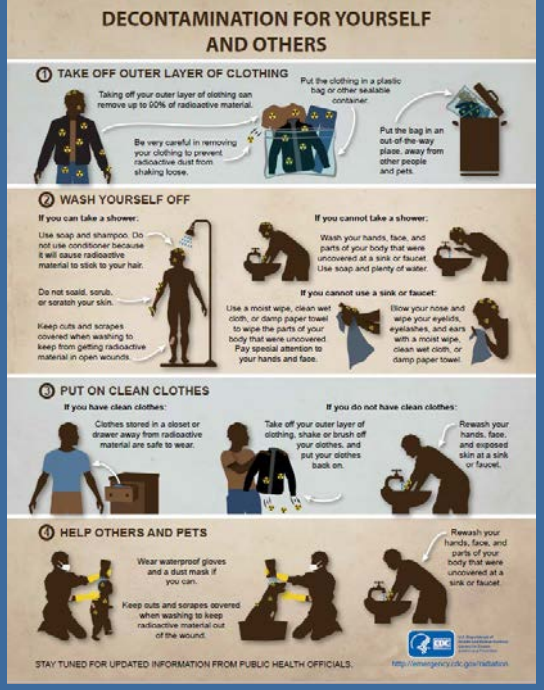
- **Imminent Nuclear Threat**
  - Protective Actions for Prompt Effects
  - 10 – 20 minutes to get into a good shelter
  - Get inside a basement or central room away from windows and doors, stay inside, stay tuned for more information
- **No Notice Detonation**
  - "Duck and cover" for prompt effects protection
  - Prompt effect protection difficult without "hyper vigilance"
- **Nuclear Fallout**
  - 15 minutes or more to take action after detonation
  - Get inside a basement or central room, stay inside for 12-24 hours, stay tuned for more information

Get Inside, Stay Inside, Stay Tunes still works, but the details may change. Emergency Management must evaluate and message on fire hazards.



Break the NPP Paradigm

- Other actions for the Public
  - Self Decon
  - Contamination Screening Criteria
    - Severely Resource constrained: “walk by”
    - Resource constrained: 100,000 cpm
    - Nominal: 10,000 cpm
    - Millstone: > 200 cpm over background
  - Mental Health and Palliative Care
  - Disaster Mortuary Services (DMORT)



Numbers and Types of Casualties from Computer Modeling of Various Nuclear Detonation Scenarios: for Medical Resource Planning Only*

Injury Type	Severity of Injury	Ground burst			Air burst			Composite burst		
		50th % tile¶	85th % tile	95th % tile	50th % tile	85th % tile	95th % tile	50th % tile	85th % tile	95th % tile
Trauma (using ISS° value)	Mild (1-9)	18,000	53,000	79,000	28,000	48,000	89,000	20,000	53,000	80,000
	Moderate (10-14)	34,000	119,000	121,000	36,000	80,000	132,000	34,000	118,000	121,000
	Severe (> 15)	14,000	62,000	143,000	18,000	75,000	109,000	14,000	63,000	143,000
Burn (% of TBSA with partial- to full-thickness burn)	Mild (5-10)	0	0	0	0	0	0	0	0	0
	Moderate (10-30)	0	0	60	0	1000	3,000	0	0	1,000
	Severe (> 30)	0	0	0	0	0	0	0	0	0
Radiation dose (cGy)	Mild (75-150)	5,000	32,000	91,000	2,000	8,000	13,000	4,000	23,000	72,000
	Moderate (150-530)	7,000	29,000	51,000	1,000	12,000	20,000	6,000	25,000	41,000
	Severe (> 530-830)	3,000	9,000	12,000	200	3,000	5,000	3,000	6,000	12,000
	Expectant (> 830)	10,000	28,000	47,000	80	5,000	10,000	5,000	16,000	47,000
Combined injury	Trauma and/or burn (mild → severe) AND > 150 cGy	3,000	20,000	44,000	300	18,000	49,000	2,000	20,000	45,000

Adapted from Knebel AR, Coleman CN, Cliffer KD, Murrain-Hill P, McNally R, Oancea V, Jacobs J, Buddemeier B, Hick J, Weinstock D, Hrdina CM, Taylor T, Matzo M, Bader JL, Livinski A, Parker G, Yeskey K. Allocation of Scarce Resources Following a Nuclear Detonation: Setting the Context. Disaster Med Public Health Prep. 2011 Mar; (5) Suppl 1: S20-31.

¶**% tile:** the % of all 185 nuclear detonation scenarios modeled that would have up to this many victims.

°**ISS:** Injury Severity Score, a numerical score assigned to victims based on the type and severity of physical injury; there have been various iterations of the systems; see Stevenson M, Segui-Gomez M, Lescohier I, DiScala C, McDonald-Smith G, An overview of the injury severity score and the new injury severity score, Injury Prevention 2001; 1(7):10-13.

TBSA: total body surface area

ARS Medical Counter Measures

- Potassium Iodine (KI) is *NOT* effective
- FDA has granted approvals to four products for the treatment of humans acutely exposed to myelosuppressive doses of radiation - hematopoietic acute radiation syndrome (H-ARS)
  - human granulocyte colony-stimulating factors (G-CSFs)
  - Based on efficacy studies in animals (under the Animal Rule)
    - NIAID-sponsored studies demonstrated that administration for treatment of immune thrombocytopenia, increased platelet counts and improved survival in preclinical models of lethal radiation exposure
  - Strategic National Stockpile (SNS)

MCMs to treat patients with radiation-induced myelosuppression following a radiological/nuclear incident (H-ARS)

Myelosuppression occurs when radiation damages the bone marrow. Suppression of the bone marrow blocks the production of blood cells. There are FDA-approved products that can help patients with H-ARS by facilitating recovery of bone marrow cells that develop into white blood cells, including neutrophils, which help fight off infections.

FDA-approved products that may be used to treat adult and pediatric patients acutely exposed to myelosuppressive doses of radiation, a condition known as Hematopoietic Syndrome of Acute Radiation Syndrome, or H-ARS:

- Neupogen (filgrastim) – approved March 2015 [more info; product label (PDF, 1.2 MB)]
- Neulasta (pegfilgrastim) – approved November 2015 [product label (PDF, 1.7 MB)]
- Leukine (sargramostim) – approved March 29, 2018 [more info (PDF, 299 KB); product label (PDF, 786 KB)]
- NPLATE (romiplostim) – approved January 28, 2021 [product label (PDF, 684 KB)]

NEUPOGEN® (FILGRASTIM)

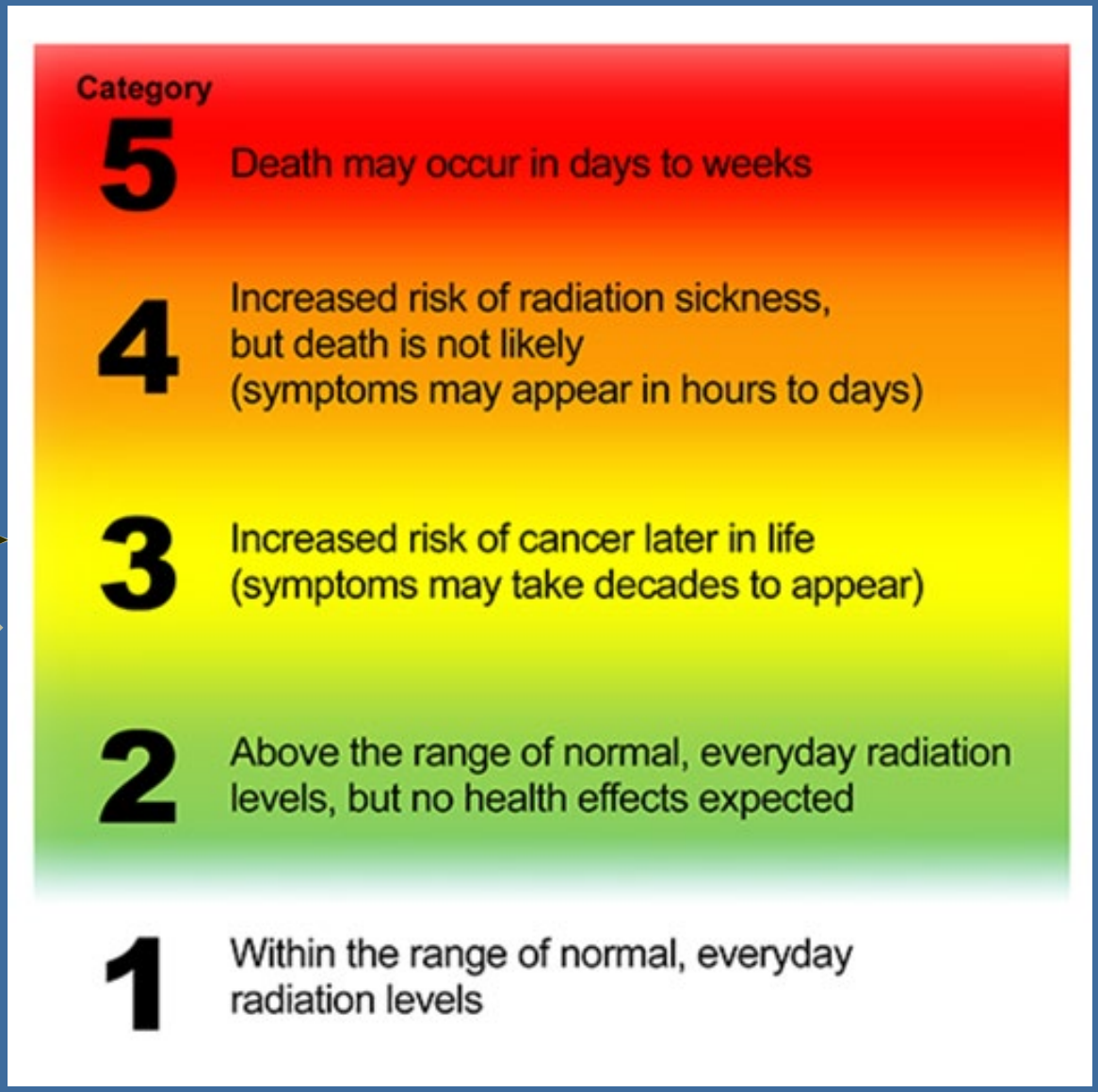
leukine® sargramostim

For Emergency Workers - Decision Doses

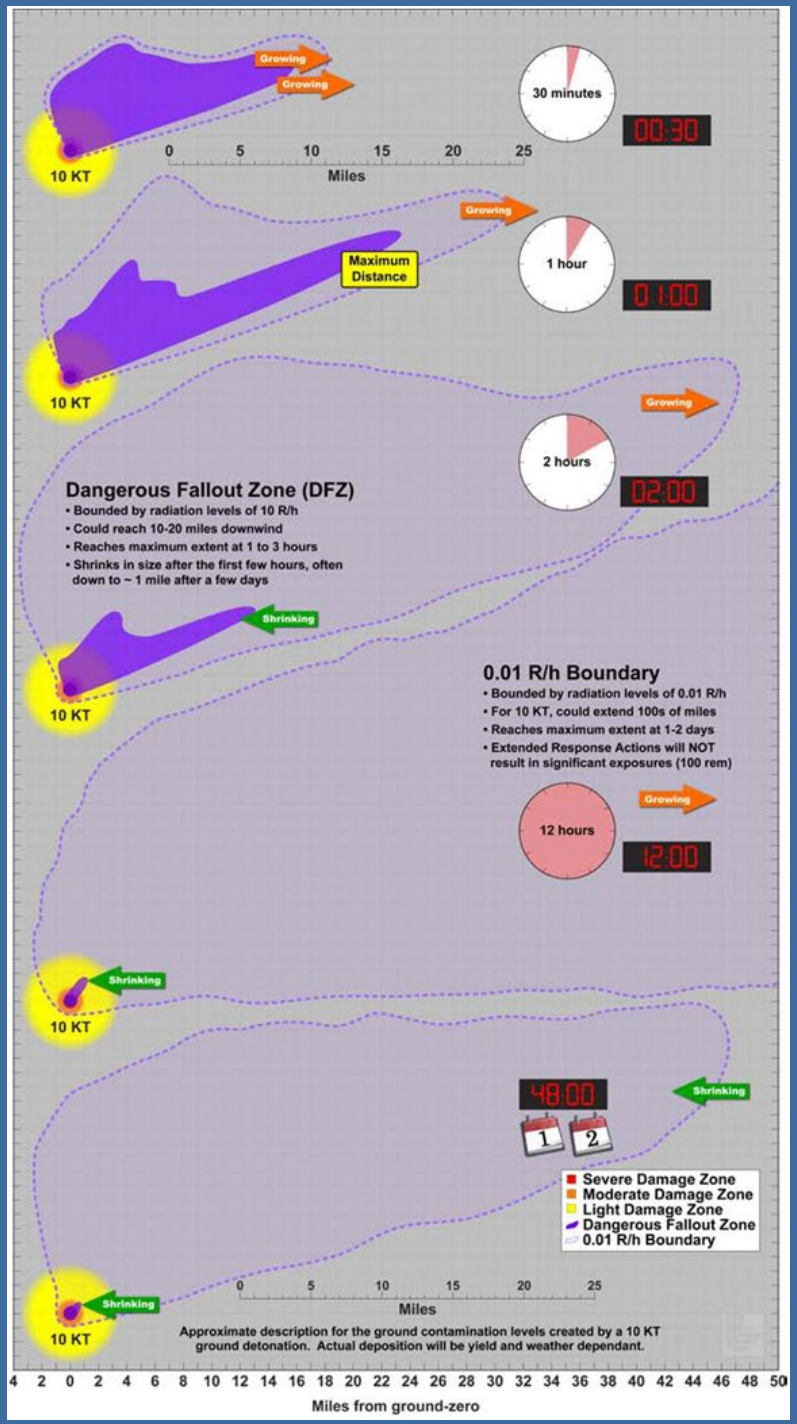
"A Decision Dose can be used by the incident commander as a tool to address the need to and the consequences of exposing emergency workers to higher doses to accomplish Mission Critical actions." (EPA-400, PAG Manual)

25 rem EPA guideline

5 rem Regulatory Limit



For Emergency Workers - Hot Zone



For Emergency Workers - Alternate Dosimetry Methods

TABLE 6.2 *Managing dosimetry issues with decreasing resources (adapted from REMM, 2018).*

Increasing Severity of the Incident →

Resource Availability		Sufficient	Incomplete	Insufficient
Operating Conditions		• Equipment and personnel are adequate for response. • Routine timelines for deploying, reviewing and recording dosimetry readings are in place.	• Operations equivalent to normal but with constrained resources. • Routine dosimetry operations may start to be modified due to incident.	• Insufficient resources to meet most dosimetry needs. • High-radiation levels increase risk to responders. • Alternate uses of dosimetry equipment and dose tracking routines must be implemented.
Response Resource Adequacy	Equipment	• Appropriate alarming dosimeters for each worker category. • Dose management takes place as identified under existing plans. • Normal archiving of dose data into existing logs or registry.	• Dosimeters for each worker category, but alarming dosimeter resources may be strained. • Strategic plan to manage dose for all responders is implemented. • Exposure data are recorded, but archiving of data into databases may be delayed as real-time monitoring of dose(s) takes precedence.	• Prioritization of equipment for high-risk responders. • Equipment substitution and adaptation necessary. • Exposure data are recorded, but archiving of dose data is delayed as real-time monitoring of doses for those at highest risk takes precedence.
	Staff	• Adequate numbers of trained staff available to disseminate dosimetry equipment, respond to the incident, track/record doses, and manage responder safety.	• Staff available to perform critical response tasks with potential dose-driven time constraints. • Few if any responders approach "crisis dose levels" [*e.g.*, >5 rem (50 mSv)]; any who do approach dose limits require prior consent. • Limited surge workers may be needed; may require just-in-time training before disseminating dosimetry equipment, responding to the incident, or tracking/recording doses. • Some workers may need to be excluded from response (*e.g.*, pregnant, immunosuppressed).	• Insufficient staffing for some tasks prior to arrival of surge work force. • Prioritization of response activities. • Many responders may exceed the regulatory dose limits [*e.g.*, >5 rem (50 mSv)]; responders may exceed regulatory limits. Additional dose controls are needed to ensure responder safety. • Some workers may need to be excluded from response (*e.g.*, pregnant, immunosuppressed). • Permanent archiving of data may be delayed while operations in crisis mode. • Large number of surge workers needed; will require just-in-time training before disseminating dosimetry equipment, responding to the incident, or tracking/recording doses.

Trigger

- Uncontrolled release of a large quantity of radioactive material.
- Large hot zone areas >10 mR h^{-1} (~0.1 mSv h^{-1}).
- Surge of external resources necessary for adequate response.

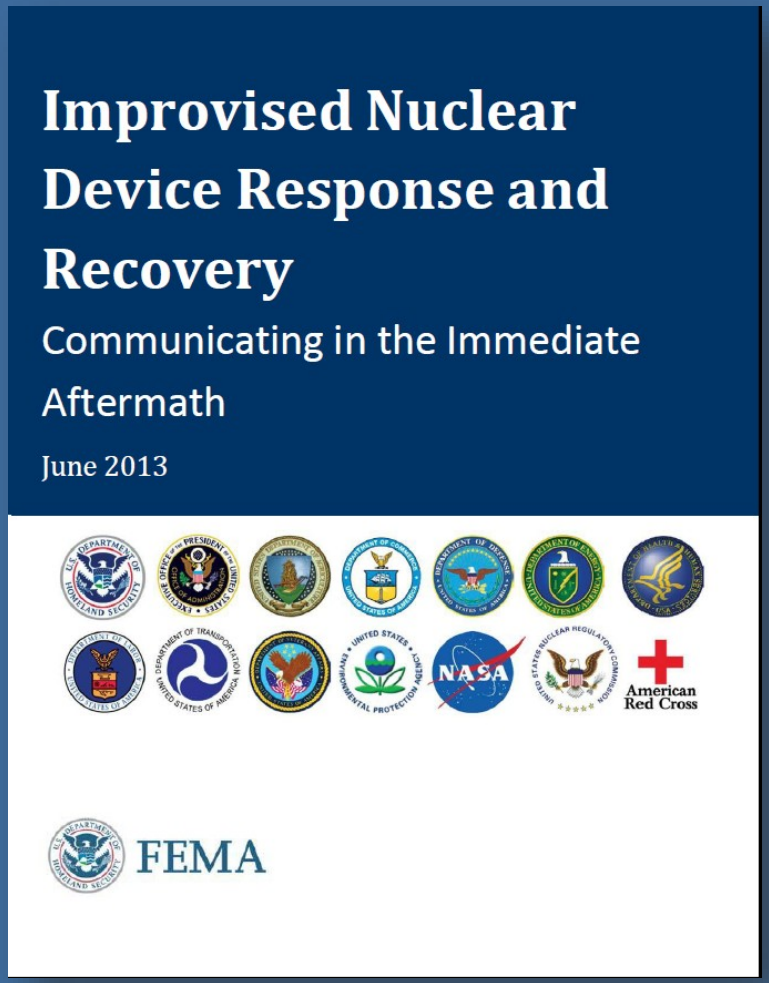
Team Dosimetry

Time in Zone

Communications

Template messages are available

- Communication infrastructure may be damaged, plan for multiple communication methods.
- Planners should select individuals with the highest public trust and confidence to deliver messages
- Be prepared to deliver key information to the public in the affected areas about protection almost immediately in order to maximize lives saved.
- A Communication Guide Exists!



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.

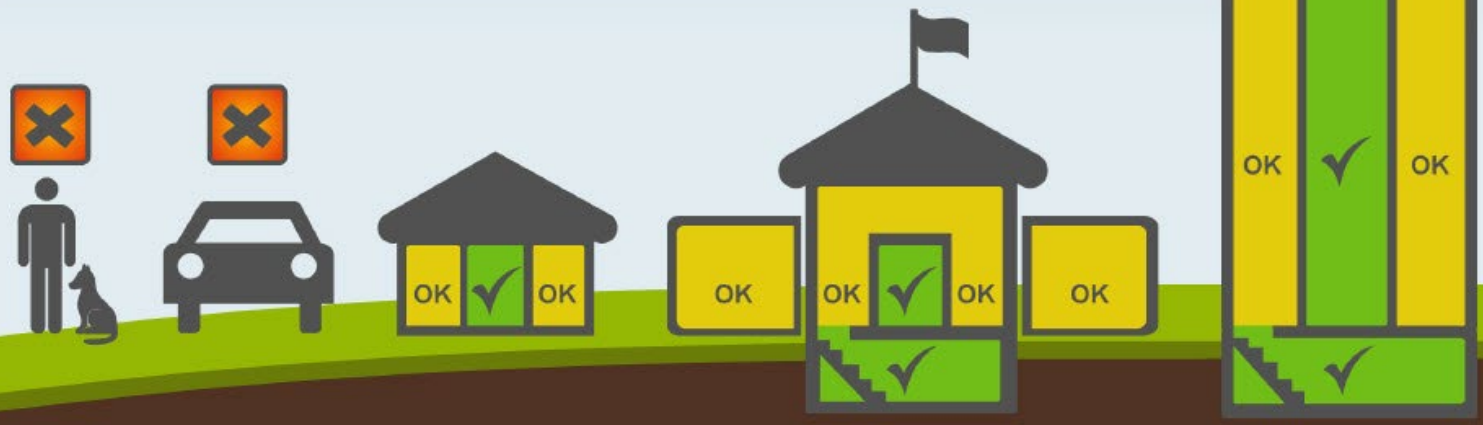
No matter where you are, the safest action to take is to: GET INSIDE. STAY INSIDE. STAY TUNED.

- 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.

NOT SAFE

OK SAFER

SAFEST



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

Public Information is Available

NUCLEAR WEAPON

What is a nuclear weapon?

A nuclear weapon is a device that uses a nuclear reaction to create an explosion. This explosion is much more powerful than that of conventional explosives (like TNT). When a nuclear weapon explodes, it gives off four types of energy: a blast wave, intense light, heat, and radiation. Nuclear weapons can be in the form of bombs or missiles.

When a nuclear weapon explodes, a large fireball is created. Everything inside of this fireball vaporizes and is carried upward. This creates a mushroom-shaped cloud. The material in the cloud cools into dust-like particles and drops back to the earth as **fallout**. Fallout can be carried by the wind and can end up miles from the site of the explosion. Fallout is radioactive and can contaminate anything it lands on.

What are the main dangers of a nuclear weapon?

A nuclear weapon would cause great destruction, death, and injury and have a wide area of impact. People close to the blast site could experience:

- Injury or death (from the blast wave)
- Moderate to severe burns (from heat and fires)
- Blindness (from the intense light)
- Radiation sickness, also known as acute radiation syndrome or ARS (caused by the radiation released)

People farther away from the blast, but in the path of fallout, could experience health effects from:

- Fallout on the outside of the body or clothes (external contamination) or on the inside of the body (internal contamination)
- Radiation sickness
- Contaminated food and water sources

What should I do to protect myself?

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

http://emergency.cdc.gov/radiation

FEMA

ROSS

Who is ROSS, and why is he in my EOC?

- During Radiological Incidents:
  SME DEMAND >> SME RESOURCES
- Radiological Operations Support Specialist (ROSS)
  - State/Local SME (FEMA-typed) asset
    - Work for you – do not represent federal agency
  - Translate between local and federal response organizations
    - Can gather, organize, synthesize, document, and distribute incident and resource information for the purpose of improving situational awareness at all levels of an incident management (IM) situation.
  - Technical Interpreter
    - Provides the expertise necessary to clearly explain the implications of modeling, measurement, and analysis methods as well as, health risks and hazards existing during a radiological incident.
  - Prepared for diverse radiological events - NPP, RDD, IND, Nuc Det

Many ROSS May Be Needed

- Nationwide – over 150 ROSS trained

Questions?

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Type 1 ROSS
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