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The CTBT and Zero Yield: A Technical Perspective

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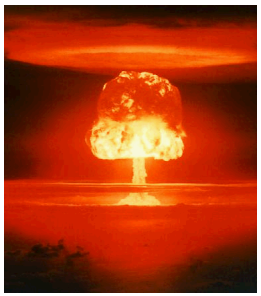
Zero Yield and The Comprehensive Test Ban Treaty

- **Basic obligation of the CTBT:**
  - Party states will not carry out a nuclear explosion
- **The treaty is often referred to as a "zero yield" treaty**
  - "Zero", "yield", and "threshold" do not appear in the treaty text
  - A "true zero yield comprehensive test ban" was the United States goal
- **A yield threshold that defines a nuclear explosion is not established by the treaty**
  - As opposed to the 150 kt limit in the 1974 Threshold Test Ban Treaty

What is Yield?

- **Yield is energy (SI unit is the Joule)**
  - Nuclear weapon explosive output is often measured in kilotons of TNT equivalent
    - 1 kt = 4.8×10^{12} J
  - You probably pay your electric bill in kWhrs
    - 1 kWhr = 3.6×10^{6} J
  - Do you count calories?
    - 1 g of sugar ≈ 4 g of TNT
- **Energy is the integral of power over time (Watts)**

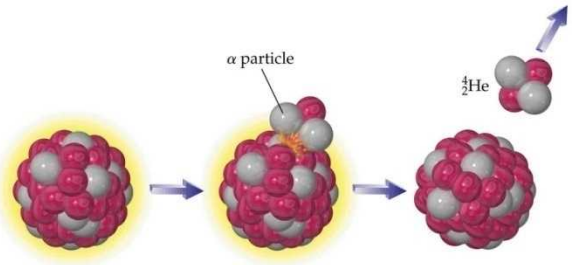


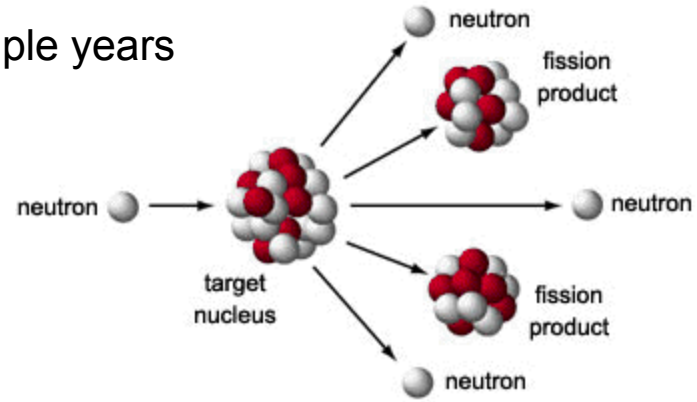
When does the release of nuclear energy become an explosion?

Nuclear Yield from Natural Events

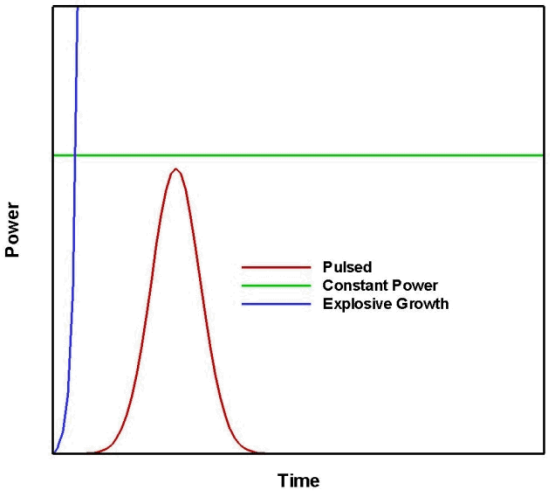
- **Energy release at the nuclear level is typically described in units of MeV**
  - 1 MeV = 1.602×10^{-13} J
- **Many nuclides relevant to nuclear weapons decay by alpha emission, and to a lesser extent, spontaneous fission**
  - Explosive at the atomic level
- **Consider a significant quantity of plutonium (8 kg)**
  - Alpha decay results in ~17 W of power
  - In 5 minutes, more than 1 g TNT equivalent is released
    - Fission yield of 1 g would take a couple years

The natural behavior of nuclear materials results in yields greater than zero



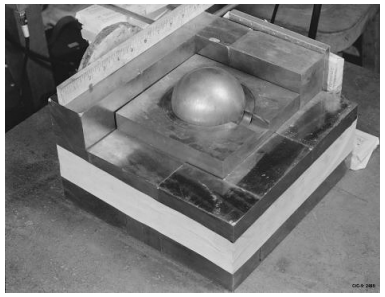


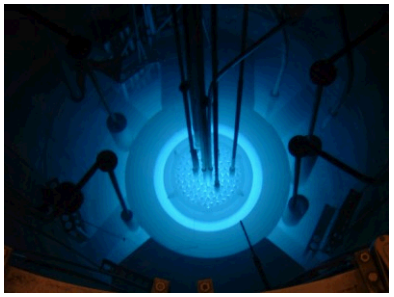
Stimulated Nuclear Yield



- **Fissile materials can be carefully arranged to multiply neutrons**
  - Nuclear reactors manipulate neutron population to produce power at a constant rate
  - Test reactors can be pulsed
  - Nuclear explosions can be initiated
- **Weapons States reserved the right to conduct hydrodynamic nuclear experiments that remained subcritical under the CTBT**
  - Explosively driven assembly of nuclear materials that results in increased neutron multiplication rates
  - Nuclear yield is stimulated past levels that would naturally occur with that quantity of material in the time span of the experiment

Low yield to high yield configurations of nuclear material





Why Not a Threshold?

- **The idea of "zero yield" is important because a threshold sanctions nuclear testing at some level**
  - Potential thresholds were discussed during CTBT negotiations, should one become necessary
    - United States favored a limit of a few pounds
    - France and Russia favored higher limits
    - China argued for several hundred tons
- **An established threshold may cede a perceived technical advantage**

Achieving Zero Yield?

- **"Zero yield" is not a technically viable statement**
  - Not an achievable state in nature
  - Impractical measure of CTBT compliance
- **"Hydro-nuclear" yields greater than zero are at least tacitly accepted under the CTBT**
  - Miniscule yield is still greater than zero
- **A threshold exists in practice**

"When I use a word, it means just what I choose it to mean -- neither more nor less"

Humpty Dumpty in Lewis Carrol's Through the Looking Glass