## RADIATION

Presented by The American Civil Defense Association (TACDA)

# RADIATION IS AN 'ERUPTION' OR 'EMISSION' OF PARTICLES FOUND IN THE NUCLEUS OF THE ATOM

Protons
Electrons
Neutrons





### NEUTRONS



### **INITIAL RADIATION**

Particle: Neutron Range: 1 1/2 miles from detonation Duration: Fraction of one second Threat : Highly penetrating

Particle: Gamma Range: Duration: Less than one minute Threat:

### ALPHA PARTICLE (Two Protons & Two Neutrons)



### **ALPHA PARTICLE**

- Particle: Two Protons, Two Neutrons
- Range: 6 to 7 cm. in air
- Size: Large
- Velocity: Slow
- Duration: short, to very long
  Ionization: Highly ionizing
- Threat: Internal

### **BETA PARTICLES**



### **BETA PARTICLE**

- Particle: Negatron (electron)
- Charge: Negative
- Range: 11 to 13 meters (33 to 40 ft.)
- Size: Small
- Duration: Short to very long
- Ionization: small ionizing capability
- Threat: small external, large internal

### GAMMA RAYS



### **GAMMA RAYS**

- Particle: No mass
- Charge: No charge
- Range: Considerable
- Velocity: Speed of light
- Ionization: Indirect
- Threat: Highly penetrating

### **RADIOACTIVE HALF-LIFE**

 The time required for the radioactivity of a given element to decrease to half its original value.

### FALLOUT

 Most far reaching of all weapons effects

 Seen as an accumulation of dust and small particles

## **TYPES OF NUCLEAR WEAPONS**

- Dirty Bombs
- Neutron Bombs
- Fission Bombs
- Fusion Bombs

## **TYPES OF BURSTS**

- High Altitude
- Air
- Surface
- Sub-surface

## FALLOUT DISTRIBUTION

- Carried in nuclear cloud
- Moved by winds
- Rainout
- Terrain
- Oceans

#### FALLOUT PATTERNS







Source: Reference 12

#### RISK AREAS One Week Dose Range

Protection Factor	High Fallout	Med. Fallout	Low Fallout
Using Shelter	Risk Area	Risk Area	Risk Area
PF 5	1200-3000	600-1200	600 rads or less
PF 10	600-1500	300-600	300 rads or less
PF 20	300-750	150-300	150 rads or less
PF 30	200-500	100-200	100 rads or less
PF 40	150-375	75-150	75 rads or less
PF 60	100-250	50-100	50 rads or less
PF 80	75-188	38-75	38 rads or less
PF 100	60-100	30-60	30 rads or less
PF 200	30-75	15-30	15 rads or less
PF 500	12-30	6-12	6 rads or less

#### RADIATION PENALTY TABLE

Acute Effects	Accumulated Exposure (R) 1 Week	Accumulated Exposure (R) 1 Month	Accumulated Exposure (R) 4 Months
Medical Care Not Needed	150	200	300
Some Need Medical Care Few if Any Deaths	250	350	500
Most Need Medical Care 50% + may die	450	600	600
Lethal Dose	600		

The accumulated exposure should not exceed those in the first row. If radiation levels reach 10/R/hr in the sheltered area, the doses in the first row will probably be exceeded. In this eventuality, the shielding in the sheltered area should be increased. In a full scale attack, about 35% of our population would be expected to exceed the above doses. A PF of 500 is recommended for all fall out shelters.

#### EXPOSURE AT 30 MILES DOWNWIND (500 KT surface burst, 15 mph wind)

(Roentgens)

Time	In Open	In Shelter PF 15	In Shelter PF 40
1 Week	3450	230	86
1 Month	4100	273	103
4 Months	4500	300	113

A PF of 40, in this scenario will give the minimum protection not to exceed row one of the Penalty Table above.

#### LOW FALLOUT RISK AREAS

Using Shelter Protection Factors	Potential In-Shelter One Week Dose Range	Medical Care Needed	Able To Work	Probable Death Rate	Comments
PF 5	600 R or less	Yes	Νο	More than 50%	Deaths would occur in about one month
PF 10	300 R or less	Yes	Νο	Less than 50%	Deaths would occur in 30 to 60 days
PF 20 PF 30 PF 40	150 R or less 100 R or less 75 R or less	No	Yes	Less than 5%	Deaths would occur in 60 or more days
PF 60 PF 80	50 R or less 38 R or less	No	Yes	None	No Symptoms
PF 100 PF 200 PF 300	30 R or less 15 R or less 6 R or less	No	Yes	None	No Symptoms

### MEDIUM FALLOUT RISK AREAS

Using Shelter Protection Factor	Potential In- Shelter One Week Dose Range	Medical Care Needed	Able to Work	Probable Death Rate	Comments
PF 5	600R-1200 R	Yes	No	100%	Deaths would occur in two weeks or less
PF 10	300R-600 R	Yes	No	More than 50%	Deaths would occur in about one month
PF 20	150R-300 R	Yes	No	Less than 50%	Deaths would occur in 60 or more days
PF 30	100R-200R				
PF 40	75R-150R	No	Yes	Less than	Deaths would
PF 60	30R-100R			5%	occur in 60 or
PF 80	38R-75R				more days
PF 100	30R-60R				
PF 200	15R-30R	No	Yes	None	No symptoms
PF 500	6R-12R				

### HIGH to VERY FALLOUT RISK AREAS

Using Shelter Protection Factors	Potential In-Shelter One Week Dose Range	Additional Survivor Cancer Deaths
PF 5	3,000 R +	No
PF 10	1,500 R +	Survivors
PF 20	750 R +	
PF 30	500 R +	23% to 30%
PF 40	375 R +	
PF 60	250 R +	15% to 23%
PF 80	188 R +	
PF 100	150 R +	4.5% to 11%
PF 200	75 R +	
PF 500	30 R +	0 to 1.4%

## **PRINCIPALS OF PROTECTION**

- Time
- Distance
- Shielding

### SEVEN-TEN RULE

 For a seven-fold increase in time after detonation, there is a ten-fold decrease in the exposure rate.

### DISTANCE INVERSE SQUARE LAW

Dose is inversely proportional to the square of the distance in air from a point of a gamma-ray source.  $(\mathbf{R}_2 / \mathbf{R}_1) = (\mathbf{d}_1 / \mathbf{d}_2)^2$  $\mathbf{R}_2 = \mathbf{R}_1 (\mathbf{d}_1 / \mathbf{d}_2)^2$ 

Source\*-----10-----20------30 1,000 R 250 R 11 R

### SHIELDING PROTECTION FACTORS (PF)

 'The ratio of the fallout exposure rate above a shielded area to the exposure rate below the shielded area.

 A PF of 2 provides protection from half the radiation as measured outside the shelter.

### SHIELDING

Shielding attenuates radiation.

Fallout shelters should have a PF of at least 1,000.

## Half-Value Thicknesses

• A half-value thickness of any material will give a protection factor (PF) of 2.

Material	Half-Value Thickness
Steel	1 inch
Concrete	3 inches
Earth (compacted)	4 inches
Water	7 inches

### Shielding with soil

4 in.	PF 2
8 in.	PF 4
12 in.	PF 8
16 in.	PF 16
20 in.	PF 32
24 in.	PF 64
28 in.	PF 128
32 in.	PF 256
36 in.	PF 512
40 in.	PF 1,024

