Fusion Research Prompts Fears of Future Bombs

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DESPITE the end of the cold war, a quiet battle is heating up in the Federal Government over whether the nation's weapon scientists should be allowed to press ahead with work toward a new generation of hydrogen bombs.

On Friday, the Federal weapons laboratory in Livermore, Calif., is to break ground on a huge laser complex designed to ignite hydrogen without an atomic match. If successful, the laser would fire a titanic bolt of energy onto a tiny pellet of hydrogen fuel, heating it hotter than the surface of the sun and causing hydrogen atoms to fuse into helium in a burst of pure fusion energy. All this would occur at a $2.2 billion complex about the size of the Rose Bowl.

In the meantime, weapon scientists have been pursuing a number of smaller projects that strive at miniaturizing the machinery needed to ignite a fusion reaction and at shedding light on thermonuclear physics. Weapon scientists are lobbying to continue such work, saying it is permitted under the Comprehensive Test Ban Treaty, which bars nuclear explosions.

Treaties and experts who have tried to slow nuclear arms development have few objections to fusion machines based on gigantic matches bigger than a football field, but fears arise when proposed ignition systems are small, raising the prospect of pure-hydrogen bombs that can be easily transported to distant targets. So critics are denouncing the thermonuclear research as dangerous.

"The time has come for our nation to declare that it is not working, in any way, to develop further weapons of mass destruction," Dr. Hans A. Bethe, a primary architect of the first atomic bomb who is now at Cornell University, wrote President Clinton late last month. Dr. Bethe pointed specifically to the danger of "pure-fusion weapons."

What especially disturbs arms controllers is that the fuel for hydrogen fusion is relatively easy to obtain and that a pure hydrogen bomb, if perfected, could in theory be very cheap to build. The main fuel for nuclear fusion is deuterium, an isotope of hydrogen that is ubiquitous in sea water.

By contrast, atomic bombs are fuelled by uranium, a scarce element that must be mined and its rare 235 isotope concentrated in an arduous industrial process or its 238 isotope transmuted into plutonium in a reactor. Either way, getting the ingredients for atomic bombs is so daunting that it has foiled many would-be atomic powers.

The hydrogen conflict is arising despite new obstacles to the making of all types of nuclear weapons.

The Comprehensive Test Ban Treaty, signed by President Clinton in 1996 and endorsed by the United Nations, was written to halt the development of new weapons of mass destruction by imposing a global ban on nuclear detonations. New types of nuclear arms must be repeatedly tested, and their designs improved as flaws are found. The absence of explosive testing sharply increases the odds that a weapon will fail.

The treaty bars "any nuclear weapon test explosion or any other nuclear explosion" and makes no distinction between the testing of atomic and hydrogen arms.

First detonated in 1952, hydrogen bombs are the deadliest weapons ever built. They work when an atomic bomb acts as a very hot match to ignite hydrogen fuel. The blasts of hydrogen bombs are up to thousands of times stronger than those of atomic bombs and have the power to destroy large cities in a single thermonuclear flash.

Despite the treaty, the nation's nuclear weapons laboratories and allies in Washington argue that the comprehensive test ban has a loophole that allows pure-fusion research, including explosive tests. And it is a good thing, they say. The research on pure fusion will aid recruiting of weapon scientists and hone weapons skills, helping the laboratories maintain the strength of the nation's nuclear arsenal.

But arms controllers argue that the United States now risks becoming not only the architect of unnecessary weapons but also a nuclear hypocrite in the eyes of the world.

Banning such research might seem simple. But the nuclear weapons labs, in New Mexico and California, wield great political influence with state delegations and conservatives in general.

Moreover, the Clinton Administration has courted them extensively (starting a bomb maintenance program that costs $4 billion a year) and has judged that it needs their support on the test ban treaty, which is to be sent to the Senate in the next month or two for ratification. So the outcome of the political war over thermonuclear research is anything but clear.

"There's a struggle over how to draw the line" for permitted types of thermonuclear research, said an Administration official who spoke on condition of anonymity. "It's an issue that has to be resolved prior to the submission of the treaty. There has to be some kind of interagency agreement."

Dr. Jeremy J. Stone, the president of the Federation of American Scientists, a private group in Washington that made public Dr. Bethe's letter to President Clinton on May 15, said he thought that the thermonuclear work would eventually be banned by Presidential decree.

"Many senators and Congressmen are going to address this problem, and many nations are concerned about it," Dr. Stone said in an interview. "It's in our national interest not to work on these things."

Atomic bombs and reactors split apart heavy atoms like uranium and plutonium. Stars and hydrogen bombs fuse hydrogen, a light atom, into helium. Both processes release huge amounts of nuclear energy.

The explosion from the first hydrogen bomb obliterated a Pacific island one mile in diameter. The bomb's power was equal to 10.4 million tons of high explosive, or about 700 times as powerful as the bomb dropped on Hiroshima.

As scientists worked to perfect hydrogen bombs, they also investigated whether the thermonuclear fires might be set off by something other than atomic explosions. Eliminating the atomic match, it was thought, would produce cleaner bombs with less radioactive fallout, a goal that was politically appealing in the days of above-ground testing.

A separate goal of the nonatomic approach was to slow and harness the fusion process, for both physics studies and energy research. Generations of scientists have dreamed of using thermonuclear fire to generate electric power in new kinds of reactors. But despite decades of research, and many billions of dollars, thermonuclear research conducted without atomic matches has so far produced no fire, only smoke.

The huge laser complex now about to materialize in Livermore, known as the National Ignition Facility, is to be the first machine to generate miniature thermonuclear explosions. A main goal is studying the physics behind hydrogen bombs and how they can be analyzed and repaired without full-scale, explosive underground tests. The machine, to be completed in 2003, is giving a new lease on life to the Lawrence Livermore National Laboratory and its 7,000 workers. The laser's $2.2 billion price tag includes operating costs of $64 million a year over a projected lifetime of 15 years.

Research on small thermonuclear ignition systems is now widely conducted at the nation's weapons laboratories. Scientists there say the research seeks to illuminate the basic physics of conventional hydrogen bombs rather than to perfect a new generation of pure-fusion weapons.

For instance, Los Alamos Laboratory in New Mexico is using high-explosive charges to create powerful magnetic fields that compress and heat hydrogen fuel, setting off extremely low levels of fusion reactions. Those blasts have repeatedly rocked Ancho Canyon, and are set to do so again this spring and summer.

Christopher E. Paine, a senior researcher at the Natural Resources Defense Council, a private group in Washington that opposes such research, said a number of costly complexes were being developed for thermonuclear research in the bomb maintenance program.

"The labs are seeking a loophole for fusion experiments," Mr. Paine said. "But the tests are unnecessary for maintaining the stockpile. They're dangerous because they could encourage the spread of nuclear weapons. And they're not permitted under the treaty."

Ray E. Kidder, a Livermore physicist who helped pioneer hydrogen bombs, said small-scale thermonuclear research was attractive to weapon scientists in the absence of underground test explosions.

"This is a really good way to keep your troops up to speed and keep them interested," Dr. Kidder said in an interview. "It's very challenging." But he added, "If you're going to be true to the intent of the treaty, you don't do these things."

In a recent paper on pure-fusion devices, Dr. Frank von Hipple, a physicist at Princeton University, asserted, "Some could potentially become compact enough to be used as weapons."

Scientists disagree on the likelihood that thermonuclear research could result in a new generation of hydrogen bombs that work on the principle of pure fusion. Some, especially weapon scientists, say the prospect of success is often greatly exaggerated.

"I hate to say anything is impossible," said Dr. Victor H. Reis, the architect of the bomb maintenance program and the Assistant Secretary for Defense Programs at the Energy Department, which created and oversees the nation's nuclear arsenal. "But it is very unlikely, extremely unlikely."

Diagrams: Lawrence Livermore National Laboratory says its National Ignition Facility could achieve the dream of controlled fusion. It would also be used for training in the closely related field of nuclear weapons fusion. Source: (Lawrence Livermore National Laboratory) (pg. C8) "Fire in the Hole" At the centre of NIF's target chamber is a metal container that holds the fuel pellet. Beams from 192 lasers hit the inside walls of the container; X-rays, produced when the laser beams vaporize the metallic chamber, bombard the fuel pellet, compressing it to 20 times the density of lead; At 200 million degrees Fahrenheit, hydrogen in the core of the pellet ignites and burns, releasing tremendous amounts of energy. Experts say a miniaturized pure fusion device could be a weapon. (pg. C8)