The Manhattan Engineer District

and

The Making of the Bomb

Sam Bono

America's history is a vast heritage of people and events. Some are heroic, some inglorious, but all are a part of America's struggle to come of age. An understanding of this history is vital to deal with the present and our future.

Preface

This pamphlet tells the story of the making of the world's first atomic bombs that helped end World War II in August 1945. The bombs were built by the United States in an unprecedented $2.2 billion top secret scientific-engineering effort, code-named the Manhattan Engineer District. Centered in Los Alamos, New Mexico, the Manhattan Project - as the effort was commonly called - developed, built, and then tested the world's first atomic device at Trinity Site 230 miles south of Los Alamos on July 16, 1945.

A few weeks later on August 6, an atomic bomb nicknamed Little Boy was dropped on Hiroshima, Japan, and then a second, named Fat Man, on Nagasaki on August 9. Their use helped bring World War II to an end after almost six years and changed the world forever. Over fifty-five years later the legacy of the Manhattan Project still affects us all.

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Introduction

In 1903 Pierre and Marie Curie, along with fellow French physicist Antoine Henri Becquerel, were awarded the Nobel Prize in physics for their pioneering work in radioactivity. Seven years later Marie was awarded a second Nobel Prize for the discovery of radium. This work by the Curies, Becquerel and others led to the splitting of the uranium atom by German scientists Otto Hahn and Fritz Strassmann in late December 1938.

Leo Szilard, Edward Teller, Enrico Fermi and other European émigré scientists who had fled from Fascist and Nazi repression to the United States were made aware of the Germans' success by Lise Meitner and Niels Bohr. Realizing that the Germans' discovery could lead to the building of an atomic bomb, the scientists approached the American government with a warning. Rebuffed, but still deeply concerned, the physicists eventually contacted the world famous scientist Albert Einstein, who was teaching at the Institute of Advanced Study near Princeton, New Jersey. With Einstein's help, Szilard, Teller, and Eugene Wigner composed the famous Einstein Letter.

Dated August 2, 1939, the letter was addressed to American President Franklin Delano Roosevelt. In the letter Einstein warned FDR that a single atomic bomb exploded in a port might very well destroy the whole port along with some of the surrounding territory.

This concern over a possible German atomic bomb eventually led to America's creation of the top secret Manhattan Engineer District in June 1942. Its ultimate goal was to build an atomic bomb before Germany or Japan.

Chapter One

Before the War

German scientists Otto Hahn and Fritz Strassmann were the first to split the uranium atom in late 1938. Working at the Kaiser Wilhelm Institute for Chemistry in the Berlin suburb of Dahlem, the two discovered that when a uranium nuclei was bombarded with neutrons it divided into two pieces and that the resultant two pieces weighed less than the original uranium nucleus. While Hahn and Strassman did not fully understand the implications of their experiment, others soon would.

On December 19, 1938, Hahn wrote of his results to his friend and former colleague, Austrian Lise Meitner. Now living in Stockholm, the Jewish Meitner had reluctantly abandoned her many years of work at the Institute and fled Nazi controlled Germany to Sweden the previous July. Five months later the sixty-year-old Meitner was spending the Christmas holidays with friends and her nephew, Otto Frisch, in the small Swedish village of Kungälv when she received Hahn's letter. Also a scientist, Frisch worked in Copenhagen, Denmark with the famous Danish theoretical physicist, Niels Bohr.

Calculations made by Meitner and Frisch over the holidays led them to a better understanding of the experiment's results, and the conclusion that with so much energy being released by splitting the uranium nuclei, a previously undiscovered process was at work. Frisch named this new phenomenon "fission," a term used in biology to describe the division of a cell. Returning to Copenhagen, he related the exciting news of the Hahn-Strassmann experiments and of his and Meitner's calculations to Niels Bohr on January 3, 1939.

A few days later Bohr sailed for the United States, where he planned to spend four months working with Albert Einstein at the Institute for Advanced Study. Docking in New York on January 16, Bohr was met by the 1938 Nobel Prize winner in Physics, Italian Enrico Fermi and his wife, Laura. The

Fermi's had arrived in the U.S. only two weeks earlier after Enrico had received the prestigious prize in Stockholm. They were accompanied dockside by Enrico's new boss, George Pegram, Chairman of the Physics Department and Dean of Graduate Studies at New York City's Columbia University.

Bohr attempted to withhold the news of the German's great discovery from the majority of the American scientific community until proper credit could be given to Frisch and Meitner for their correct interpretation of the Hahn-Strassmann experiments. While failing to keep the news totally secret, he still startled most of the fifty-one official participants of the Fifth Washington, D.C. Conference on Theoretical Physics three weeks later with the exciting news of the German's discovery. Richard Rhodes, in his Pulitzer Prize-winning history of the Manhattan Project, *The Making of the Atomic Bomb* (1986), wrote that Bohr's news so galvanized the room that several local physicists rushed out of the Conference to repeat the experiment in their own laboratories.

Two months later on March 16, 1939, Nazi dictator Adolf Hitler, finished dissecting the Republic of Czechoslovakia and brought Europe closer to war. That same day in New York City, physicists Eugene Wigner, Leo Szilard, and Enrico Fermi met with George Pegram at Columbia. Deeply concerned with the Führer's latest move in Europe and with the potential threat of the Hahn-Strassmann experiments, Wigner decided that it was time to warn the United States government of the Germans' discoveries. The other scientists agreed.

Since Fermi was traveling to Washington, D.C. later that same day, he volunteered to carry the warning to the government. The next afternoon Fermi arrived at Navy Headquarters to meet with Admiral Stanford C. Hooper, Technical Assistant to the Chief of Naval Operations. After spending more than an hour explaining the intricacies of nuclear physics and the deadly possibilities of Germany's discoveries to the Admiral and his staff, Fermi was dismissed with only a vague promise that a Navy representative would visit Columbia University sometime in the future.

Following other unsuccessful attempts to warn the government, Szilard, Teller and Wigner decided to solicit the aid and prestige of Einstein who was spending his summer on Long Island, New York. On Sunday, July 16, Szilard and Wigner drove to Einstein's house on Old Grove Pond. Szilard

remembered years later that Einstein was quick to see the implications of the Germans' discovery and was very willing to do anything that needed to be done. The decision was made to send a warning letter, signed by Einstein, to the President. The letter was dated August 2, 1939, less then a month before the start of World War II.

A friend of the President, Dr. Alexander Sachs, was recommended to carry what became known as the Einstein letter to FDR. Sachs had first met Roosevelt when he had worked on his 1932 presidential campaign. Then between 1933 and 1936 he worked for the National Recovery Administration (NRA), one of FDR's many New Deal programs. After talking to the scientists Dr. Sachs not only agreed to carry the letter, but also because of its vital importance, he decided to present it directly to FDR in the White House.

Due to the rapidly deteriorating political situation in Europe that led to the start of World War II on September 1, Sachs was not able to meet with Roosevelt until the afternoon of October 11, 1939. FDR, impressed with Sachs presentation and Einstein's letter, assured his friend that action would be taken. In his October 19 reply to Einstein, the President wrote that he had created a Board consisting of the head of the Bureau of Standards and representatives from the Army and Navy to thoroughly investigate the possibilities of uranium.

In the United States, despite Roosevelt's assurances, little was accomplished toward building a bomb for almost two years. Meanwhile in Germany, Hitler threatened England and France with a secret weapon, "a weapon against which there is no defense."

Chapter Two

Pearl Harbor to Trinity

It was not until after the December 7, 1941, Japanese attack on American forces in Hawaii and elsewhere in the Pacific that work on a U.S. atomic bomb began to accelerate. Six months later, the bomb project (now called the Laboratory for the Development of Substitute Metals) was transferred to the control of the U.S. Army Corps of Engineers. On August 13 the top-secret bomb effort was renamed the Manhattan Engineer District. The Corps of Engineers had divided the U.S. into districts, and the original headquarters of the bomb project was in New York's Manhattan District at 261 5th Avenue. The re-naming was the result of concern on the part of Corps Deputy Chief of Construction, Colonel Leslie R. Groves, who felt that the old name would "arouse the curiosity of all who heard it."

On September 17, 1942, Col. Groves was given command of the Manhattan Project, as the effort soon became known. To give the new project leader more clout in the rank-conscious military hierarchy, Groves was promoted to Brigadier General six days later. Despite an abrasive personality and manner, Groves was considered a good choice to head the bomb project, since he was an excellent administrator with a reputation for getting things done on time.

As the new head of the Project, one of the General's first goals was to duplicate the Germans' success in splitting the uranium atom on a much larger and controlled scale. To lead this effort Groves selected the Italian, Enrico Fermi.

Fermi achieved the General's goal by building Chicago Pile 1, (CP-1). This primitive nuclear reactor consisted of a 400-hundred ton, twenty-foot high pile of large brick-shaped graphite blocks with forty-six tons of uranium oxide and metal (U 238) spread throughout it. This reactor, or pile, was built on a squash court located underneath the west stands of Stagg Field, the University of Chicago's football stadium.

General Leslie R. Groves was one of the three men most responsible for the building of the first atomic bombs by the Manhattan Project.

Leslie Richard Groves was born in Albany, New York on August 17, 1896. His father was a Presbyterian military chaplain, so Groves grew up on different Army posts across America's West, in Cuba and in the Philippines. According to Groves, his greatest ambition as a child was to attend the United States Military Academy at West Point, New York. After two years at the Massachusetts Institute of Technology, Groves won a presidential appointment to West Point in 1916.

Graduating fourth in his class on November 1, 1918, Groves was commissioned a Second Lieutenant in the Corps of Engineers in the same month that World War I ground to a halt in Europe. Groves spent the next twenty years serving on various assignments in the United States, France, Nicaragua, and Hawaii. In 1939 he joined the War Department's General Staff before being appointed Special Assistant to the Quartermaster General. Later he became the Corps' Deputy Chief of Construction. In this position he was responsible for the building of the Pentagon, the War Department's centralized headquarters across the Potomac from Washington, D.C. in Arlington, Virginia. At that time the Pentagon was the largest office building in the world. Under Grove's direction, the Pentagon was finished ahead of schedule, and under budget!

One of Groves' subordinates, Lieutenant Colonel Kenneth D. Nichols, described Groves as not only "the biggest sonovabitch" he had ever met in his life, but also one of the most capable individuals who had an ego second to none.

General Groves headed the Manhattan Project almost from its inception in 1942 until 1947 when it became the Atomic Energy Commission (AEC). After leaving, Groves served as the Chief of the Armed Forces Special Weapons Project until he retired from active duty on February 29, 1948. He wrote of his years with the Manhattan Project in, *Now It Can Be Told: The Story of the Manhattan Project* (1962).

The theory behind the pile was that if enough uranium is placed in close proximity, neutrons emitted by the uranium atoms would possibly hit

other uranium atoms causing them to split (or fission), and hopefully result in a nuclear chain reaction. In addition, if the neutrons are "moderated" (slowed down) they are more likely to hit and spilt other atoms.

For their moderator the Germans had rejected graphite in favor of heavy water (deuterium oxide). The United States had no ready source of this rare and expensive liquid, but it did have large amounts of graphite which was discovered to be a more effective moderator of neutrons than heavy water.

CP-1, with Fermi at the controls, became self-sustaining on the afternoon of December 2, 1942. Fermi operated the reactor at a power level of only one-half watt for 4.5 minutes before shutting it down at 3:53 p.m. CP-1 reached a maximum power output of 200 watts on December 12, then was dismantled and moved to what is now the Argonne National Laboratory south of Chicago. Successful at splitting the atom in Chicago, the Manhattan Project needed to decide what type of nuclear material to use for the bomb.

An atomic bomb needs some type of fissionable material to create a nuclear explosion, either uranium 235 or the highly fissionable isotope of plutonium, Pu 239. Both of these materials are "produced" from natural uranium, which is mostly (99.28%) uranium 238. The small percentage of U 235 found in natural uranium could be separated from U 238 by using a number of different methods. Plutonium can be obtained from U 238 that has been irradiated in a nuclear reactor and then processed through a chemical separation process. Not sure which of the two nuclear materials would be easier to produce, but needing to move as quickly as possible to win the atomic race with the Germans, project leaders decided to manufacture both materials simultaneously.

This decision to produce both U 235 and Pu 239 at the same time resulted in the building of two distinctly different atomic bombs and three large top-secret production facilities at: Los Alamos, New Mexico; Oak Ridge, Tennessee; and Hanford, Washington State.

To separate U 235 from U 238, a remote location in Anderson and Roane Counties, Tennessee, twenty miles west of Knoxville, was selected. Named the Clinton Engineer Works after a nearby town (but commonly called Oak Ridge after the summer of 1943), the site consisted of 59,000 acres of Appalachian semi-wilderness and farmland.

Oak Ridge was originally planned to house about 13,000 people, but by the time General Groves moved the Project's headquarters there from Manhattan in the summer of 1943, population estimates had all ready soared past 45,000. By the end of the war, Oak Ridge had become the fifth largest city in Tennessee with over 75,000 residents.

The different U 235 separation facilities were located away from the booming city of Oak Ridge for both security and safety. The Y-12 electromagnetic plant was located over one ridge to the south of the city. While the X-10 area, home of an experimental plutonium reactor and chemical separation facilities, was farther south and west, close to the Happy Valley Housing Area. Nearby X-10 were the K-25 gaseous diffusion plant and the S-50 thermal diffusion plants. Gaseous diffusion, thermal diffusion, and the electromagnetic process were all potential methods for separating U 235 from U 238.

Gaseous diffusion was the first choice for producing the U 235 needed for a bomb. This method, championed by the British contingent to the Project, was authorized in 1942. By September 1942, construction had begun on K-25, the gigantic 2,000,000 square-foot Gaseous Diffusion Plant.

Despite an enormous amount of money and effort put into the K-25, it never produced the quantity or quality of U 235 needed. As a result, in late summer 1943 it was decided that K-25 would play a lesser role than originally planned. Instead of producing fully enriched U 235, K-25 would now only provide around 50% enriched uranium for use as feed material for Y-12, the electromagnetic separation plant.

E. O. Lawrence had pioneered the electromagnetic process at the University of California at Berkeley. The brilliant Nobel Prize-winning scientist had also been General Groves' first choice to head the weapons design lab at Los Alamos but was kept on the development of the electromagnetic process because of its importance. Like K-25, the Y-12 electromagnetic plant was plagued with problems and never supplied the desired amounts of enriched U 235 to Los Alamos.

Seeking an even more isolated site for the potentially dangerous production of plutonium, members of General Groves' staff visited sites along the Colorado and Columbia Rivers in the states of California, Oregon, and Washington. Besides the requirement of being isolated for safety and

security, and from the remote possibility of Japanese attack, plutonium production required large amounts of electricity and cooling water that could only be provided by a large river.

After viewing six different locations in the three states, the site selection team decided on 500,000 acres located in eastern Washington State along the Columbia River in the area of the small villages of Hanford and White Bluffs and the towns of Pasco and Richland. The land, mostly devoted to sheep grazing, orchards, vineyards and small farms, was flat and rocky, ideal for the construction of the huge plutonium production buildings. Most of the half million acres were purchased by the spring of 1943 for a total of $5.1 million. This new facility was given the name of The Hanford Engineer Works after the little riverside village.

Plans called for three water-cooled nuclear reactors, designated 100-B, 100-D, and 100-F to be built about six miles apart on the south bank of the Columbia. Four chemical separation plants, constructed in pairs (200-West and 200-East), would be built ten miles south of the reactors. A third facility would be located twenty miles southeast of the chemical separation plants near Richland. Workers would be housed temporarily in Hanford while they erected all the new plants and the permanent housing located near Richland. By the summer of 1944, Hanford had a population of over 50,000 and growing.

Richard Rhodes wrote in *The Making of the Atomic Bomb* that: "The mighty scale of the works at Clinton and Hanford was a measure of the desperation of the United States to protect itself from the most serious threat to its sovereignty it had yet confronted, that of a German atomic bomb."

With Hanford and Oak Ridge under construction, General Groves gave Major John J. Dudley the task of finding a suitable site in the west for a third facility, code-named Project Y, where the actual design and production of the bombs would take place. To head Project Y, Groves picked the brilliant theoretical physicist, J Robert Oppenheimer, a colleague of E. O. Lawerence at Berkeley. Groves chose the thirty-nine year old scientist over the protests of his own security organization and others who were uncomfortable with some of Oppenheimer's past political associations and his lack of a Nobel Prize. In his confirming letter to Project Security, dated July 20, 1943, the General wrote that a security clearance must be issued for the employment of Oppenheimer without delay for he was absolutely essential to the Project.

J. Robert Oppenheimer was born April 22, 1904 into an upper middle class family in New York City. His father, Julius, at first intended to name his son simply Robert, but feeling that the name lacked distinction, added his own initial at the front. Young J. Robert grew up in a spacious apartment on Riverside Drive overlooking the Hudson River and at the family's summerhouse on Long Island.

Frail and frequently ill, Oppenheimer remembered himself as a repulsively good little boy with a sheltered childhood that did not prepare him for the fact that the world is full of cruel and bitter things.

Encouraged by his doting mother, Oppenheimer turned into an outstanding young scientist. He did laboratory experiments in the third grade, began keeping scientific notebooks in the fourth, and began studying physics in the fifth. One of his childhood "toys" was a professional microscope.

As a young man, Oppenheimer was described by a friend as being "very frail, very pink-cheeked, very shy, and very brilliant." Others described him as "clumsy, undeveloped, and strangely childish."

Oppenheimer was the Valedictorian of the 1921 graduating class at his high school that was operated by New York City's Society of Ethical Culture. While spending that summer in Europe with his family before entering Harvard in the fall, he came down with a near-fatal case of trench dysentery that was followed by a case of colitis that kept him out of Harvard.

Recovered by the spring of 1922, Oppenheimer's father sent him west to New Mexico and Colorado to toughen him up before he entered Harvard that autumn. Thus began Oppenheimer's love affair with New Mexico and the Southwest.

Taking into account Groves' site requirements, Major Dudley searched across the west for a suitable location. His first choice was the small town of

Oak City, located in south-central Utah. After further consideration, Dudley rejected Oak City and recommended the little village of Jemez Springs, New Mexico, some 45 miles northwest of Albuquerque. While viewing the Jemez site in the middle of November of 1942, Groves and Oppenheimer both quickly rejected Dudley's choice. Groves felt that the narrow canyon of the Jemez River was too confining and lacked room for expansion and explosive testing while Oppenheimer wanted something more expansive, or as he put it, "a laboratory with a view."

As an alternative to Jemez Springs, Oppenheimer suggested the Los Alamos Ranch School, a private boys school located 40 miles to the northeast. Oppenheimer had remembered the school from the two summers he had spent in New Mexico recovering his health in the 1920's. Though Major Dudley had already visited Los Alamos twice, he had rejected it because of an inadequate water supply. After driving to the remote school, Groves and Oppenheimer both agreed that the school should be the location for Project Y.

Los Alamos is located at an altitude of 7,400 feet on the isolated Pajarito Plateau fifty miles northwest of Santa Fe. The very expensive college prep school had been founded in 1917 to include a rugged outdoor experience for the sons of the well to do. Because of the war, the owners of the school had little choice but to sell out to the military for $350,000. Unfortunately for the school, a closure that they hoped would only be "for the duration" turned out to be permanent.

As far as Groves was concerned, the main problems with Los Alamos were its primitive access roads and its lack of water. As an engineer, Groves realized that better roads were just a matter of time and money although the water situation, despite the building of a dam, would be a problem in Los Alamos for years. On the plus side, the school site was isolated for security and testing, had plenty of room for expansion, and its lofty mesa top position gave Oppenheimer his desired laboratory with a view. The lab's remote location also would allow for the free exchange of ideas among the scientists, an environment that Oppenheimer and others felt would speed the bomb's development.

In a letter from the Secretary of War dated December 1, 1942, school officials were given only until February 8, 1943 to graduate their last class though the construction of laboratory buildings began almost immediately.

At the same time that the new lab was being built on "the hill," Oppenheimer was criss-crossing the country putting together a first rate staff. Shortly after Oppenheimer arrived back at Los Alamos in mid-March, his new staff began arriving from famous universities across the country. Overnight, Los Alamos became an intellectual boomtown.

Because of the tight security surrounding the top secret project, newcomers were first ordered to the lab's "front office" at 109 East Palace Avenue in Santa Fe. There they met the lady in charge, Dorothy McKibbin. Manhattan Project historian Ferenc Szasz in his definitive book on the Trinity test, *The Day the Sun Rose Twice* (1984), describes Dorothy as one of the unsung heroines of the Manhattan Project. As the first official contact of Project newcomers in New Mexico, she soothed nerves, calmed fears, and softened their disappointments. Dorothy also supervised the shipment of belongings, issued temporary security passes, and arranged for transportation from Santa Fe up the hill to Los Alamos.

The primitive wooden lab buildings, the constant shortage of water, and all the dust or mud on the hill must have been quite a shock for the scientists who were more accustomed to the ivy-covered walls and the many comforts of campus life. Still, work began almost immediately on the bomb as hundreds of military personnel, scientists, technicians, and others arrived at Los Alamos to win the race with the Germans.

Less then two years later, in February 1945, the final design for a uranium bomb was frozen. Because of high confidence in the probable success of this bomb, (nicknamed Little Boy), and a severe shortage of U 235, it was decided not to test it prior to its possible use in combat.

Project scientists were confident that the uranium Little Boy bomb would work as planned because of its relatively simple design. Little Boy was a gun-type device in which sub-critical masses of U 235 were located at opposite ends of a large gun barrel. When the bomb was detonated, one piece of uranium was driven down the barrel toward the other by a conventional high-explosive charge. Colliding, the two pieces formed a super-critical mass and exploded. Work on a similar plutonium bomb, dubbed Thin Man after President Roosevelt, was halted when Project scientists realized that the gun method would not work with plutonium. One reason was because two separate masses of sub-critical plutonium could not

being used in combat. This test, the world's first atomic explosion, was planned for sometime in the summer of 1945.

The search for a suitable location for the test began in May 1944. Some of the site requirements included that it be relatively flat, with good weather, and isolated from any population centers. The area also had to be within a reasonable distance of Los Alamos. In addition, General Groves ordered that the test site should have no Native American population.

In charge of the search were Army Major W. A. (Lex) Stevens and Los Alamos physicist, Kenneth T. Bainbridge. Their initial list consisted of eight locations - four in New Mexico and four in other western states. The potential sites in New Mexico included: the Tularosa Basin near Alamogordo, the lava beds (now the El Malpais National Monument) south of Grants, part of the Alamogordo Bombing Range in the south-central part of the state, and an isolated area southwest of Cuba, north of Thoreau. The other four sites not in New Mexico included: an Army Desert Training Center near Indio in southern California; San Nicolas Island, off the coast of southern California; and on Padre Island south of Corpus Christi, Texas in the Gulf of Mexico. The last choice was in Colorado's beautiful San Luis Valley, near today's Great Sand Dunes National Monument. (The San Luis Valley is the world's largest alpine valley at 8,000 feet above sea level, and 100 miles long by 60 miles wide.)

The choices for the test site were narrowed down to two in the summer of 1944. First choice was General George Patton's Desert Training Center in southern California, and second choice was on part of New Mexico's Alamogordo Bombing Range, located in the Jornada del Muerto Valley. General Groves made the final site selection in late August 1944. When Groves discovered that in order to use the California location he would have to talk to General Patton, he quickly decided on the New Mexico site. This was because Groves did not want anything to do with the flamboyant George Patton whom he had once described as the most disagreeable man he had ever met. Despite being the second choice, the desolate Jornada del Muerto Valley was a good location for the test for it provided isolation for secrecy and safety, was only 230 miles south of Los Alamos and was already under military control with no Native American population.

Jornada del Muerto - The history of this area is in itself quite fascinating since it was given its name by the early Spanish colonists of New Mexico. The Jornada was a shortcut on the *Camino Real*, the King's Highway that linked Old Mexico to Santa Fe, the capital of New Mexico. It also is interesting to note that in the late 16th century, the Spanish considered New Mexico to include most of North America west of the Mississippi to the Pacific.

The Camino Real went north from Mexico City until it joined the Rio Grande near present day El Paso, Texas. Then the primitive road followed the river valley north to a point where the river curved to the west, and its valley narrowed and became impassable for wagons. To avoid this obstacle, the supply wagons left the river valley and took the dubious detour due north across the Jornada del Muerto. This detour was across ninety miles of desert with very little water and numerous hostile Native Americans. Hence its name, which roughly translates as the Journey of Death.

In January 1942, shortly after the Japanese attack on Pearl Harbor, a large portion of the Jornada was taken over by the War Department for use as a bombing practice area. This 3,200-square-mile area was named the Alamogordo Bombing Range. Now named the White Sands Missile Range, it is still used extensively for non-nuclear testing.

The test site was given the code name Trinity. While the name's exact origin is lost to history, one popular account attributes the name to Oppenheimer. According to this version, the well-read Oppenheimer based the name on the fourteenth Holy Sonnet by John Donne, a 16th century English poet and sermon writer. The sonnet began, "Batter my heart, three-personed God . . ."

Another version of the name's origin is told by Robert W. Henderson (head of the Engineering Group in the Explosives Division at Los Alamos). According to Henderson, he and a Major Lex Steven were at Trinity

The Trinity test was originally planned for July 4, 1945. However, final preparations for the test did not begin in earnest until Thursday, July 12. An abandoned ranch house, located about two miles south of the test site, served as the assembly point for the device's core. After assembly, the core was transported to Trinity site in the back seat of a 1942 Plymouth Special Deluxe for insertion into the *thing,* or *gadget* as the device was called. On the first attempt to insert the core, it stuck! After letting the temperatures of the core and the gadget equalize, the core fit perfectly to the great relief of all present.

The completed device was raised to the top of a 100-foot steel tower on July 14. During this process, workers placed mattresses (hastily gathered from the Trinity Base Camp) beneath the device to cushion a possible fall. When the gadget reached the top of the tower without mishap, installation of the explosive detonators began. The 100-foot tower was designated Point Zero. Ground Zero was at the base of the tower.

In Los Alamos, a betting pool began on the possible yield (explosive power) of the Trinity device. Yields from 45,000 tons of TNT to zero were selected by various bettors. Partly as a joke, Enrico Fermi was also willing to bet with anyone that the test would destroy the earth, and he gave special odds for the mere destruction of the State of New Mexico.

Anxiety surrounding the possibility of a test failure took the form of a short verse that was circulated around Los Alamos. It went:

"From this crude lab that spawned a dud.

Their necks to Truman's axe uncurled

Lo, the embattled savants stood,

and fired the flop heard round the world."

Back at Trinity, technicians worked long hours in the desert heat, dust and strong winds installing seismographic and photographic equipment at varying distances from the tower. Other instruments were set up to record radioactivity, temperature, air pressure, and similar data wanted by the Project scientists.

According to Lansing Lamont in his 1965 book, *Day of Trinity* , life at the test site could at times be very exciting. He wrote that one afternoon while workers were busily setting up test instruments in the desert, the tail gunner of a low flying B-29 bomber spotted some grazing pronghorn antelope and opened fire with his twin .50-caliber machine guns. A dozen scientists under the plane dropped their instruments and hugged the ground in terror as the bullets thudded around them.

Workers also built three observation points 10,000 yards (5.68 miles) north, south, and west of Ground Zero. These heavily built wooden bunkers were reinforced with concrete and covered with tons of earth. South-10,000 would serve as the control center for the test. This is where the blast would be triggered and where Oppenheimer would watch the test.

Trinity Base Camp, located about ten miles southwest of Ground Zero, was designated as an another observation point. The main observation point was located on Compãnia Hill, about twenty miles to the northwest of Trinity near today's Stallion Range Center Gate and about five miles south of Highway 380. Most of the scientists and observers present on the day of the test gathered on top of Compãnia Hill.

Scheduled for 4:00 a.m. Monday morning, July 16, 1945, the test was delayed due to severe thunderstorms that would have increased the amount of radioactive fallout locally and would have also interfered with test results. The rain finally stopped.

At 5:29:45 a.m., Mountain Wartime, the Trinity device was detonated, and the Atomic Age was born.

This first nuclear blast created a flash described as brighter than a dozen suns. It was seen over the entire state of New Mexico and in parts of Arizona, Texas, and Old Mexico. Its mushroom cloud rose to over 38,000 feet within minutes, and the heat of the explosion was 10,000 times hotter than the surface of the sun! Felt at ten miles away, this heat was like standing directly in front of a roaring fireplace. Every living thing within a mile of the tower was obliterated. The yield of the device was estimated to be equal to 20,000 tons of TNT (40,000 pounds) or equivalent to the conventional bomb load of 2,000 fully-loaded B-29 Superfortresses!

After witnessing the blast, Oppenheimer quoted a line from a sacred Hindu text, the *Bhagavad-Gita*: "I am become death, the shatterer of worlds." In Los Alamos over 230 miles to the north, a group of scientists'

wives who had stayed up all night atop a nearby mountain saw the light and heard the distant sound. One wife, Jane Wilson, described it this way: "Then it came. The blinding light no one had ever seen. The trees, illuminated, leaping out. The mountains flashing into life. Later, the long slow rumble. Something had happened all right, for good or ill."

General Groves' deputy commander, Brigadier General Thomas F. Farrell, described the explosion in great detail. He wrote that the effects were "unprecedented, magnificent, beautiful, stupendous, and terrifying. No man-made phenomenon of such tremendous power had ever occurred before. The lighting effects beggared description. The whole country was lighted by a searing light with the intensity many times that of the midday sun. It was golden, purple, violet, gray, and blue. It lighted every peak, crevasse and ridge of the nearby mountain range with a clarity and beauty that cannot be described but must be seen to be imagined."

Another eyewitness was *New York Times* reporter William L. Laurence, the only journalist permitted at Trinity. In his Pulitzer Prize-winning book, *Dawn Over Zero: The Story of the Atomic Bomb* (1946), Laurence described the test this way. "There rose from the bowels of the earth a light not of this world, the light of many suns in one. It was a sunrise such as the world had never seen."

In Albuquerque, 130 miles north, Captain Thomas O. Jones dozed in a south-facing, fourth-floor room of the downtown Hilton Hotel after a long night of preparations. As the local security chief for the Project, he was responsible for the evacuation of towns surrounding the test site if radiation became a problem. When the device detonated, Jones bolted upright in his bed as if "someone had shot off a flashbulb in his face. A red glow filled the southern sky outside his window and he wondered if anyone was [still] alive at Trinity."

After the test, a Sherman M-4 tank, equipped with its own air supply and lined with two inches of lead to protect the tank's occupants from the high radiation levels at Ground Zero, explored the site. The tank's three passengers found that the 100-foot steel tower had virtually disappeared with only the blasted stumps of its legs remaining. Surrounding Ground Zero was a crater almost 2,400 feet across that was in places up to ten feet deep. The desert sand in the crater had been fused by the extreme heat of the blast's

fireball into a green glass-like material. This unexpected result of the first atomic test was at first named *Atomsite* and later renamed *Trinitite*.

Due to the intense secrecy surrounding the test, no accurate information of what happened that morning was released to the public until after the atomic bomb was dropped on Japan the next month. However, many New Mexicans were well aware that something very extraordinary had happened in the early morning of July 16, 1945. The blinding flash of light, followed by a shock wave, made a vivid impression on people who lived within a radius of 160 miles from Ground Zero. Windows were shattered 125 miles away in Silver City, NM, and residents of Albuquerque saw the bright light of the explosion on the southern horizon and heard the deep rumble of the blast moments later.

Trinity Site - On September 11, 1945, Trinity was opened to the press for the first time to dispel rumors of lingering high radiation levels there as well as in Hiroshima and Nagasaki. Led by Groves and Oppenheimer, this widely publicized visit made Trinity front-page news across the country.

Trinity Site was later fenced off and posted with signs warning of radioactivity. In 1952 the remaining Trinitite in the crater was bulldozed into a nearby underground concrete bunker, and the crater was back filled with fresh soil.

In 1963 the buried Trinitite was removed from its bunker, packed into 55-gallon drums, and loaded onto trucks belonging to the Atomic Energy Commission (the successor of the Manhattan Project). The Trinitite was then hauled north to Los Alamos for permanent storage.

About 650 people attended the first Trinity Site open house sponsored by the Alamogordo Chamber of Commerce and the White Sands Missile Range in September 1953. Two years later, a small group from Tularosa, New Mexico visited the site on the 10th anniversary of the test to conduct a religious service and pray for world peace. Today Trinity Site, now a National Historic Landmark, is still closed to the public except for the first Saturday of April and October.

With the successful test of the plutonium device at Trinity, Project officials knew that they had enough nuclear material remaining for two bombs, one uranium Little Boy and one plutonium Fat Man. Enough plutonium for another Fat Man would not be available until sometime in late August 1945.

Chapter Three

Hiroshima and Nagasaki

After the suicide of Adolf Hitler on April 30, and Nazi Germany's surrender on May 8, the heads of the major Allied countries meet in Potsdam, Germany in mid-July 1945. Among the important issues under discussion, was what would be the quickest way of ending the continuing war with Japan. So at the same time that the Trinity device was being tested in New Mexico, the new President of the United States, Harry S. Truman (FDR had died suddenly on April 12, 1945), was in Germany meeting with Joseph Stalin, of the Soviet Union, and with England's, Winston Churchill.

This conference resulted in the Potsdam Declaration, issued on July 26, 1945. This Declaration warned the Japanese that unless they surrendered immediately they "would face prompt and utter destruction." In his July 28, response to the Allied ultimatum, Japanese Prime Minister, Baron Kantaro Suzuki stated: ". . . there is no other recourse but to ignore it entirely and resolutely fight for the successful conclusion of this war." The Japanese word translated by the Allies as "ignore it" was *mokusatsu.* This word has been variously translated as "to kill with silence," "treat it with silent contempt," "take no notice of it" or "ignore it." Suzuki's intent was for *mokusatsu* to mean simply "no comment."

In *Japan Subdued: The Atomic Bomb and the End of the War in the Pacific* (1961), the final volume of author Herbert Feis four volume diplomatic history of World War II, he wrote: "It may be assumed that all [Japanese officials] construed the threat of 'prompt and utter destruction' to mean merely a continuation of the assault from the air and the sea, . . . None conceived a new weapon [the atomic bomb] that would give an astounding new meaning to this threat."

President Truman made his still controversial decision to use the atomic bomb while in Potsdam. On Tuesday July 24, General Groves wrote the operational order for the combat use of the atomic bombs. In part it read

that the 509th Composite Group, 20th Air Force, will deliver its first special bomb as soon as weather permitted visual bombing after August 3, 1945, on one of the following Japanese cities: Hiroshima, Kokura, Niigata or Nagasaki. The order continued that additional bombs would be delivered on the above targets as made ready by the project staff. After being approved by Truman, U. S. Army Chief of Staff, General George C. Marshall, and the Secretary of War Henery L. Stimson, the order was sent to General Carl Spaatz, the Commander of the Strategic Air Force in the Pacific. The first day after August 3 with acceptable bombing weather was Monday, August 6, 1945.

The Army Air Forces organization charged with dropping the atomic bombs was the 509th Composite Group. After training in modified B-29s (called Silverplates) at Wendover, Utah, the 509th was now based on the southwest Pacific island of Tinian, which along with Guam and Saipan, are part of the Mariana Islands. The commander of the 1,767 men of the 509th was Colonel Paul W. Tibbets, Jr. A veteran of dozens of B-17 missions over Europe, Tibbets had been selected to command the 509th because he was considered to be one of the best bomber pilots in the Army Air Forces.

On the afternoon of August 5, the 9,700-pound uranium Little Boy bomb was loaded into the 509th's B-29, No. 82. After the $10\frac{1}{2}$ foot-long atomic bomb was squeezed into the plane's forward bomb bay, Tibbets had his mother's first and middle names, Enola Gay, painted on the left nose of the big silver bomber in foot high black block letters.

Using almost ever inch of one of Tinian's 8,500 foot crushed coral runways, Tibbets eased the 150,000 pound *Enola Gay* into the air shortly after 2:45 a.m., August 6, on its long flight toward Japan and into history. Fifteen minutes later, weapon expert, Naval Captain William S. "Deke" Parsons, and his assistant, Second Lieutenant Morris R. Jeppson, crawled into the bomb bay of the B-29 to arm the bomb. Concerned over the possibility of the over-loaded *Enola Gay* crashing on take-off (B-29s suffered from many engine problems), Parson's had made the decision, only the night before, to arm the weapon after the plane was airborne. The delicate operation of loading the high-explosive charge into the breech of the bomb's "gun" took about fifteen minutes in the cramped confines of the bomb bay.

William S. "Deke" Parsons, along with Groves and Oppenheimer, was one of the leaders of the Manhattan Project. As Associate Director of Los Alamos and Ordnance Chief, Parsons knew more than virtually anyone about the atomic bomb's construction, science, engineering, assembly and delivery. It was Parsons who turned Oppenheimer's laboratory "gadget" into a practical, deliverable weapon. It was also Parsons who made the decision not to fully arm Little Boy until after the *Enola Gay* had safely taken off from Tinian, and then armed it in the B-29s forward bomb bay as it flew toward Japan.

Even if he had never worked on the bomb, Parsons should still be famous for his work on the development of radar and the proximity fuze. In the climactic battle for Okinawa alone, American naval losses from Japanese *kamikaze* attacks were over 5,000 sailors and marines killed, 26 warships sunk and 164 damaged! Without proximity fuzed anti-aircraft shells, the toll from the Japanese suicide attacks, in this prelude to the planned November 1 invasion of the Japanese home islands, would have been much higher.

The day after Hiroshima was destroyed, Parsons wrote his father back home in Fort Sumner, New Mexico that "there is a definite possibility that this kind of attack may crack them [the Japanese] and end the war without an invasion. If so it will save hundreds of thousands of American (and even Japanese) lives."

Years later, upon hearing of Oppenheimer's fall from grace as a result of the anticommunist crusade of Wisconsin Senator Joseph McCarthy, Deke Parsons became "extremely upset" according to his wife. He died of a heart attack the next day, December 5, 1953.

During the long flight to Japan, Tibbets gave his final briefing to his eleven-man crew over the plane's intercom. He revealed the secret that they were carrying an atomic bomb, a bomb unlike any other ever used in warfare.

At 5:22 a.m. the bomber began climbing to 9,300 feet as it approached Iwo Jima. The small Island, captured only six months previously at the cost of over 7,000 American marines and navy men killed and 19,000 wounded,

was the rendezvous point for the *Enola Gay* and two 509th observation and photography B-29s. After meeting her two escorts, the three planes continued on toward Japan with the *Enola Gay* in the lead.

At 7:30 a.m., Parsons returned to the bomb bay, replaced Little Boy's three green "safe" firing plugs with red arming ones, and activated the Little Boy's internal batteries. About the same time, Tibbets began the 45-minute climb to the planned bombing altitude of 31,000 feet.

At 8:50 a.m., the three B-29s crossed the coastline of Japan on course toward their primary target of Hiroshima. The large city was a major port and the headquarters of the Second Japanese Army under the command of Field Marshal Shunroku Hata. The defense of southern Japan against Operation Olympic, the planned November 1, American invasion of Japan, was to be directed by Hata from his headquarters in Hiroshima Castle. Twelve miles from the target, the *Enola Gay's* bombardier, Major Thomas Ferebee, advised Tibbets that he could see Hiroshima through the cross hairs of his Norden bombsight. Taking over control of the B-29 with the bombsight, Ferebee flew the plane to his aiming point (AP), the T-shaped Aioi Bridge that spanned a fork in the Ota River. Hiroshima Castle, built between 1589 and 1591, was less then two miles from the bridge.

It was a beautiful, clear morning over Hiroshima. Local time was about 8:10 a.m. The temperature was already 80 degrees with no wind.

Two minutes before bomb release, the *Enola Gay's* radio operator, Rhichard H. Nelson, broadcasted a loud "blip" to warn the other two B-29s that the bomb would be dropped shortly. Then, fifteen seconds before release, a continuous warning tone was transmitted. Little Boy exploded at 8:16:02 a.m. Hiroshima time, 43 seconds after it left the Enola Gay. Detonation was 1,890 feet above the courtyard of Shima Hospital and 550 feet southeast of Thomas Ferebee's aiming point with a power (yield) equal to 13 thousand tons of TNT.

In less then a minute the bomb's shock wave, traveling at almost 1,100 feet a second, caught up with the *Enola Gay*. Navigator, Captain Ted "Dutch" Van Kirk, remembered that the plane bounced and jumped, and there was a noise like a piece of sheet metal snapping. Tibetts wrote that the whole plane cracked and crinkled from the blast. The *Enola Gay* circled around as a deadly mushroom cloud rose above the destroyed city. Van Kirk compared the cloud to a pot of boiling black oil, and then he thought, "Thank

God the war is over, and I don't have to get shot at any more. I can go home."

On the ground, 70,000 of Hiroshima's 76,000 buildings were damaged or destroyed. Of Hiroshima's 280,000 to 290,000 remaining civilian residents (a large number of the cities pre-war population of almost 400,000 had been evacuated) and 43,000 military personnel, more then 70,000 and perhaps as many as 130,000 were killed instantly by the blast effects of the bomb. Another 130,000 were wounded. By the end of 1945 the total death toll was estimated to be 140,000, and by 1950 it had risen to 200,000, mostly as a result of the radiation released by the nuclear weapon. Despite the almost total destruction of Hiroshima, Japan's leaders did not surrender.

At 3:47 a.m., on August 9, a B-29 carrying the Fat Man plutonium bomb took off from Tinian for its primary target, the Japanese arsenal-city of Kokura. The 509th's B-29 Number 77 (shortly after the Nagasaki mission, #77 was named *Bockscar* after its regular airplane commander, Captain Frederick C. Bock), was piloted by Major Charles W. Sweeney, Commander of the 509th's 393rd Bombardment Squadron (Very Heavy).

Unlike the uranium Little Boy bomb, the larger and much more complicated Fat Man could not be armed while in a B-29s bomb bay. Except for the safing plugs, Fat Man was fully operational at takeoff. Ten minutes into the flight, weaponeer Navy Commander Frederick L. Ashworth entered the un-pressurized forward bomb bay to replace the green safing plugs with the red arming ones. Sweeney ordered this done ahead of the planned time so he could gain altitude to fly above the heavy rainsqualls that were buffeting the aircraft.

Delayed fifty minutes waiting for the two B-29 escort planes over the island of Yaku-Shima, #77 did not arrive over the target-city of Kokura until 10:44 a.m. Despite earlier weather reports of mostly clear skies over Kokura, Sweeney found it covered by heavy haze and smoke and their aiming point nowhere in sight. After three runs across the Japanese city trying to spot his AP, and with enemy flak and fighters closing in, he decided to head for his secondary target - Nagasaki.

By this point the plane's fuel supply had become critical, with only enough remaining to fly over Nagasaki while heading towards the closest American-controlled airfield on Okinawa. Nearing Nagasaki, and finding it

also cloud-covered, Sweeney had to make a quick decision. Since he did not have enough fuel left to haul the 10,800 pound Fat Man all the way to Okinawa, he decided to go against General Groves' explicit orders to drop the atomic bombs visually with the Norden bombsight. He decided instead to use the B-29s radar-bombing device. (Another option he never seriously considered was to dump the multi-million dollar bomb into the East China Sea on the way to safety in Okinawa).

Nearing the target, a hole opened in the clouds, and bombardier Captain Beahan shouted "I got it', I see the city; I'll take it now" (Because of Beahan's skill with the Norden bombsight, another 509th B-29 was named *The Great Artiste* after him). Beahan quickly took over from the radar bombsight and selected a new AP that gave him a twenty-second visual bombing run with the Norden. At 11:01 a.m. the twenty-kiloton Fat Man exploded between and above two large Mitsubishi armament plants, destroying both of them and a large part of Nagasaki. One of the demolished Mitsubishi factories had produced the specially modified torpedoes that did so much damage to America's Battle Fleet at Pearl Harbor on December 7, 1941.

The ridges and valleys of Nagasaki limited the area of greatest destruction to a 2.3 by 1.9-mile section of the city. Still an estimated 35,000 Japanese were killed, and another 60,000 were injured. By the end of 1945 the death toll had reached 70,000, and five years later it had doubled again to over 140,000.

The B-29 was knocked about by five distinct shock waves that bounced off the steep hills surrounding Nagasaki. Though critically low on fuel, Sweeney circled the burning city before heading for safety in Okinawa.

Within sight of Okinawa's Yontan Airfield, the plane's right outboard engine sputtered and stopped from lack of fuel. Quickly firing off all the B-29's flares to clear the busy runway for an emergency landing, Sweeney brought the large bomber in for a hard landing on only three engines. As the plane touched down, the left outboard engine also quit. After #77 was towed off the runway, only seven gallons of fuel were found remaining in her tanks.

The next day, August 10, 1945, the Japanese Cabinet, prodded by Emperor Hirohito, accepted the terms of the Potsdam Declaration on the condition that the supreme power of the Emperor not be compromised. At noon on August 14, after attempts by fanatical Japanese militarists to

continue the war, an unprecedented pre-recorded radio broadcast was made by the Emperor of Japan. In what was the first time, the majority of Japanese heard their Emperor speak. Hirohito ordered, without any formal assurances for his personal safety, the acceptance of the provisions of the Potsdam Declaration. President Truman formally accepted the Japanese surrender at 7:00 p.m., August 15, in the Oval Office of the White House.

World War II was finally over after six years and some 55 million deaths worldwide. For the United States, the war had lasted three years, eight months and seven days and had cost the lives of 292,131 Americans.

Epilogue

The Manhattan Project was successful in its $2.2 billion effort to build an atomic bomb ahead of Germany. The use of atomic weapons against Japan helped bring World War II to a quicker end, though the necessity of dropping them has been extensively debated since 1945.

It has been argued that the use of the bombs was unnecessary since the Japanese would have probably surrendered as a result of the intensive air and naval attacks that were destroying their cities. It is further argued that the severe shortage of numerous raw materials and food caused by the mining of Japanese waters would have forced their capitulation. Then there's the possibility that the Japanese would have ended their futile resistance and the war sooner had the Allies removed their onerous demand for "unconditional surrender" contained in clause thirteen of the Potsdam Declaration and assured the safety of the Japanese Emperor. Those who point out that Japan was trying to start peace negotiations with the U.S. before the bomb was dropped are countered by those who point out that the Japanese were negotiating a peace treaty with the U.S. when they attacked Pearl Harbor. Still others contend that the use of the bomb against Japan was racially motivated or that we dropped the bomb to intimidate the Soviet Union, our soon-to be-Cold War opponent. Some also debate the necessity of using two atomic bombs, believing that if the U.S. had waited longer after dropping the first bomb on Hiroshima, the Japanese would have surrendered. Finally, others believe that the dropping the atomic bombs was an act of revenge by the United States for the Japanese surprise attack on Pearl Harbor and their inhuman treatment of American and Allied POWs.

We will, of course, never know if a negotiated peace might have ended the war or if the Japanese would have capitulated for these or any other reasons. What we do know is that the United States dropped an atomic bomb on Hiroshima on August 6 and another on Nagasaki on August 9, 1945.

The Instrument of Surrender officially ending the war with Japan was sighed aboard the American battleship, *Missouri,* by Allied and Japanese representatives on the morning of September 2, 1945. The *Missouri* was only one of ten Allied battleships anchored in Tokyo Bay, part of an armada of 254 American, Australian, British and New Zealand warships. Noticeably absent from the Bay were any of the large aircraft carriers that had played such a pivotal role in winning the war in the Pacific. American naval commanders, still wary of possible Japanese treachery, had kept them out to sea.

Allied Supreme Commander Southwest Pacific, General of the Army, Douglas MacArthur opened the surrender ceremony with this brief speech. "It is my earnest hope and indeed the hope of all mankind that from this solemn occasion a better world shall emerge out of the blood and carnage of the past. A world founded upon faith and understanding. A world dedicated to the dignity of man and the fulfillment of his most cherished wish, for freedom, tolerance, and justice."

As the Japanese delegation departed the *Missouri* after the thirty-minute surrender ceremony, a mass formation of over 1,900 allied aircraft, including 500 of the giant B-29s, roared low across Tokyo Bay in celebration of the war's end.

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