

# Radiological Preparedness & Emergency Response

# Session I

## Overview of Different Types of Threats Using Historical Examples

# Objectives

- Discuss the threat from radiological terrorism and accidents.
- Describe the different types of incidents using historical examples.

# Why Are You Here?

- Radiation threats are real.
- We may not be well prepared.

# Are Radiation Sources Available?

- There are around:
  - 150,000 licensed radioactive facilities in the USA
  - 2,000,000 radioactive sources
  - 400 lost sources per year in the world



Source IAEA

# Emergency Responders Attitudes and Perceptions

- A survey performed in Hawaii hospitals has shown that responders ranked radiation threats highest in terms of the fear generated when compared to chemical or biological terrorist attacks.

# Emergency Responders and Radiological Preparedness

- Research has shown that US clinicians and Public Health workers felt unprepared to respond to radiological or nuclear incidents.
- Canadian survey-based study: 31% of EMS providers reported receiving training in radiation detection.



# US Emergency Medicine Physician Survey

- 48% felt uncomfortable caring for radiation victims.
- 56% felt similarly about performing a radiation detection survey on patients.
- 52% and 68% felt uncomfortable diagnosing ARS and internal contamination.
- Majority were unfamiliar with use of DTPA, Prussian blue, and Filgrastim.
- Many respondents were unable to differentiate between contamination and exposure with radiological material.





# Study in the Medical Reserve Corps Volunteers

- Evaluated perceived threat, perceived efficacy, and personal/organizational preparedness in 4 scenarios:
  - Weather-related disaster
  - Pandemic influenza emergency
  - Radiological (“dirty bomb”) emergency
  - Inhalational anthrax emergency
- The radiological emergency consistently received the lowest scores for the attitude/belief statements and response willingness across scenarios.

# Possible Scenarios

- Simple radiological device.
- Improvised nuclear device (IND).
- Nuclear weapon detonation.
- Nuclear power plant accident.
- Radioactive dispersal device (RDD).



# Simple Radiological Device

- Exposure to penetrating ionizing radiation.
- Insidious onset.
- Initially silent.



# Lja, Republic of Georgia-2002



Source IAEA



# Yanango, Peru. Feb 20, 1999

- Iridium source loss.
- Picked up by worker and put in his back pocket.
- The patient developed severe radiation burn in his pelvic area as well as ARS.
- He survived with significant disability.

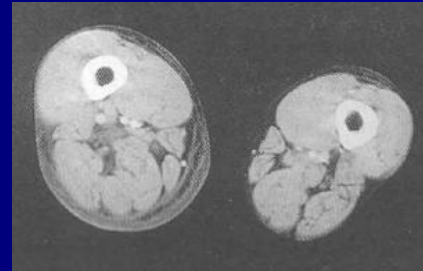


Photo 5. Blistering lesion surrounded with large inflammatory halo on the mid-upper line of the rear surface of the right thigh (22 February 1999).



Photo 9. Extended superficial erosion surrounded by a large dusky inflammatory area in the rear surface of the right thigh (1 March 1999).

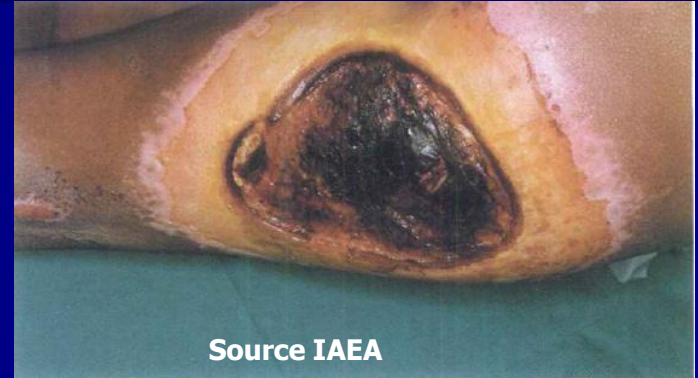
Source IAEA

# Yanango - Peru

## May and December, 1999

Patient treated in France

May 1999

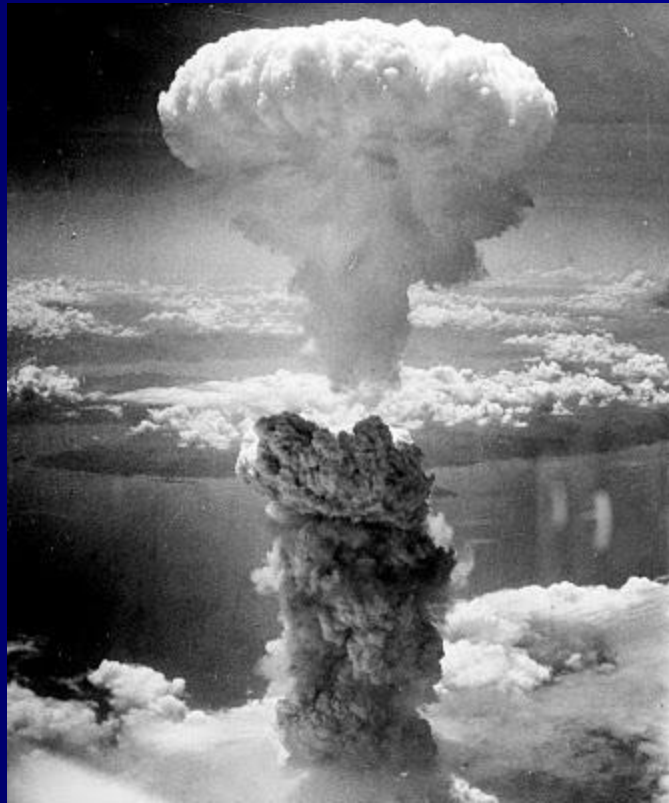


*Photo 15. Very large necrotic lesion extended in the upper third of the right thigh. The depth of the defect is significant. The bottom is covered by a crust and is superinfected. The lesion edges are well defined, blistered and are above the surface of the surrounding tissue. They are surrounded by a depigmented halo (3 May 1999).*

December 1999



# Nuclear Weapon Detonation or Improvised Nuclear Detonation (IND)



**Air burst versus ground burst**

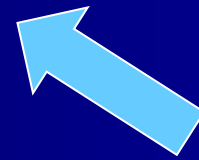
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# Nuclear Detonation

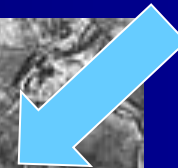
- Fission reaction.
- Damage and mortality secondary to Nuclear weapon detonation:
  - Thermal blast (35%)
  - Radiation (15%): initial and fallout
  - Shock (50%)
- Electromagnetic pulse.



# Nagasaki, 1945

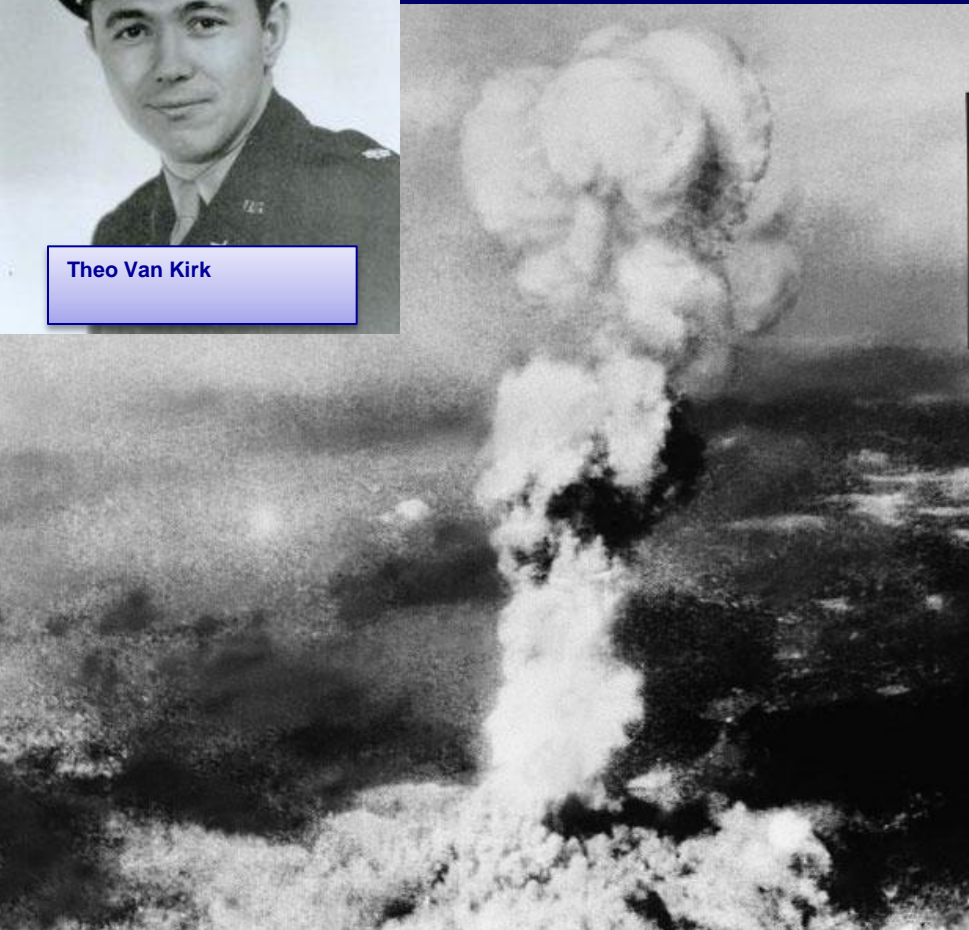


**Pre and  
Post**

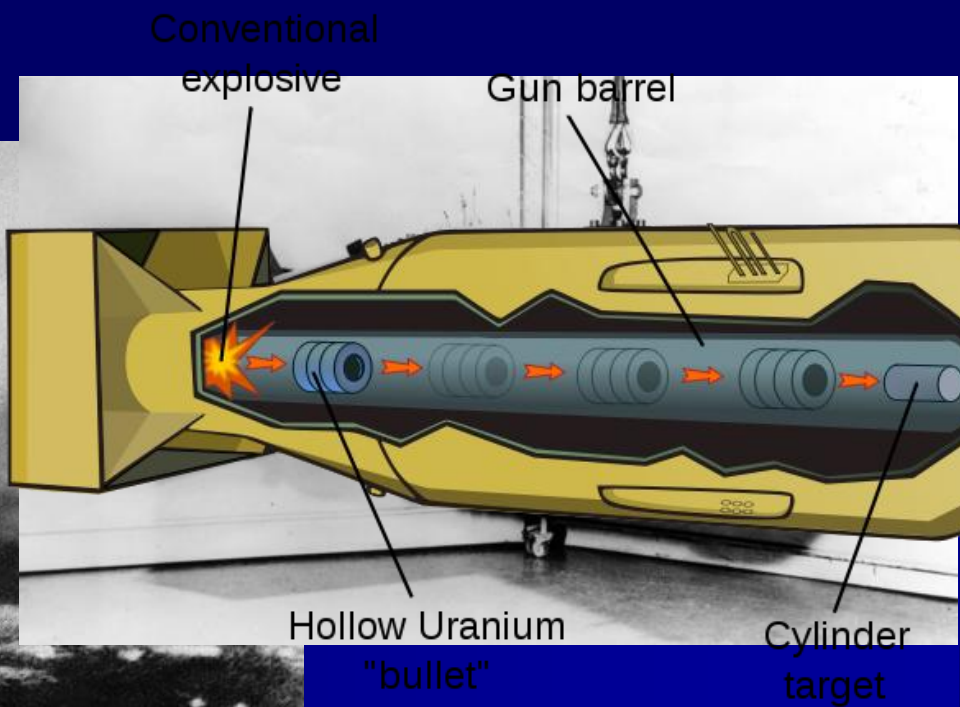




Theo Van Kirk

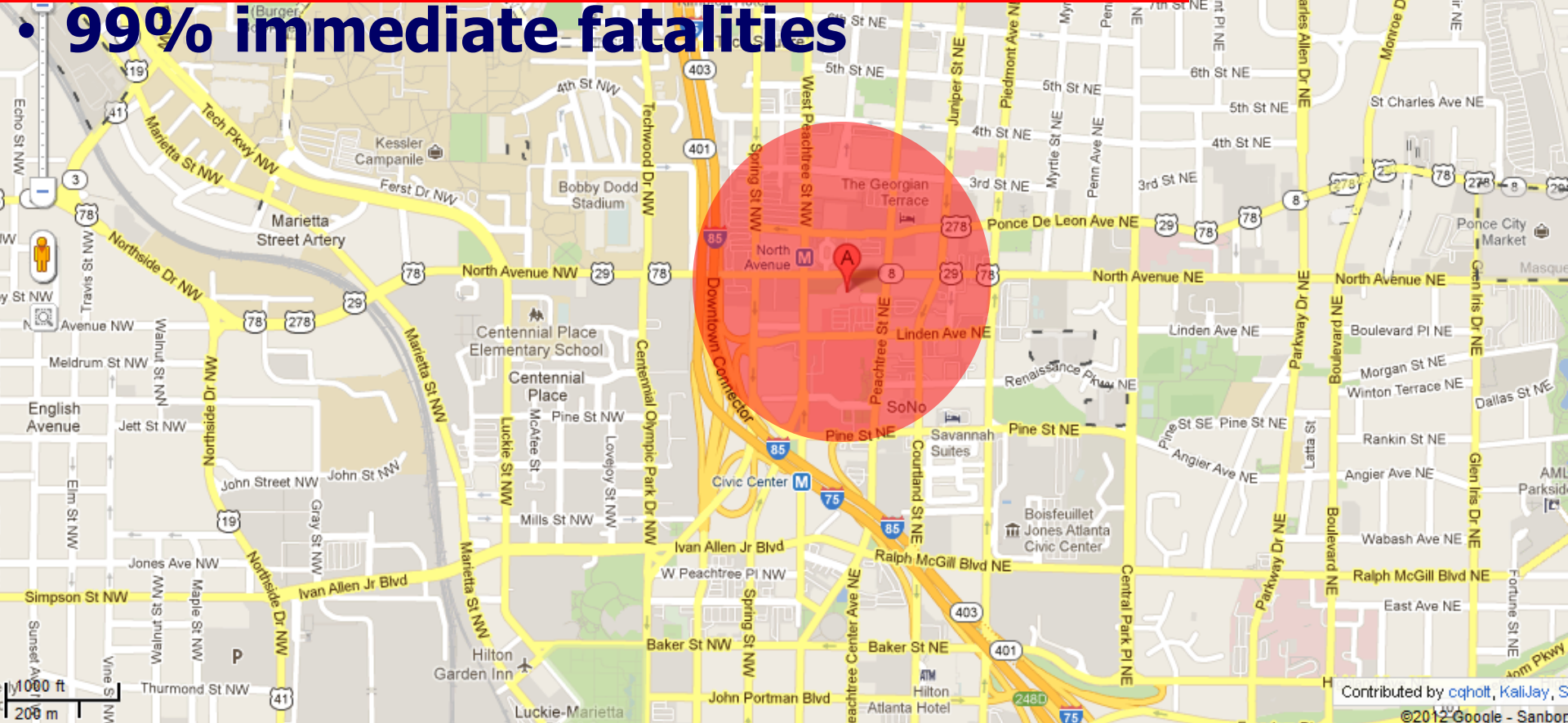


Little Boy dropped on Hiroshima in August 6 1945



# Severe damage zone (0.5 mile radius):

- Near complete collapse
- Few, if any, buildings still standing
- 99% immediate fatalities



# Nevada Atomic Bomb Testing Site - 1955

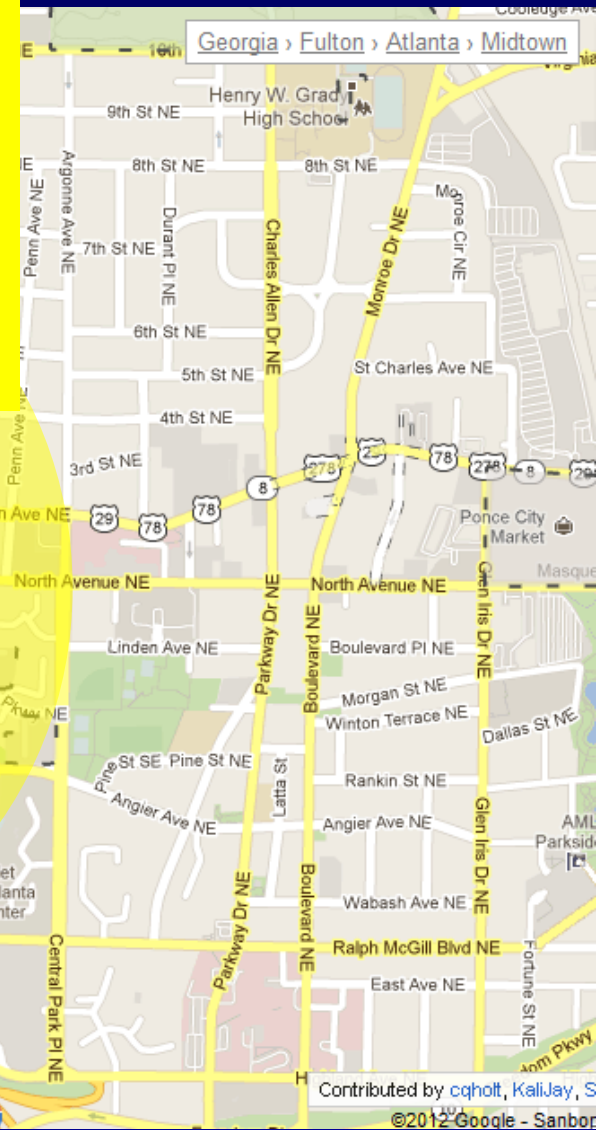
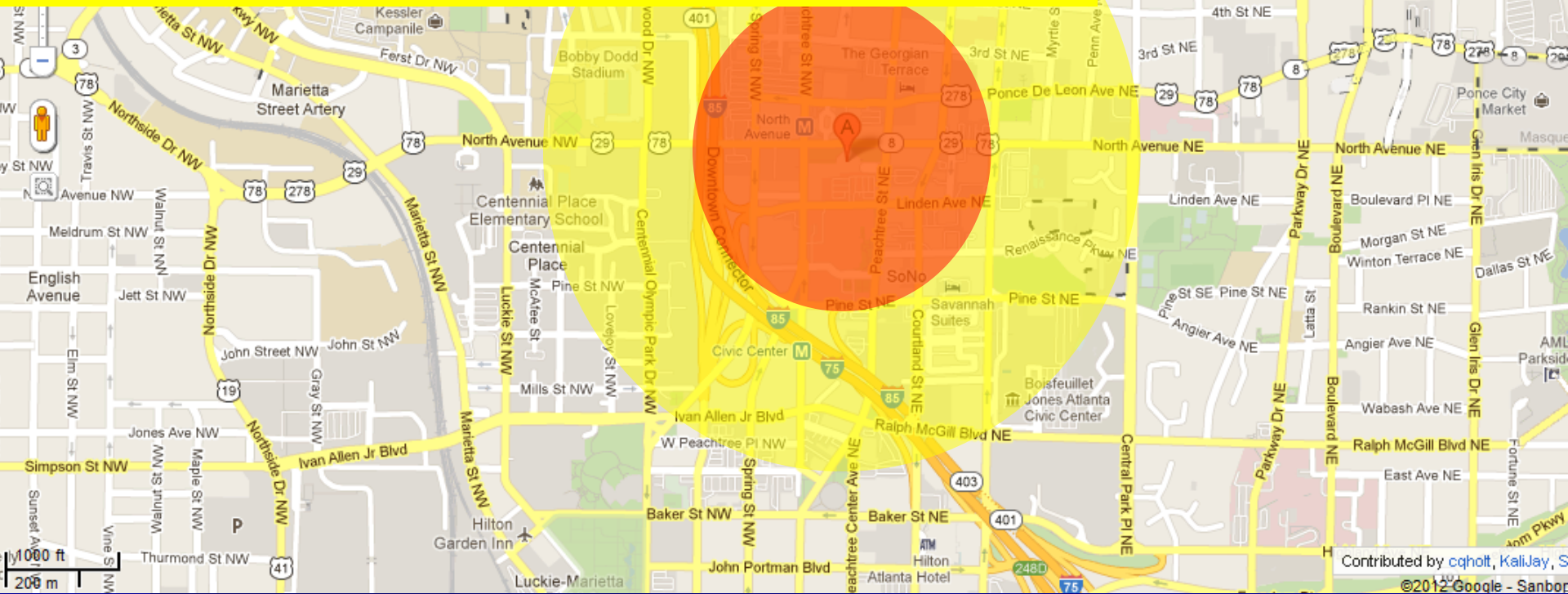


Film and images at 1 km (0.6 mile) from ~16kT yields

Equivalent to the outskirts of the severe damage zone

# Moderate damage zone (1 mile radius):

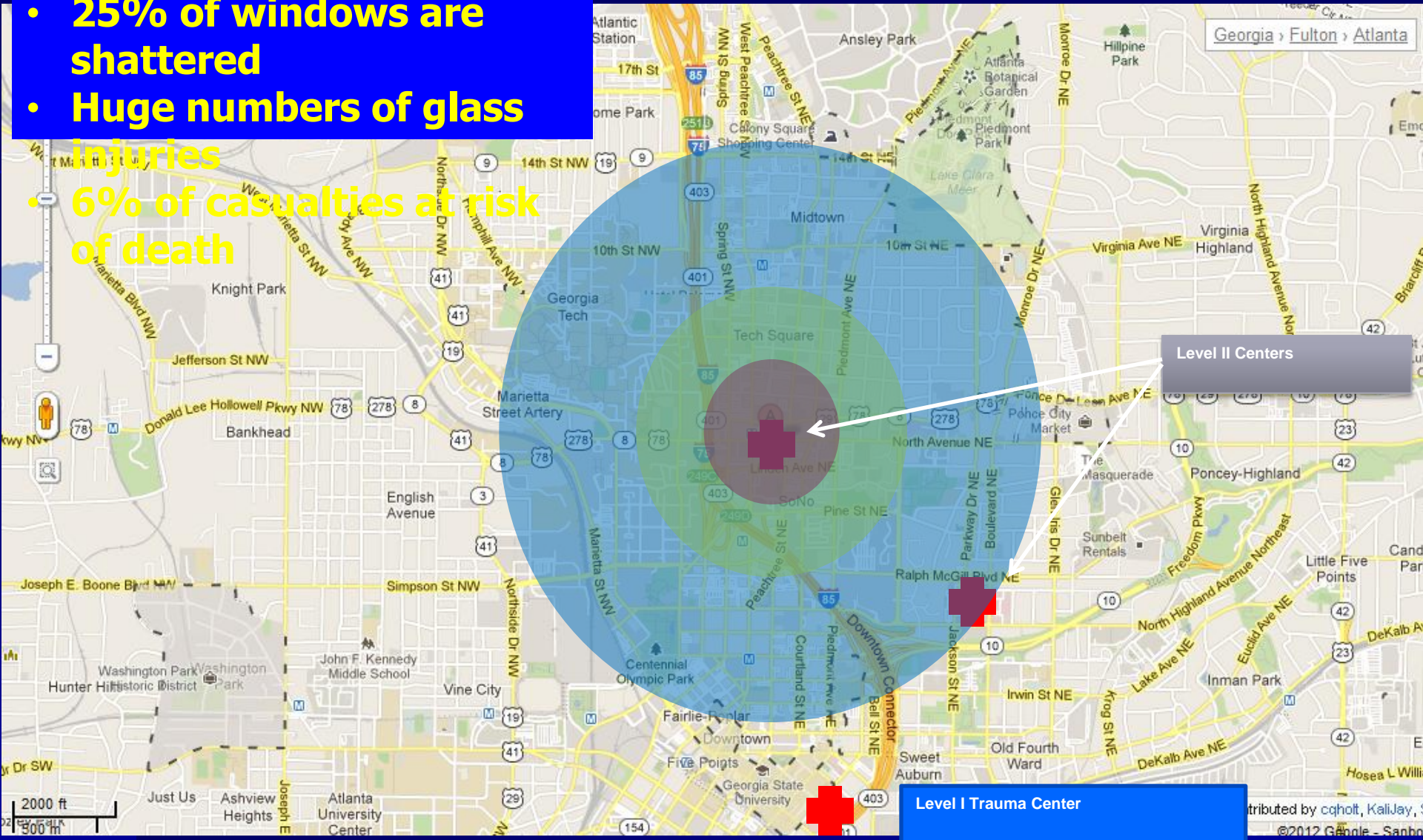
- Some collapsed buildings, blown out building interiors, overturned automobiles, fires
- Significant thermal burns if outdoors
- 38% immediate fatalities, 14% expectant



# Light damage zone:

- 2-3 mile radius
- 25% of windows are shattered
- Huge numbers of glass injuries

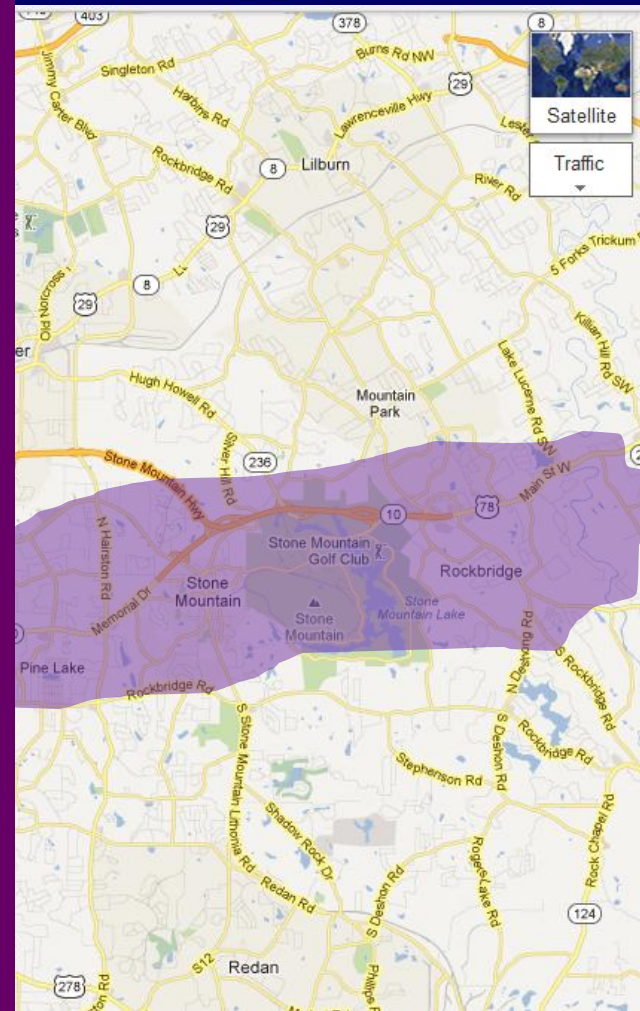
- 6% of casualties at risk of death



**Temporary blindness 5-10 miles away!**

# Dangerous Fallout Zone or Dangerous Radiation Zone:

- Extends 25 miles downwind of ground zero
- Reaches maximum extent at 1 hr
- Severely hazardous fallout will descend to the ground within a few hours and may shrink to a few miles in a couple of days (decay)
- Mostly visible to naked eye (grains of sand)
- Exposure rate  $>10$  R/h



# Casualties (10 kT model)

- For large city with 2 million population
  - 230,000 immediate fatalities
  - 323,000 injured survivors
    - 99,000 will succumb without medical treatment
    - 73,000 will still succumb with medical treatment
    - **26,000 can be saved with medical treatment**



# Nuclear Power Plant Accident- Fukushima

- 6 reactors
- Meltdown risk
- I-131
- Other radionuclides



# Nuclear Power Plant Accident-Chernobyl

- Nuclear reactor can occur leading to an explosion.
- Iodine is a fission product and is majorly responsible for human exposure.



# Firefighters in Chernobyl

- 237 emergency workers had ARS.
- ARS was identified as the cause of death for 28 of these people within the first few months after the disaster.



Source Wikipedia

# Long Term Clean Up



Source NY Times

# Criticality Accident-Tokai Mura Japan in 1999

- Irradiation accident resulting from human error.
- Uranium mixing error.
- 119 workers exposed to 1 mSv.
- 3 workers were involved.



Source IAEA and Health Physics

# Worker 1

- Lost consciousness a few minutes after the explosion and then began to vomit.
- He recovered consciousness 70 minutes later and had diarrhea.
- He developed acute radiation syndrome.
- Received BMT from sister.
- Died 3 months later.

# Worker 2

- Vomited after an hour.
- Developed acute radiation syndrome.
- Survived almost one year.



Source JAEA

# Worker 3

- Was in an office 10-20 m away.
- Asymptomatic. Only mild nausea.
- Survived.



# Radiological Dispersal Device (RDD)

- Radioactive material
  - Dispersed using explosives (dirty bomb)  
or
  - Dispersed without the use of explosives  
(Goiania incident)

# Moscow Park and Market- 1995



Source PBS

# Jose Padilla

- Arrested in 2002 in Chicago's O'Hare airport.
- Accused of plotting a terrorist attack in the US.
- Thought to have received dirty bomb detonation instructions in Pakistan.



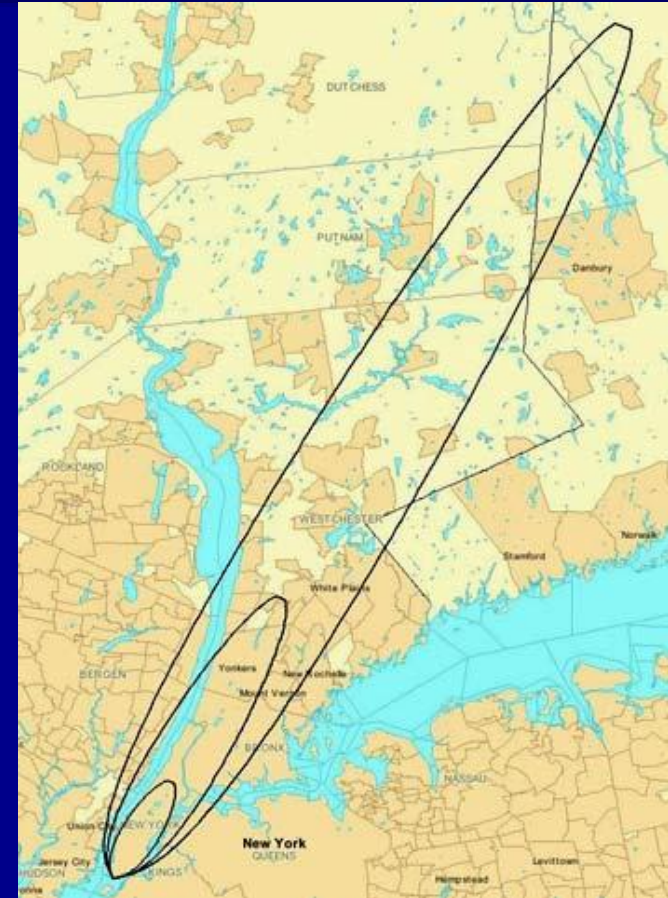
Source Wikimedia Commons

# “Dirty Bomb”

- Conventional explosive + radioactive material= “dirty bomb”.
- High “fear factor” in the press/public.
- Economic toll

# “Dirty Bomb simulation”

- Simulation of long-term contamination due to a cobalt-60 bomb in New York City.
- Cancer deaths due to radiation: Inner ring: One per 100 people Middle ring: One per 1,000 Outer ring: One per 10,000.



*Courtesy Federation of American Scientists*

# Goiania Incident: RDD



Source IAEA

- 1985.
- Abandoned teletherapy clinic.
- 2 thieves and a junkyard owner.
- Material glows at night.

# Goiania incident

- 112,000 people were surveyed at the Olympic stadium.



5. Monitoring people for contamination at the Olympic stadium.

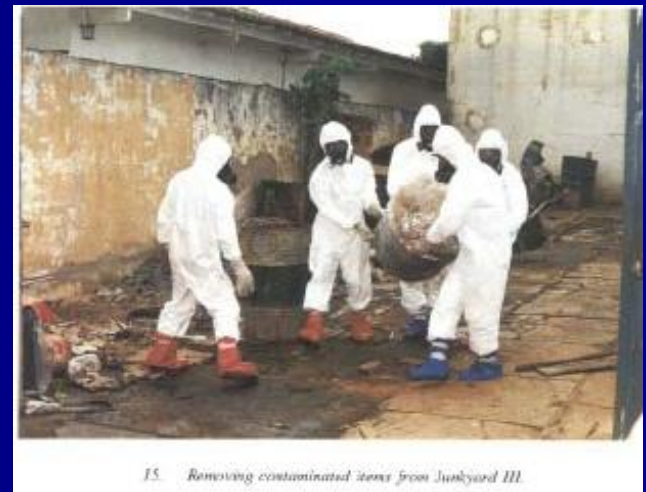


4. The physicist W.F. monitoring for contamination at the Olympic stadium.

Source IAEA

# Goiania incident

- 249 found to be contaminated.
- 1 amputation
- 4 Deaths.
- Prussian Blue therapy.
- Evacuations.
- Demolition of homes, etc.



Source IAEA



# Summary Points

- Radiological and nuclear threats are real.
- Emergency responders are not well prepared to respond.
- Different types of threats exist.

# Any Questions?

