

together.

Nuclear Fission: The splitting of atomic nuclei.

Chain Reaction: A self-sustaining reaction in which one reaction event stimulates at least one additional reaction event to keep the process going.

References

A. J. Software and Multimedia (2006). *Atomicarchive.com*. Retrieved October 8, 2006 from <http://www.atomicarchive.com/Fission/Fission2.shtml>.

Clark, R. W. (1980). *The greatest power on earth: The story of nuclear fission*. London:

Sidgewick and Jackson. Hewitt, P.G. (1997). *Conceptual Physics* (3rd ed.). Menlo Park, CA: Addison Wesley.

Additional Resources

Links to websites depicting graphical representations of the process of fission:

<http://www.atomicarchive.com/Fission/Fission1.shtml>

http://library.thinkquest.org/3471/nuclear_energy_body.html

Links to middle/high school lesson plans on nuclear fission:

<http://www.sciencenetlinks.com/Lessons.cfm?DocID=40> (Splitting the Atom: grades 9-

12)<http://school.discovery.com/lessonplans/programs/savagesun/> (Understanding the types of

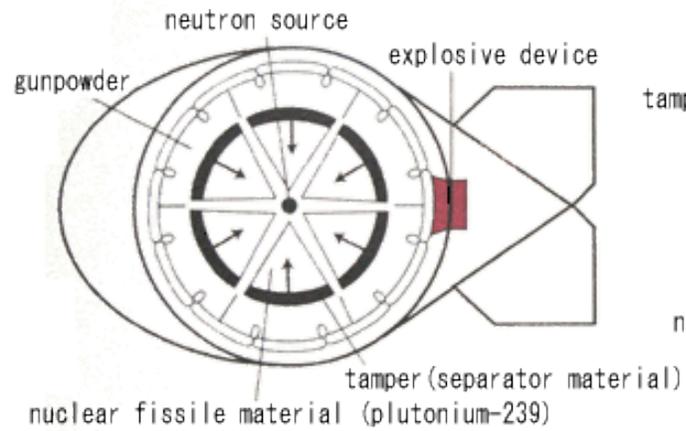
nuclear reactions: grades 9-12)<http://school.discovery.com/lessonplans/programs/actinide/> (The Actinide Series: grades 9-12)

Component 4, Part 2

The Atomic Bombs—Hiroshima and Nagasaki

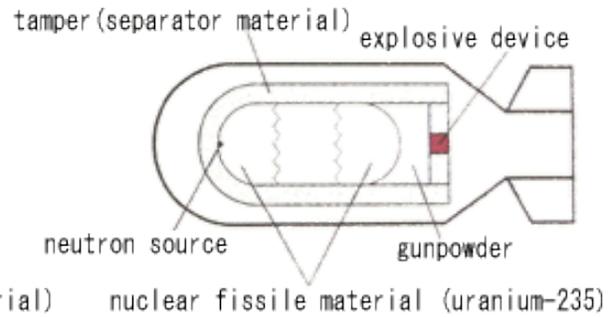
As we learned in Part 1, a sustained nuclear fission (with critical mass) reaction in U-235 can result in a massive explosion if enough uranium material is involved. In the case of the atomic bomb dropped on Hiroshima, U-235 was the fissile material utilized. Within the bomb, U-235 was divided into two sections, both being below critical mass (to keep the bomb from exploding as soon as it was constructed). A detonating device was used to unite the two sections, causing an immediate explosion. This bomb was named “Little Boy” for President Franklin Delano Roosevelt. A different procedure and nuclear material was utilized in the production of the bomb dropped on Nagasaki. Plutonium-239 was the fissile material. It was divided into several subsections within the bomb’s housing and surrounded by gunpowder. Once detonated, the plutonium subsections were squeezed together, thus creating the critical mass necessary for a chain reaction and explosion. This bomb was named “Fat Man,” for England’s Prime Minister, Winston Churchill. Figure 1 provides a comparison of the two different bombs dropped on Hiroshima and Nagasaki (The Nagasaki Peace Declaration, 2006).

The Nagasaki Bomb



length 3.25m/diameter 1.52m/weight 4.5 ton
explosive force: equivalent to 21,000
tons of TNT
It was nick-named "fat man"

The Hiroshima Bomb



length 3m /diameter 0.7m/weight 4 tons
explosive force: equivalent to 15,000
tons of TNT
It was nicknamed "little boy"

Figure 1 - Graphic Credit: [The Nagasaki Peace Declaration](#)

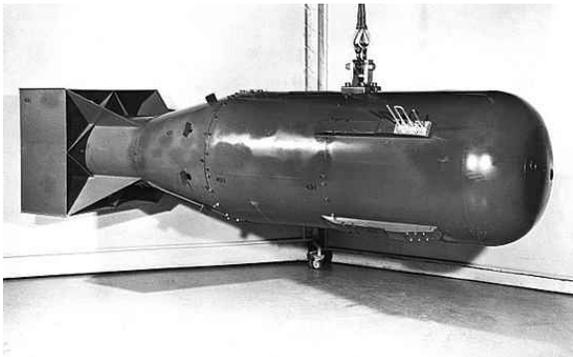


Figure 2 - "Little Boy" - Graphic Credit: [Encarta](#)

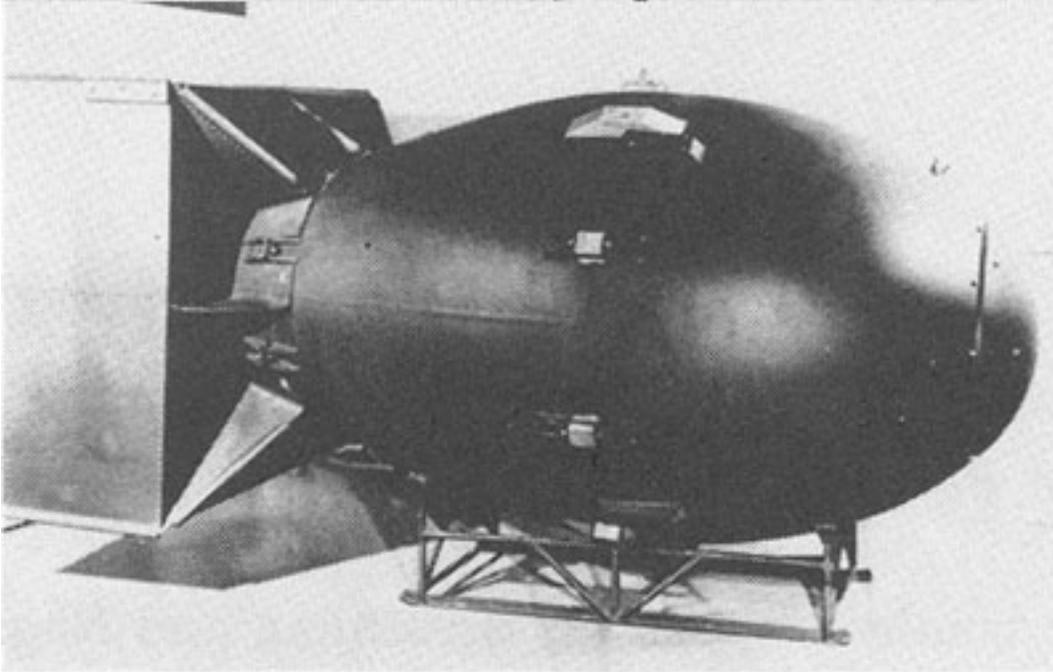


Figure 3 - Photo Credit: AtomicBombMuseum.org

Energy Released

Each of the two atomic bomb blasts were thought to have been approximately equivalent to a blast produced from 20,000 tons of TNT (The Manhattan Engineer District, 1946).

Figures 4 and 5 are photos depicting the “mushroom clouds” that formed as the bombs were dropped on Hiroshima and Nagasaki respectively.

(To see recovered video footage of the Hiroshima bombing, click on the following link:

<http://www.cnn.com/WORLD/9608/10/japan.hiroshima.film/index.html>)

According to the Atomic Bomb Museum (2006), there were three main forms of energy released as a result of the nuclear bombs dropped over Hiroshima and Nagasaki:

1. Fireball (heat)
2. Shock wave and air blast (accounted for 50% of energy)
3. Radioactivity

Heat

Directly beneath where the bomb was dropped on the ground (**hypocenter**) it has been estimated that the temperature reached approximately 7000 degrees F (Atomic Bomb Museum, 2006).

Bomb Blast

The explosions created areas of extremely high pressure which resulted in winds in excess of 980 mph at the hypocenters. The pressures created were approximately 8,600 pounds per square feet. From the hypocenters out to approximately 1/3 of a mile, most substantial concrete buildings were obliterated. Even a mile from the hypocenter, all brick buildings were destroyed as the

wind velocity in these areas reached 190 mph and pressure was approximately 1,180 pounds per square foot (Atomic Bomb Museum, 2006).

Radiation

Alpha, beta, gamma, and neutron rays were generated by the nuclear bombs, with the gamma and neutron rays doing the most immediate damage and causing most early radiation deaths. From 1/16 mile out in all directions from the hypocenter, most people died within a few hours. Those located 1/2 mile from the hypocenter died within 30 days (Atomic Bomb Museum, 2006).

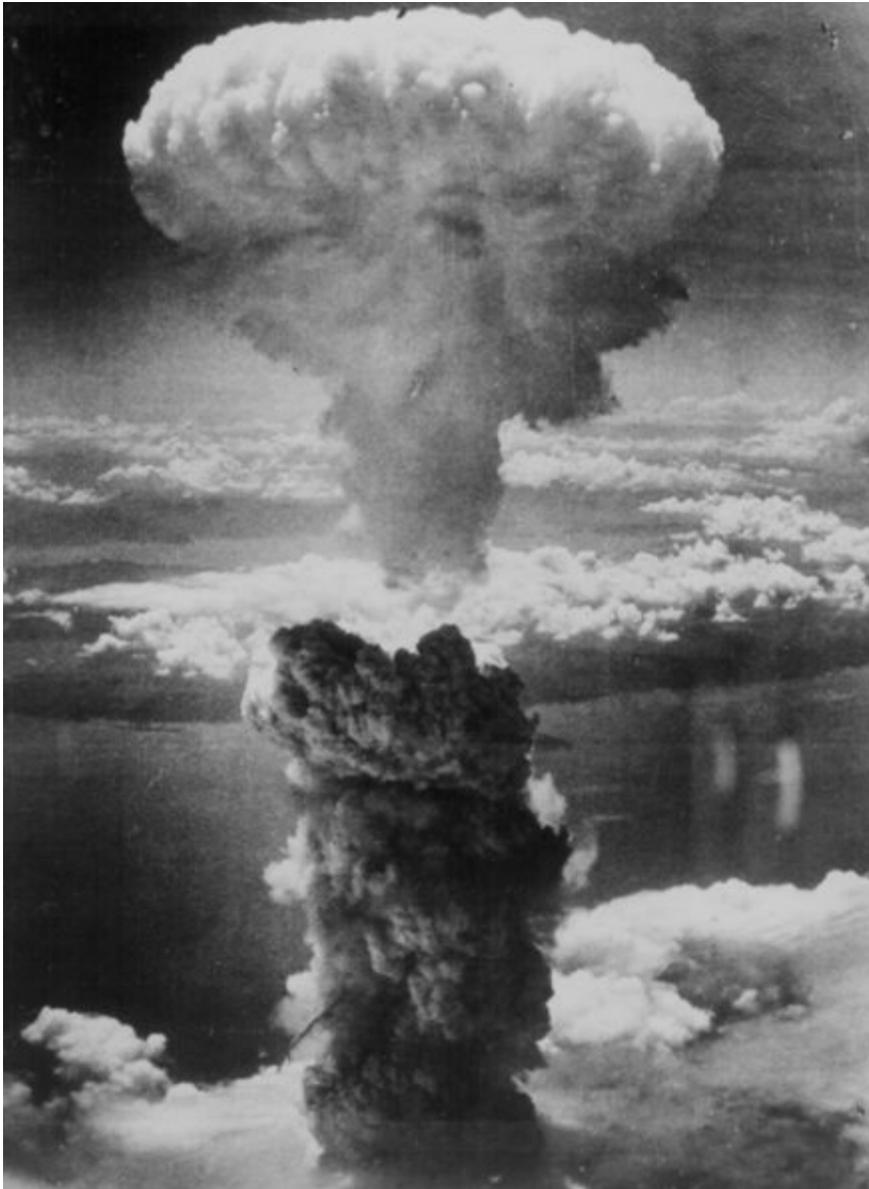


Figure 4 - Photo Credit: [Archives.gov](https://www.archives.gov)

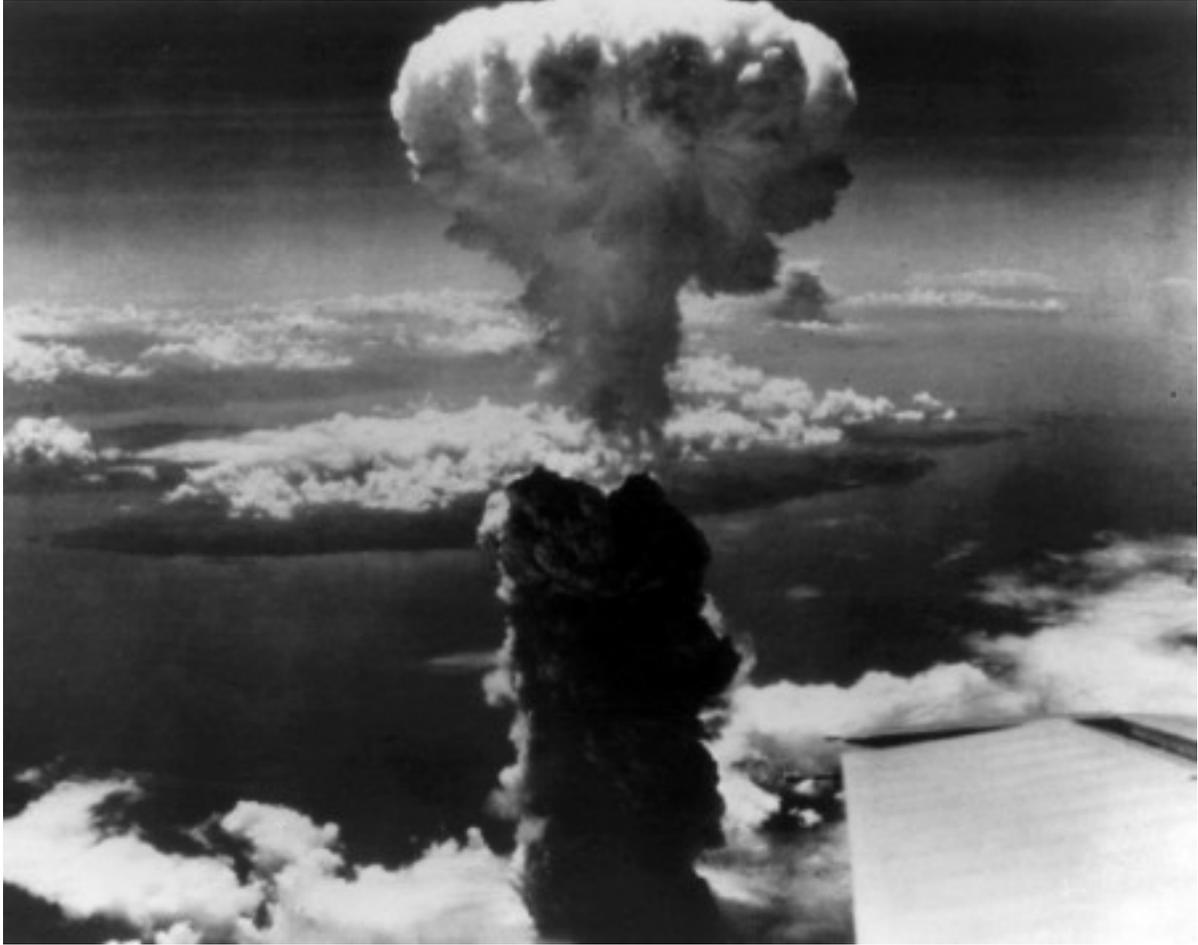


Figure 5 - Photo Credit: AtomicBombMuseum.org

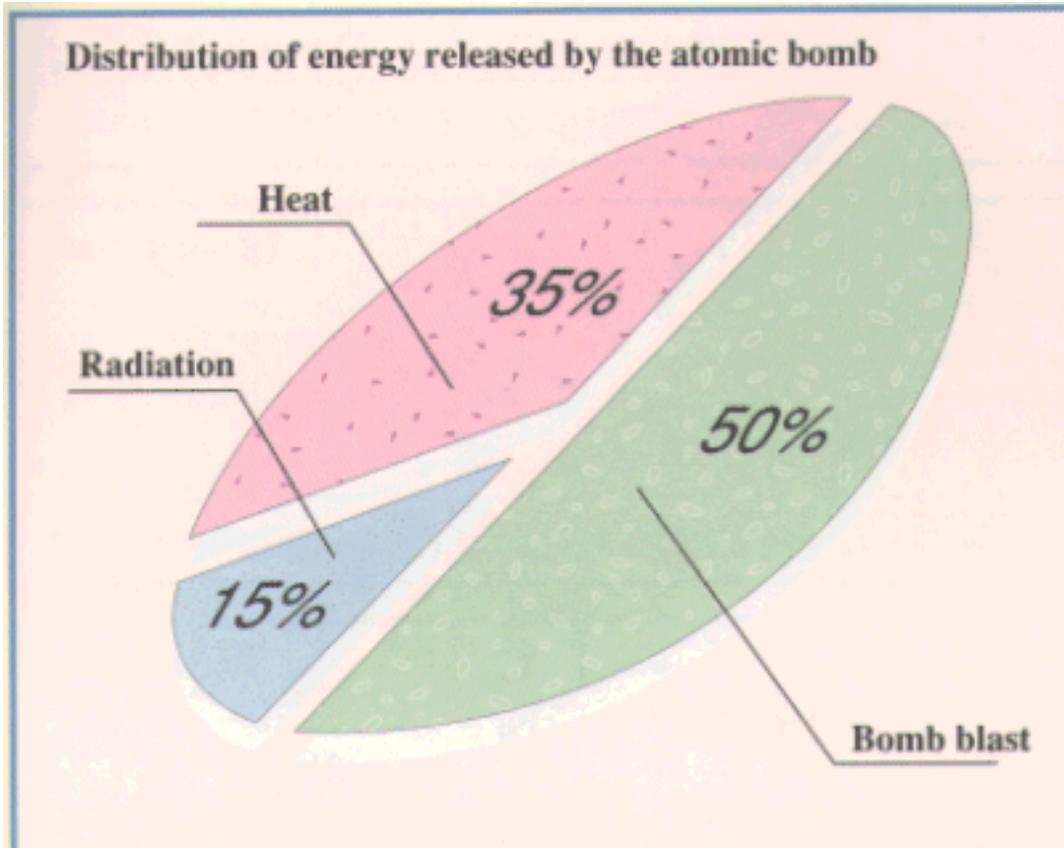


Figure 6 - Photo Credit: [Atomic Bomb Museum.org](http://AtomicBombMuseum.org)

Note To Teacher

KEYWORDS in this module are underlined in bold:

Hypocenter: point on the surface of the earth directly below the air burst of a nuclear detonation.

References

Atomic Bomb Museum (2006). *The first atomic bombs: "Little Boy" and "Fat Man."* Retrieved October 8, 2006

from www.atomicbombmuseum.org/2_firstbombs.shtml.

The Manhattan Engineer District (1946). *The atomic bombings of Hiroshima and Nagasaki.* Retrieved October 6, 2006

from http://www.cddc.vt.edu/host/atomic/hiroshim/hiro_med.pdf#search=%22The%20Manhattan%20Engineer%20District%20pdf%20A%20Bombing%20Of%20Hiroshima%20And%20Nagasaki%20Summary%22

The Nagasaki Peace Declaration (2006). *Atomic bomb: How it works.* Retrieved October 8, 2006 from

http://www1.city.nagasaki.nagasaki.jp/abm/abm_e/qa/heiwa_e/a_bomb_e.html.

Additional Resources

Links to sites about the mechanics of the atomic bomb:

<http://www.mtholyoke.edu/acad/intrel/hiroshim.htm>

<http://www.childrenofthemanhattanproject.org/HISTORY/ERC-1.htm>

<http://www.yale.edu/lawweb/avalon/abomb/mpmenu.htm>

Link to maps showing the hypocenters of Nagasaki and Hiroshima:

<http://www-sdc.med.nagasaki-u.ac.jp/n50/disaster/D-map.gif>

Component 4, Part 3

Structural and Environmental Damage (Distance from Hypocenters)

Hiroshima and Nagasaki

According to the Hiroshima Peace Site (2006), because the atomic bomb was dropped almost directly over the Hiroshima's center and because Hiroshima was located in relatively flat terrain, massive and instantaneous damage resulted in the city's almost complete destruction (90% of all buildings were destroyed). Figure 1 is an aerial view of the destroyed city of Hiroshima taken by United States Air Force Pilot of the Enola Gay, Paul Tibbets.

