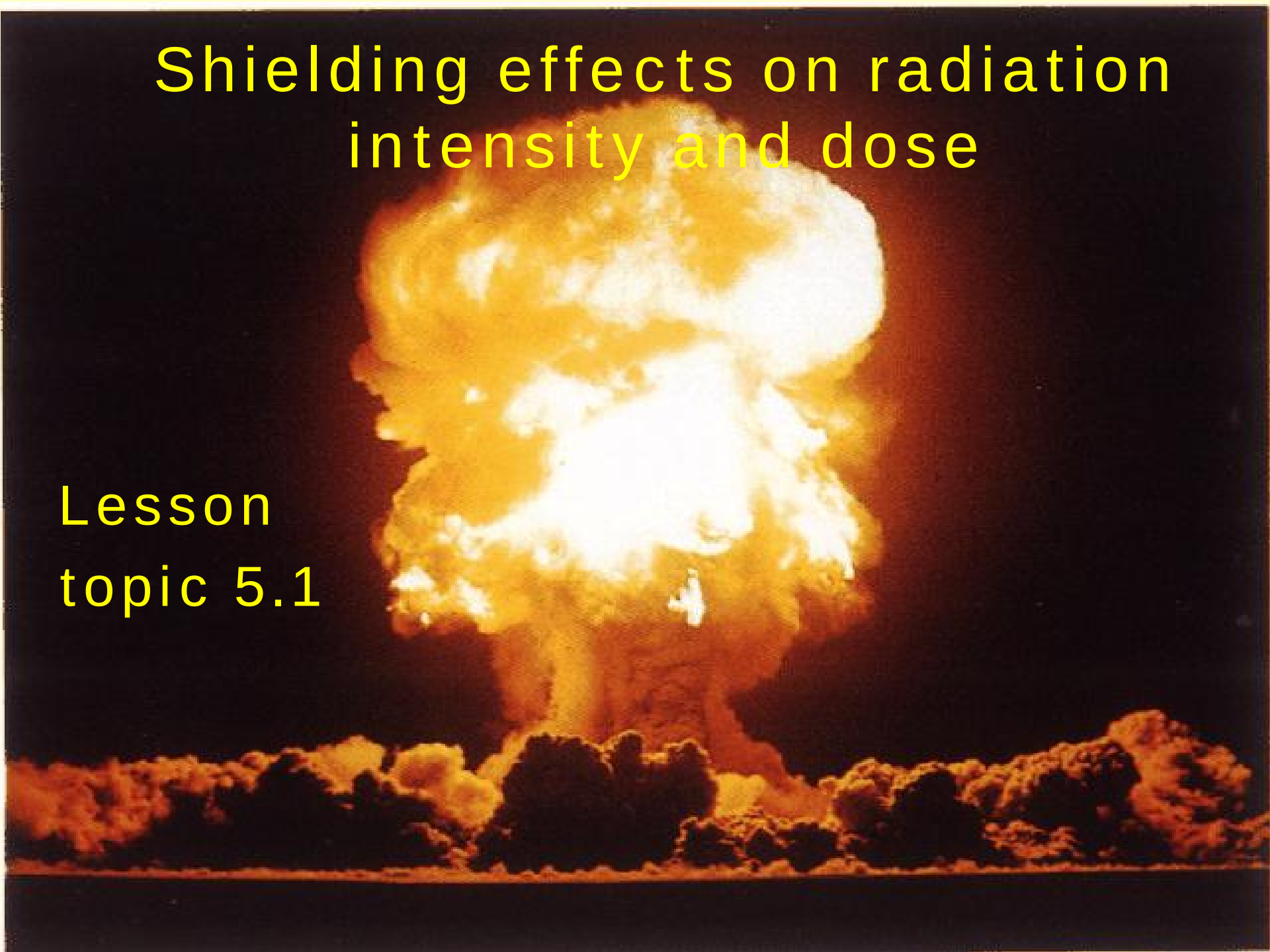
Shielding effects on radiation intensity and dose



Lesson topic 5.1

Enabling Objectives

- ***Describe*** how time, distance, and shielding effect radiation intensity and dose
- ***Describe*** the characteristics of the types of nuclear bursts
- ***Describe*** the characteristics of alpha, beta, gamma, and neutron radiation

Enabling Objectives

- ***Describe*** the following nuclear terms: fireball, Electromagnetic pulse, initial radiation, thermal radiation, shockwave, blast wave, column/plume, base surge, residual radiation, fallout, and radioactive cloud
- ***Describe*** the following nuclear terms: radiation, contamination, radioactive half life, dose, dose rate, roentgen, RAD, cintigray, and REM

Nuclear Terms

- *Radiation*
  - Rays/particles emitted from an unstable atom
- *Contamination*
  - Deposit of radioactive material on surfaces
- *Radioactive half-life*
  - Time required for the intensity of a given isotope to decrease to half of its original value

Nuclear Terms

- ***Dose***
  - Total amount of radiation received by a person regardless of time
- ***Dose rate***
  - Amount of radiation received in a unit of time
- ***Roentgen***
  - Measurement of gamma or x-ray radiation
  - Designated "R"
  - Dose Rate = R/hr

Nuclear Terms

- ***Radiation Absorbed Dose (RAD)***
  - A unit of absorbed dose of radiation
- ***Centigray (cGy)***
  - NATO designation for RAD
- ***REM*** - Unit of biological dose of radiation

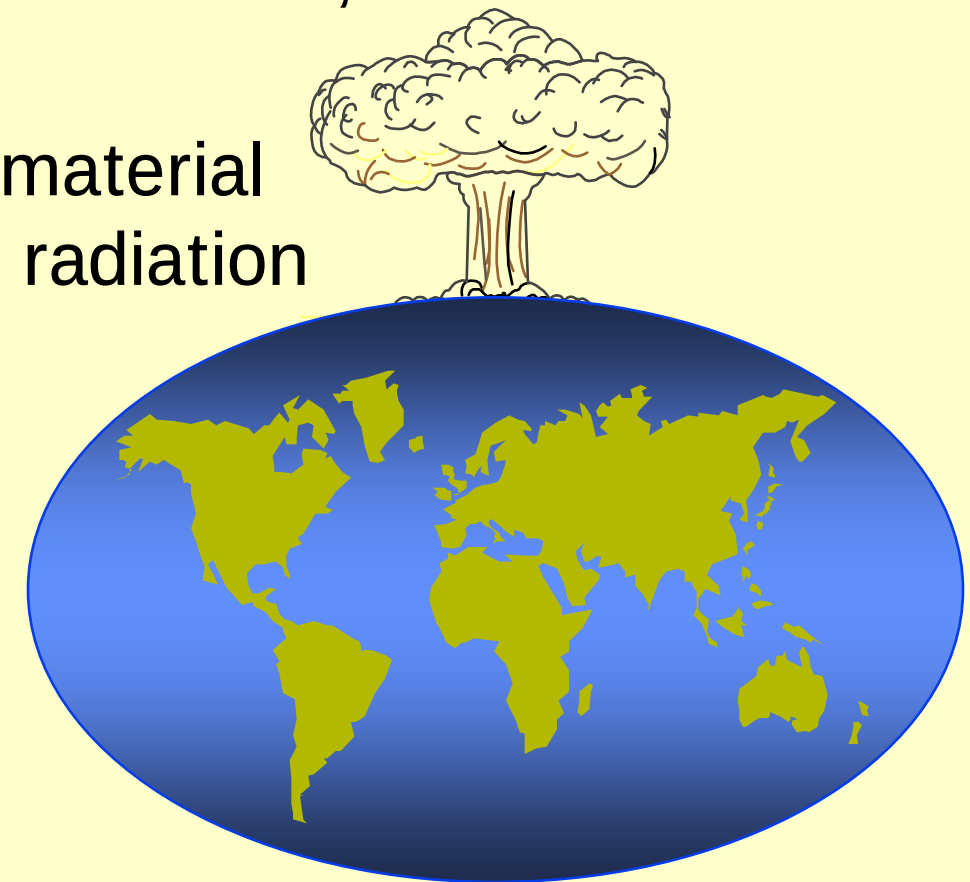
For radiological calculations, all terms (Roentgen, RAD, Centigray) are a 1 for 1 ratio 10r/hr = 10 RADS per hr

Factors Influencing radiation intensity/dose

- ***Time***
  - Shorter the exposure time, the smaller the dose received
  - Dose = Intensity x Time
- ***Distance***
  - Farther the distance from the radiation source, the smaller the dose received

Factors Influencing radiation intensity/dose

- ***Shielding***
  - Material that absorbs radiation, decreases radiation intensity
  - Thickness & type of material influences amount of radiation absorbed



Types of radiation

- ***Alpha particles***
  - Travels 0 to 3 inches in the air
  - Low penetrating ability
- ***Shielding***
  - Paper will completely stop the particle
  - Personnel hazard internal
- Nuclear defense importance: low

Types of radiation

- ***Beta particles***
  - Travel 6 to 10 feet in the air
  - Low penetrating ability
- ***Shielding***
  - Aluminum foil sheet
  - Protective clothing

Beta particles

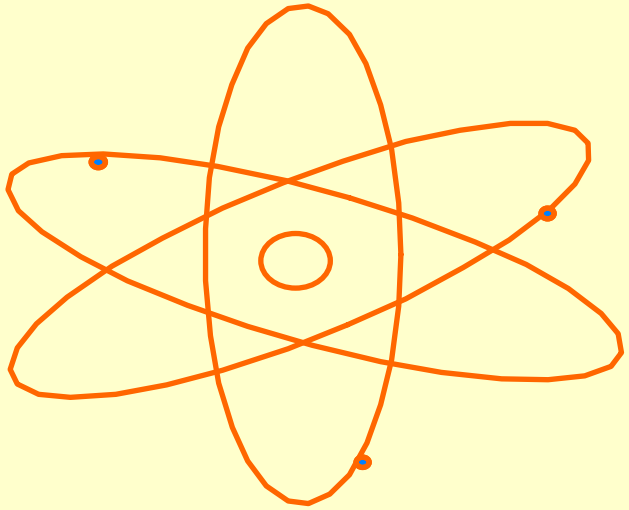
- ***Personnel hazard***
  - Skin burns
  - Internal problems
- ***Nuclear defense importance***
  - Moderate importance
  - Travels moderately far

Types of radiation

- **Gamma rays**
  - Travels long distances
  - High penetrating ability
- ***Shielding***
  - High density material
- ***Personnel hazard external & internal***
  - Penetrates deep into body tissue

Gamma rays

- Nuclear defense importance: Grave
  - High penetrating ability & distance traveled



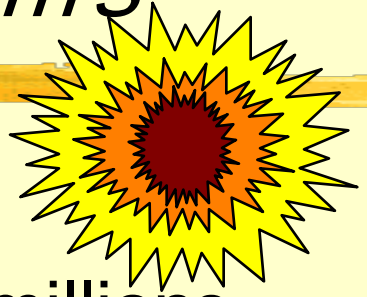
Types of radiation

- ***Neutron radiation***
  - Travels long distances
  - Penetrating ability depends on shielding
  - Shielding - Hydrogenous material
  - Lead & steel not effective shields

Neutron radiation

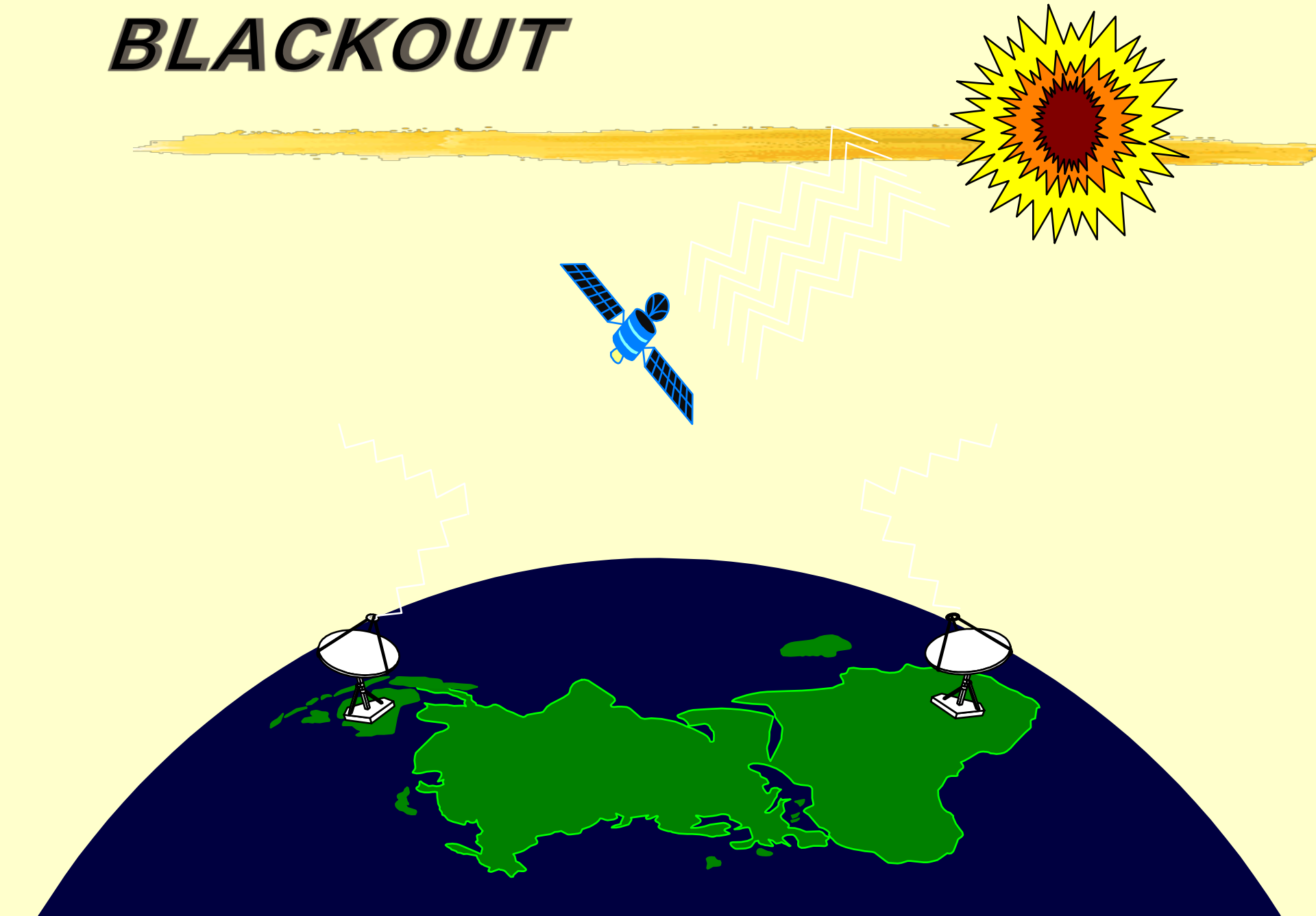
- Personnel hazard
  - Cells because of their high water content
  - Can induce an atom in the body to become unstable/radioactive
  - Mostly external because it travels thousands of yards in air
- Nuclear defense importance
  - Only in the first minute or so of a nuclear burst

Nuclear Weapon Burst Terms



- Fireball
  - Material present is heated to tens of millions degrees and forms a hot glowing mass
- Initial radiation
  - Radiation emitted during the first minute after a nuclear explosion
- Electromagnetic Pulse (EMP)
  - A sharp pulse of radio frequency electromagnetic radiation
  - Causes Blueout & blackout

BLACKOUT



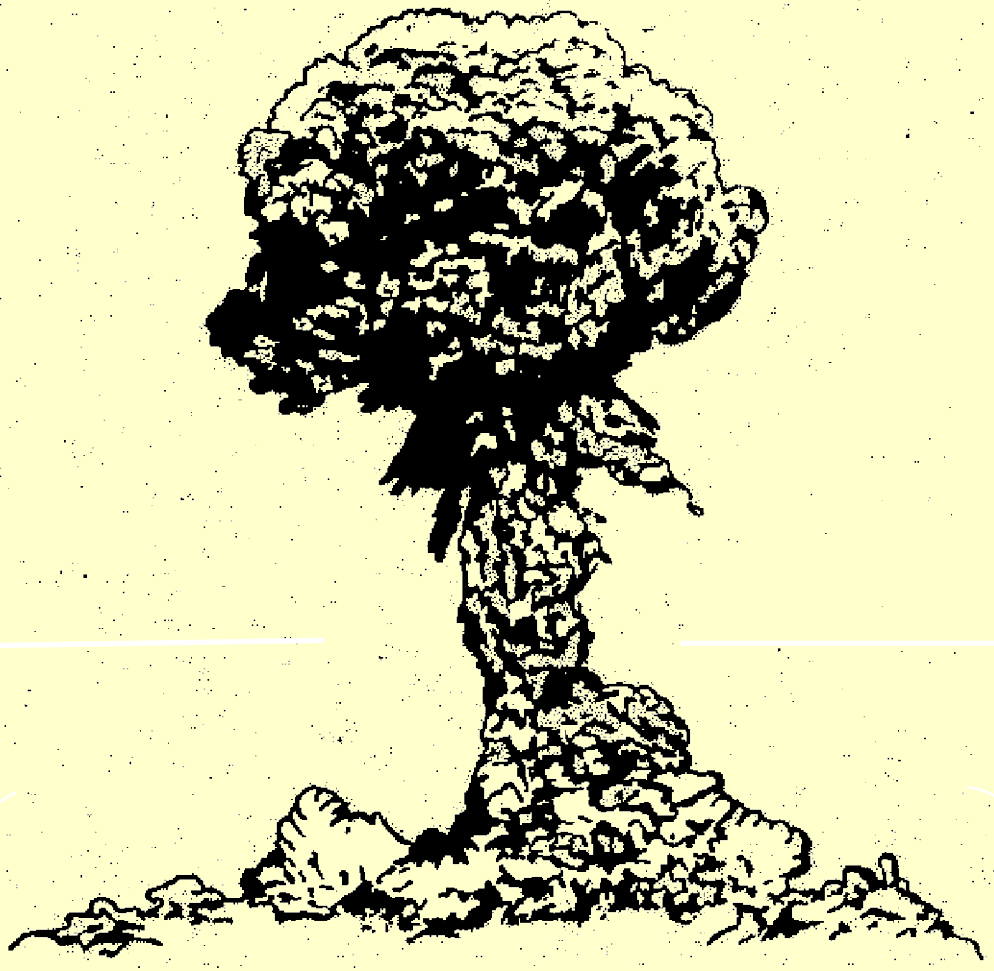
Nuclear Weapon Burst Terms

- Thermal radiation
  - Travels at the speed of light
  - Temperature reaches tens of millions of degrees (C) and the rate of energy emission is very high.
  - Very prominent characteristic of a nuclear explosion

Nuclear Weapon Burst Terms

- Visible Light
  - Some of the thermal energy in a nuclear explosion is in the form of visible light
  - Burst produces an extremely bright initial flash
  - Do not look at the fireball, Permanent eye injury can result

Shock wave



Shock wave

- Extremely high temperature and pressure
- Traveling through air is called a blast wave, or air blast
- The pressure is several million pounds per square inch (psi)

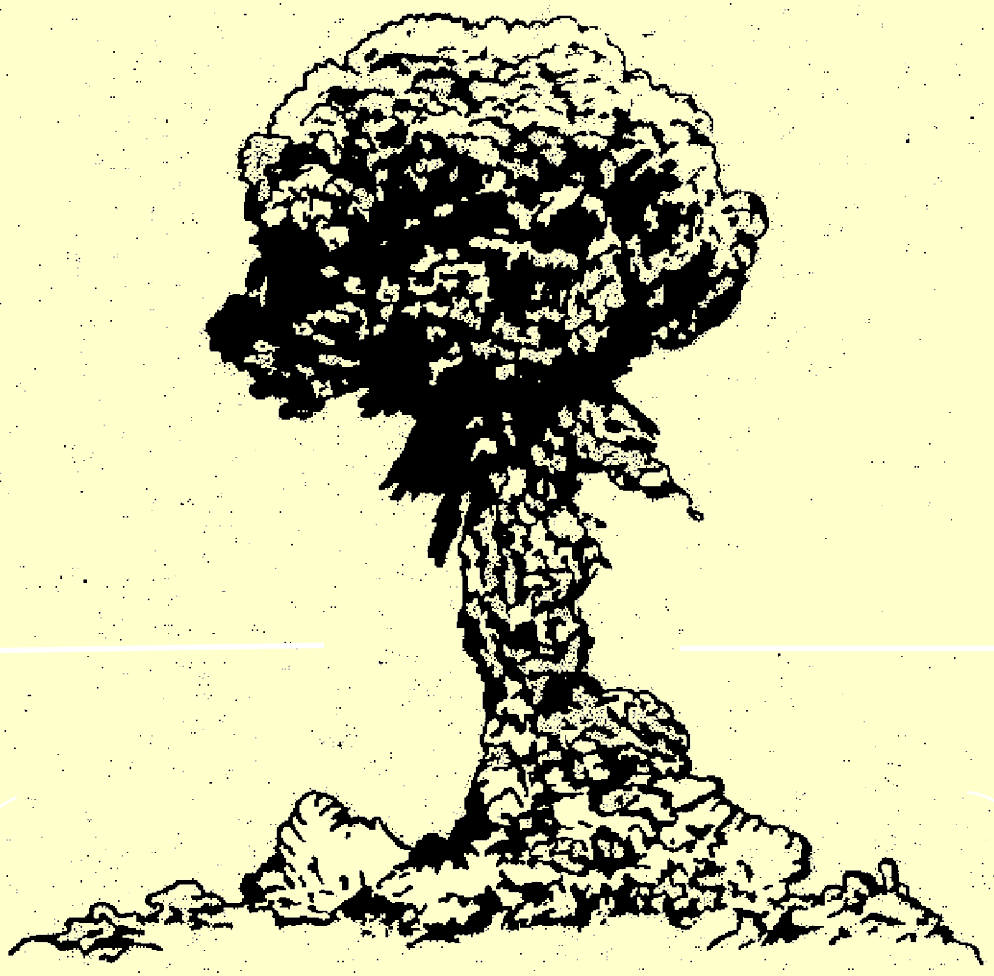
Nuclear Weapon Burst Terms

- Column or plume
  - Hollow cylinder of water & spray thrown up from an underwater burst
- Base surge
  - Dense aerosol cloud of small water droplets forms and moves rapidly outward in all directions from surface (or ground)
  - Highly radioactive

Nuclear Weapon Burst Terms

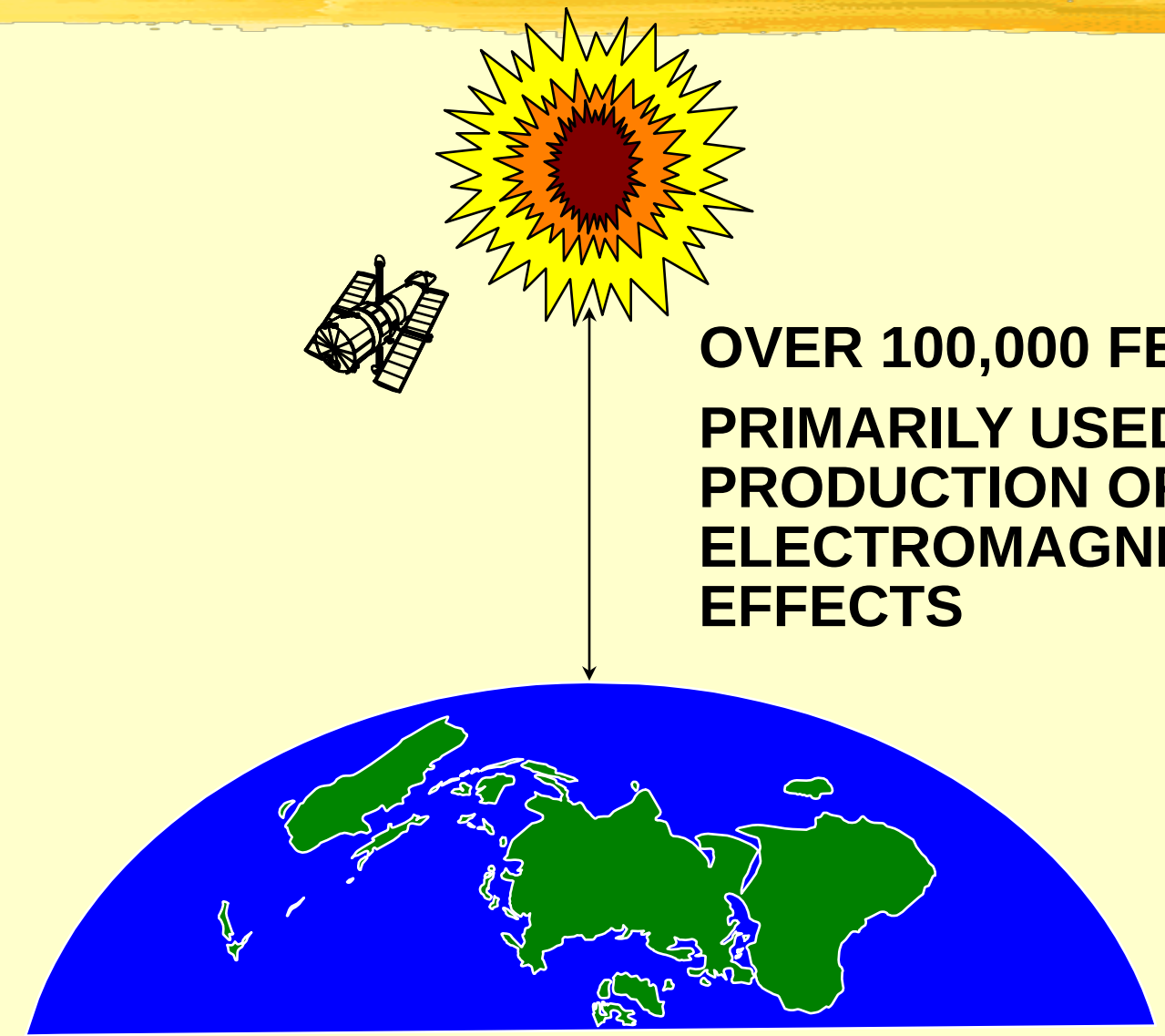
- Residual radiation
  - Radiological decay after the burst
  - Radioactive contamination that is created in a nuclear explosion
- Fall out
  - Radioactive particles that fall back to earth
  - Early fallout is of tactical military significance

Types of Nuclear Bursts



MITSUGI KISHIDA

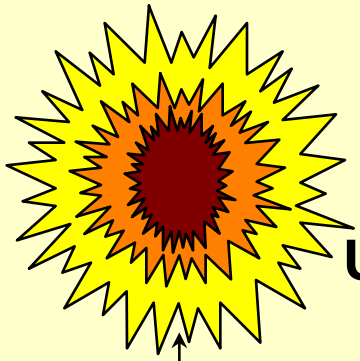
HIGH ALTITUDE AIR BURST



OVER 100,000 FEET

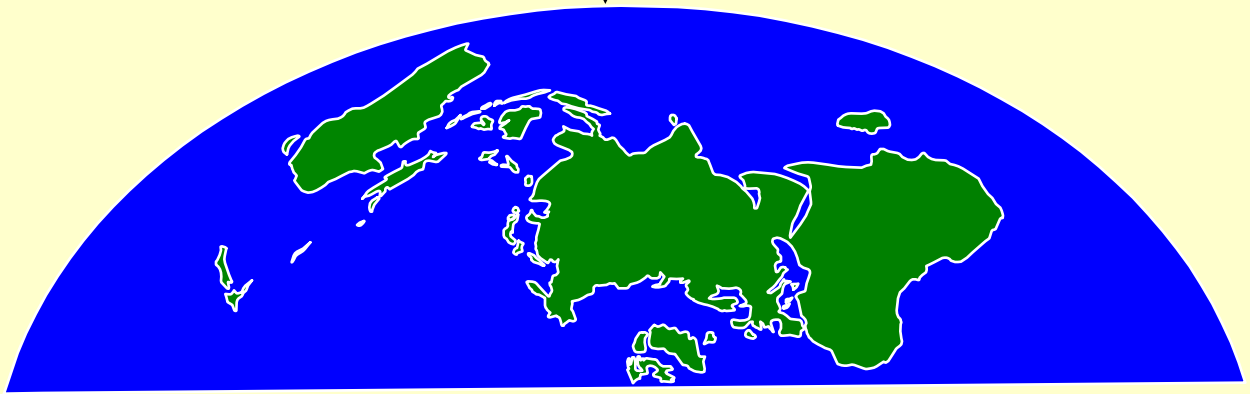
PRIMARILY USED FOR PRODUCTION OF ELECTROMAGNETIC EFFECTS

AIR BURST



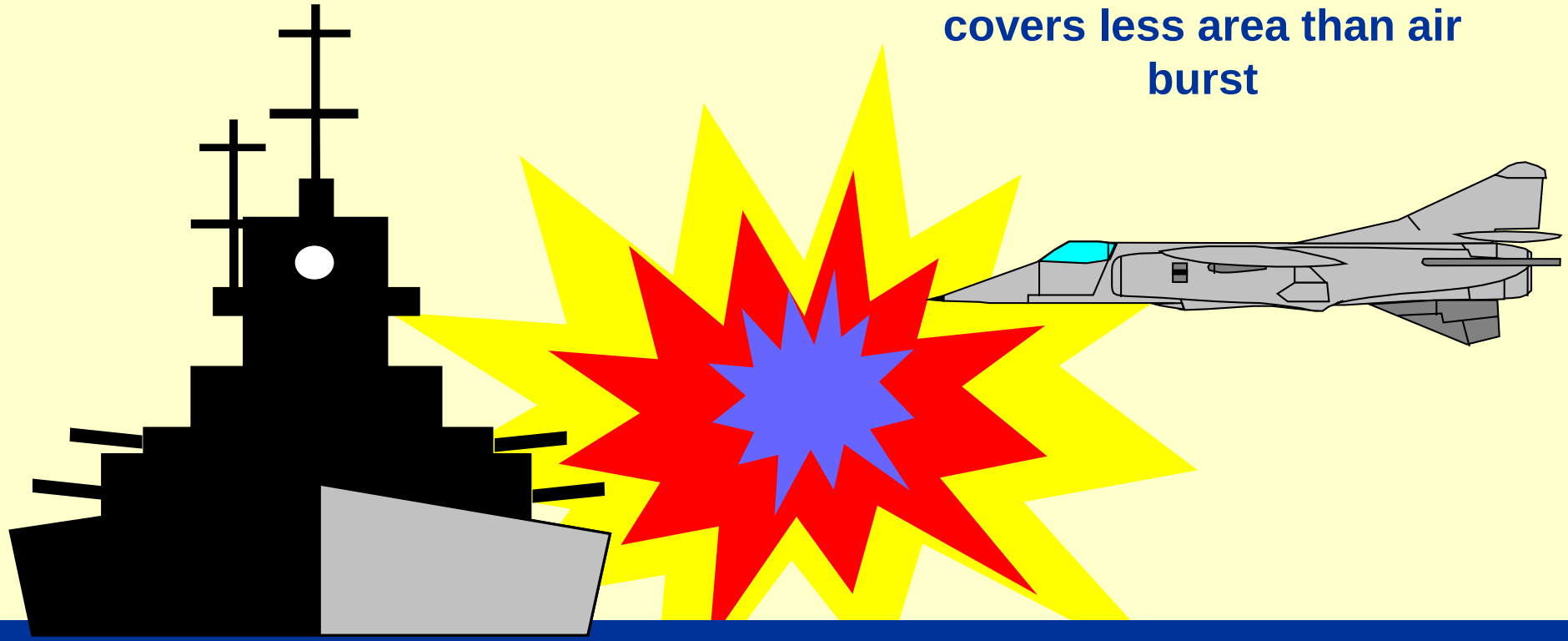
UP TO 100,000 FEET

FIREBALL DOES NOT TOUCH THE SURFACE OF THE EARTH



SURFACE BURST

FIREBALL TOUCHES THE SURFACE OF THE EARTH. Maximizes blast and thermal effects against ships/structures covers less area than air burst



SUB SURFACE BURST

FIREBALL VENTS TO THE WATER SURFACE. EFFECTS: Underwater shock wave, blueout, and base surge.

Summary and Review

- Nuclear terms
- Factors influencing radiation intensity/dose
- Types of radiation
- Nuclear weapon burst terms
- Types of nuclear bursts