BILLY HOLCOMB CHAPTER 1069

OF THE

ANCIENT AND HONORABLE ORDER OF E CLAMPUS VITUS

ANNOUNCES ITS ANNUAL SPRING CLAMPOUT

And he shall judge among the nations, and shall rebuke many people: and they shall beat their swords into plowshares, and their spears into pruning hooks: nation shall not lift up sword against nation, neither shall they learn war any more.
Isaiah 2:4, King James Version

Billy Holcomb Chapter 1069

A History of the Peaceful Use of Nuclear Weapons

The Plowshare Program

Credo Quia Absurdum

History Prepared By:

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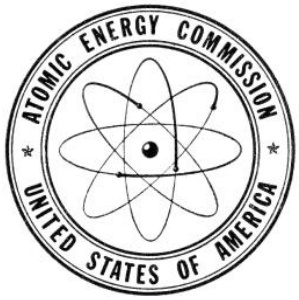

PROJECT CARRYALL

…and they shall beat their swords into plowshares, and their spears into pruning hooks: nation shall not lift up sword against nation, neither shall they learn war any more. Micah 4:3

WITH THE END OF WORLD WAR II AND THE ONSET OF THE COLD WAR, AMERICA EMBARKED ON AN AMBITIOUS PROGRAM TO ENSURE THE NATION'S PREEMINENCE IN THE NUCLEAR ARMS RACE. TO THIS END EDWARD TELLER AND THE ATOMIC ENERGY COMMISSION DETONATED HUNDREDS OF NUCLEAR DEVICES UNDERWATER, UNDERGROUND, AND IN THE ATMOSPHERE. WEAPONS DEVELOPMENT REMAINED PARAMOUNT, BUT THE AEC ALSO HELD A MANDATE TO DEVELOP PEACEFUL USES FOR ATOMIC POWER. IN 1957 CALIFORNIA'S LAWRENCE LIVERMORE LABORATORY LAUNCHED AN EXPERIMENTAL PROGRAM CALLED OPERATION PLOWSHARE TO USE NUCLEAR ENERGY FOR SUCH APPLICATIONS AS POWER PLANTS, MEDICINE, MINING, THE EXTRACTION OF OIL AND NATURAL GAS, AND FOR THE EXCAVATION OF CANALS, HARBORS AND ROADWAYS. UNDER PLOWSHARE, A 1963 FEASIBILITY STUDY WAS CONDUCTED FOR PROJECT CARRYALL, A PLAN TO REALIGN THE ATCHISON, TOPEKA AND SANTA FE RAILROAD AND PROVIDE A ROUTE FOR INTERSTATE 40. 23 NUCLEAR EXPLOSIONS TOTALING 1.8 MEGATONS WERE TO BE USED TO EXCAVATE A 2-MILE CUT UP TO 350 FEET DEEP THROUGH THE BRISTOL MOUNTAINS EAST OF LUDLOW AND REMOVE 60 MILLION CUBIC YARDS OF ROCK. DESPITE MANY ASSURANCES OF SAFETY FROM THE AEC, OBVIOUS ENVIRONMENTAL AND HEALTH CONCERNS OVER THIS AND OTHER PLOWSHARE PROJECTS CAUSED SEVERAL POSTPONEMENTS, AND IN 1968 THE PROJECT WAS DROPPED COMPLETELY. 28 NUCLEAR TESTS WERE CONDUCTED UNDER OPERATION PLOWSHARE BEFORE ITS TERMINATION IN 1975.

PLAQUE DEDICATED BY THE BILLY HOLCOMB CHAPTER
OF THE ANCIENT AND HONORABLE ORDER OF E CLAMPUS VITUS
IN COOPERATION WITH THE BUREAU OF LAND MANAGEMENT AND
THE KNOLL FAMILY
MAY 2, 2010

THE DAWN OF THE ATOMIC AGE

After the end of World War II, the U. S. government was faced with the problem of how to regulate the new field of atomic energy. During the war years, the Manhattan Project, enormous as it was, was conducted in the utmost secrecy. After the dropping of the atomic bombs on Hiroshima and Nagasaki, however, in an open and democratic society like the United States, this method was no longer acceptable. As the American public became aware of the existence of atomic bombs, they became obsessed with the subject. They speculated, along with the media, about the design, construction, and capabilities of atomic weapons, and there were calls from the world community for a system to control this awesome new power, possessed only by the United States.

President Truman set the tone for American atomic policy in the immediate postwar years. He stated that although there was a need for international control, the United States should go forward in its development of both military and civilian uses of atomic power. He assured the public that the technical secrets of producing such bombs would be closely guarded until it was possible to "protect us and the rest of the world from the danger of sudden destruction." He declared that atomic energy had a tremendous potential for the advancement of human welfare and could be a "forceful influence for world peace," and told Americans that he would ask Congress to establish a committee to regulate the production and use of nuclear energy in all its forms.[1]

BIRTH OF THE AEC

Toward that end, on October 3, 1945 Truman submitted a proposal to Congress that addressed these points. After several revisions, a bill was ready to be sent to Congress. Quick passage was expected, but this was not to be the case. There was much opposition from the scientific community, which felt that the security measures included in the bill were so strict that they would inhibit basic physics research, and that the military was being given too much power and control. Even during the Manhattan Project, atomic scientists had chafed against the restrictions and secrecy rules imposed by the military.[2]

After several revisions and much political wrangling, a compromise bill was passed by both the House and the Senate. Truman finally signed it into law on August 2, 1946, seven years to the day since Albert Einstein had written his famous letter to Franklin D. Roosevelt urging the United States to develop an atomic bomb.

The Atomic Energy Act, which created the Atomic Energy Commission, took effect on January 1, 1947. The bill nominally placed the control of atomic energy in the hands of civilians, but in reality it followed policies instituted by the American military for the Manhattan Project. The new legislation allowed disproportionate control by the military and ensured that weapons development would remain the highest priority of the AEC for the next three decades. Reflecting this bias, many of the key personnel were generals and admirals. In fact, during the first fifteen years of the AEC's existence, 70% of its expenditures were for development and construction of nuclear weapons.[3]

EARLY NUCLEAR TESTING

Although the United States was the first nation to deploy an atomic bomb, the scientists of the day really had very little practical knowledge about the power of such devices. Toward the end of World War II the Joint Chiefs of Staff began to make plans for a full-scale test program. Truman approved the program and designated a permanent test area in the Marshall Islands, southwest of Hawaii, amongst coral atolls only recently captured from the Japanese. During the period of atmospheric testing until the Partial Test Ban Treaty of 1963, the U. S. detonated 106 nuclear devices, including hydrogen bombs, in the South Pacific. These early tests, before the formation of the AEC, were conducted under the authority of the Manhattan Project.

The original requests came from the Navy, who wanted to know what a bomb like those dropped on Japan would do to a fleet of warships. In January of 1946 plans were approved for Operation Crossroads, to take place in the lagoon of Bikini Atoll. The first test was planned for May 15. This date was postponed, as Truman felt it was important for key senators and congressmen, heavily involved in legislation that would eventually result in the creation of the AEC, to be in

Washington at that time. Truman couldn't spare them from Capitol Hill, but he wanted them to be in attendance at the test.

Finally, at 9 a.m. (Bikini time) on July 1, 1946, the fourth atom bomb, called "Gilda" from a Rita Hayworth movie, was detonated 1,000 feet above a fleet of surplus warships in the Bikini lagoon. "Able Shot" sunk five ships outright, and heavily damaged nine others. Impressive as this was, it seemed like an anticlimax to some observers who had heard greatly exaggerated stories of the bomb's power. It was perhaps at this point that the public began to think that atomic power, as terrible as it was, could perhaps be controlled and even turned to peaceful uses.[4]

The second detonation of Operation Crossroads, "Baker Shot," took place three weeks later, on July 25. Unlike Able, dropped from a plane, Baker was exploded beneath the surface of the lagoon to test its effects on the steel hulls of warships. The fallout from the Able blast dissipated relatively quickly and was considered acceptable under the standards of the day, giving hope that atmospheric testing would not cause severe, lingering effects on the public. However, there was great concern that the Baker shot would vaporize huge amounts of water, which would then trap the fallout and fall back to earth as concentrated radioactive debris. Although little was known at this time about the effects of radioactive fallout on the world at large, the Baker test caused scientists to think long and hard on the subject.

A third test in the Crossroads series, Charlie, was scheduled for March of 1947. This test, to be detonated in deep water, was cancelled by Truman in September 1946, perhaps because of the radiation concerns brought to light by Able and Baker. However, it also appears likely that since the Atomic Energy Act had been passed in August and the AEC was scheduled to take over operations on January 1, 1947, Truman felt that the new agency should set its own rules and standards for the blast and not simply inherit the responsibility for a test already in progress.[5]

After Crossroads, nearly two years elapsed before further testing was undertaken in the South Pacific. The AEC determined that due to the onset of the Cold War, peaceful use of nuclear energy would have to be postponed while national defense concerns took center stage. AEC commissioners spent more and more time consulting with the military

establishment, and debate intensified over whether a stockpile of nuclear weapons was needed, and if so, who should control it.

DEVELOPMENT OF THE HYDROGEN BOMB

At this time, in keeping with President Truman's hard-line policy against the Soviet Union, development of thermonuclear weapons (hydrogen bombs) assumed the highest priority. The AEC proposed more test shots in 1948, and Truman quickly voiced his approval. After reviewing the logistical requirements, Eniwetok Atoll, three hundred miles from the U. S. Navy base at Kwajalein, was chosen as the site for three shots which would constitute Operation Sandstone.

Unlike the Bikini tests, which had taken place with great public fanfare, the Sandstone tests were conducted secretly in recognition of the growing tensions of the Cold War. Dates were not announced in advance, and outside visitors were kept to an absolute minimum. The three test shots, X-Ray, Yoki, and Zebra, were conducted on April 15, May 1 and May 15, respectively, on three different islands within the atoll. The tests were considered a great technical success.

The AEC did not test in the South Pacific for three more years. In the meantime, the United States lost their monopoly in the nuclear field when the Soviet Union detonated their first atom bomb, Joe One, named after Josef Stalin, on August 2, 1949. In February 1950 atomic scientist Klaus Fuchs was arrested for passing information to the Russians during the days of the Manhattan Project, causing grave concerns in the U. S. about the capabilities of the Soviet military machine. Only a few months later, in June of 1950, America found itself involved in a war against Communist forces in Korea.

Pressured by these dire events, Truman ordered accelerated development of the hydrogen bomb. To this end, he called for the establishment of testing grounds in the U. S., thus easing the huge logistical burdens of conducting tests thousands of miles from the centers of research and production in the United States. For example, 42,000 people with their supplies, equipment, food, living facilities, etc. had to be transported thousands of miles across the Pacific for the Bikini

tests, and samples of short-lived nuclear isotopes from the detonations had to be flown immediately back to the U. S. for testing.

Despite having a continental test site (of which we will hear more later) the AEC returned to Eniwetok in the spring of 1951 for Operation Greenhouse, a four-shot series designed to test some of the mechanisms being designed for the H-bomb. From that point until October of 1958, when President Eisenhower voluntarily ended South Pacific atmospheric testing, fifty-seven additional tests had been conducted in the Marshall Islands, thirty-six on Eniwetok, and twenty-one on Bikini. President Kennedy renewed testing in 1961 after the Soviet Union violated the voluntary moratorium. The AEC thereupon returned to the South Pacific, and conducted thirty-five atmospheric tests on Christmas and Johnston Islands between April and November of 1962.[6]

FALLOUT COMES TO THE FORE

With one exception, these Pacific tests went off without any untoward incidents, but that one caused serious difficulties for the AEC. It occurred on March 1, 1954 when the AEC detonated “Bravo” on Bikini Atoll. It was the first of six hydrogen bombs tested as part of Operation Castle. Other thermonuclear devices had already been detonated, but Bravo was considered the first “deliverable” H-bomb.

Immediately following the blast, which at fifteen megatons was more than twice as powerful as predicted and 750 times more powerful than the Hiroshima device, the wind changed direction and carried a twenty-mile-high mushroom cloud as far as 240 miles eastward. The cloud contaminated a vast area of the Pacific and passed over several small inhabited islands. Twenty-eight Americans (AEC radiation monitors) and about 250 native inhabitants were showered with radioactive fallout.

The Americans donned special suits and stayed inside tightly-sealed buildings until evacuated a day and a half later. On the other hand, the native populations, who were much more exposed, were not evacuated promptly. The last of them were not removed from their islands until three days after the blast. In addition, Japanese fishing boat and its twenty-three-man crew was working about ninety miles downwind

from the blast. They all suffered exposure to heavy radioactive fallout, and one died from radiation sickness.[7]

In what came to be a pattern, the AEC downplayed the exposure. It issued statements to the effect that a certain amount of risk was acceptable when compared to the tremendous gains in national security that would result from the testing. The U. S. paid two million dollars in compensation to the Japanese government but admitted no liability for their actions. They also expanded the test area to eight times its original size. It was perhaps at this point that the international community began to have very serious doubts about the safety of atmospheric testing.

THE NEVADA TEST SITE

As early as 1948 the Armed Forces Special Weapons Project undertook a study of possible test sites within the United States. The study was shelved in 1949 with the proviso that it would be taken up again in case of national emergency. As the U. S. became involved in the Korean War the study was revived, with the plan that low-yield testing would be done in the U. S. while bigger detonations would still take place in the South Pacific. A continental test site would allow much greater economy and simpler logistics and expedite the weapons development program.

Five potential sites were chosen: the Alamogordo-White Sands Missile Range in New Mexico (where the Manhattan Project's Trinity test took place); Dugway Proving Ground in Utah; an area near Fallon, Nevada; the Camp Lejune area in North Carolina; and the Las Vegas Bombing and Gunnery Range.

On December 13, 1950 the AEC decided the Las Vegas Bombing and Gunnery Range best fit the requirements and should be developed as a test site. 5,000 square miles within the range would become the Nevada Proving Grounds, later the Nevada Test Site. It would later be expanded to 13,500 square miles. Figured into the equation was the existence of an adequate downwind "fallout sector," defined at the time as 125 miles. The AEC's computations, which also included confident claims about predictable wind patterns, would prove in later years to be seriously flawed. It was becoming increasingly evident that the

understanding of radioactive fallout and its resultant effects on humans was very much in its infancy.[8]

FATHER OF THE H-BOMB

The Nevada Test site, like the Pacific Ocean testing grounds before it, was created as a resource for the Los Alamos weapons lab in New Mexico. With the establishment of NTS, some atomic scientists felt that an additional laboratory was needed. Prominent among them was Hungarian-born Dr. Edward Teller, who came to the United States in 1935. While working on the Manhattan Project at Los Alamos, he began calculations on the feasibility of producing a thermonuclear weapon known as the "super." For more than four decades, Teller would be the most vocal of all the nuclear scientists on the importance of America's nuclear weapons program as a deterrent to the growing Communist threat, as well as a staunch supporter of peaceful uses for nuclear energy. He was so confident of the scientific community's ability to control atomic power to shape the environment that he was once quoted as saying "if your mountain is not in the right place, just drop us a card."

When the AEC in 1949 deferred the establishment of a high-priority program to develop the super (the hydrogen bomb), he left the AEC for a position at the University of Chicago. Here he became actively involved in the campaign for another national laboratory to further the development of the H-bomb. A site was chosen at Livermore, California, forty miles from the University of California's Berkeley campus. There was already a UC Radiation Laboratory here, and in late 1952 the Livermore site became active as America's second nuclear weapons laboratory. The Los Alamos site grew, but Livermore grew even faster, and by 1963 had outgrown Los Alamos by a considerable margin. With this growth came new prestige for the lab, and for Teller as well.

A NEW ERA OF TESTING

As the Nevada Proving Ground (after 1955 the Nevada Test Site) became operational, the presence of nuclear testing in the continental United States, as opposed to faraway locations in the South Pacific, public relations assumed a greater importance. It was feared that public concerns about radioactive fallout might jeopardize the testing program, and a new policy was adopted. News reporters were invited to view tests, and the testing schedule, secret up to this point, was made public.

Over the next few years, tests of all sorts were conducted at the NTS. Various pieces of military equipment were exposed to nuclear blasts, and small cities, complete with buildings, cars, roads, household goods, appliances, foodstuffs, etc., were constructed in the blast zone. Soldiers were stationed close to ground zero, and conducted exercises simulating an attack into the radioactive area. Civil defense drills were held, as well as exercises simulating mass casualty care, evacuation, and providing food and water, sanitation, decontamination, and communications in a radioactive environment. In one such exercise, over a hundred pigs were fitted with specially sewn GI uniforms, including buttons and zippers, to evaluate the uniforms' ability to protect against burns. 72 of 111 pigs were killed outright, but the military stated that it was still able to derive useful information from the test.[9]

Despite all precautions, some accidents did occur. Sixteen civilian workers were exposed to high levels of radiation. Again, given the scientific climate of the day, these exposures were deemed not to be serious and unlikely to cause any health problems.

Only one serious incident to people and animals outside of the NTS occurred. This took place during a series of test shots from March to June, 1953. Inhabitants of St. George and Cedar City, Utah, as well as large flocks of sheep, were exposed to high levels of fallout. There were no human deaths, but of approximately 12,000 contaminated sheep, 4,500 died within a few weeks of the shots. In 1956 the sheepherders sued the government for the loss of the sheep, but, given the state of science at the time, they were unable to definitively prove that they died of radiation and their claim was denied.

ATOMS FOR PEACE

As weapons testing continued and the public became more accustomed to the idea of atomic energy, there was a growing philosophy that nuclear energy could be used for more peaceful purposes. In December of 1953 President Eisenhower delivered what has been called his “Atoms for Peace” speech. In it, he first described the tremendous power of the American nuclear weapons stockpile, then addressed the hope that the world would turn to more positive uses for nuclear energy.

In this early part of the atomic age, it was imagined that nuclear energy could be used generate electrical power for huge cities, propel ships, locomotives, automobiles, and even airplanes, for mining, extracting oil and natural gas from underground formations, growing and preserving food, and other purposes too numerous to mention. Among these was the idea of “geographical engineering,” in which nuclear devices would be used for digging harbors and canals (including a second Panama Canal), and creating underground storage for oil, natural gas, and nuclear waste, and excavating huge amounts of earth quickly, easily, and cheaply. From this idea would be born Operation Plowshare, of which we will hear more later.

MORATORIUM AND TREATY

Meanwhile, atmospheric testing continued apace. From 1951 to 1958, when a testing moratorium went into effect, the Nevada Test Site hosted scores of nuclear tests. In addition, some seventy tests were conducted in the South Pacific from the end of World War II to the moratorium, which had been mutually agreed upon by the United States and the Soviet Union. Eisenhower decreed that “peaceful” nuclear testing was specifically excluded from the agreement. When the Soviets violated the agreement in August of 1961, testing resumed, with 135 American detonations over the next two years. In 1963 the United States, the Soviet Union, and the United Kingdom concluded the Limited Test Ban Treaty, and all testing went underground. In addition to the prohibition of atmospheric tests, the treaty banned nuclear explosions underwater or in outer space, and proscribed any detonations that allowed the spread of radiation outside the boundaries of the test

country. This eliminated testing in the South Pacific, and all nuclear testing was now to take place at the NTS. [10]

PLOWSHARE IS BORN

Operation Plowshare, an offspring of the Atoms for Peace movement, traces its roots to a symposium held at the Livermore Laboratory in February 1957. It took its name from the Biblical reference in Isaiah 2:4 to beating swords into plowshares. The nuclear sword was to be beaten in a plowshare which would dig canals and waterways, uncover mineral riches, and effortlessly cut canyons through great mountain ranges. Some say that the concept came in part from the Suez Crisis of 1956, in which Egypt seized control of the Suez Canal. It was felt that the power of the atom could be used to excavate a second canal through Israel and restore the status quo in the Middle East.

The peaceful application of nuclear energy could not flourish until thermonuclear devices (H-bombs) were fully developed. The first atomic bombs were fission devices, which were very expensive and released huge amounts of radiation. H-bombs worked on the principle of nuclear fusion, were much cheaper to manufacture, and although radiation would still be released, the bombs could be tailored to significantly decrease the amount of radiation and therefore its harmful effects.

The nation's first underground test, code name Rainier, took place in September of 1957. It was detonated in a cave drilled 2,000 feet into the side of a mountain. It was hugely important to Plowshare, as it showed that a nuclear explosion could be contained completely underground without producing any radioactive fallout.[11]

PROJECT CHARIOT

Now that Operation Plowshare was on the drawing board, the obvious question was where to begin. Since nuclear testing sites already existed in the South Pacific and at NTS, scientists began to look elsewhere for a place to publicly demonstrate the practical use of nuclear explosions for peaceful purposes. They discussed such sites as Alaska, northern Canada, Chile, and Christmas Island in the Pacific.

Experience with radioactive fallout obviously indicated that such a project would need to take place in a relatively uninhabited area. After considerable discussion, in early 1958 they decided on Cape Thompson in northwestern Alaska. It was thought that the area between Point Barrow and Nome had important deposits of coal and oil, and a deep-water harbor would be necessary to exploit these resources. Project Chariot was envisioned to provide this harbor.

The AEC decided to go forward with the project, and a team of scientists was dispatched to Alaska. There was a large public relations effort which stressed the economic advantages of the harbor. Although public boosters were largely in favor of the project, economic reasons, rather than environmental concerns, eventually caused abandonment of the project. The supposed mineral wealth in the region was actually located hundreds of miles away on the opposite side of the rugged Brooks Range, and a harbor in this location would be icebound for nine months out of the year. Edward Teller was active in promoting the project's scientific and economic benefits, and brushed aside concerns about fallout and radiation. He said of the project that the AEC could "dig a harbor in the shape of a polar bear, if required."

Since the project could not be justified economically, the plan was downgraded to blasting out a "demonstration" harbor to prove the concept, even if it was never to be a working port. Even though the moratorium was in effect at the time, the AEC indicated that the "experiment' should be undertaken and authorized planning and consultations to go forward. As a "peaceful" detonation, the blast would not be subject to the moratorium. A second Plowshare symposium was held in May of 1959, partly to discuss these plans and studies, and also to address environmental and ecological issues associated with the blast. In addition, it would show the world that the United States did indeed have a viable program for peaceful nuclear testing completely separate from the development of nuclear weapons.

As the planning progressed, it seemed that each new piece of data brought more questions than answers. When the Soviet Union resumed nuclear testing in September of 1961, thus breaking the terms of the moratorium signed by the US, USSR, and UK in 1958, the United States followed two weeks later with a series of underground tests at NTS. They quickly readied another Plowshare test, this time with little controversy,

1,200 feet underground in a salt formation southeast of Carlsbad, New Mexico: Project Gnome.

PROJECT GNOME

Project Gnome took place on December 10, 1961, and resulted in the unexpected venting of large amounts of highly radioactive fallout into the atmosphere. The AEC had to admit that they didn't have complete control over the testing process, and suffered considerable public embarrassment, even though it continued to state that there was no appreciable danger from the fallout. Gnome, which had been designed to produce public confidence in Plowshare, had just the opposite effect. This added to the controversy over Project Chariot, as did new concerns over the land rights of the Eskimos living in the vicinity of the proposed harbor, and Chariot was cancelled on April 30, 1962, to be replaced on May 8 by Project Sedan.[12]

PROJECT SEDAN

Sedan was designed as a "cratering" experiment, to test the feasibility of nuclear earthmoving for peaceful purposes. The largest nuclear bomb exploded in North America up to that time, 104 kilotons, was detonated 635 feet below the surface of the NTS on June 6, 1962. The test was well-documented, with multiple camera angles, seismic instruments, stations for measuring the amount of debris and fallout and the distances to which they extended, and biological studies that included the use of live beagles at distances of thirty-one and forty-two miles from ground zero. It produced a crater 1,200 feet wide and 320 feet deep.

Although it was clearly a success in earthmoving, with over twelve million cubic yards of earth and rock displaced, there was much more radioactivity released than had been predicted. Once again, it was evident that the scientists could not fully control the testing process. Despite the AEC's glowing public relations statements, nuclear testing was producing radioactive fallout that was increasingly being recognized as a dangerous health hazard.[13]

PROJECT CARRYALL

Another highly controversial Plowshare proposal was Project Carryall, planned to take place in the heart of Holcomb Country. In 1963, officials of the Atchison, Topeka, and Santa Fe Railroad approached the AEC about the possibility of nuclear explosions to detonate a pass for the railroad through the Bristol Mountains, east of Ludlow and north of Amboy. They were making plans to realign their rails in the region, cutting about fifteen miles off the distance and providing a better, straighter grade for the rail line.

At about the same time, the California Division of Highways was studying a realignment of Route 66. It was trying to determine if nuclear explosives approved by the AEC might be able to cut the required gap through the rocky mountain range. Each became aware of the other's plans, and Project Carryall was conceived by the AEC to bring both proposals together. Without Carryall, the railroad would have had to bore an expensive two-mile tunnel through the Bristols, rendering the project economically unfeasible.

Under Carryall, the realignment of the railroad and the construction of Interstate 40 (already underway) could be combined. The cut could accommodate both the rails and the new superhighway. A study was completed in late 1963 by staff from the AEC, the Livermore Laboratory, the Santa Fe, and the Division of Highways. They proposed cutting a pass approximately 10,000 feet in length, in places as much as 350 feet deep, which would displace sixty million cubic yards of rock. The study reported that project was technically feasible.[14]

The rapid growth of the region in the postwar years had placed heavy demands on existing transportation facilities, and both the modern highway and the more efficient rail alignment would help mitigate the situation. The Bristol Mountain region was sparsely populated, and practically the whole area was owned by the U. S. government, the state of California, or the Santa Fe, thus limiting concerns of legal challenges over land ownership. It seemed like the perfect location for a dramatic public demonstration of the Plowshare program.

The AEC's plan called for the creation of a two-mile cut, using twenty-three nuclear devices totaling 1.8 megatons, detonated in two

phases. According to the official calculations, the Carryall explosions would be eighteen times larger than the Sedan test, but were predicted to produce only about two-thirds as much fallout. This projection was predicated on the development of much "cleaner" bombs, a theory that did not come to fruition.

Strict timetables for the construction of the new rail line and highway ensured that the Carryall blast site would have to become a work site as quickly as possible. Assessments of the radiation danger were factored into the equation, and a Livermore report stated that workers would likely encounter "some airborne radioactivity" for up to six months, thereby requiring respiratory protection for workers. Protective clothing would be needed for approximately one year, but if these precautions were taken, it was felt that forty-hour work weeks would be possible within about four days of the blasts![15] This seems astounding today, but such was the state of the art, and perhaps of the governmental "spin machine," of the era.

Once again, serious environmental concerns surfaced. An independent review of the feasibility study predicted the release of five times more radioactive fallout than originally projected. Some of this discrepancy was undoubtedly due to political pressure, but some was a result of what was euphemistically called "basic uncertainties in the field." Although the region was sparsely populated, it still had approximately 30,000 people downwind from the blast site. At the time, there was a considerable amount of dairy farming near Needles, California, sixty-eight miles from ground zero in the direct fallout path, and it was well known that nuclear isotopes were entering the food chain via contaminated milk. Nonetheless, plans went forward, and a tentative date sometime in 1967 was set for the implantation of Carryall.

As the result of a growing number of political, technical, and environmental questions, the project began to appear more and more marginal. The railroad and Division of Highways were anxious to get it underway, but Carryall was contingent on the completion of other nuclear tests that were to provide information on making cleaner bombs, and these tests could not be hurried. The schedule was delayed for eighteen months, into the fall of 1968.

Interstate 40 and the new rail line could not wait, and in the end the realignment was undertaken with the use of conventional explosives. The AEC never formally cancelled the project, but the delays had rendered it irrelevant. Carryall had been intended as a dramatic test of the peaceful uses of atomic energy and a vindication of the AEC's plans and policies, but Operation Plowshare would now have to go forward without Project Carryall.

THE END OF PLOWSHARE

After the demise of Carryall, the AEC continued with plans and test blasts for other projects, including the excavation of a second canal across the Isthmus of Panama. Biological testing became more common and more comprehensive. Bold claims of success competed with stories of the dangers of radiation exposure. The inescapable fact remained, however, that there had been no practical demonstration of the successful use of nuclear energy for geographical engineering. The "atoms for peace" concept lingered, but the AEC had failed to achieve any concrete results, a clear failure for the agency. Nuclear fallout was widespread in the atmosphere, and it was clear the use of atom bombs for excavation projects was reaching the point of diminishing returns.

The AEC found it harder and harder to obtain funding. In its 1970 budget request, it asked for $29 million for Plowshare, actually obtaining about half of that. It asked for $44 million in 1971, but only received $8 million, none of which was budgeted for excavation projects. By this time, only projects involving the extraction of natural gas and shale oil, undertaken in conjunction with private industry, were being funded.

Opposition to nuclear testing from environmental groups became more vocal and there was increasing concern over health effects, contaminated water and food supplies, etc. In 1974 Colorado, the site of the Rulison and Rio Blanco blasts in 1969 and 1973, passed legislation banning any further nuclear explosions in the state without the consent of the electorate. The writing was on the wall, and with the exception of a handful of follow-up studies, Operation Plowshare was completely defunded after 1974. The concept was a noble one, but the harsh realities nuclear physics precluded any practical application of the plan, and Operation Plowshare faded into oblivion, its potential unfulfilled.

POST-PLOWSHARE FACTS

The AEC was abolished in 1974. It was replaced by two new agencies: the energy Research and Development Administration, and the Nuclear Regulatory Commission.

On September 10, 1996 the U. N. General Assembly voted in favor of the Comprehensive Nuclear Test Ban Treaty, which prohibits all nuclear testing. On September 24, President Clinton signed the treaty on behalf of the United States. Sixty-six other nations also signed, including the other four countries which possessed nuclear devices at the time: China, France, Russia, and the United Kingdom. India, North Korea and Pakistan did not. These three countries have since violated the terms of the treaty by testing nuclear devices. (*Scientific American,* March 2009).

The United States has conducted a grand total of 1,030 nuclear tests. It participated in an additional twenty-four joint tests with the United Kingdom (Department of Energy).

PROJECT PLOWSHARE TESTS

Test Name	Date	Location	Yield (kilotons)
//////////	///////	//////////////////////	//////////
Gnome	12-1-61	Carlsbad, New Mexico	3
*Danny Boy	3-5-62	Nevada Test Site	0.43
Sedan	7-6-62	Nevada Test Site	104
Anacostia	11-27-62	Nevada Test Site	5.2
Kaweah	2-21-63	Nevada Test Site	3
Tornillo	10-11-63	Nevada Test Site	0.38
Klickitat	2-20-64	Nevada Test Site	70
Ace	6-11-64	Nevada Test Site	3
Dub	6-30-64	Nevada Test Site	11.7
Par	10-9-64	Nevada Test Site	38
Handcar	11-5-64	Nevada Test Site	12
Sulky	11-5-64	Nevada Test Site	0.9
Palanquin	4-14-65	Nevada Test Site	4.3
Templar	3-24-66	Nevada Test Site	0.37
Vulcan	6-25-66	Nevada Test Site	25
Saxon	7-11-66	Nevada Test Site	1.2
Simms	11-6-66	Nevada Test Site	2.3
Switch	6-22-67	Nevada Test Site	3.1
Marvel	9-21-67	Nevada Test Site	2.2
Gasbuggy	12-10-67	Farmington, New Mexico	29
Cabriolet	1-26-68	Nevada Test Site	2.3
Buggy	3-12-68	Nevada Test Site	5x1.1
Stoddard	9-17-68	Nevada Test Site	31
Schooner	12-8-68	Nevada Test Site	30
Rulison	9-10-69	Grand Valley, Colorado	43
Flask	5-26-70	Nevada Test Site	105
Miniata	7-8-71	Nevada Test Site	83
Rio Blanco	5-17-73	Rifle, Colorado	3x33

* Some sources list the Danny Boy detonation as a military test, while others place it under Plowshare.

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ENDNOTES

[1] Titus, pgs 22-23
[2] Kirsch, pg 17
[3] Titus, pg 27
[4] Ibid, pg 39
[5] Ibid, pg 43
[6] Ibid, pg 46
[7] Ibid, pg 47-48
[8] Kirsch, pg 21-23
[9] Titus, pg 63
[10] Ibid, pg 65
[11] Byrne and Rich, pg 37
[12] Kirsch, pgs 112-115
[13] Ibid, pgs 119-131
[14] Byrne and Rich, pg 55
[15] Kirsch, pg 175