

Effects and Physical Impacts of Nuclear Explosions

Edward Geist

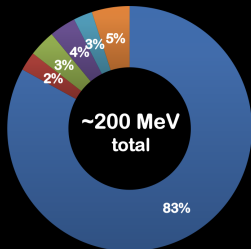
June 7, 2023

What happens when a nuclear bomb goes off?

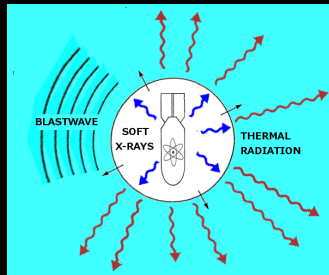
- ▶ It depends
- ▶ We're not sure

Nuclear explosion outputs

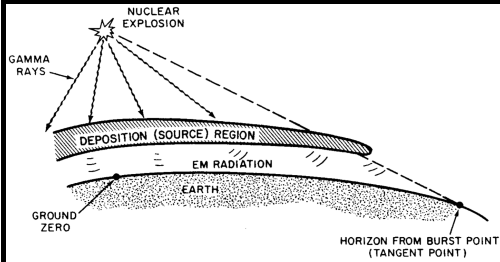
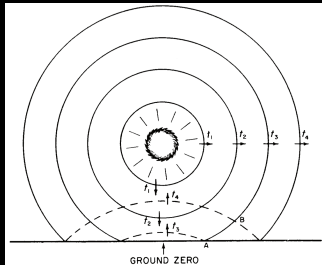
Average Energy Released by U-235 Fission, MeV



- kinetic energy of fission products
- neutrons
- direct gammas
- fission product gammas
- betas
- antineutrinos



It depends

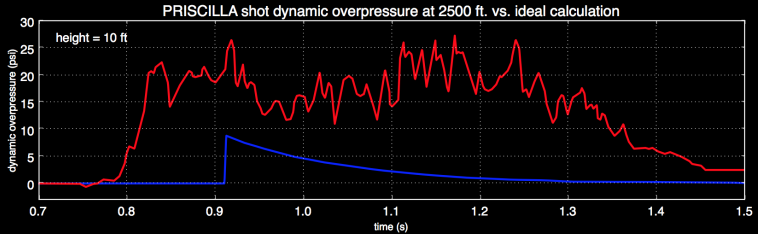
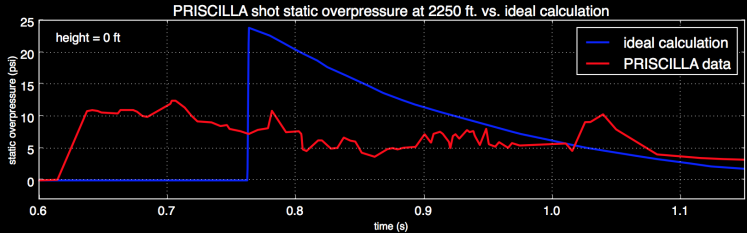


Left: Nuclear explosion in air. Right: Nuclear explosion in space.

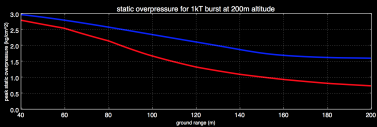
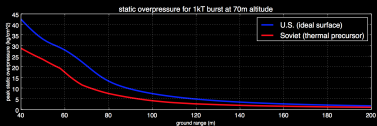
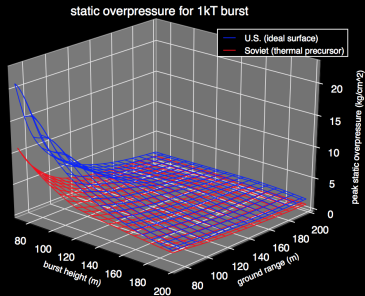
We're not sure

- ▶ Idiosyncrasies of specific nuclear detonations
- ▶ Limited available data from nuclear weapons tests
- ▶ Simulations can only do so much to reduce these uncertainties

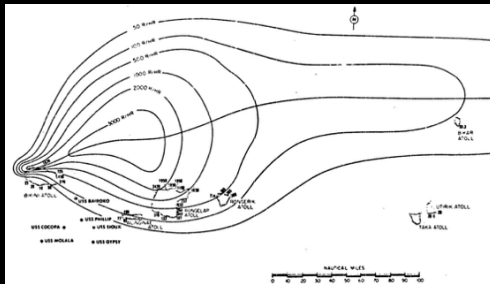
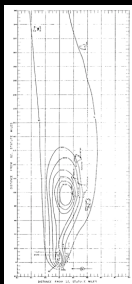
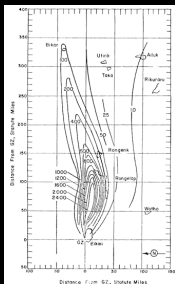
Idealized blast prediction compared with actual test data



U.S. and Russian nuclear blast models compared



Castle Bravo fallout reconstructions



Left: Air Force Special Weapons Project

Center: RAND

Right: Naval Radiological Defense Laboratory

Implications for effects on human beings

- ▶ Uncertainties likely compound
- ▶ The impact of nuclear weapons effects on human beings are, on average, even greater less certain than the nuclear weapons effects themselves!
 - ▶ Example: how much radiation exposure is a lethal dose, on average?
 - ▶ How much can we generalize from the atomic bombings in Japan?