THE RESEARCH
SCIENCE AND THE SHAPING OF MODERN LIFE
REVOLUTION

A VIEWING AND DISCUSSION PROGRAM IN AMERICA'S LIBRARIES

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Session 1 Focus on Science
Atomic Energy

The nuclear weapons of the twentieth century fall into two categories: fission and fusion. Fission bombs, commonly called atomic bombs, which include the two dropped at the end of World War II, split atoms to release energy; fusion weapons, called hydrogen or thermonuclear bombs, unite smaller atoms to form larger ones, releasing energy in the process.

How can we have it both ways?

Atoms can be thought of as made primarily of neutrons and protons that form a central, heavy nucleus, with much smaller electrons orbiting the nucleus. Each proton has a positive electrical charge; they repel each other, and it takes energy to bring them together. However, when they get very close together they are subject to a force of attraction-called the strong force-that is stronger than electrical repulsion. Once they feel the pull of the strong force, they come together as tightly as possible. Different elements have more or less tightly packed nuclei; the tighter they are, the less energy-called nuclear binding energy-is needed to hold them.

It is the difference in nuclear binding energy that is released in fusion and fission reactions. Iron, with an atomic weight of 56 or 58 (26 protons and 30 or 32 neutrons), and its elemental neighbor nickel have the tightest nuclei. A element lighter than iron will release energy if it is augmented by protons that make it a new element with weight closer to iron; a heavier element will release energy if broken up.

Einstein's special theory of relativity, with its famous equation $E=mc^2$, indicated that mass and energy were fundamentally interchangeable. In the nucleus of the atom, that abstract notion becomes very real, and the binding energy is effectively mass-that is, the proton in a proton-neutron pair (deuterium) weighs more than the proton in a helium nucleus (two protons, two neutrons). When two deuterium nuclei slam together to form a helium nucleus, the extra mass is released as energy. Similarly, but from the other end, the mass of a uranium nucleus is a little greater than the mass of the smaller nuclei that result from splitting it up, so fission can be explosive, too.

The energy released by each atom isn't much, but a little bit of mass (m) becomes a great deal of energy (E) when multiplied by a number as great as the speed of light squared (c^2). In fact, it becomes so much energy that it's hard to describe it. One gram of mass-a large raisin-converted entirely to energy would release the equivalent of 20,000 tons of TNT-the power of the Nagasaki atomic bomb-or enough to provide 90 megawatts of power for eleven days! It's no wonder that the weapons are so dreadful and that the dream of safe nuclear energy is such a powerful one.

Badash, Lawrence. *Scientists and the Development of Nuclear Weapons: From Fission to the Limited Test Ban Treaty 1939-1963.* Humanities Press, 1995.

Alsos Digital Library for Nuclear Issues
http://alsos.wlu.edu/
The Alsos Library provides a wide range of annotated references for the study of nuclear issues; an excellent starting place for Web research

Trinity Atomic Web Site
http://nuketesting.enviroweb.org/
Nuclear Weapons: History, Technology, and Consequences in Historic Documents, Photos, and Videos

Resources - The Race to Build the Atomic Bomb
http://www.cccoe.k12.ca.us/abomb/resources.htm
There are several interesting primary documents on this website

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