

NATIONAL ACADEMY OF SCIENCES

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WALTER HENRY ZINN  
1906–2000

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*A Biographical Memoir by*  
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National Academy of Sciences.*

*Biographical Memoirs*, VOLUME 85

PUBLISHED 2004 BY  
THE NATIONAL ACADEMIES PRESS  
WASHINGTON, D.C.



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W. H. Zinn

## WALTER HENRY ZINN

*December 10, 1906–February 14, 2000*

BY ALVIN M. WEINBERG

**W**ALTER (“WALLY”) HENRY ZINN was Enrico Fermi’s close associate during the Manhattan Project. After World War II he became the leading U.S. figure in the earliest development of nuclear energy. So pervasive was his stamp on nuclear development that a proper obituary to Walter Zinn must be nothing short of an account of the origins of nuclear energy and how Zinn profoundly affected its development.

Fission was discovered in 1938. By then Zinn had already received his Ph.D. in physics from Columbia (in 1934) and had been on the faculty of City College of New York. He also had a laboratory at Columbia, where he collaborated with Leo Szilard and Enrico Fermi in elucidating the nature of fission. In those exciting days nuclear physicists were asking how many neutrons were emitted by a uranium nucleus undergoing fission induced by a neutron. If the answer were greater than one, a nuclear chain reaction was possible; if less than one, a divergent chain reaction was impossible. Zinn and Szilard found that about two neutrons were emitted by a fissioning uranium nucleus; in this they confirmed the results of Fermi, Anderson, and Hahnstein. Thus was born experimental verification of the Manhattan Project’s purpose: to make an atomic bomb.

After the number of neutrons released from fission was shown to be around two, Fermi lost no time in demonstrating the chain reaction. Zinn joined Fermi's experimental team, and he soon became Fermi's "executive officer." In this capacity Zinn organized the heavy experimental work that was needed to carry out Fermi's plan to build a divergent chain reaction.

The aim was to demonstrate that a lattice consisting of uranium and graphite would chain-react if it were large enough. Since the critical size of such a lattice was larger than the amount of uranium and graphite then available, Fermi devised the so-called exponential experiments (i.e., subcritical arrays in which the neutrons were distributed exponentially). Zinn participated in the first of these experiments, which was carried out at Columbia. The multiplication constant was found to be a disappointing  $k = 0.87$ , but Fermi was confident that purer uranium and graphite and a better lattice dimension would achieve the magical  $k = 1.0$ .

By late 1941 the plutonium branch of the uranium project was consolidated under Arthur Compton at the University of Chicago Metallurgical Laboratory, and Zinn accompanied Fermi to the Met Lab. At Chicago some 30-odd exponential experiments were conducted to measure the multiplication constant in different lattices of uranium and graphite. Each experiment involved a pile of graphite and uranium about 11 feet high and 8 feet on the side. Changing from one configuration to another required a team of strong University of Chicago athletes bossed by Zinn, who was in daily contact with Fermi.

The first experiment that showed  $k > 1$  was performed in May 1942. Arthur Compton's announcement of  $k > 1$  was for me the most exciting event of the uranium project. I remember discussing the actual demonstration of the divergent chain reaction with Fermi and Wigner when Wigner

bravely said he was so sure the pile would chain-react that he doubted he would attend the historic event (he actually did attend).

We had a bowling club that met weekly, and on the night of December 1, 1942, I walked with Zinn to our club. By this time Zinn and Herbert Anderson's team had erected a pile that would be critical the next day.

I was too junior to attend the first criticality experiment at about 3:20 p.m. on December 2, 1942. Fermi was in overall charge, but Zinn saw to it that Fermi's directions were carried out. At the instant of criticality Zinn was responsible for the so-called "zip" rod, a simple bar of cadmium held by a spring and tied outside the pile by a 100-pound counterweight. Zinn held an axe with which he was ready to cut the rope that held the zip rod if the chain reaction were to get out of hand. Fortunately the "landing in the new world" (words used by Arthur Compton in a phone call to James Conant) was uneventful. Zinn did not have to cut the rope that kept the zip rod from entering the pile.

By 1946 the Atomic Energy Act had been passed by Congress and the Manhattan Project was transformed into the U.S. Atomic Energy Commission (AEC). Most of the senior members of the project, such as Bethe, Compton, Fermi, Oppenheimer, Teller, and Wigner, returned to their universities; their replacements included Norris Bradbury at Los Alamos and Zinn at Argonne.

Zinn had emerged during the wartime Hanford development as a natural leader. He was intelligent, very close to Fermi, and he was tough. According to his son Professor Robert Zinn of Yale, Zinn spoke at home only of pleasant happenings; yet he would explode when he was too involved with people he regarded as foolish.

In those earliest days the AEC had hardly decided on how to develop nuclear energy. In 1948 the AEC desig-

nated Argonne as the National Laboratory responsible for all work on reactors. As director of Argonne, Zinn found himself the nominal scientific boss of several different reactor projects, particularly the High Flux (a water-moderated, highly enriched reactor being designed in Oak Ridge under Wigner's supervision); the NaK-cooled fast breeder prototype (EBR-1) being developed directly under Zinn's supervision at Argonne; and the newly established Submarine Thermal Reactor (STR) for naval propulsion that was essentially a pressurized version of the High Flux water-moderated reactor. The EBR-1 project, having been Zinn's baby from the first, smoothly merged with the rest of Argonne, and EBR-1 became the first reactor to generate electricity.

The High Flux, renamed the Materials Testing Reactor (MTR), had already received extensive preliminary design at Oak Ridge. The project was divided between the Oak Ridge group, which was responsible for the interior of the MTR, and the Argonne group, which was responsible for the external facilities required to manage the 30,000 kW generated in the MTR. Zinn, as director of Argonne, became chairman of a five-member steering committee that oversaw the entire project. MTR was the first successful demonstration of a very-high-power-density, water-moderated, and water-cooled reactor.

The submarine reactor, STR, was a different story. Both Zinn and Captain H. G. Rickover were tough; although the AEC had assigned a naval reactor role to Argonne, Zinn's relations with Rickover were never friendly. The general layout of the STR had been the brainchild of Harold Etherington of Argonne, yet Rickover insisted that Argonne's STR group take its orders from Rickover and not from Zinn. The upshot of the matter was that Zinn actually threw Rickover out of Argonne, because as Wally told me, he could not tolerate two bosses for the same reactor! After the blowup

with Rickover, Argonne's role in developing STR became secondary to that of the Westinghouse Bettis Laboratory.

Relieved of prime responsibility for STR, Zinn at the suggestion of Sam Untermyer experimented with boiling-water reactors. Thus was born the BWR (Boiling-Water Reactor) that now accounts for about 20 percent of the world's fleet of approximately 440 nuclear power plants.

Although EBR-1, MTR, and the BWR were the main efforts at Argonne, the laboratory designed or built several other reactors: the first medium power (300 kW) heavy-water reactor; the huge D<sub>2</sub>O tritium producers built and operated at Savannah River, South Carolina, by the Du Pont Company; and power reactors cooled by various coolants. Zinn was an important player in most of these developments.

Zinn's role as leader of the postwar development of reactors was symbolized at the First Geneva Conference on Peaceful Uses of Atomic Energy in Geneva, Switzerland, in August 1955. This U.N.-sponsored conference involved over a thousand nuclear energy experts from both sides of the Iron Curtain. The opening session was like a thirteenth-century jousting tournament with the Soviet Union and United States each putting forward its champion. D. I. Blokhinsev described the Obninsk 5000-kW graphite-moderated, water-cooled pilot plant. He was followed by Zinn, who gave the first public account of successful experiments with the boiling-water reactor. The Russian pilot plant was the forerunner of their plutonium-producing reactors. Zinn's boiling-water experiments led to the 90 large commercial boiling-water reactors (BWR) now operating.

Zinn left Argonne in 1956 after serving for eight years as its first director. The general campus-like layout of the laboratory reflects Zinn's sensitive practicality. Zinn could be stubborn both in his relations with the contracting entity, the University of Chicago, and the AEC, which funded Argonne.

As a former National Laboratory director, I can say that Zinn was a model of what a director of the then-emerging national laboratories should be: sensitive to the aspirations of both contractor and fund provider, but confident enough to prevail when this was necessary. This is illustrated by the following anecdote: Zinn, Harrell (University of Chicago contracting officer), and Tammaro (area manager for the AEC) were discussing whether Argonne's security fence should include the entire site or simply separate buildings. Zinn and Tammaro couldn't agree. Tammaro finally said that Harrell (a University of Chicago vice-president who had signed the contract with the AEC) should decide. At this point Zinn took over. "He can't decide a single thing," which illustrates Zinn's commitment to experts, not to bureaucrats.

Zinn, as director of Argonne, was in no position to design and build large power reactors. He therefore left Argonne to establish the General Nuclear Engineering Company (GNEC) with headquarters in Dunedin, Florida. The company flourished and was much involved in large-scale pressurized-water reactors. Eventually GNEC was acquired by Combustion Engineering Company, and Zinn became head of its fast-growing Nuclear Division. He retired from Combustion in the early 1970s but remained on the company's board of directors until the early 1980s.

By this time Zinn had become sort of a gray eminence of nuclear development. He also received the highest honors: the Ford Family's Atoms for Peace Award, the Enrico Fermi Award, and membership in both the National Academy of Sciences (in 1956) and the National Academy of Engineering (in 1975). He also served on the President's Science Advisory Committee during the 1960s.

Many of the most important decisions of the American nuclear effort during the post-1940s were attributable to Zinn. Among those were:

- The establishment of the Reactor Test Station in Arco, Idaho, where the prototypes of the first naval reactor as well as MTR, EBR-1, and EBR-2 were built and operated.
- The founding of the American Nuclear Society (ANS), which was strongly influenced by Zinn, its first president. Today ANS has about 10,000 members and is the main technical society in the field of nuclear science and engineering.

By the end of the war we realized that counting the different moderators and coolants the number of power reactor concepts could be counted in the dozens. Not all could be pursued simultaneously. Choices had to be made, and Zinn's view greatly influenced the earliest decision as to which paths to follow. Two basically different paths were suggested by Zinn: variants of the naval reactor STR, which led to the commercial PWRs and BWRs, and the fast breeder, which led to the EBR-1 and its successor, EBR-2, and breeders in Russia, Japan, the United Kingdom, France, and India. It was Zinn's persistent advocacy of the NaK-cooled EBR-1 that thrust the U.S. reactor program on this dual path: light-water burners and liquid-metal-cooled fast breeders. This path has been followed by most nuclear developers, Canada being a notable exception.

Zinn's espousal of the first breeder was based on the earliest estimates of how much uranium could be extracted. In those early days before much exploration for uranium had taken place we thought uranium was scarce. The breeder would have to be developed if nuclear energy was to be a long-term source of energy. This was a deeply held conviction of Fermi, Wigner, and Szilard; and it was the guiding principle for Zinn (who was influenced by Fermi). Thus a primary goal of the earliest reactor development plan was the fast breeder. This remained an important element of Zinn's approach to reactor development. But now some

60 years after December 2, 1942, we realize that the earth's cache of uranium is many times larger than our earliest estimates and therefore the *quick* development of the fast breeder may be unnecessary. That is not to say that Zinn's EBR-2, a 20,000-kW sodium-cooled reactor was not a major technical success. Although it was shut down after 40 years of corrosion-free operation and thus vindicated Zinn's judgment that the Liquid Metal Fast Breeder Reactor (LMFBR) was a practical device, the shutdown of EBR-2 was a major error in the U.S. reactor plan.

WALTER ZINN AS VIEWED BY HIS SON PROFESSOR ROBERT ZINN

Walter Henry Zinn was born December 10, 1906, in Kitchener, Ontario, Canada (he became a naturalized U.S. citizen in 1938), and died on February 14, 2000, in Clearwater, Florida. The son of John Zinn and Maria Anna Stoskopf, he had an older brother, Albert, who was 10 years his senior. Of his working class family Walter was the only one of his immediate family to attend college. His father worked for much of his life in a tire factory, and Albert was also a factory worker. As a boy, Walter also worked in one or more factories.

Walter skipped a few grades during elementary school and entered Queen's University. He graduated from Queen's in 1927 with a B.A. degree in mathematics and remained there until he earned an M.A. degree in 1930. In 1957 Queen's awarded him an honorary D.Sc. degree. In 1930 Walter became a graduate student in physics at Columbia University. He married Jennie A. Smith in 1933, whom he had met when they were both students at Queen's. Jennie, who was always called Jean, died in 1964. Walter became a naturalized U.S. citizen in 1938.

Walter held teaching positions at Queen's during 1927-1928 and at Columbia during 1931-1932 and was on the faculty of City College of New York from 1932 to 1941. He

also had a research laboratory at Columbia, where in 1939 he participated in the famous early work on the fission of uranium and the possibility of a chain reaction.

In 1966 Walter married Mary Teresa Pratt, who survives him, as do his sons, John Eric and Robert James Zinn, and his stepson, Warren Johnson. Another stepson, Robert Johnson, died in 1991. Walter had nine grandchildren.

Walter frequently recalled events that surrounded the beginning of the Manhattan Project and the first chain reaction. His descriptions corresponded with those that have been published by historians, but captured much more of the excitement of the moment and also the great concern that scientists had for Germany's development of the atomic bomb and the possibility that the Germans were ahead of the United States in the race to produce the first bomb. Walter had a tremendous admiration for Enrico Fermi, and he was awed by Fermi's genius both as an experimental physicist and as a theorist. Walter's comments on Fermi were often to the effect that at one moment Fermi could invent a novel way to make a difficult measurement and in the next could argue a subtle point in theory with the very best theorists (e.g., Eugene Wigner). Walter also enjoyed telling how he served twice as a real estate agent for Fermi by finding places for the Fermi family to live near New York City and later Chicago, how they traveled to work together, and how it was to have Fermi as a friend and colleague.

Walter also had high regard for Leo Szilard, his collaborator on one of the first experiments on fission. While Walter acknowledged that Szilard was of little real help with design or operation of the experimental apparatus, he said that Szilard was an "idea man" with few peers and that he motivated others to conduct the "right" experiments.

The McCarthy era occurred during Walter's tenure as director of Argonne National Laboratory, and he had a few

stories to tell about the hysteria that enveloped that period, including imagined security breaches at Argonne. One particularly frustrating episode for Walter involved a small bottle of slightly enriched uranium that some media people and politicians were convinced had been taken by Russian spies. Walter was in some hot water over this issue until the missing bottle was discovered in the garbage in Argonne's landfill. Experiences like that caused Walter to hold most politicians in low esteem, because they seemed less interested in truth than in advancing their own careers.

Walter was proud of his work on the development of nuclear energy for the production of electricity. He worked on many of the designs that later became the standard ones for the nuclear power industry. He worked hard on reactor safety, and he would recall experiments at the Idaho test site, where a reactor was purposely destroyed to better understand various safety issues. He believed that properly designed and operated reactors were very safe. He firmly believed in a bright future for nuclear energy. When in 1948 the AEC assigned responsibility for reactor development to the Argonne National Laboratory, Walter emerged as a natural leader of the U.S. effort to develop nuclear power.

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