

Port Chicago - 50 Years:

was it an atomic blast?

By [David Caul](#) and Susan Todd

(EDITOR'S NOTE: In January 1990, the Napa Sentinel commenced a series of articles concerning the explosion at Port Chicago in San Francisco Bay on July 17, 1944. Several other articles were produced to support the theory that the explosion was nuclear. Over the years, the Sentinel has been challenged on one point of the articles: If it was a nuclear explosion what about the radiation? For several years our research team has devoted itself to searching for records of other atomic explosions of the era to determine the levels of radiation association with those tests. This four part article addresses the question of radiation at Port Chicago.)

DESCRIPTION OF THE BLAST

On the night of July 17, 1944, a huge explosion occurred aboard one of the two merchant ships docked at the Port Chicago Magazine located on the Suisun Bay, 11 miles upstream from Vallejo. Clocks in the town of Port Chicago, over a mile away, were stopped by the shock waves at 10:19 p.m. The enormity of the blast was shown by the 3.5 magnitude earthquake registered as far away as Bonner's Ferry, Nevada. The explosion's fire ball, as observed by pilots flying over the area, towered in the night sky to an altitude of 8000 or 9,000 feet before being extinguished.

Observers reported a blinding flash "...that literally filled the sky with flame." It was followed "...by other flashes of less intensity, and then a dull, very odd orangish glow that seemed to hang in the sky for as long as ten or fifteen minutes, then it all went black". Two ships, thousands of feet from surface zero, navigating the narrow Roe Island Channel, were reported by their crews as being lifted up from the surface of the water by the underwater shockwaves bouncing off the river bottom. Their first impressions were that they had run aground. One of these ships, the 210-foot Redline tanker had the top of its superstructure completely ripped off by the air blast. Part of the deck was lifted. All doors were blown in. All tanks were ruptured. All of the ships bulkheads were blown in, one being forced completely out of the ship through the opposite side. All of this was the result of air shockwaves.

The ship turned around and sank in shallow water, riddled with shrapnel. Two 450 cargo ships were berthed facing opposite directions on the finger pier at Port Chicago: The *Quinault Victory*, newly arrived and as yet not loaded, and the *E. A. Bryan*, squatting low in the water with her cargo of munitions. The main explosion had occurred aboard the *E. A. Bryan*, which was completely vaporized. No identifiable part of it was ever found,.

Different eyewitness reports from the crews of the ships in the channel later litanized the 450 foot, 7,000 ton *Quinault Victory's* final ordeal:

- Her bow end, from the foremost mast forward, was lifted high up into the air.
- Pieces of docking were seen in the air with pilings attached.
- A funnel-shaped area was observed 200 feet in the air, on top of which was the bow of one of the ships with mast attached.

All that remained of the *Quinault* was sixty feet of keel with propeller attached, pushed 1,000 feet out into the channel.

Parts of the bodies of the Navy work battalion and their officers, as well as those of the ships' Merchant Marine crews and Navy Armed Guards were found on Roe Island, across the channel, almost a mile away, many blown there as human missiles by the force of the explosion. In addition there were many heavy pieces of railroad cars and thick ship plating found on the island.

The crater on the river bottom was, at its deepest, 27 feet. At least 10 feet of this was mud, which is more difficult to cavitate than soft rock. The crater was approximately 700 feet long and three hundred feet wide. The explosion, which took place below the water line of *the E.A. Bryan*, occurred at an average depth of 15 feet below the surface. With the flooding tide, the water was over 33 feet deep. Thus, the force of the blast had to remove an enormous amount of water before it could even get to the bottom, and once it did, it still removed 27 feet of soft rock and mud.

In culling over the various newspaper accounts and eyewitness reports of the Port Chicago explosion, no phenomena seems more ubiquitous than the white flash. The *Napa Journal* description of July 21, 1944, is typical, though from the perspective of 23 miles away: "Plainly visible here was the towering pillar of flame that flared into the southern sky. The hills of the Napa Valley were momentarily illuminated as by sunlight." Scores of persons, convinced that an earthquake was imminent, ran from their homes in their night clothes. On land, to the south of the disaster, the buildings of the Naval Base suffered damage beyond repair. All buildings in the town of Port Chicago, which was a mile to a mile and a half from the explosion, were damaged seriously. Ten per cent were damaged beyond repair. Fifty percent were uninhabitable due to being knocked off their foundations. The bridge crossing the Carquinez Straights was rocked violently as described by passengers crossing the bridge on a bus. All the downtown store windows were shattered in Vallejo, 22 miles away. Mare Island suffered considerable damage from the explosion, with some streets being littered with as much as two inches of glass.

The explosion which vaporized the Liberty Ship *E. A. Bryan* and blew to bits all but a small section of the keel of the other ship, the *Quinault Victory*. It also killed 320 men and destroyed the Port Chicago base, a critical munitions facility supplying the Pacific War. Today, we know Port Chicago as the Concord Naval Weapons Station, a sprawling 5500 acre Navy complex extending over the hills from the Suisun Bay into Clayton Valley, near Concord.

The official theory of the explosion maintains that 1.5 kilotons of war munitions containing TNT and Torpex, placed on the pier and in the holds of the Liberty ship *E.A. Bryan*, were accidentally detonated all at once - "highorder". There is disagreement between the government damage reports on the size of the blast. The U.S. Army/Navy Safety Board Report, Technical Paper #6 reports the yield of the Port Chicago explosion as 2.13 kilotons, which is in excess of the conventional explosives inventoried aboard the *E.A. Bryan*. The Naval Court of Inquiry came to the conclusion that the accidental detonation was caused by several factors, including:

- War-induced oversized work load and pressure on the men.
- Incompetency of the officers at the base.
- The Base Commandant's promotion of competition among loading officers.
- Gross violation of safety precautions.

Various articles reported in the *Sentinel* by researcher Peter Vogel and David Caul, have outlined the entire history of the explosion, of the dawn of the nuclear age, of the prototype atomic bombs that existed and of correspondence and official reports concerning atomic testing, Los Alamos and Port

Chicago. We would refer readers to those various articles for background as well as Mr. Vogel's 1982 *Black Scholar* article, "The Las Wave From Port Chicago," and will not repeat that material in this series.

The first concept of an atomic bomb was that it would be necessary to place it on a naval vessel and send it into the port of the enemy. In 1944, no strategic aircraft or airfield was available that could be used for delivery of an atomic bomb. At the time of the Port Chicago explosion the United States involvement in the Pacific war was largely focused on maritime battles and the need for a "port buster" was of the highest importance. Scientists at Los Alamos had an exquisite interest in determining the lethal or sinking ranges of all types of surface vessels and submerged submarines for nuclear bombs detonated under water. This concern is very prominent in the first edition of *The Effects of Nuclear Weapons*, 1950. There were two striking advantages in detonating atomic bombs in the water as port-busters:

- A bomb which was detonated under water could be a ton lighter because it would not require a heavy tamper. This lightness would enable it to be carried by lighter, more maneuverable aircraft
- A water detonation would not subject the crew of the drop plane to radiation and heat because the water would act as a shield.

Accordingly, the bomb would not have to be dropped from 30,000 feet, a technology which was not available in the summer of 1944. The *Enola Gay*, by Thomas and Witts documents the timetable of the development of high altitude bombing techniques. As far back as 1943, the High Military Policy Committee, the board of directors of the Manhattan Project, had chosen the Japanese fleet concentrations in the harbor at Truk in Micronesia, as the first target for the atomic bomb. Declassified documents from the Manhattan District History, Project Y, from the U.S. Department of Commerce, have been uncovered. The National Technical Information Service, LAMS-2532, Vol. I, December 1961, page 8:13, refers to the "...results of certain underwater tests (performed in 1944)...which had been directed toward achieving the goal of using a nuclear weapon against the Japanese fleet concentration at Truk, in Micronesia." Port Chicago would have been a perfect "blast gauge" for a port-buster type atomic bomb.

The height of the fireball, the Wilson condensation ring, and the damage to 14 counties of California, all point to something more insidious than incompetence causing 1.5 kilotons of ammunition to go off all at once. Evidence for the theory includes:

- declassified letters and memoranda with incriminating wording,
- scientists from the Los Alamos Laboratory arriving at the site miraculously early,
- the hidden facts about the test of a bomb called Mark II,
- the white flash and other circumstantial evidence. Some of the counter evidence against the nuclear theory is:
- lack of radiation reports at Port Chicago, and
- the alleged impossibility of supply of enough fuel for even a small bomb in July 1944.

The possibility that the explosion was nuclear but accidentally detonated while being transshipped through Port Chicago on one of the cargo vessels has also been put forward.

Port Chicago:

what classified memos said

By David Caul and Susan Todd

(Part Two of a Four Part Series)

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Through the Freedom of Information process, dozens of suspicious letters surrounding the Port Chicago explosion have surfaced. A memorandum from Captain William S. Parsons to Major General Groves, director of the Army's activities related to the Manhattan Project, is particularly interesting. Captain Parsons was the deputy director of Los Alamos Laboratory in 1944 and conducted the lab's study of the Port Chicago explosion. The Parsons-Groves memorandum dated 25 September 1944 was his third preliminary report on the Port Chicago explosion.

The memorandum read: "I believe that it is necessary at this time to examine the scope of the responsibilities and duties which are imposed by a directive to develop, manufacture and furnish, with the prospect of successful delivery during this war, a weapon of entirely new characteristics.

"I divide this mission into three separate parts, which have in common the fact that failure or lateness of any one will surely bar the weapon from the war.

"...The fact of the war, and the fact that victory may be in sight in 1944 in Germany, and probably in 1945 in Japan, combine to force concurrent rapid prosecution of (the) . . .work."

Later, in the letter, Parsons addressed the proposal on the part of some of the more progressive scientists on the Manhattan Project to test the bomb in the desert instead of using it against the enemy. "This same exaggerated idea of the destruction possibilities of thousand-ton explosions had led to proposals in high and responsible quarters that if we are winning the war anyway, perhaps the best use of the gadget is in a staged field test in an American desert; to which could be invited such foreign observers as the United States desired to impress with our victory over the atom and our potential power to win victories over our future enemies.

"The kind of reasoning in the above paragraphs is also attractive in that it disposes of the two really difficult and disagreeable problems; (a) final assembly design and manufacture, and (b) military delivery. To have our project culminate in a spectacularly expensive field test in the closing months of the war, or to have it held for such a demonstration after the war, is, in my opinion, one way to invite a political and military fizzle, regardless of the scientific achievement. The principal difficulty with such a demonstration is that it would not be held one thousand feet over Times Square, where the human and material destruction would be obvious, but in an uninhabited desert, where there would be no humans and only sample structures. From my observation of Port Chicago, I can give assurance that the reaction of observers to a desert shot would be one of intense disappointment. Even the crater would be disappointing."

Why would Port Chicago be linked with a report on an atomic test? Parsons was concerned that the war might end without the use of the bomb. His first priority was to enter the bomb into the war, before it was too late. In this letter he cancels any suggestion that the use of the bomb must be governed and justified by moral considerations. It becomes obvious that Parsons wants the bomb to demonstrate both the material and the human casualty factors.

The human factor Port Chicago was carefully recorded by the damage reports to Los Alamos and to the National Defense Research Committee, which oversaw the Manhattan Project. Port Chicago would have been an ideal area by which to gauge the bomb's effects. A topographical map of the area in 1944 shows the ideal setup. Even the prevailing winds were correct to blow the radioactive debris out over the channel and Honker Bay and deserted marshlands. The nearest downwind populated areas was the tiny town of Fairfield, 20 miles away, surrounded by farmland.

There is yet another letter in the paper trail leading back to a suspected nuclear explosion at Port Chicago. This letter was first made public in the Napa Sentinel magazine in February 1994. James Conant, who was a member of the board of directors of the Manhattan Project referred to a full-scale test of the weapon in a letter to General Groves. In the letter he indicated that the secret test occurred shortly before August 1944. The Port Chicago explosion took place on July 17, 1944. The explosion Conant refers to was a year before the Trinity test, which has officially been documented as the first atomic test.

The interesting part of Conant's report is that the results of the first atomic test shortly before August 1944 exactly match the damage report Captain Parsons wrote on Port Chicago. The letter states that dwelling houses were damaged in the test. The letter is dated August 17, 1944, one month after the Port Chicago explosion. It is one of the most heavily sanitized, declassified documents on the subject. It is entitled "Report on Visit to Los Alamos." In the name of national security, 50 years later, the censor left only a few sentences intact: "It is agreed that the Mark II should be put on the shelf for the present. If all other implosion methods fail, it could be taken off the shelf and developed for combat use in three to four months time." Conant's letter continues: "It was agreed that for dwelling houses the area of Class B damage was about as follows for 1000 tons of TNT:

- 90 percent Class B damage = 0.5 miles radius .75 square mile area.
- 10 percent Class B damage 1.5 miles 7.5 square mile.

The emphasis is on the word 'was'. He states the damage "was" not "would be".

This fits the description of the damage at Port Chicago. According to Conant's letter, the Mark II was a working bomb as of July 1944 and it could have been readied for combat delivery in a few months.

Just where the atomic test Conant referred to was held is not stated in the letter. The first page of the letter was censored out. Obviously Conant and Groves had known all along that the test had been held. But what was their motive for keeping it secret. The Mark II is rarely talked about in the literature about nuclear weapons. Surprisingly, the damage to Port Chicago cited by Captain Parson corresponds exactly to that attributed to the Mark II by Conant:

90 percent Class B damage = 0.5 miles radius .75 square mile area. 10 percent Class B damage 1.5 miles 7.5 square mile.

Research and *Sentinel* articles reveal that Los Alamos scientists and engineers were on the scene at Port Chicago the morning after the explosion. These early arrivals of key Los Alamos and Manhattan Project officials to Port Chicago create some suspicion. Captain Parsons visited the site of the Port Chicago explosion twice. One of the explicit purposes of his second visit was to interview air crews flying in the vicinity of the base at the time of the explosion. He was specifically concerned to determine the height of the fireball.

The documentation has been extensive in previous *Sentinel* articles. Now that the foundation has been laid, the next two parts will explain the radiation aspects and comparison to other nuclear tests of the

era.

Port Chicago: how it compares with other tests

By David Caul and Susan Todd

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Third of a Four Part Series

Throughout the years, there have been several critics of the Port Chicago nuclear explosion theory. Among the most noted were the late Russ Coughlan, general manager of KGO TV and his producer Bob Anderson. In their documentary entitled "The Mystery of Port Chicago", they discounted the nuclear theory based on what they believe was the absence of flash burns among victims, temporary blindness and radiation sickness, such as reported from Hiroshima and Nagasaki.

Nuclear explosions produce temperatures on the order of millions of degrees centigrade, whereas conventional explosions generate heat on the order of thousands of degrees. In addition, at the time of a nuclear detonation, intense penetrating radiation emanates from the fireball.

This article will present an explanation of how a nuclear explosion at Port Chicago could have features which would prevent flash blindness and flash burns, and also explain how it was that the effects of the radiation exposure on the personnel at the facility would not have been as obvious as KGO indicated.

Given the many variables which surround nuclear explosions, such as weather, placement, potential yield, type of device, and topography, it is not always possible to judge in advance what will happen. Therefore, nuclear explosions can be very unique events and do not always duplicate each other.

The lack of flash burns and flash blindness or "eclipse blindness" at Port Chicago is consistent with the explosion being nuclear. All of the damage reports cite the center of gravity of the explosion as being 15 feet below the water line of the *E.A. Bryan*, and, therefore the explosion would have thrown up a large plume of water. This phenomenon, together with the fact that the bomb detonated within one of the holds of the 7500 ton cargo ship, would have sharply attenuated or eliminated the thermal radiation emanating from the fireball within the first few seconds of the explosion. This would have happened in two ways:

- the steel of the ship and the water would have both absorbed the heat, thereby reducing it, acting as a heat sink; and
- the ship and the water would have shielded the thermal radiation from reaching the populated areas. Even clouds, smoke or fog can substantially decrease the thermal radiation from a nuclear flash.

By the time the fire ball had vaporized the ship and risen above the surface of the water, and out of the plume, the spray and debris, the fireball would have cooled to the point that flash burns and blindness would not have occurred.

It is interesting to note that even at Hiroshima, where there was nothing to block the thermal radiation,

the blink reflex and the recessed position of the eyes helped to prevent flash blindness, and the effect of thermal radiation on the eyes was surprisingly small. The so-called "eclipse blindness" associated with viewing a nuclear explosion results when the intensity of the light uses up all of the eye's supply of visual purple in the retina; blindness then persists for a half an hour or longer, until enough of the substance is produced in the eye to allow vision again. The lack of flash burns and flash blindness at Port Chicago is fairly easily explained by the shielding effect of the water and the ship. Even at Bikini, the underwater explosion was observed without eye protection for the men.

Anderson and Coughlan cite in their KGO documentary that the wreckage was conspicuously uncharred and unburned. This, they state, is yet another sign that the explosion was non-nuclear. However, the Los Alamos damage report states that most missiles thrown out by the blast were melted by heat. The *Napa News Chronicle* reported "great hunks of hot metal" lying all around the vicinity after the explosion. Similar reports are to be found in the book *No Share of Glory* by Robert Pearson. Tom Shaw, a Napan who watched the complete progression of the explosion from an apartment one mile away in the town of Port Chicago, told the *Sentinel* that he observed large, red and white hot pieces of the ship's plating tumbling end over end streaking toward him. These reached him before the blast wave, and so were traveling in excess of the speed of sound. He was able to take it all in before he was knocked to the floor by the explosion.

Anderson's and Coughlan's strongest argument against a nuclear thesis rests on a test they performed on pieces of shrapnel they found near the blast site. "We subjected the pieces of shrapnel from the blast to radiation tests." Coughlan and Anderson concluded that the tests showed that the pieces could not have been in an atomic explosion. However, just finding any pieces of metal near the explosion 44 years later does not mean that they came from the ship in which the bomb had detonated. The pieces could have come from the ship which did not contain the bomb, or from one of the boxcars or machinery on the pier. In that case, the test becomes less meaningful. In order for metal to pick up radioactivity, it must have close proximity to the bomb. The likelihood of radioactivity diminishes with distance. Coughlan and Anderson have no way of determining where the pieces came from. Second, they don't say what test they performed on the pieces. If they simply tested for radioactivity, then it is not surprising that the pieces showed none. The British Government detonated a 24 kiloton plutonium bomb at Monte Bello, Australia in October of 1952. The bomb was placed on a Frigate in shallow water and detonated. None of the isolated steel fragments of metal that had been thrown out from the Frigate on to the surrounding islands showed any sign of radioactivity whatsoever after ten years. At Port Chicago, Coughlan and Anderson found no signs of radioactivity in the metal after 44 years, yet they concluded the explosion could not have been nuclear. The shielding and absorption effect by the ship and the plume would also have greatly diminished the nuclear radiation (i.e., gamma, neutron and x-ray), as well as the thermal radiation. This still leaves open the possibility of residual radiation being left in the area, and we will cover that aspect shortly.

In August 1990, the *Sentinel* contacted Ernest Sternglass, professor of Radiology at the University of Pittsburgh specializing in Radiation Physics. Sternglass is well-known for his work on nuclear fallout from bomb tests and nuclear power plants, and its effects on the population, especially children. Dr. Sternglass original reaction in 1990 to the Port Chicago nuclear thesis was negative. He made a comparison between Port Chicago and the Bikini under-water test in 1946. He said that what happened at Bikini would have happened at Port Chicago, since in both cases the bomb would have detonated in water. The radiation problem at the Bikini test was much worse than the Trinity test, or at Hiroshima or Nagasaki, were the bomb was detonated above the surface. At Bikini, immediately after the explosion, the radiation levels were very high in the lagoon and on the target vessels. There were reports of lingering radiation which was difficult to clean from the target ships. Eventually, elevated cancer rates were discovered among the Bikini veterans. (Editor's Note: Dr. Sternglass now feels that it is quite possible that Port Chicago could have been a nuclear explosion.)

Taking our cue from Dr. Sternglass, we can ask the following critical question of the Port Chicago nuclear thesis: If a nuclear device had exploded at Port Chicago, and Port Chicago would have been like Bikini, how could the rescue crews, operating both in the water and on land have been able to withstand the radiation that would have permeated the area, especially so soon after the detonation?

Army units from Camp Stoneman, eight miles to the east, began arriving at 2 a.m. (the blast was at 10:19 p.m.). Port Chicago was never abandoned, although the Navy immediately began to use the Army facilities at a Richmond dock as a temporary replacement.

It would seem from these facts that the Port Chicago explosion was non-nuclear. But a closer examination of the Bikini underwater explosion will show that the harm to the men at Bikini were not initially very obvious. The radiation effects were much more subtle than that.

BIKINI EXPERIENCE AND COMPARISON

Nuclear explosions present radiation hazards to the public in two fundamentally different ways:

- **initial radiation's, which take the form of gamma, x-rays and neutrons coming out of the fireball during the first three seconds of the event; and**
- **delayed fallout, where radioactivity fission products and debris from the mushroom cloud descend to the earth.**

The first type is over in three seconds, the second type lingers on. Both can be intense. Bombs which explode in the air such that the fireball doesn't touch the earth produce high initial radiation from the vicinity of the explosion, surface zero, but the delayed radiation for that area is negligible. Hiroshima and Nagasaki received virtually no fallout from the bombs.¹¹ The delayed fallout descends to the earth later or miles away downwind. Bombs which explode in the water tend to produce no initial radiation hazard, but can leave high levels of delayed fallout in the vicinity of the explosion. This is what happened at Bikini. The radiation left in the Bikini lagoon from the underwater test was much greater than that which was left on the ground at the Trinity test site in New Mexico, Hiroshima, or Nagasaki, or the Bikini-Able aerial test.¹² But the water in which the Bikini bomb was placed acted as a shield against the initial radiation.¹³

In an air burst, as the fire ball cools, the radioactive residues of the weapon condense into extremely small particles which remain suspended in the atmosphere for a long time. ". . . in a low burst, the earth, dust and other debris from the earth's surface are taken up into the fireball, and an increasing proportion of fission (and other radioactivity) products of the nuclear explosion condense into particles of appreciable size.¹⁴ These large particles tend to fall out immediately, causing contamination in the area of detonation. Additionally, proximity to water is especially conducive to the deposition of large amounts of radiation near surface zero because the coolness of the water prevents the fireball from rising to as great a height as in the case of an aerial detonation. Radioactive material then tends to fall back more quickly to the base of the explosion rather than to be blown away from the area, falling out over a period of time downwind. It is the delayed fallout that would have been a problem at Port Chicago, just as it was at Bikini, not the initial radiation from the fireball.

Some of the "victims" of the Bikini test, the target vessels which were arrayed around the surface zero at various distances were drenched in radioactive substances; there was intense radiation left in the waters of the lagoon. After four days, the authorities at Bikini conceded that the inspection parties were to spend only limited time aboard the doomed vessels because of the radiation. However, the authorities told the press and the men that this precaution was in accordance with a safety factor of 1000. They told the press and the men that they could take a thousand times that much radiation and

not be killed. They told them that this was a "peacetime" standard, and that during wartime the standard would be much less.

The planners of the Bikini test had been taken by surprise by the lingering radiation. The long-term radiological results of the test had been ". . . either utterly unforeseen, or had been placed in such conjectural terms that its relevance, even to strategic considerations, was not understood". The Navy admitted that ". . .the nature and extent of contamination of the targets was completely unexpected, and no plans had been organized for decontamination measures". Two or three days after the explosion the Navy began to realize this. The Navy had known that there would have been high initial radiation in the area, but they hadn't counted on the delayed fallout contaminating the area in the vicinity of the lagoon.

Knowledge of the effects of radiation was scant. "No one yet recognized the greatest danger of atomic warfare, lingering radioactivity..." At first the Navy resorted to old-fashioned methods, crews of men were set to scrubbing down the contaminated ships without any special protection, using "lye, foamite, salt water and soap spread with liberal amounts of Navy profanity. Men were ordered to spend the night on some of the "hot" target ships. Radioactive material was all over the decks, and the men tracked it around and got it on their clothing, hands and faces. Many of the officers thought that the risks could be ignored. It is true that there were no reports of radiation sickness at Port Chicago, however, there were no official reports of radiation sickness at Bikini either, and this was an announced nuclear test. The Bikini tests had showcase-extravaganza status, and monopolized the attention of the world's media for weeks. Port Chicago was unannounced.

Only some of the later written accounts of the Bikini test describe military personnel as suffering illness from radiation. These reports took years to reach the public. The first book about Bikini, one which focuses on the radiation problem, asserts clearly that there was no radiation sickness or injury there either.

The Veterans Administration was able for years to deny any connection between illness among Navy personnel and Bikini exposure. As of 1981, the VA had turned down "98 percent of all radiation-based claims for atomic veterans", including the Bikini vets arguing that it was impossible to determine whether the maladies in question would have occurred regardless of radiation exposure. And this was so even though everyone knew that the men had participated in an atomic bomb test.

From the beginning, the cat was out of the bag at Bikini. But, how easy would it have been to correctly diagnose the radiation sickness and other more subtle nuclear symptoms with this knowledge? If the men had been told, for example, that the explosion at Bikini was from conventional munitions on a ship, they would have looked for other causes for their maladies. And even though they knew they were exposed to the effects of an atomic bomb, it took years for the first claims to be put in.

Port Chicago: Epilog -

By David Caul and Susan Todd

EPILOG

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In the second article of this series we quoted declassified letters discovered by Peter Vogel. The letters were written by one of the top people in the Manhattan Project and referred to a secret detonation of a

low-yield atomic bomb in July 1944, designated the Mark II. The letters were dated shortly after the Port Chicago explosion. Neither the government nor any publication, except the Napa Sentinel, has officially acknowledged either the detonation, or the letters which describe it, and there is strong evidence that the detonation referred to in the letters was actually Port Chicago.

The design of the Mark II is an anomaly in the history of U.S. nuclear weapons development. It was a crude, first attempt at making an atomic bomb which operated on the principle of implosion. Understanding how that crude Mark II bomb worked will help us to see an important difference between the Port Chicago radiation situation and that of Bikini.

The bomb consisted of a sub-critical hollow tube of uranium contained in another cylinder of molded explosive material. When the cylindrical explosives were detonated, the hollow tube of uranium was crushed into a critical mass, and fission took place.

According to Peter Vogel, the uranium in the hollow cylinder was enriched to less than 30 percent U-235, the rest being U-238. The Hiroshima bomb, which detonated over Japan, was enriched up to 80 percent. The Mark II's low fuel enrichment made it quite different from the uranium bomb which was dropped on Japan. However, there was another striking difference: It used a moderator, like a nuclear reactor, and this is the secret of how it was able to operate on such poorly enriched uranium.

What fissions in an atom bomb or a nuclear reactor is uranium U-235. Natural uranium contains only .7 percent of this isotope, the rest being U-238, which cannot fission except under very special circumstances. A process of "enrichment" is used to increase the percentage of U-235, and it is very slow and costly; this was especially true in 1944.

Nuclear reactors are enriched up to 3 percent, but uranium bombs generally contain up to 80 percent. Reactors can run on such lean enrichment diets because their uranium fuel is placed in a moderator, such as hydrogen, paraffin or graphite.

There are two advantages in slowing down the neutrons. First, slow neutrons have the highest probability of producing fission of the U-235 fuel. Second, uranium which is not highly enriched, containing larger amounts of U-238, absorbs or "captures" too many of the neutrons needed for fission. This capturing process hinders the fission process. It takes neutrons out of circulation. When a neutron enters a U-238 nucleus, the U-238 is changed into plutonium through a series of transmutations.

However, U-238 can only capture neutrons traveling at the intermediate speeds. By slowing down the flow of neutrons through the use of a moderator, the neutrons can still produce fission because they are free from capture by the U-238.

U-238 is a contaminate which poisons the atomic reaction by preventing fission. One way to deal with the problem is called "enrichment", removing the U-238 from the fuel leaving U-235. The fuel of the Hiroshima bomb, Little Boy, under this slow and costly process. Another way is to remove as much U-238 as is practical, and use slow neutrons so that the U-238 which remains is no longer a poison to the reaction. This is what the Mark II design did.

The moderator was created in the Mark II by compacting the uranium fuel and forming it into a plastic hydride. The hydrogen in the plastic slowed down the flow of neutrons. Layers of hydrogen containing paraffin were also used. This unique design was a response to a problem of the times: scarcity of higher enriched uranium. Much enriched uranium was needed to run the reactors which were breeding the plutonium at Hanford, plutonium that would fuel later bombs.

Because the Mark II design included a moderator and used fuel which was enriched to less than 30 percent, it was somewhere in between a nuclear reactor and a nuclear bomb. By making as much of the fuel as possible go critical in a very short period of time, it was like a bomb. By using a moderator at the same time, it was like a reactor. Subsequent developments in enrichment made the Mark II obsolete. However, at the time, the Mark II provided a detour around the enrichment problem.

This ingenious device, however, was not at all efficient. The simple geometry of explosives in the shape of a pipe was imperfect in squeezing the fuel into a critical mass. Sections of the precious fuel squirted out the ends, escaped fission and were wasted. The squeezing wasn't fast enough. Also, though slowing the neutrons reduced parasitic capture by the U-238, the fuel took too long to fission. Slowing down the fission process is desirable in a nuclear reactor, speeding up the process is desirable in a bomb. In spite of this, for the mark II the fuel tended to blow part before most of it could undergo fission. The neutrons took "...so long to act that only a feeble explosion would result." In a non-moderated bomb, all of the neutrons are liberated within less than a millionth of a second. Anything less than a kiloton was regarded as "feeble" by the bomb designers whose expectations ranged in the tens of kilotons.

In later bombs, such as Fat Man, a spherical configuration replaced the "pipe bomb" design and the "perfect squeeze" of the fuel was finally accomplished. Before that, however, the inefficient Mark II was the United States' only nuclear option. It was reliable, but its yield was less than a kiloton. The testing and putting on the shelf of the Mark II enabled Los Alamos to hedge their bets on the untested Little Boy, and the drawing board stage Fat Man.

After the Port Chicago explosion, James B. Conant, a critical figure in the development of a nuclear bomb, wrote a memorandum suggesting putting the Mark II on the shelf after a July 1944 test, a test never recorded in any public annals, but paralleling the date of the Port Chicago explosion. Conant wanted to commence work on the Mark III.

The Mark II contained about five kilograms of fuel, and it used that fuel very inefficiently. Much of the uranium did not undergo fission, and was squeezed or blown out of the critical mass and melted, avoiding fission. Even when a bomb is "efficient", only one percent of the fuel actually fissions.

The workers, rescue personnel and survey teams at Port Chicago during the days immediately following the explosion would have been exposed to a devil's wish-list of other chemical poisons from vaporizing ships which would have been as serious as unfissioned uranium. Since the Mark II's neutrons were moderated to below capture speeds, there would have been very little transmutation of its U-238 into plutonium, a very serious radiological hazard, especially if inhaled. Its design goes out of its way specifically to prevent the production of plutonium. With only 30 percent enrichment of its fuel, it could not work any other way.

Large amounts of the dangerous plutonium were left at the Bikini site, and accounted for a good share of the risk there. The danger from plutonium lies in the tendency of the element to concentrate in the bone where the continuous emission of alpha particles may cause significant injury. The Bikini bomb fuel consisted entirely of plutonium. Fear of plutonium contamination of the Bikini lagoon was strenuously advanced by Los Alamos as a reason to cancel the Baker test. Because of the way the Mark II worked, this did not happen at Port Chicago.

Bikini was not the only underwater bomb test site where plutonium was found to contribute to the radiation risk. On October 3, 1952, the British Government tested a 25 kiloton plutonium bomb on the Monte Bello Islands, off the western coast of Australia. The bomb was placed in a forward hold of the frigate HMS Plym and detonated "Port Chicago style". Plutonium was found scattered over the area, and it was cited as a serious inhalation hazard in a report of the Royal Commission.

Approximately 70 percent of Mark II's fuel was U-238 which could not undergo fission. If this unfissioned uranium had contaminated the area in the vicinity of the explosion, it would not have been a serious radiological hazard, but a chemical poison which attacks the kidneys. And more importantly, its radioactivity would not have been apparent in the summer of 1944. In 1943, the Nazis ordered the use of its entire uranium stocks, 1200 metric tons, to substitute in its ammunition because of a shortage of wolframite. The battlefields of Europe became littered with hundreds of tons of uranium shell fragments and bullets, a much larger quantity of uranium than the 10 pounds which would have filtered down over the marshes and waterways adjacent to Port Chicago as a result of the explosion of the Mark II. Yet, Europe has never reported any problems associated with the expenditure of uranium by the Germans.

The Port Chicago explosion was very different from the Bikini test in several important respects. First, it occurred in shallow water. Both editions *The Effects of Nuclear Weapons* states that a shallow water nuclear detonation may not, under certain conditions, severely contaminate the area immediately in the vicinity of surface zero. *The Effects of Nuclear Weapons* states that a certain minimum depth is necessary to produce significant radiation in the vicinity of the point of detonation. A similar opinion was held by Vannevar Bush, chairman of the Board of the Manhattan Project. The Bikini bomb was placed at 90 feet, the Port Chicago explosion occurred at 15 feet. In addition to this, military people did not regard it as a foregone conclusion that a shallow underwater detonation would contaminate a harbor area to the extent that troop maneuvers would have to be suspended.

In an article in the American Meteorological Society, as well as in *The Effects of Nuclear Weapons*, the extreme humidity of the Bikini area is cited as a contributing factor to the contamination of the site of the explosion. Accordingly, high humidity is a necessary condition for severe contamination at the vicinity of surface zero in the case of an under water detonation. It is possible that all phenomena, exactly as observed at the Bikini test, would not occur if an atomic bomb were exploded under water when a dry air mass is present.

The main mechanism by which radiation from a nuclear explosion in water is returned to the place of detonation is something called the "base surge". The base surge is a highly radioactive mist which forms at the base of the water column, and which travels outwardly in a ring at a very high speeds. This mist contains lethal radiation and tends to deposit a relatively long-lived radioactive sludge on the surfaces of objects in its path.

The manner of formation of the base surge is very important to the issue. When the fireball leaves the water, water is driven upward, following the fireball, as the water comes in to fill the void created by the million degree bubble. The speed of this vertically driven water is over a mile a second at first. It slows rapidly, but will attain a height of 10,000 feet in less than a minute. At 10,000 feet the water and all the bomb residues, including the fission products, the mass of the ship, and whatever has been scavenged from the bottom, are vaporized.

In a short time the mixture cools and condenses back into liquid form. Within 10 to 12 seconds the column begins to fall back into the water, much of it in the form of an aerosol. This aerosol or fog is highly radioactive as a result of the particles, which form the nuclei of the droplets, are themselves radioactive. The intimate mixing which takes place between the water and the radioactive solids is accomplished by the convection currents of the mushroom cloud at an altitude between 6000 to 10,000 feet. The radioactive aerosol slides down the sides of the column under the influence of gravity at a very rapid rate as a result of a phenomenon called "bulk subsidence". In bulk subsidence, the aerosol behaves like a homogeneous fluid. When it reaches the water, it billows and forms waves and is laterally transported away from the column, in all directions, spreading its poison along the surface of the water.

The phenomenon of bulk subsidence was not completely understood at the time of the Bikini test, and at

first scientists thought that the column consisted only of water. Photographic evidence later showed that the column was largely an aerosol. Due to the research of P.A. Leighton of Stanford, it became known that these aerosol drops, in suspension, fall under the influence of gravity at rates up to 10,000 times greater than such aerosol particles normally fall. This is the aerological mechanism which delivers the material almost immediately back to the base of the column and which created the radiological havoc at Bikini. The rate of fall of the aerosol is what is important. The possibility has been raised that if the air were dryer at the altitudes at which the fission products and the water condense back into liquid and solid form again, about 6000 feet, the base surge would not be formed. The water droplets would simply evaporate into the air, and there would exist no aerosol to be accelerated downward in accordance with Leighton's bulk subsidence. What would exist then would be the slower fallout scenario typical of an air burst distributing radioactivity over a large, downwind area.

Over Port Chicago the night of the explosion at 6000 to 8000 feet, the relative humidity was less than 15 percent. This record was from Oakland, the nearest reporting station. The reading was taken about 2-1/2 hours before the explosion. This was a very low relative humidity. The Bikini test aerological data from several Navy and hydrographic observation ships were requested months ago by the *Sentinel* from the National Oceanographic and Atmospheric Administration. The *Sentinel* has been informed that these documents have been removed from their files and are unavailable. However, the Administration did send sample pilot balloon humidity data for other years from Kwajalein Island which they claim are typical for July, and these show high humidity at 6000 feet, approximately 75 percent.

If the base surge did not occur at Port Chicago as a result of the shallowness of the water and the dryness of the atmosphere, then this would have prevented much of the delivery of the radiological "witches brew" back to the vicinity of the detonation, including the long-lived and dangerous fission products of the bomb.

Documented evidence from the Manhattan Project and Los Alamos, four years of investigation, the development and test of the Mark II in July 1944, the low yield of the Mark II, and the bomb placement in respect to the water level and weather conditions, would conclude the explosion at Port Chicago was nuclear and could have been triggered with a munitions explosion.

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