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J. Robert Oppenheimer and his colleagues opposed development of the hydrogen bomb.

In the years immediately following World War II, the United States was the only nation with the atomic bomb. Its strategic dominance, however, rested on a thin veneer of actual military capability.

As late as 1947, the US did not have any atomic bombs assembled and ready for use. The Atomic Energy Commission, which held custody, was to work up the bombs and transfer them to the Air Force if and when they were needed. The Air Force had only a few airplanes, "Silver Plate" B-29s, that could deliver the bomb, and few trained crews.

The leading atomic scientists who developed the atomic bomb during the war had left the Los Alamos weapons laboratory in New Mexico. Most of them were opposed to further military development of atomic energy.

The US in 1946 proposed international control of atomic weapons. The offer to the United Nations fell through because the Soviets demanded the US eliminate its nuclear weapons as a precondition to agreement.

The first thermonuclear explosion was the "Ivy Mike" test at Eniwetok Atoll in the Pacific in 1952. The fireball was three miles wide and vaporized the coral islet on which the shot occurred.

The concept for a far more powerful nuclear weapon—the hydrogen bomb, called the "Super" by the atomic scientists—had been around for some time. Few outside of the scientific community knew about it, and except for a few scattered advocates, there was almost no interest in pursuing it.

Until October 1949, the President of the United States had never heard of the hydrogen bomb, nor had the Joint Chiefs of Staff. Disclosure beyond the scientific inner circle was brought about by dramatic events and a few determined insiders.

The Soviet Union exploded a nuclear device, "Joe 1," Aug. 29, 1949. It was an exact copy of the "Fat Man" atomic bomb dropped on Nagasaki, Japan. British scientist Klaus Fuchs, arrested in London, admitted in January 1950 that he had passed atomic secrets, stolen at Los Alamos, to the Soviet Union.

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By John T. Correll

President Truman, informed that a hydrogen bomb was possible and advised that the Soviets might not be that far behind, ordered a development program into high gear. The United States did not yet know that the Soviet Union had been working on a hydrogen bomb since 1948, aided by research obtained by espionage from Los Alamos.

AT EASE

An atomic or fission bomb is exploded by bringing enhanced uranium or plutonium to critical mass. A hydrogen or fusion bomb is a two-stage device. The primary stage is an atomic bomb, which acts as a trigger, aided by another atomic "spark plug" in the secondary stage, to compress and ignite hydrogen isotopes. The thermonuclear chain reaction thus induced releases 1,000 times more energy than an atomic bomb.

The Manhattan Project team at Los Alamos was aware of the theory that an atomic bomb might be able to detonate a fusion explosion. However, with time pressures of the war bearing down on them, they chose to concentrate on the fundamental task of producing an atomic bomb, a formidable challenge in itself.

Physicist Edward Teller, the foremost advocate of the Super, was permitted to conduct theoretical fusion research as a minor effort at Los Alamos, but lab director J. Robert Oppenheimer kept the project's emphasis on the atomic bomb, which was tested successfully in July 1945. The clash between Teller and Oppenheimer would continue spectacularly over the next 10 years.

When World War II ended, the United States felt secure in its military superiority and had no inclination to develop more powerful weapons—or to take an adversarial position toward its wartime ally, the Soviet Union.

In his famous speech at Westminster College in Fulton, Mo., in March 1946, Winston Churchill warned that an "Iron Curtain" had descended on Europe. It is seldom remembered that the speech was poorly received at the time. *The New York Times* reported that President Truman had no comment and the prevailing opinion in Congress and "in the high councils of the Administration" was that Churchill had been excessively provocative toward the Soviet Union.

In June 1946, the United States offered to give up its store of atomic weapons and turn its atomic secrets over to a proposed UN International Atomic Development Authority, which would use atomic energy for peaceful purposes. It might have been accepted if the Soviet Union had not refused to concede veto power in the UN on atomic issues. The international control issue bubbled along into 1948, but it was essentially over.

Edward Teller, the foremost advocate of the hydrogen bomb, could not get his "Classical Super" to work. Detonation of a thermonuclear device, it was subsequently learned, required compression of the fission fuel, not just high levels of heat.

Oppenheimer wrote and spoke often in favor of international handling of atomic energy and open communication on science. "We vastly overestimate the value of secrecy and underestimate the corrosive effects of it," he said.

The Atomic Energy Act of 1946 transferred control and custody of nuclear weapons from the military to the new Atomic Energy Commission. The first AEC chairman was David E. Lilienthal, an ardent New Dealer, head of the Tennessee Valley Authority, and an implacable foe of the Super, which he regarded as dangerous and unnecessary.

Most of the AEC commissioners sided with Lilienthal. The exception was Lewis Strauss, a former investment banker, a rear admiral in the Navy Reserve, and a hard-nosed Cold Warrior. He, along with Teller, Oppenheimer, and Lilienthal would figure prominently in the melodrama to come.

The armed forces were not particularly worried about nuclear weapons. Military intelligence did not expect a challenge to the US monopoly. The Navy predicted the Soviets would not have the bomb until 1965. The Army guessed 1960; the Air Force said by 1952.

In January 1949, the AEC nuclear stockpile reached 56 atomic bombs.

TRUMAN'S DECISION

The Soviet atomic bomb test in August 1949 was discovered soon thereafter by the United States and announced to the world by President Truman on Sept. 23. The surprise set off renewed interest in the hydrogen bomb by the AEC and in Congress by the Joint Committee on Atomic Energy.

At an AEC meeting Oct. 5, Strauss distributed a memo to his fellow commissioners proposing a "quantum jump" in nuclear capability and "an intensive effort to get ahead with the Super."

It was the first clear proposal for the hydrogen bomb.

Lawrence Livermore National Laboratory photo

Department of Energy photo

J. Robert Oppenheimer, who led the development of the atomic bomb, was opposed to the hydrogen bomb. He was stripped of his security clearance by the AEC in 1954 because of his continued association with Communists and a casual attitude toward information security—although animosity from those who disliked him likely played a part as well.

President Eisenhower takes a briefing from Lewis Strauss, AEC chairman, on the hydrogen bomb tests in 1954. Strauss distrusted Oppenheimer.

Strauss then met with the executive secretary of the National Security Council and instigated the first notice to Truman of the possibility of a hydrogen bomb. The Joint Chiefs of Staff were let in on the secret the following week. It became public knowledge in November when Sen. Edwin C. Johnson (D-Colo.) revealed on a local television broadcast in New York that American scientists were trying to make a "super bomb" many times more powerful than the atomic bomb.

AEC chairman Lilienthal responded by calling in the Commission's General Advisory Committee, which was chaired by Oppenheimer. The committee members were atomic scientists stridently against a hydrogen bomb. After a two-day meeting, they produced a report on Oct. 30 saying that all-out development of the hydrogen bomb would be "wrong."

In remarkably harsh language, Oppenheimer and the GAC said that "a super bomb might become a weapon of genocide," represented "a threat to the future of the human race," and that "a super bomb should never be produced." In the opinion of the GAC, "the extreme dangers to mankind inherent in the proposal outweigh any military advantage that could come from this development."

By that time, Truman had heard directly from Strauss, who urged him to give the highest priority to H-bomb development. The Joint Chiefs of Staff agreed with Strauss. Truman sought further advice from a special committee consisting of Lilienthal, Secretary of State Dean Acheson, and Secretary of Defense Louis A. Johnson. Acheson and Johnson advised Truman to proceed with the Super.

Speculation in the press was inflamed by the news from Britain that physicist Fuchs had confessed to passing atomic and hydrogen secrets to the Soviet Union. Fuchs had been a British representative at Los Alamos and had seen all of the research in the archives there on thermonuclear weapon research.

Truman made his decision Jan. 31, 1950. He asked Acheson, Johnson, and Lilienthal whether the Soviets could develop a hydrogen bomb. They agreed that the Soviets probably could. "In that case, we have no choice," Truman said. "We'll go ahead."

Congress gave Truman overwhelming approval, across party lines, for his decision, but the atomic scientists and many in the news media disagreed vehemently. Lilienthal resigned, as he had planned to do anyway.

Truman's decision gained additional credibility that summer when the FBI arrested Julius and Ethel Rosenberg and other members of a Soviet spy ring that had stolen atomic secrets from Los Alamos during the war.

THE DESIGN THAT WORKED

Edward Teller struggled through the postwar years but could not get his design for the "Classical Super" to work. He assumed, erroneously, that the heat from an atomic device alone would be enough to ignite fusion.

In 1950, mathematician Stanislaw Ulam, using new high speed computers, discovered a mistake made by Teller and his associates in 1946. Direct ignition would take an impractical amount of tritium, one of the hydrogen isotopes in the fission fuel, if it would work at all.

Ulam said Teller "was not easily reconciled" to the report of the error but "warmed" to the idea of a "staged" approach when Ulam suggested it in January 1951. In March, Teller and Ulam wrote a classified paper on a new concept, in which an atomic bomb might ignite a secondary explosion in fission fuel located separately from the atomic trigger in the hydrogen bomb casing.

Detonation of the thermonuclear fuel would require compression as well as heat. Teller improved the idea by adding a second atomic component as a "spark plug" in the second stage of the process. Thus, embedded within the hydrogen bomb were the atomic bomb trigger and the atomic spark plug in a separate cylinder.

The revised configuration was ultimately successful, but to Teller's displeasure, it was called the "Teller-Ulam design." Teller resented Ulam's contribution being accorded equal credit with his own previous 10 years of work and said that the final configuration had been his. Nevertheless, the Teller-Ulam designation stuck and went on to be used in almost all modern nuclear weapons by all of the major nuclear powers.

IVY MIKE

The first successful explosion of a hydrogen device was the "Ivy Mike" test Nov. 1, 1952, in the Marshall Islands, a remote section of the Pacific about 1,200 miles east of Guam. The device weighed 82 tons and was essentially more a building than a bomb. It was constructed on Elugelab, one of 40 coral islets in the Eniwetok Atoll.

After the war, the United States had designated Eniwetok, along with the Bikini Atoll, for testing of nuclear weapons and the native inhabitants had been relocated. Observers watched the Ivy Mike test from various islands a safe distance away.

Ivy Mike detonated with a thermonuclear yield of 10.4 megatons, a thousand times more powerful than the "Little Boy" bomb at Hiroshima, and vaporized Elugelab. "Once the explosion broke through the casing, it expanded in seconds to a blinding white fireball more than three miles across (the Hiroshima fireball had measured little more than one-tenth of a mile) and rose over the horizon like a dark sun," said Richard Rhodes, author of *Dark Sun: The Making of the Hydrogen Bomb.* "The crews of the task force, 30 miles away, felt a swell of heat as if someone had opened a hot oven, heat that persisted long enough to seem menacing."

The first thermonuclear test by the Soviets, "Joe 4," came less than a year later. They evacuated tens of thousands of people from Semipalatinsk in northeastern Kazakhstan, mounted a bomb the size of the US "Fat Man" atomic bomb atop a tower, and touched it off for a modest yield of 400 kilotons in August 1953.

More tests followed on both sides. The highest yield ever achieved by a US device, 15 megatons, was the "Castle Bravo" shot at Bikini in March 1954. The fireball was nearly four miles wide. The Soviets dropped a 1.6 megaton bomb from a Tu-16 bomber in November 1955.

Soviet leader Nikita Khrushchev gloated that his nation had been first to explode a hydrogen bomb from an airplane. The previous US explosion, he said, "was not a hydrogen bomb but a hydrogen installation." The United States dropped its first H-bomb from an airplane in May 1956.

OUSTING OPPENHEIMER

Strauss became director of the AEC in July 1953. The stage was set for the final showdown with Oppenheimer, who was regarded by many in the AEC and the Pentagon as a security risk.

By then, Oppenheimer was director of the Institute for Advanced Study in Princeton, N.J., and no longer on the GAC but he was a consultant under contract to the AEC. In that capacity, he routinely got copies of classified reports from all AEC divisions. His consultancy was to expire in 1954 and his security clearance had to be renewed if the contract was to be extended.

The question of his security clearance was not strictly a matter of loyalty. It also had to do with his casual attitude toward information security, an issue on which he and Strauss had tangled before. Oppenheimer's continued association with known Communists was also a concern.

Some of it was old news. Oppenheimer's wife and brother had been members of the Communist Party in the 1930s. Oppenheimer described himself as a "fellow traveler" who contributed money to Communist causes until 1942. His qualifications to be scientific director of the Manhattan Project had overridden concerns about his previous activities.

After that, however, Oppenheimer generated new questions about his judgment and veracity with conflicting accounts in 1943 and 1946 of his dealings with Hakkon Chevalier, a friend and fellow member of the faculty at Berkeley. In 1943, Chevalier tried to recruit Oppenheimer to provide technical information to the Soviet Union. Oppenheimer delayed for months telling Manhattan Project security about it and then said the approach was by an unknown stranger. He later acknowledged to the FBI that the Soviet agent had been Chevalier.

Oppenheimer's pattern of conduct led Air Force leaders in 1951 to order that he not be used as a consultant or given classified information. Strauss had deeper doubts and thought Oppenheimer might be "another Fuchs." In November 1953, a former staff director of the Joint Congressional Committee on Atomic Energy wrote to the FBI saying that Oppenheimer was not trustworthy.

With these allegations swirling about in 1953, Oppenheimer made the situation infinitely worse by visiting his old friend Chevalier in Paris and going to dinner with him. To Oppenheimer's mind, Chevalier's politics were harmless, but US officials were enraged. President Eisenhower cut off Oppenheimer's access to atomic secrets and the AEC suspended his clearance in December 1953.

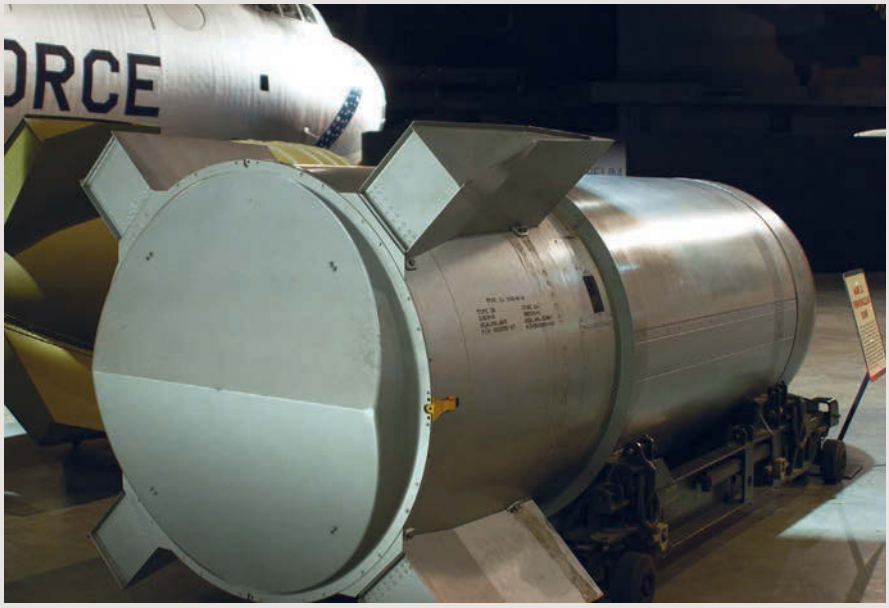
A special AEC Personnel Security Board held hearings, taking testimony from Oppenheimer and others over a period of two months. Among those testifying was Edward Teller, who

Truman, shown here on a tour of Andrews Field, Md., with Air Force escorts, had never heard of a hydrogen bomb until October 1949. He decided that the United States had "no choice" except to proceed with development.

said Oppenheimer had continually used his influence to slow down work on the hydrogen bomb. Teller did not accuse Oppenheimer of disloyalty but said he "would feel personally more secure if public matters would rest in other hands."

In May 1954, the Personnel Security Board recommended against the reinstatement of Oppenheimer's clearance. Oppenheimer appealed to the full AEC, which concurred in June with stripping him of his clearance.

Oppenheimer, who had gotten favorable press throughout his ordeal, won the battle for public opinion. The standard interpretation is that he was unfairly ousted by vindictive enemies on the political right. For the rest of his life, Oppenheimer was a cult figure and something of a folk hero. Strauss and Teller became pariahs.



USAF Photo

The B53 thermonuclear bomb display at the National Museum of the US Air Force in Dayton, Ohio.

THE HYDROGEN ERA

Strictly speaking, the "Atomic Age"—much heralded at the time—did not last long. Ten years after the first atomic test in the New Mexico desert in 1945, the atomic bomb had been all but superseded by the hydrogen bomb.

The armed forces, which had been shut out of nuclear affairs by the AEC, gained a stronger hand. On several occasions, President Truman transferred a number of complete bombs to military control although AEC and the State Department convinced him not to make it a regular policy. In 1956, Eisenhower gave the Defense Department custody of nuclear weapons whenever an emergency was declared, and in 1959 released all operational bombs and warheads outright to the military.

Advancing technology made hydrogen bombs smaller and more powerful, leading to warheads that were light enough to be delivered by an ICBM as well as an airplane. Eventually, the Mark 12-A thermonuclear warhead used on Minuteman missiles would be less than six feet long and weigh about 700 pounds.

A casing of the Mark 53 hydrogen bomb, deemed "an enduring symbol of the Cold War," is on display at the National Museum of the US Air Force in Dayton, Ohio. It weighed 9,000 pounds, generated a yield of nine megatons, and was carried by B-47, B-52, and B-58 bombers. The Titan ICBM delivered a modified version.

The public learned a new word: fallout, referring to radioactive particles gathered up by a nuclear explosion and carried around the world by upper air currents. There was not enough fallout from atomic bombs to make it a major problem, but hydrogen bombs, with fireballs four miles wide, scooped up massive amounts of dirt, sand, and dust.

As the AEC explained it to the newspapers, fallout from a hydrogen bomb explosion over Washington, D.C., would reach almost to New York and be potentially lethal to the entire population within the first 140 miles. This led to the civil defense boom of the 1950s and 1960s, with many families building fallout shelters in the backyard.

The Super became an issue in the 1956 presidential election with Eisenhower's Democratic challenger Adlai Stevenson proposing that the United States stop further tests of the hydrogen bomb. He said the Soviet Union would be willing to join in such a policy. His running mate, Sen. Estes Kefauver (D-Tenn.), said it was "general information" that a hydrogen bomb could "blow the Earth off its axis by 16 degrees." According to *The New York Times,* "responsible scientists" found Kefauver's claim "incredible."

Eisenhower, who said the Stevenson's plan was "pie-in-the-sky promises and wishful thinking," won the November election by a landslide.

Khrushchev, in his customary fashion, said the USSR would soon "have a guided missile with a hydrogen bomb that can fall anywhere in the world."

LEGACY OF THE SUPER

Critics of the hydrogen bomb in the 1950s said that it had no military value other than an imputed psychological effect that might to some extent restrain an adversary. The point was correct but that imputed effect—known as deterrence—kept the nuclear peace until the Cold War ended some 40 years later.

The terms "atomic bomb" and "hydrogen bomb" are seldom used today, except in a historical context. The standard reference is to "nuclear weapons," without differentiation between fission and fusion devices.

Almost all of the nuclear weapons in the hands of the major powers at present are of thermonuclear design because it is more efficient. Thermonuclear bombs, of course, use atomic bombs as triggers for detonation, just as Ivy Mike did.

The British tested a thermonuclear device in 1958, followed by China in 1967, France in 1968, and India in 1998. Israel is presumed to have the hydrogen bomb.

Pakistan has not tested a thermonuclear device, but could probably do so with a determined effort.

In 2014, North Korea said its scientists had achieved nuclear fusion, but the claim was generally discounted.

For some years, the United States continued to deploy atomic weapons for tactical use, but the last atomic bomb in the US inventory, the B57, was removed from service in 1993. ✪

John T. Correll was editor in chief of Air Force Magazine *for 18 years and is now a contributor. His most recent article, "Opposing AWACS," appeared in the September issue.*