

Medical Considerations in a Nuclear Attack

Matt Mihelic, M.D.
University of Tennessee
Graduate School of Medicine
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National Planning Scenarios

- Scenario 1: Nuclear Detonation – 10-Kiloton Improvised Nuclear Device
- Scenario 2: Biological Attack – Aerosol Anthrax
- Scenario 3: Biological Disease Outbreak – Pandemic Influenza
- Scenario 4: Biological Attack – Plague
- Scenario 5: Chemical Attack – Blister Agent
- Scenario 6: Chemical Attack – Toxic Industrial Chemicals
- Scenario 7: Chemical Attack – Nerve Agent
- Scenario 8: Chemical Attack – Chlorine Tank Explosion
- Scenario 9: Natural Disaster – Major Earthquake
- Scenario 10: Natural Disaster – Major Hurricane
- Scenario 11: Radiological Attack – Radiological Dispersal Devices
- Scenario 12: Explosives Attack – Bombing Using Improvised Explosive Device
- Scenario 13: Biological Attack – Food Contamination
- Scenario 14: Biological Attack – Foreign Animal Disease (Foot and Mouth Disease)
- Scenario 15: Cyber Attack

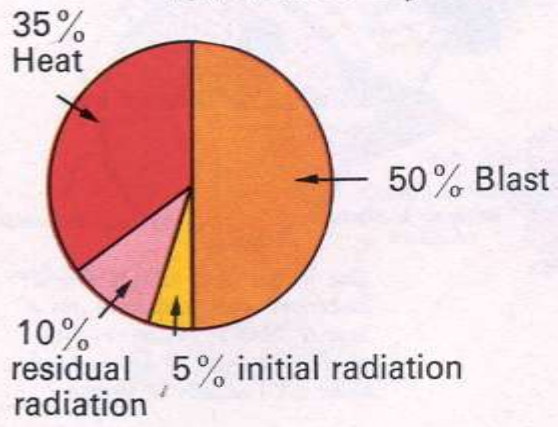
Nuclear Weapon Inventories

- US 5,300 (58 portable)
- Russia 7,200 (122 portable)
- France 348 (60? portable)
- Britain 200
- China 380
- Israel 75-200
- India 40-50
- Pakistan 24-48
- North Korea 1-12 ?
- Iran ?

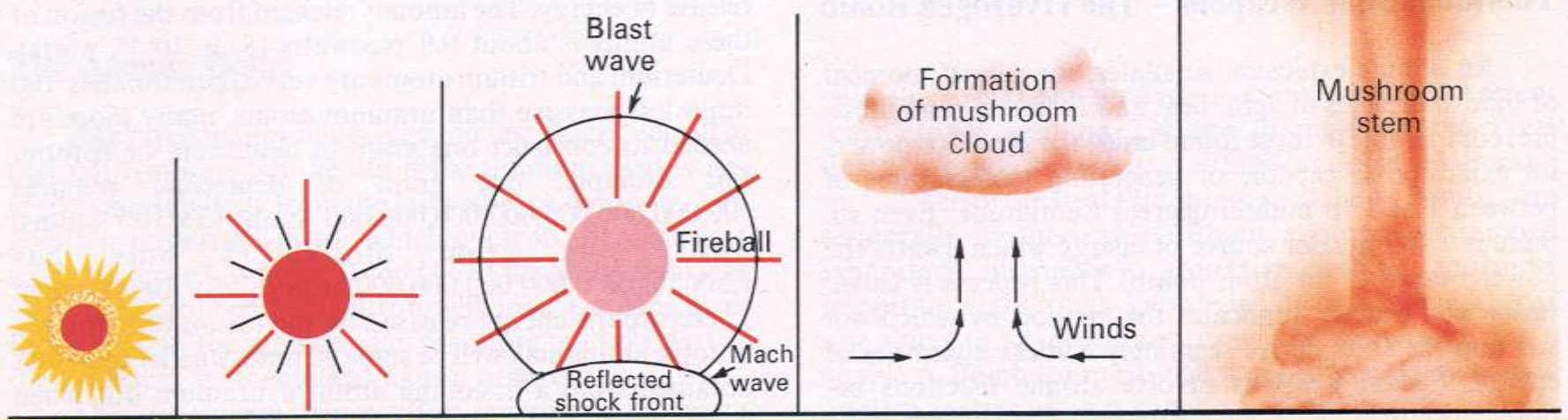
Nuclear Weapon Yields

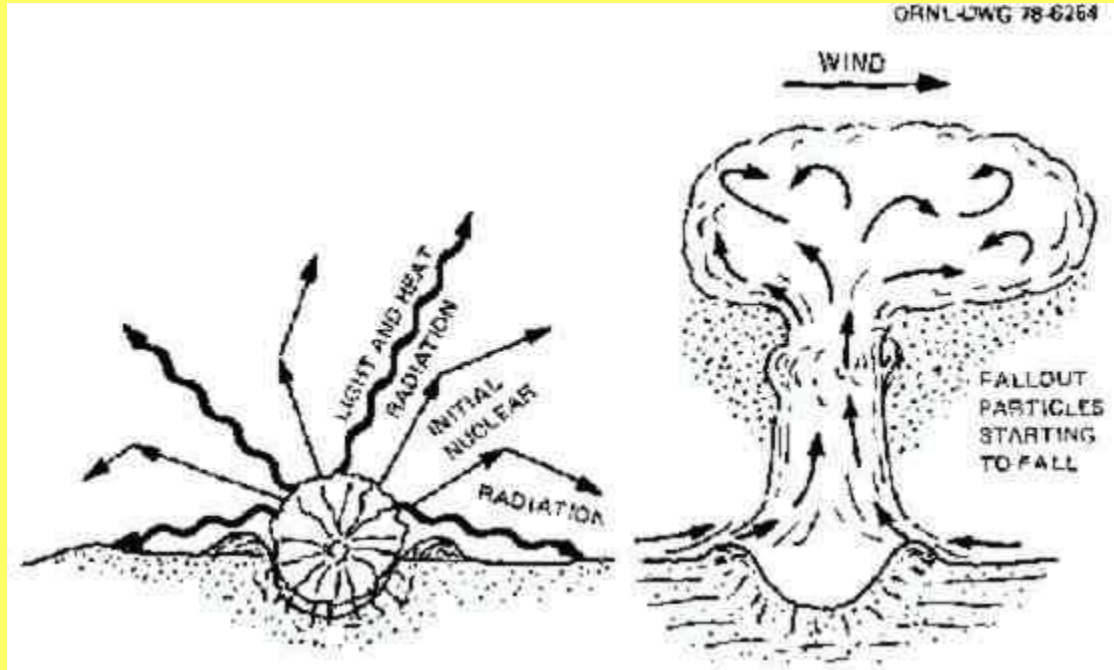
- suitcase nuke 1-10 KT
- Hiroshima bomb 13 KT
- most Russian ICBM's 1 MT
- Russian SS-9 Scarp ICBM 25 MT
- U.S. Minuteman II 1 MT
- U.S. Minuteman III 160 KT
- U.S. Titan II 5 MT
- Chinese ICBM's (estimated) 2-20 MT

Distribution of energy from nuclear explosion



DEVELOPMENT OF A NUCLEAR EXPLOSION (AIR BURST)

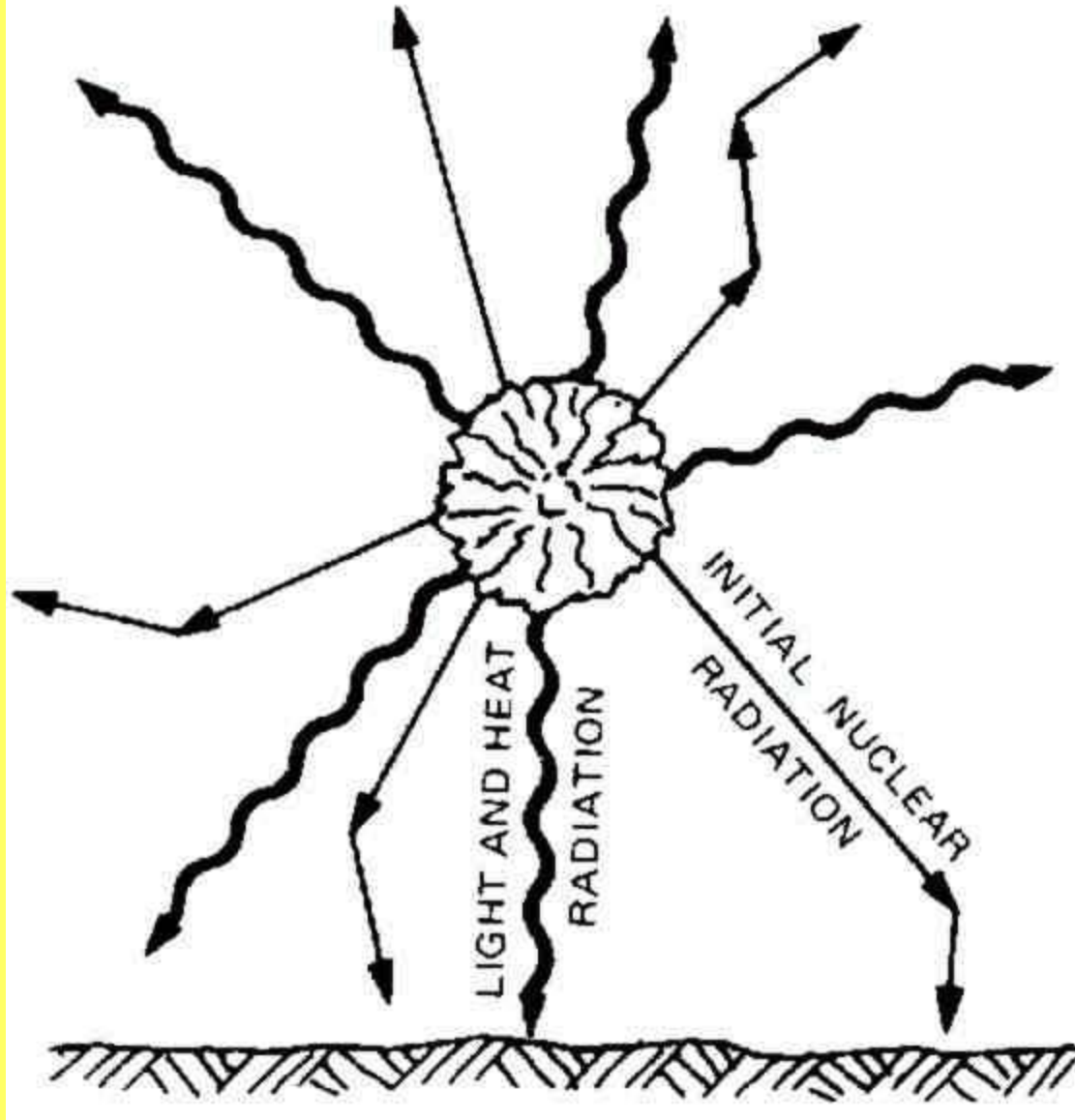




Nuclear Crater Formation

- 10 KT crater depth
 - 10 KT crater width
 - 1 MT crater depth
 - 1 MT crater width
- 32 ft
 - 100 ft
 - 904 ft
 - 2100 ft

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Flash effects of a nuclear detonation

- fireball reaches peak intensity in 1 second
 - 10 KT lasts 2 sec., 1 MT lasts 20 sec.
- anyone looking at the fireball may be blinded, either temporarily or permanently
 - Flash blindness vs. retinal burns approx. 2:1
- temporary blindness out to 13 miles away by day, and out to 53 miles away by night
- **DO NOT LOOK AT THE FIREBALL**

Estimated Yield from Illumination Time

<u>Illumination time (seconds)</u>	<u>Yield</u>
Less than 1	1 to 2 KT
1	2.5 KT
2	10 KT
3	22 KT
4	40 KT
5	60 KT
6	90 KT
7	125 KT
8	160 KT
9	200 KT
10	250 KT
12	325 KT
14	475 KT
16	700 KT
20	1 MT
24	1.5 MT
27	2 MT
40	5 MT
55	10 MT
75	20 MT

Thermal effects of a nuclear detonation

- Anything combustible and in a line of sight may be ignited (grass, leaves, curtains, etc.) at a range of 0.75 miles for a 10 KT detonation, and 7 miles for a 1 MT detonation
- Second degree burns of exposed skin (clothing may provide some protection) at a range of 1 mile for a 10 KT and 10 miles for a 1 MT
- take cover behind anything that might provide “shade” from the detonation

EMP

(Electromagnetic Pulse)

- 1958 - A hydrogen bomb detonated over Johnson Island in the Pacific knocked out street lights in Hawaii which was 800 miles away.
- A single 20 MT detonation at an altitude of 200 miles would create an EMP large enough to knock out much of the civilian electrical equipment in the United States.

EMP

- A 10 KT surface burst would produce an EMP “source region” of 2.6 miles.
- A 10 KT high altitude detonation could cause disruptions over several states

Blast effects of a nuclear detonation

- 0.5 miles (10 KT) – all multistory brick and wood buildings destroyed
 - 5 miles for 1MT
 - reinforced concrete buildings would fare somewhat better, but would probably be made totally useless
- 2.0 miles –all glass shattered
 - 20 miles for 1 MT

Estimated Range from Flash-to-Bang Time

Flash-to-bang (min:sec)	Range from Ground Zero (miles)
:05	1.1
:10	2.2
:15	3.5
:20	4.5
:25	5.5
:30	6.7
:45	9.9
1:00	13.7
1:15	16.8
1:30	19.9
1:45	23.0
2:00	26.7
2:15	29.8
2:30	32.9
3:00	39.8
4:00	52.8
5:00	65.9
10:00	130
15:00	200
30:00	400

Radiation effects of a nuclear detonation

- Initial - directly radiated from the explosion and last up to one minute (for 1 MT) after detonation
- Residual - caused by the irradiation of matter within the fireball and distributed after the explosion as fallout

Initial radiation effects of a nuclear detonation

- radiation emitted increases with time after detonation, and lasts until the fireball is gone
- it would be beneficial to take cover behind a massive structure if possible

Initial radiation effects of a 1 MT detonation

- BLAST EFFECTS (5 mi. for 1MT)
OUTDISTANCE RADIATION EFFECTS*
- gamma radiation
 - 10,000 rads at 2,000 yards
 - 100 rads at 3,300 yards
- neutron radiation
 - 10,000 rads at 1600 yards
 - 100 rads at 2,500 yards
- *EXCEPT FOR NEUTRON BOMBS

Neutron Bomb Effects

- 10 ton yield
 - 1000 REM at 1500 ft.
 - 50 REM at 2500 ft.
- 100 ton yield
 - 10,000 REM at 1500 ft.
 - 500 REM at 2500 ft.

Effects of radiation on humans

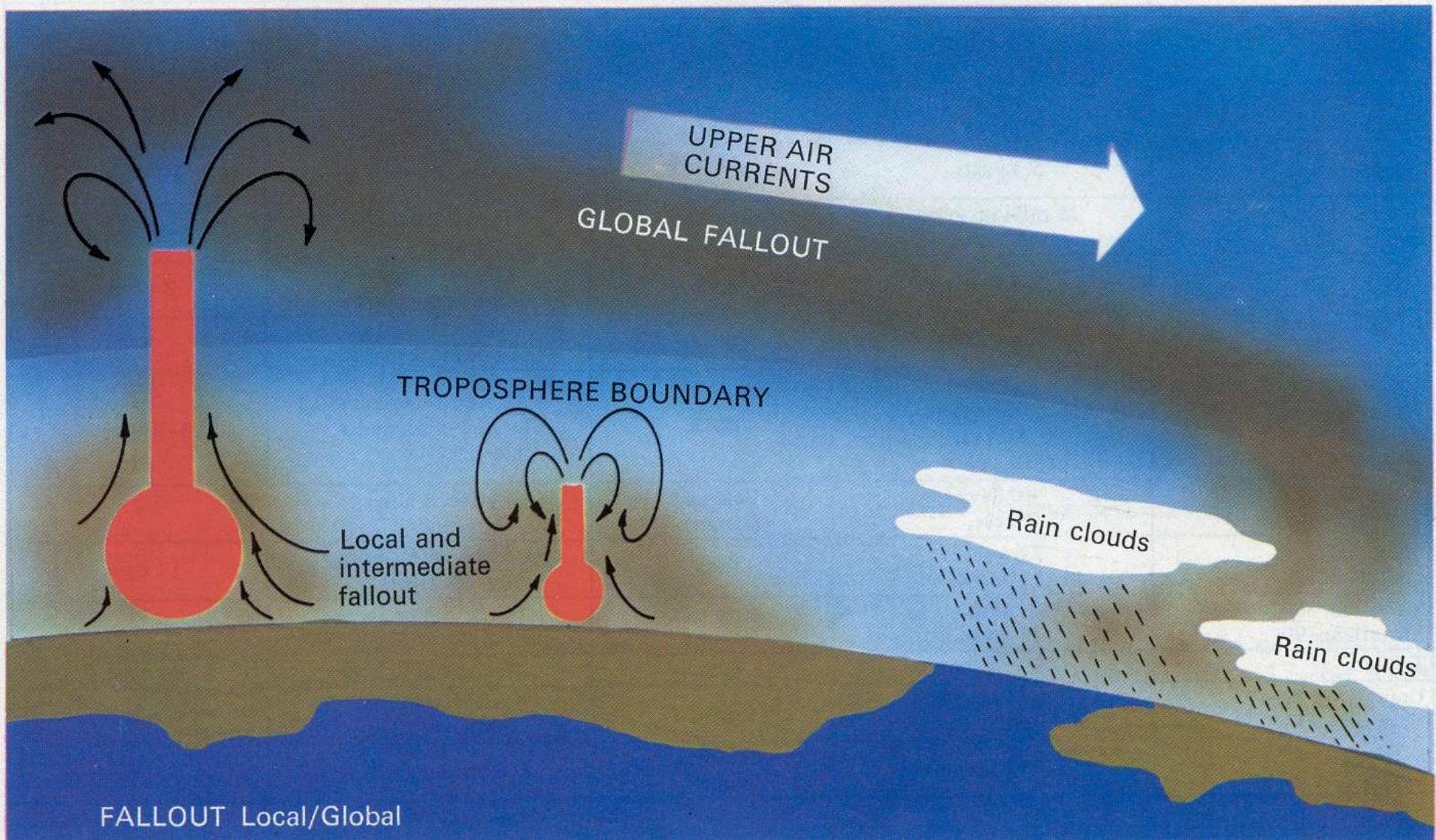
- 100-150 rads - mild to moderate symptoms
- 200 rads - nausea, vomiting, weakness
- 450 rads - LD50, death in weeks
- 600 rads - LD100, death in weeks
- 1000 rads - death in days
- 2000 rads - death in hours

Summary of immediate effects of a 10 KT detonation

- 0.3 miles - total destruction, no survivors
- 0.5 miles - few reinforced buildings remain, at least 50% mortality
- 0.75 miles - extreme fire hazard, houses severely damaged, 5% mortality from blast and 20% mortality from thermal effects
- 1.0 miles - moderate structural damage, 10% mortality, 35% injured

Summary of immediate effects of a 1 MT detonation

- 3 miles - total destruction, no survivors
- 4.5 miles - few reinforced buildings remain, at least 50% mortality
- 6.5 miles - extreme fire hazard, houses severely damaged, 5% mortality from blast and 20% mortality from thermal effects
- 10 miles - moderate structural damage, 10% mortality, 35% injured



Nuclear Cloud Dimensions

- 10 KT detonation
 - Cloud height: 6 miles
 - Cloud diameter: 2 miles
- 1 MT detonation
 - Cloud height: 14 miles
 - Cloud diameter: 21 miles

(tropospheric boundary at 10 miles)

Residual Radiation / Fallout

- Fallout comes from matter which is sucked up into the fireball and is vaporized, irradiated by neutrons, and mixed with fission products.
- This matter will cool and condense to form particles ranging in size from a grain of sand or salt, to a very fine dust.
- A high enough air burst will produce no significant residual radiation. (2 oz/KT)

Fallout

- Particles begin to arrive in the area of the blast soon afterward.
- Particles begin to arrive 20 miles away 1 hour after the blast.
- Particles begin to arrive 100 miles away 4 hours after the blast.
- Fallout from the 1954 Bikini atoll test spread 20 miles upwind and 350 miles downwind, in a pattern that was 60 miles wide covering 7,000 square miles.

Fallout radiation

- Fallout is a complex mixture of over 200 different isotopes of 36 elements
- alpha and beta radiation
 - penetrate only up to 10-12 ft. in air
 - stopped by clothing
 - a danger if on skin (beta burns) or ingested
- gamma radiation
 - a much larger concern
 - much more penetrating

Fallout

- The earlier the fallout, the more radiation it contains.
- 80% of the radioactive material from a ground burst will return to earth within 24 hours, but very fine particles may stay aloft for months or years.

Radioactivity Dispersal Devices (RDD)

- Weapons of Mass Disruption: Panic and economic impact the intended results
- Hazard boundary about 500 meters for area of highest concern
- Primary concerns of early first responders should be to protect from “groundshine”, consider how to handle contamination, and assess inhalation risk
- Inhalation risk from plume, which passes within 10 minutes (prior to arrival of most responders) – respiratory protection advised

Likely RDD Materials

- Cesium-137 – very water soluble powder



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- Strontium-90 – fairly water soluble powder



YXC

- Americium-241



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RDD Materials

- You don't need conventional explosives to disperse radiation
 - Cesium Chloride (Cs137) –talcum-like powder
 - Brazil, 1987



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Radiation Emission Device (RED)

- A “passive” RDD
- Likely radioactive sources

– Iridium-192

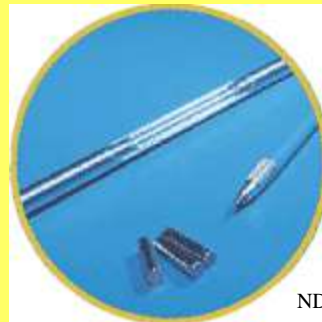


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IAEA

– Cobalt-60



NDS Nordion

Medical treatments that can be used for contamination with some specific radionuclides

- DTPA – for Plutonium
- Alkalinization of urine – for Uranium
- Prussian Blue – for Cesium
- Hydration – for Tritium
- Potassium Iodide – for Iodine

DTPA

- Use for contamination with plutonium and other transuranics - increases excretion
- Best to administer within one hour of exposure
- Dose is 1 gram in 250 cc of NS or D5 administered daily
- Ca-DTPA more effective chelator than Zn-DTPA
 - Use Ca-DTPA for first two doses, then switch to Zn-DTPA
 - Use Zn-DTPA salt in children or pregnancy

Resources

- NCRP-65
 - National Council on Radiation Protection and Measurements Report No. 65
 - *Management of Persons Accidentally Contaminated with Radionuclides*
- REAC/TS
 - Radiation Emergency Assistance Center/Training Site
 - Oak Ridge Institute for Science and Education

Alkalinization of the Urine

- Use for uranium contamination
- Uranium is very nephrotoxic (chemically)
- Increases excretion
- Maintain urine pH 7.5-8.0
- Sodium bicarbonate tablets

Prussian Blue

- Use for cesium and thallium contamination
- insoluble Prussian blue (Radiogardase®)
 - not systemically absorbed
- Binds ions in the gut and stops recirculation
- Reduces the biological half-life of cesium
- Dose is 3 grams TID in adults and 1 gram TID in children ages 2-12
- Duration of treatment is one month

Aluminum Phosphate

- Reduces absorption of strontium
- Dose is 100 cc PO one time
- Aluminum hydroxide also can be used in the same dose (Alternagel®)

Hydration

- Increased hydration for Tritium exposure
- Tritium is a beta emitter
- Force fluids 3-4 liters per day

Potassium Iodide

- Treat before exposure to radioactive Iodine
- Blocks thyroid binding sites for Iodine
- Also blocks radioactive Technetium
- Treat 1-4 hours prior to exposure
- Tablets of KI
 - 300 mg, 170 mg, 160 mg, 130 mg, 85 mg
- SSKI (47 mg/drop)
- Povidone iodine is theoretically useful

Potassium Iodide

(saturated solution)

- Fill 60% of the volume of a small bottle with potassium iodide crystals, then add water to fill the bottle completely. Some crystals should remain undissolved.
- 47 mg/drop
- “Kerney dose”:
 - <12 months → 2 drops PO Qday
 - >12 months → 4 drops PO Qday

Potassium Iodide

- FDA, CDC, and WHO dose (daily)

up to 1 month	16 mg
1 mo.-3 yrs.	32 mg
3-18 yrs	65 mg
adults	130 mg

Radiation exposure from fallout

(20 miles downwind from a 2 MT detonation)

- 1 hour - 3 rads/hr
- 2 hours - 500 rads/hr
- 6 hours - 200 rads/hr
- 18 hours - 50 rads/hr

- total unprotected accumulation at 18 hours is 2,000 rads

The Three D's of Radiation Protection

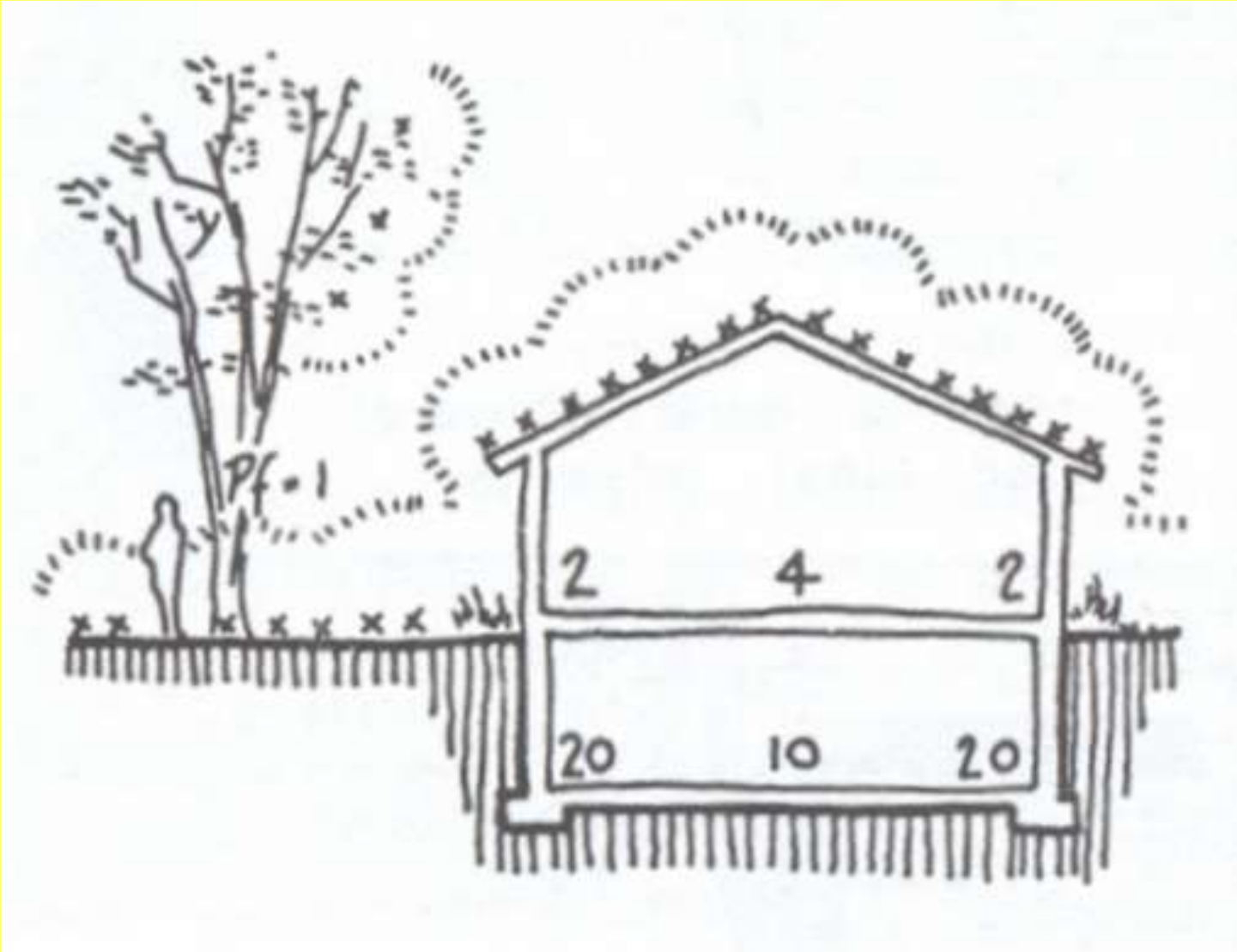
- Distance
- Density
- Duration

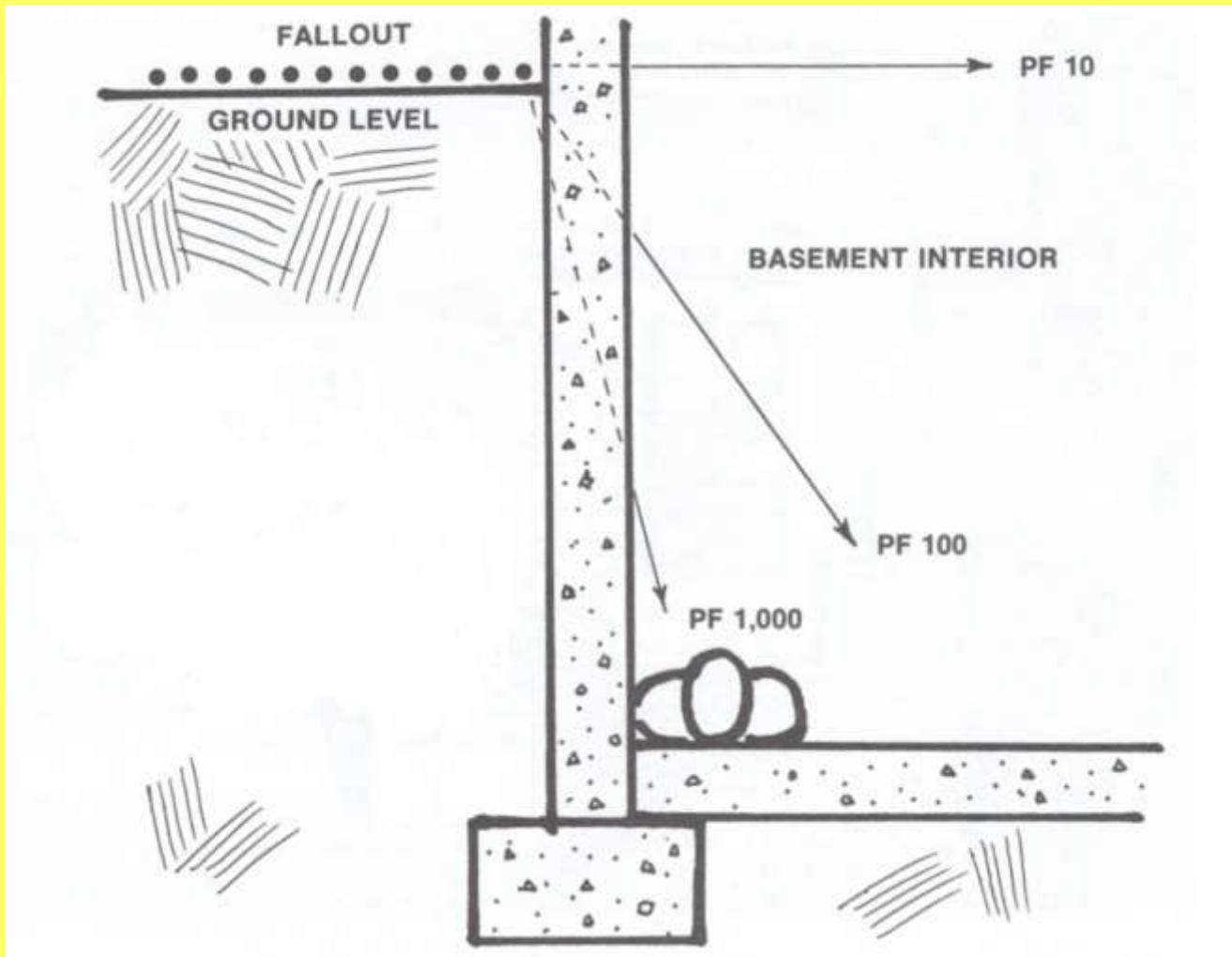
Principles of Shielding from Radioactive Fallout

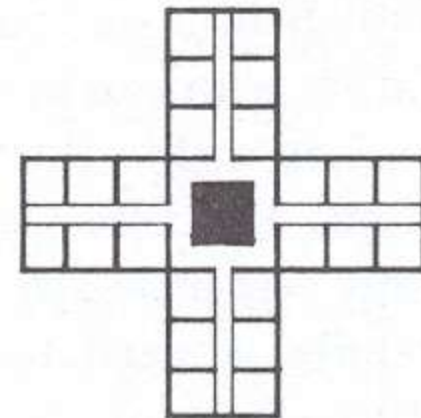
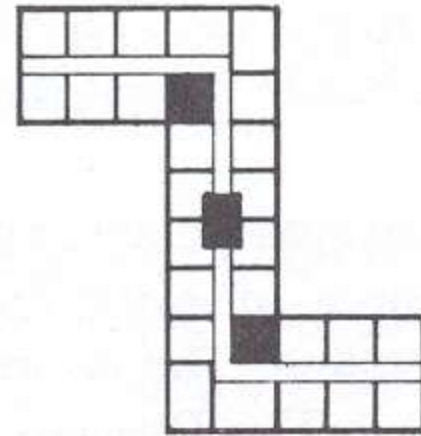
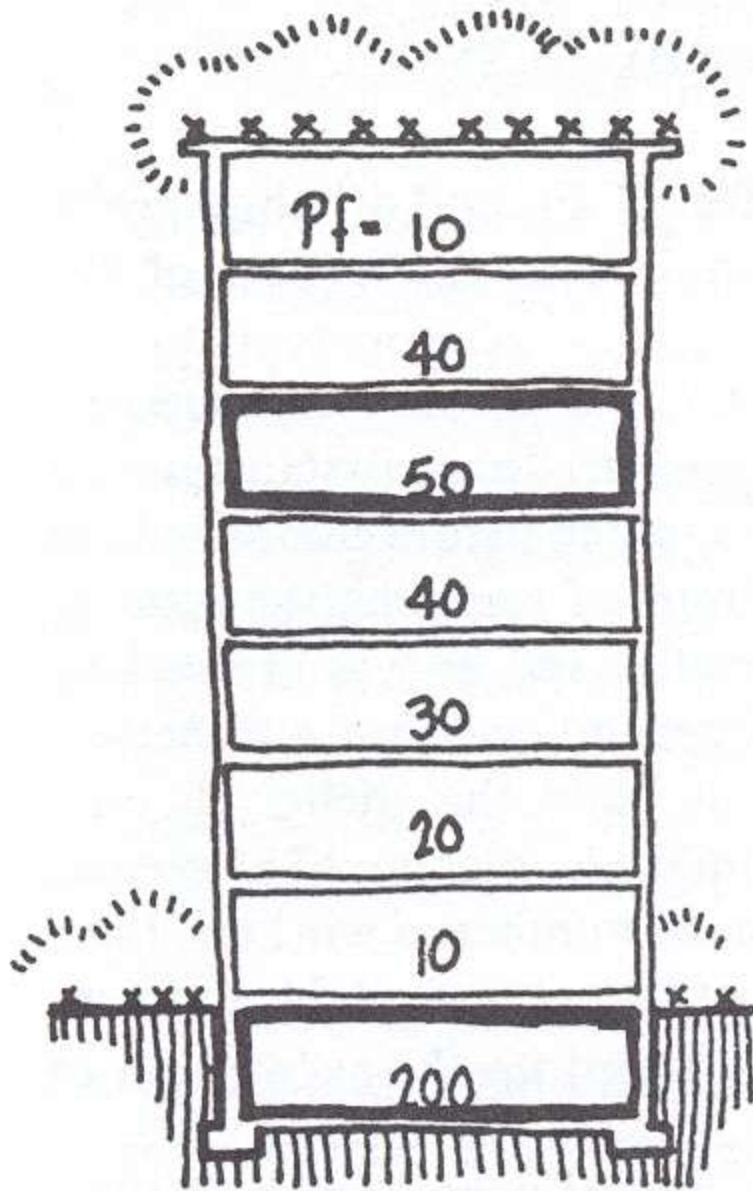
- Maximize distance from fallout
 - when the distance from a source of radiation is doubled, the amount of radiation is quartered
- Build a mass barrier between yourself and the fallout
 - a density of at least 150 pounds per sq. ft. will provide a Protective Factor (PF) of 10 (i.e. reducing the radiation to 1/10 of the original)

Shielding Materials Necessary for 150 pounds per sq. ft.

- 12 inches of concrete
- 15 inches of bricks
- 18 inches of sand or gravel
- 21 inches of packed earth
- 30 inches of water
- 42 inches of books or magazines
- 54 inches of wood

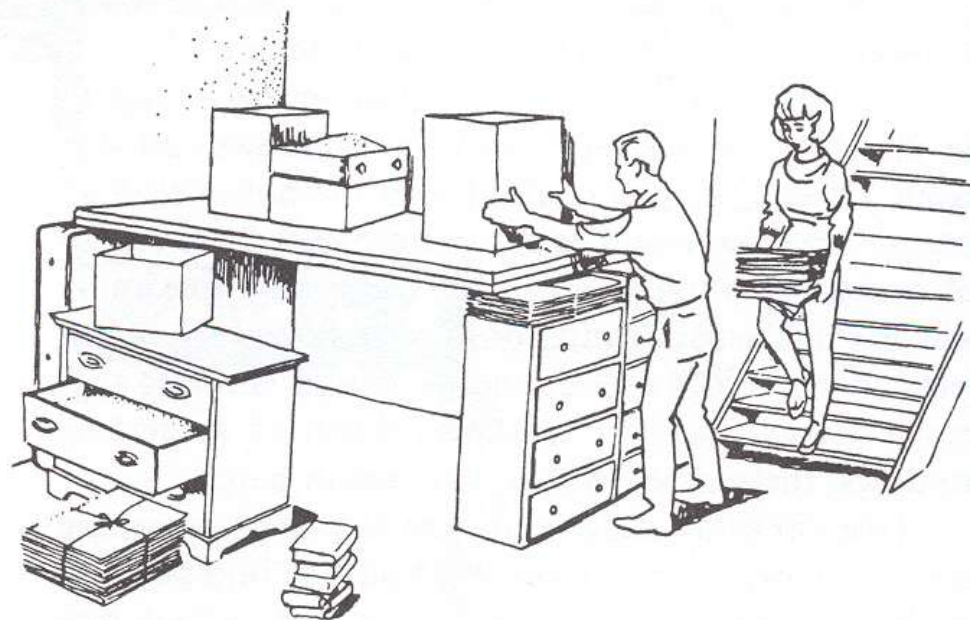
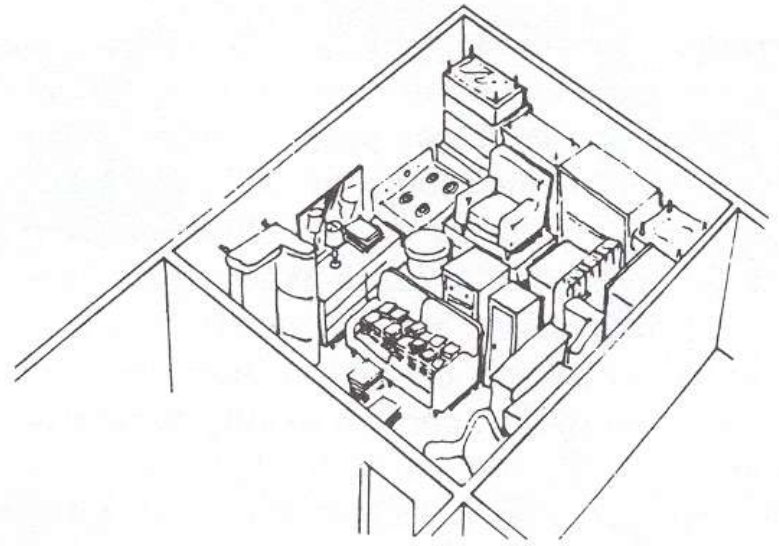
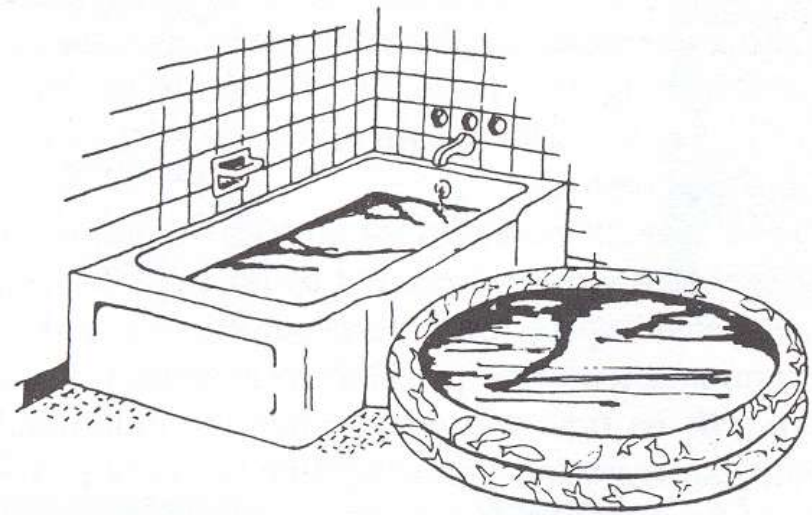


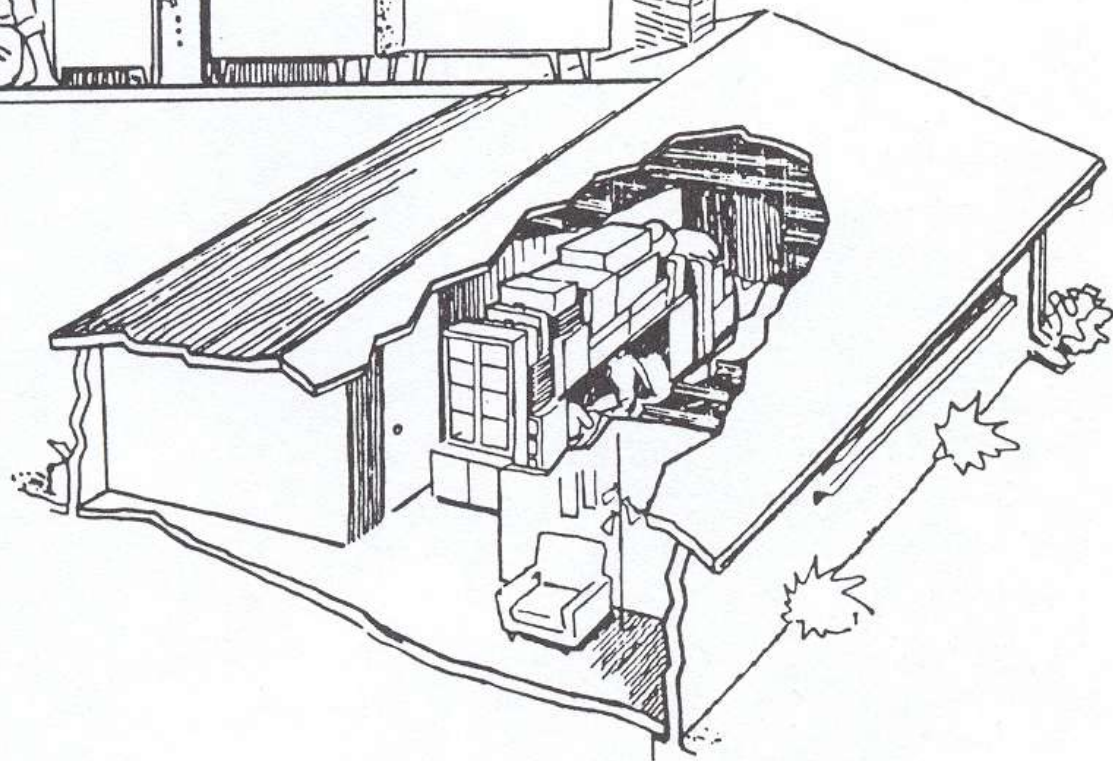
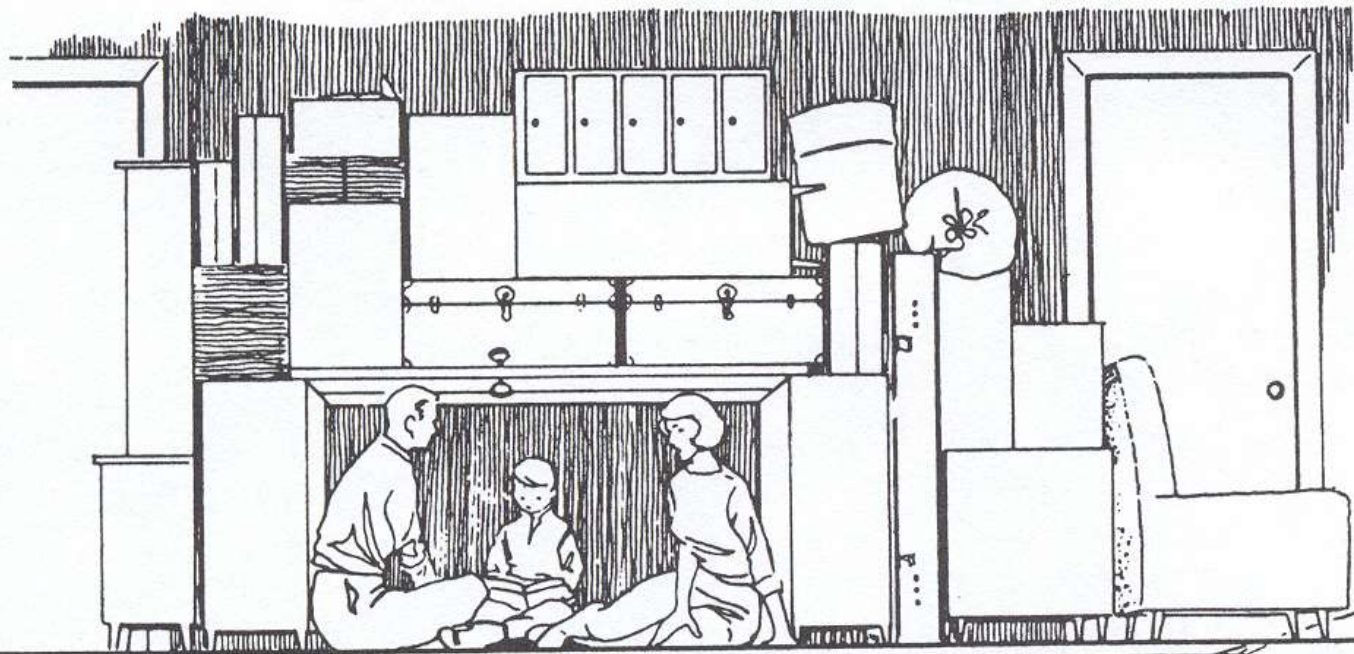




PF's of positions in a building

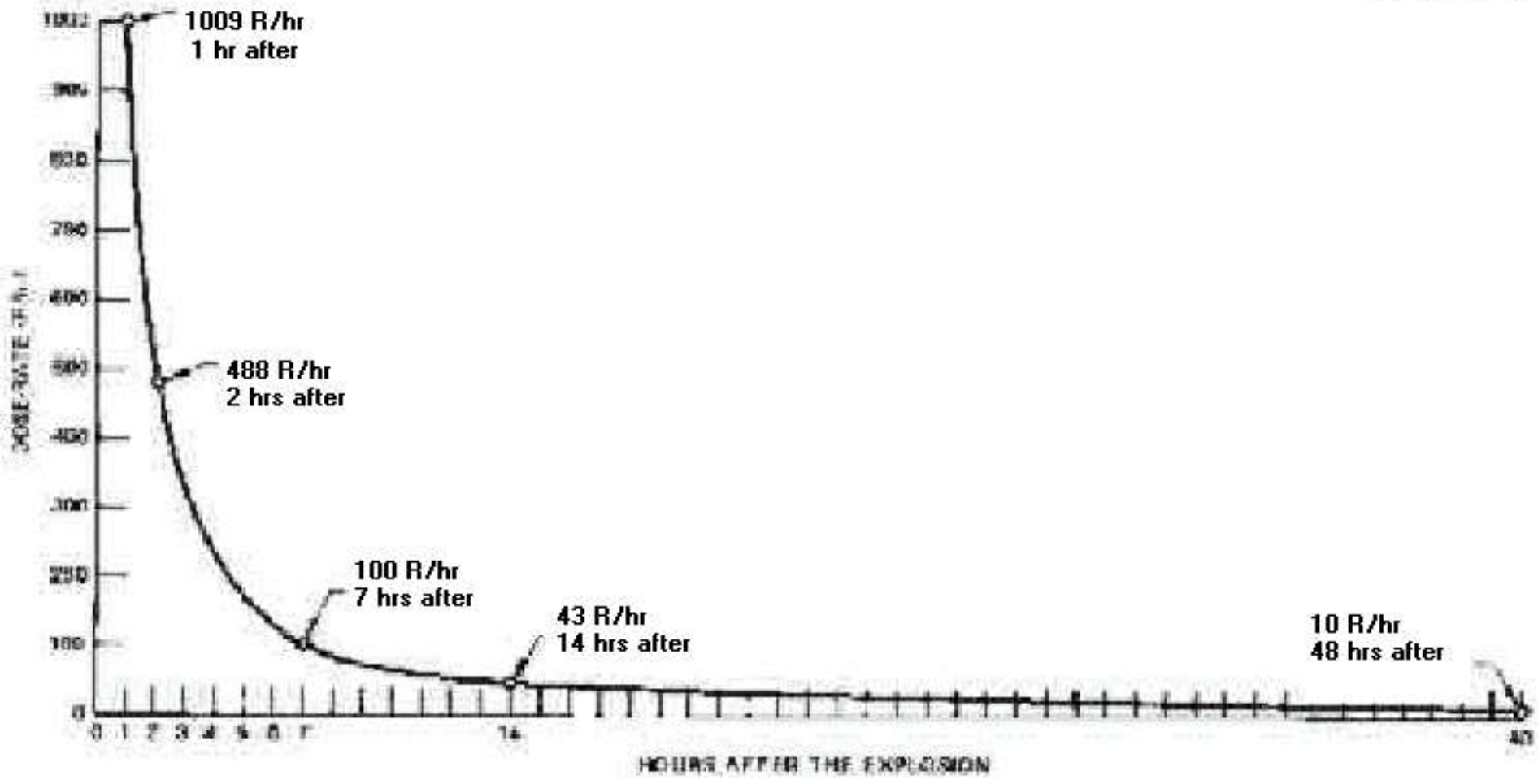
- first floor of house near external wall - 2
- center of first floor of house - 4
- center of house basement - 10
- house basement near external wall -20-1000
- high rise top floor - 10
- high rise mid to upper floors - 50
- high rise ground floor - 10
- high rise basement - 200





Rule of Seven

- The intensity of residual radiation will decrease by a factor of 10 for every seven fold increase in time.



Shelter time

- Time I - 2 weeks to 2 months (avg.1 month)
- Time II - 2 years
 - time of most exposure
 - Being out of shelter for 8 hours per day will give a total accumulation of 3 rads / day.
(The body can repair up to 10 rads/day.)
 - sleep in shelters, etc.
- The average life span should only be decreased by 1.2 years if the above were followed, and by only 0.2 years if only those over 40 years of age left the shelter at first.

Medical Triage

- 3 types of injuries expected
 - blast
 - thermal
 - radiation – initial vs. fallout
- you don't want to waste resources on blast and thermal patients who will die of radiation poisoning

Medical Triage

- CNS Symptoms - convulsions, tremor, ataxia, lethargy
 - indicates exposure to 2,000 rads or more
 - will die within 48 hours
 - Initially this will probably be rare because anyone close enough to receive that much initial radiation will more likely have been killed by blast and thermal effects.
 - (may be more likely due to fallout radiation)

Medical Triage

- GI Symptoms - nausea, vomiting, diarrhea
 - if within 1 hour indicates >600 REM's
 - near 100% mortality
 - if within 2 hours indicates 200-600 REM's
 - 25-75% mortality
 - if within 3 hours indicates 100-200 REM's
 - $<25\%$ mortality

Medical Triage

- Hematopoietic Syndrome - anemia, thrombocytopenia, immune suppression
 - Those patients receiving 200-500 rads may remain relatively symptom free for 2-4 weeks, but white cell depression will begin to occur within a few days.
 - Maximum effects in 3-4 weeks.
 - These patients may survive if lethal complications can be prevented and the marrow is allowed to regenerate.

Medical Triage

- Burns
 - Patients with third degree burns over 50% of the body will have little chance of survival, even under optimal conditions.
 - From a practical point of view there will be minimal salvage of anyone having more than 25% BSA burns and severe radiation injury

Medical Triage

- Clinical Guidelines
 - No active care of heavily irradiated patients if there is concomitant early onset of CNS symptoms, early onset of GI symptoms, deep burns exceeding 25% BSA, or severe trauma that would have an estimated 50% mortality if uncomplicated by severe bone marrow depression.

Casualty Management

- Other Considerations for Combined Injuries
 - Required surgery should be done ASAP because patients will not be able to withstand surgery better than immediately following exposure.
 - Surgery should be avoided during the third and fourth weeks because this is the time of maximum bone marrow depression.
 - Wounds might be best handled by delayed primary closure. This minimizes the likelihood of early sepsis but provides an intact skin cover when bone marrow depression becomes severe.

Casualty Management

- Other Considerations for Combined Injuries
 - Start prophylactic broad spectrum antibiotics immediately.
 - Meticulous debridement of wounds to leave no nidus of infection.
 - Liberal fresh whole blood or platelet transfusions if thrombocytopenia, hematuria, petechiae, or other clinical signs of bleeding appear.
 - Electrolyte imbalances and dehydration will probably best be handled by oral electrolyte solutions because of the lack of availability of IV solutions.

Other factors promoting the spread of disease in the aftermath of a nuclear attack:

- shelter conditions
- lack of sanitation
- unburied corpses
- lack of communications
- lack of medical supplies
- lack of adequate nutrition

Psychological factors in the aftermath of nuclear war

- What about the nation as a whole?
 - Total demoralization?
 - Willingness to follow anyone who offers authority, answers, and hope?
 - Acceptance of martial law?
 - Potential for the rise of a powerful dictatorship?
 - Potential for whole groups to be destroyed if a leader were to point fingers at “causes” and “causers”?

“In the event of attack, the lives of those families which are not hit in the nuclear blast and fire can still be saved if they can be warned to take shelter and if that shelter is available. We owe that kind of insurance to our families and to our country.”

President John F. Kennedy

July 25, 1961