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Title: Project Trinity: The Myth, The Legend, The Legacy

Author(s): Carr, Alan B.

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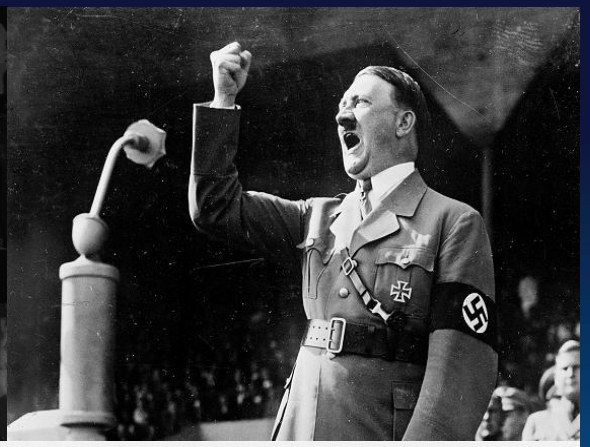
Los Alamos
NATIONAL LABORATORY
EST. 1943

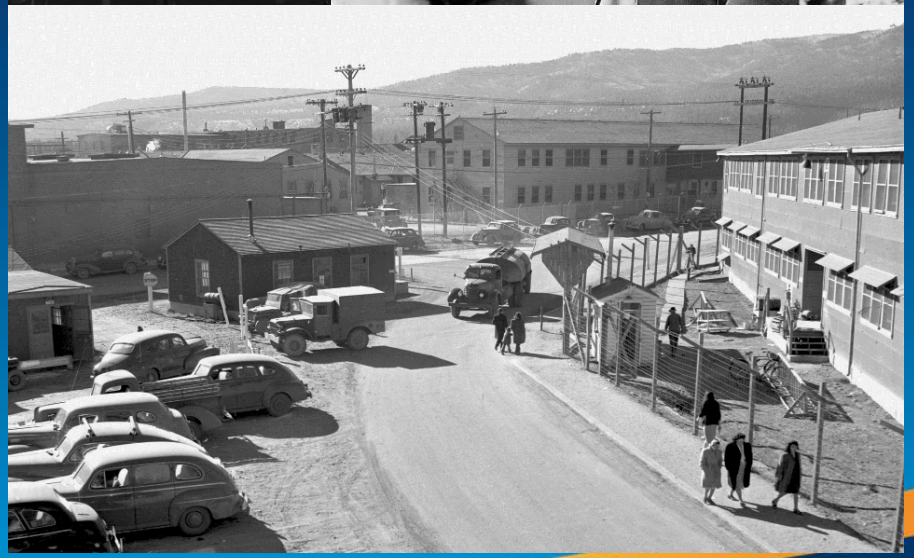
Project Trinity

The Myth, The Legend, The Legacy

The Road to Trinity

- The Manhattan Project was established in June 1942
- Its mission: beat the Nazis to the atomic bomb
- Los Alamos was selected as the site for the weapons design laboratory
- J. Robert Oppenheimer served as the Laboratory's director
- In the spring of 1944, Los Alamos scientists discovered plutonium would not work in a gun assembly
- That summer, the Laboratory was reorganized to build an implosion bomb





Why Test?

"No one was content that the first trial of a Fat Man (F.M.) gadget should be over enemy territory, where, if the gadget failed, the surprise factor would be lost and the enemy might be presented with a large amount of active material in recoverable form." – Kenneth Bainbridge

- Scientists were confident Little Boy, the uranium gun weapon, would perform in combat
- Initially, however, scientists were skeptical its imploding plutonium counterpart would function
- Eventually, due to improvements in the high explosives (HE), most scientists were confident the implosion bomb would work…
- …but not confident enough to use it in combat without testing it first!
- Oppenheimer persuaded General Leslie Groves, Commander of the Manhattan Engineer District, to test

Why *Trinity*?

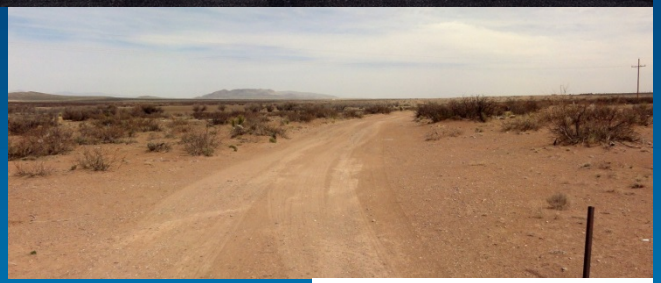
- According to one account, an Army Colonel stated the project team would need help from the Holy Trinity to move Jumbo
- Physicist Robert Jungk believes the name was borrowed from a nearby abandoned turquoise mine
- Historians Marjorie Bell Chambers and Ferenc Szasz believe Oppenheimer's understanding of the Hindu Trinity may have helped inspire the name

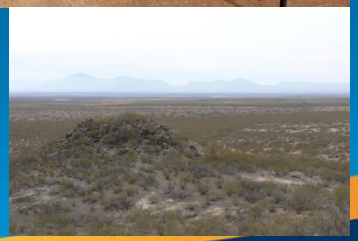
- The White Sands Public Affairs office has offered an admittedly fictional explanation: Trinity represented the culmination of the work of the Manhattan Project's three main sites (Los Alamos, Oak Ridge, and Hanford)
- In actuality, Oppenheimer named the test at a time when he had John Donne's poetry on his mind: "Batter my heart, three person'd God;"

Requirements for the Site

- More than a year before Trinity, in spring 1944, Oppenheimer started searching for a test site
- Bainbridge, who was selected to serve as test director, quickly took charge
- The site had to meet the following set of requirements:
  - It had to be flat
  - Its weather had to be favorable
  - For security and safety, it had to be isolated
  - Preferably, it would be close to Los Alamos
  - Preferably, the land would be easy to acquire
  - Native Americans could not be displaced

Possible Locations for the Test





- The following sites were considered:
  - Tularosa Valley, New Mexico
  - A desert training area near Rice, California
  - The lava region south of Grants, New Mexico
  - Sand bar islands ten miles off the coast of Texas
  - San Nicolas Island off the coast of southern California
  - Southwest of Cuba and north of Thoreau in New Mexico
  - Jornada del Muerto Valley, New Mexico (Alamogordo Bombing Range)
  - San Luis Valley near Great Sand Dunes National Monument in Colorado
- In September 1944, the Jornada del Muerto was selected

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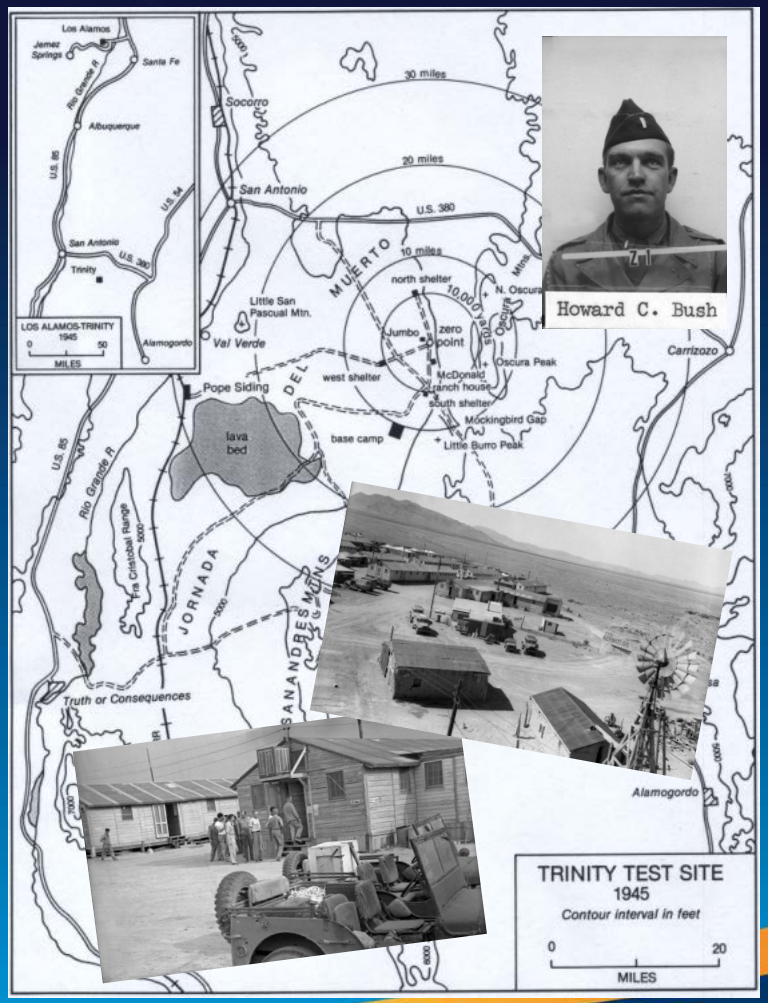
Preparing the Site

- Plans for the base camp were prepared in October 1944
- The camp was completed in December 1944 and expanded in March 1945
- A dozen soldiers, under the command of Lieutenant Howard C. Bush, staffed the camp
- In the spring, 200 laborers worked seven days a week for thirty days *three times* with brief breaks between stints
- They built dozens of miles of roads, erected hundreds of poles for wires, built three bunkers, and two towers
- The laborers also built a 25-mile road just to get Jumbo to Zero



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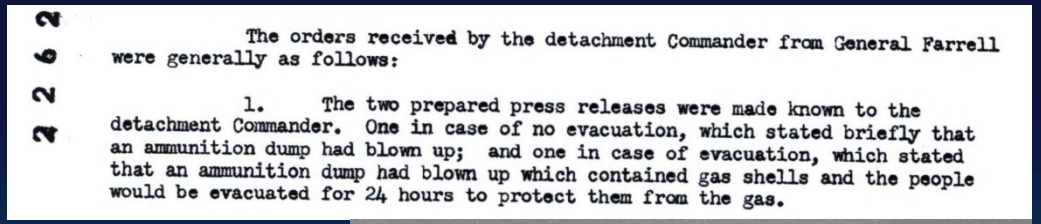
Security Precautions

- The connection between Los Alamos and Trinity was secret
- The site was patrolled by MPs on horseback and in Jeeps
- The soldiers who worked at Trinity were not told the camp's purpose
- There were no phone calls, mail was censored, and talk of the camp was prohibited
- Despite security requirements and living conditions, Lieutenant Bush maintained high morale at the camp
- To keep the nature of the test secret, press releases were prepared indicating an ammo dump on the Bombing Range had exploded



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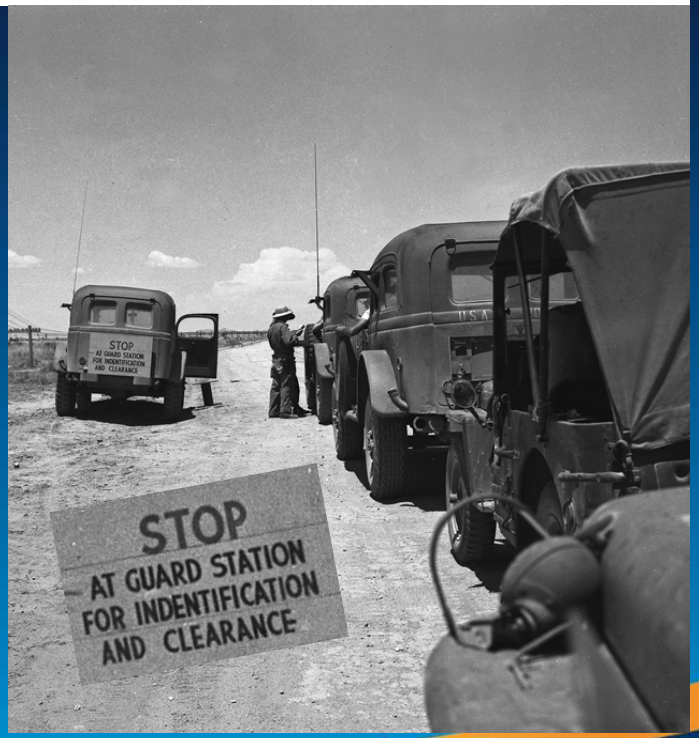
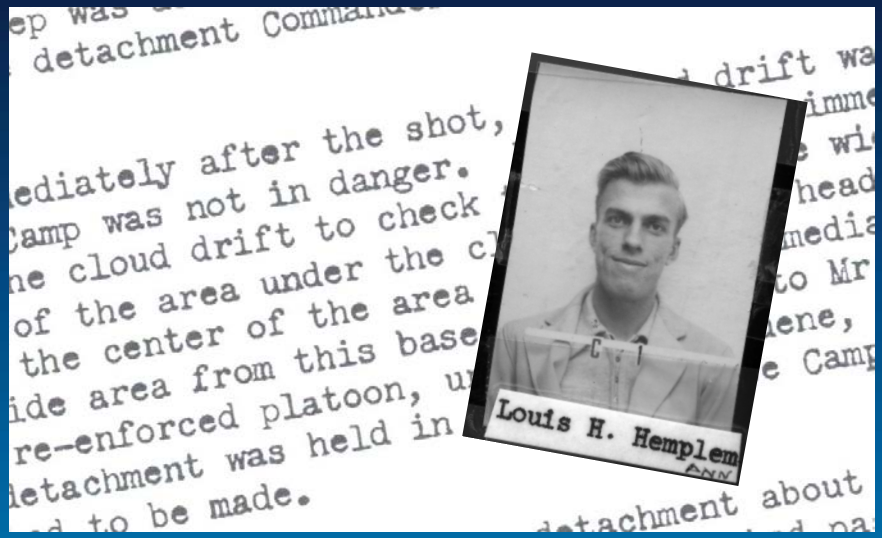
The orders received by the detachment Commander from General Farrell were generally as follows:

1. The two prepared press releases were made known to the detachment Commander. One in case of no evacuation, which stated briefly that an ammunition dump had blown up; and one in case of evacuation, which stated that an ammunition dump had blown up which contained gas shells and the people would be evacuated for 24 hours to protect them from the gas.



Safety Precautions

"..it is my opinion that no personnel outside of the area controlled by us will in fact be measurably exposed." - Oppenheimer to Groves (27.6.45)

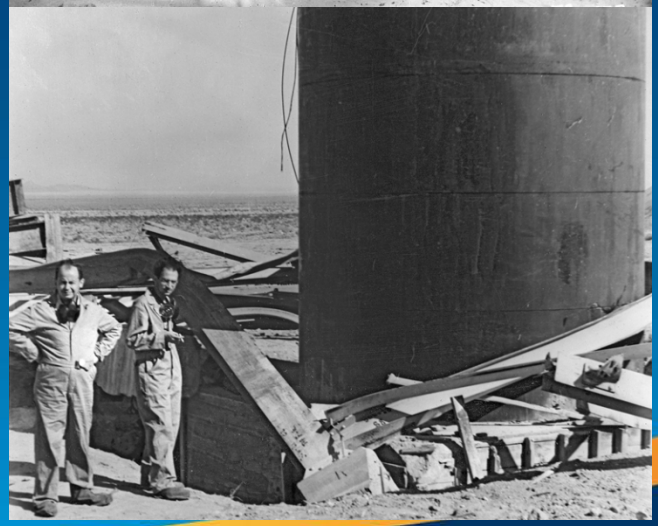


"All I could think of was, my God, all that radioactivity up there has got to come down somewhere." - Dr. Louis Hempelmann, Project Y Health Group Leader

- The scientists were aware of serious potential health hazards, but safety was not the top priority
- Fallout was not treated as a major danger until after the 100-ton test
- A detachment of 144 soldiers was made available to evacuate nearby population centers
- A crew of technicians monitoring conditions around the test area would alert the detachment if an evacuation proved necessary
- Significant emphasis was placed on obtaining accurate forecasts: good weather would keep fallout risks to a minimum

The Strange Story of Jumbo

- Early-on, scientists were very concerned the implosion bomb would not work
- If the HE detonated, but the device did not produce a nuclear yield, the plutonium would be dispersed over a wide area
- Different methods were devised to contain the plutonium in the event of a fizzle
- The most (in)famous of these was Jumbo, a 214-ton unused containment vessel
- Jumbo was suspended from a 75’ tower a half mile from Ground Zero, but survived Trinity
- General Groves attempted to have Jumbo destroyed in 1947, but failed
- Jumbo was buried, excavated, abandoned, and eventually moved near Zero where it continues to rest today



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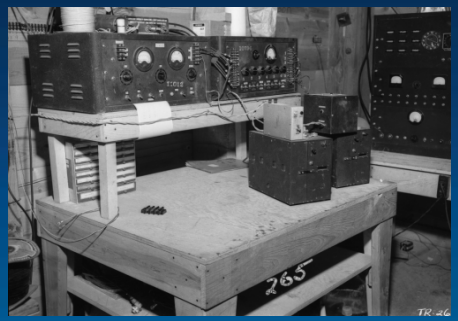
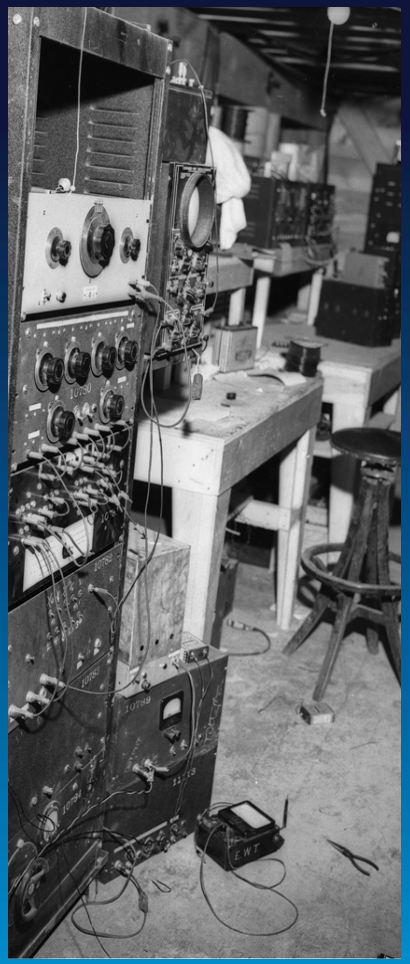
The Trinity Experiments





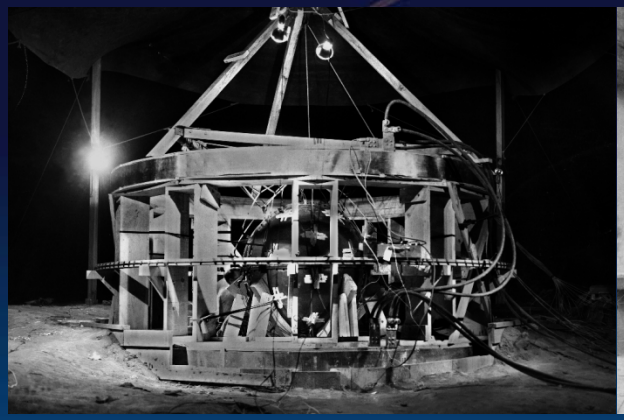
- The primary purpose of the Trinity test was to ensure the gadget worked
- However, many scientific experiments were conducted to:
  - Assess the efficiency of the implosion
  - Measure energy release
  - Measure the blast
  - Record earth shock
  - Observe the behavior of the fireball
  - Interpret radiological phenomena
- Though some experiments failed, most were very successful
- The results are recorded in dozens of Los Alamos reports

The 100-Ton Test

Video transfer courtesy of Peter Kuran

- Bainbridge proposed a rehearsal test, primarily to study the effects of the blast and calibrate instruments
- 100 tons of TNT was detonated May 7, 1945: it was the largest measured blast to that point in time
- Radioactive material was added to the TNT so the airborne debris could be tracked
- Not everything went according to plan: the TNT detonated a quarter-second early, for instance
- Thus, the test was valuable for gaining experience and making improvements to experiments

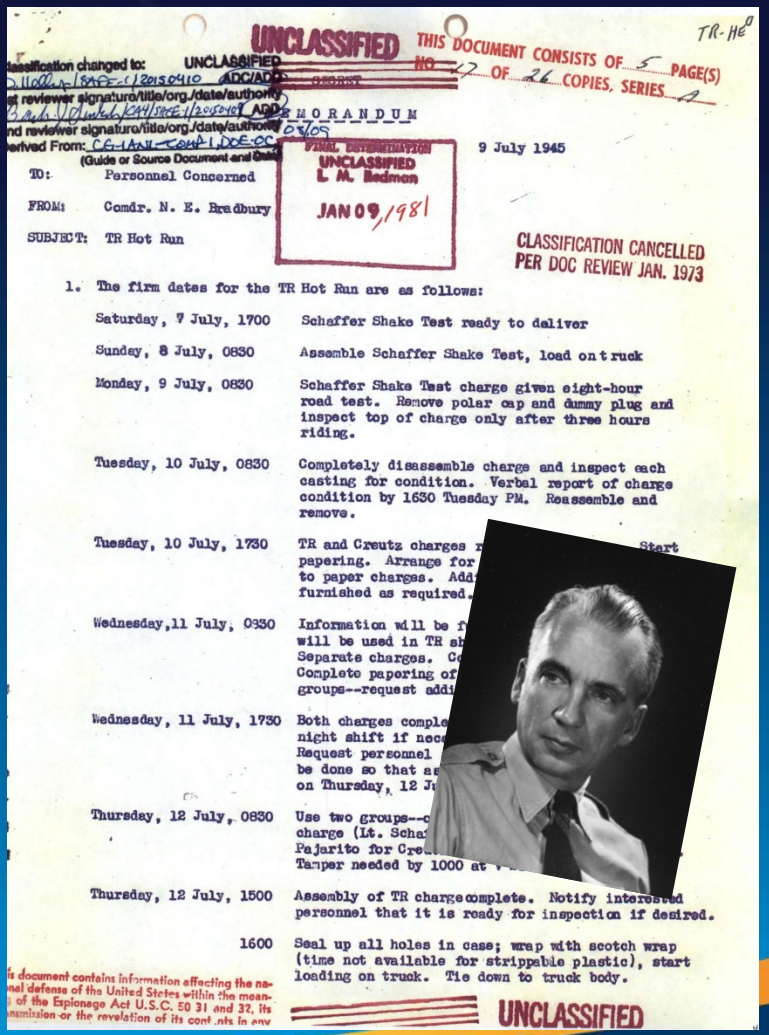
Disaster Averted: The Creutz Test



- On July 14th, an HE test was conducted at Pajarito Site in Los Alamos
- Edward Creutz was charged with conducting the test, thus it became known as the Creutz test
- In the experiment, a mock pit was imploded with a full-scale HE lens system
- Initially, the results indicated Trinity would be a failure: it appeared the implosion was too slow to make the pit go critical
- Hans Bethe, the Theoretical Division leader and future Nobel Laureate, quickly determined the results were calculated improperly

How Do You Do a Nuclear Test??

- The test date was chosen based on weather forecasts and politics
- Commander Norris Bradbury, a group leader in the eXplosives Division, wrote the procedure for the Trinity test
- Virtually every aspect of the test was unprecedented:
  - How do you photograph an atomic bomb?
  - How do you transport the gadget?
  - How do you assemble the gadget?
  - How do you detonate the gadget?
  - What if the test is a failure? Then what??
- Bradbury exhibited calmness and levity
- He would succeed Oppenheimer as Director, serving from 1945 until 1970



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THIS DOCUMENT CONSISTS OF 5 PAGE(S)
NO 17 OF 26 COPIES, SERIES A

TR-HE

MEMORANDUM

9 July 1945

TO: Personnel Concerned

FROM: Comdr. N. E. Bradbury

SUBJECT: TR Hot Run

FINAL DETERMINATION UNCLASSIFIED L. M. Redman JAN 09 1981

CLASSIFICATION CANCELLED PER DOC REVIEW JAN. 1973

1. The firm dates for the TR Hot Run are as follows:

Saturday, 7 July, 1700	Schaffer Shake Test ready to deliver
Sunday, 8 July, 0830	Assemble Schaffer Shake Test, load on truck
Monday, 9 July, 0830	Schaffer Shake Test charge given eight-hour road test. Remove polar cap and dummy plug and inspect top of charge only after three hours riding.
Tuesday, 10 July, 0830	Completely disassemble charge and inspect each casting for condition. Verbal report of charge condition by 1630 Tuesday PM. Reassemble and remove.
Tuesday, 10 July, 1730	TR and Creutz charges r... Start papering. Arrange for ... to paper charges. Add... furnished as required.
Wednesday, 11 July, 0330	Information will be f... will be used in TR sh... Separate charges. C... Complete papering of... groups--request addi...
Wednesday, 11 July, 1730	Both charges comple... night shift if nec... Request personnel ... be done so that as... on Thursday, 12 J...
Thursday, 12 July, 0830	Use two groups--c... charge (Lt. Scha... Pajarito for Cre... Tamper needed by 1000 at ...
Thursday, 12 July, 1500	Assembly of TR charge complete. Notify interested personnel that it is ready for inspection if desired.
1600	Seal up all holes in case; wrap with scotch wrap (time not available for strippable plastic), start loading on truck. Tie down to truck body.

...is document contains information affecting the na...nal defense of the United States within the mean... of the Espionage Act U.S.C. 50 31 and 32, its ...nsmission or the revelation of its cont...nts in any

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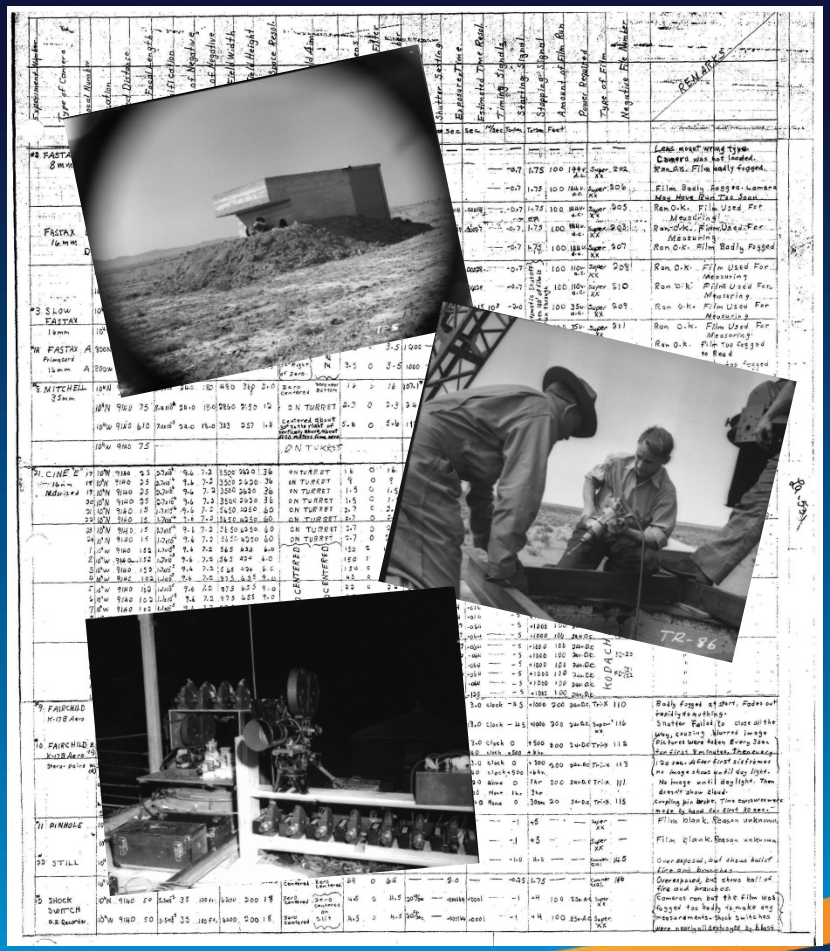
Visually Documenting the Test

- More than 50 cameras of different types would record the test
- The primary purpose of Trinity photography was to record scientific phenomena
- Fastax cameras, running at 10,000 FPS, would record the opening phases of the test in great detail
- Light wavelengths produced by the blast would be recorded by spectrographic cameras
- Gamma rays would be recorded by pinhole cameras
- Many observers were given handheld cameras to record the test



Assembly

- July 16th, the day before the Potsdam Conference opened, was set as the test date
- Bradbury led the assembly of the Gadget, with Oppenheimer supervising, on Friday the 13th
- Engineers attempted to insert the active material into the HE, but it wouldn't fit: the plutonium had expanded slightly in the desert heat
- The team successfully completed installation of the plutonium a few minutes later, after it cooled
- The morning of the 14th, the gadget was hoisted (over mattresses!) to the top of its 100' tower
- The combat weapons would be detonated high above their targets to maximize blast damage
- It was believed testing the gadget atop a tower would help scientists more accurately measure the shockwave

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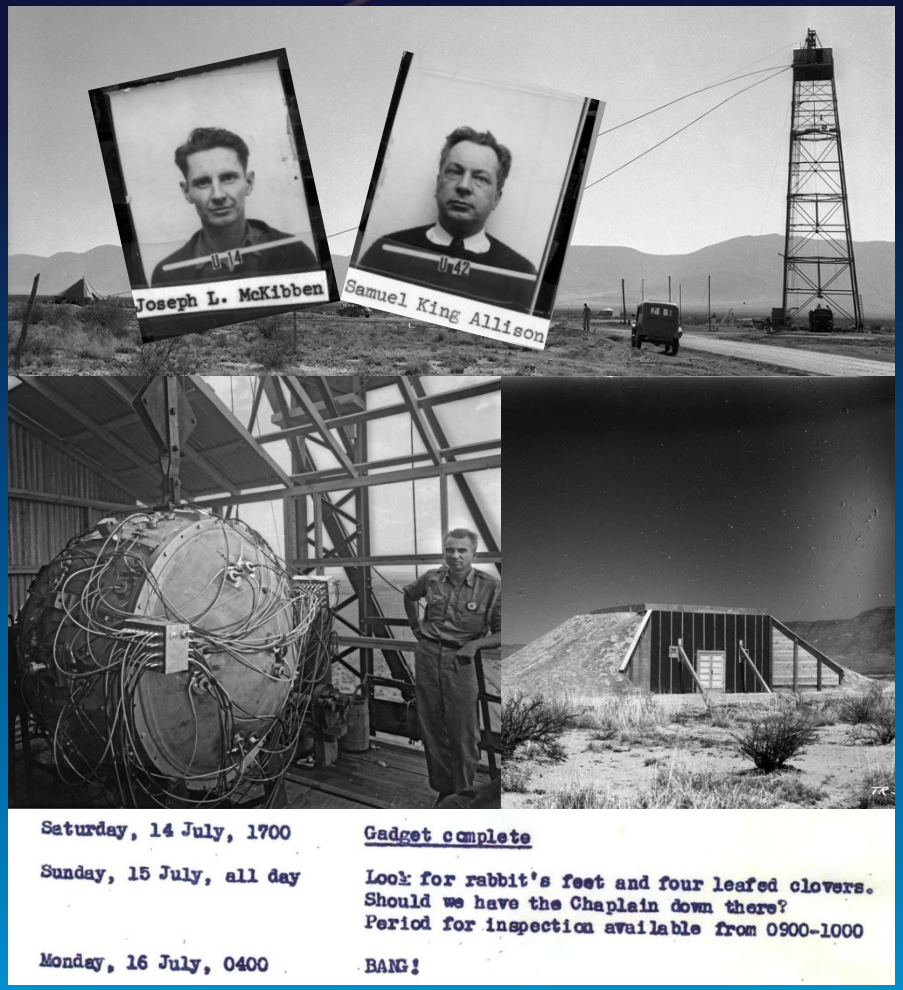
Countdown



- As July 15th drew to a close, Bainbridge, Joseph McKibben, and George Kistiakowsky set off to arm the device
- It would be detonated from the South 10,000-yard station
- The test, initially scheduled for 4:00 AM, was delayed due to a violent thunderstorm
- A postponement was discussed, but the meteorologist was confident the storm would subside at dawn
- The countdown began at 5:09:45 AM
- Kistiakowsky bet Oppenheimer a month's wages against $10 it would work!

“Now!” The Atomic Age Dawns

- At 5:29:45 the device detonated
- The gadget produced a yield equivalent to 21,000 tons of TNT
- The fireball instantaneously reached a temperature in the millions of degrees
- The mushroom cloud grew ~1000m wide before it rose in a column of smoke
- It took ~40 seconds for the shockwave to reach General Groves and several others at the 17,000-yard observation point (base camp)
- The sound, similar to the crack of a large gun, arrived seconds later
- The cloud reached an altitude in excess of 40,000 feet in ~5 minutes then gradually dispersed

Photo by Jack Aeby

By the Associated Press

Following a blast felt over hundreds of miles Monday morning, explosion of "a considerable amount of high explosive and pyrotechnics" in a remote area of the Alamogordo air base reservation was reported by Col. William O. Hareckson, commandant.

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Samples of Trinity Photography

Fastax Cameras

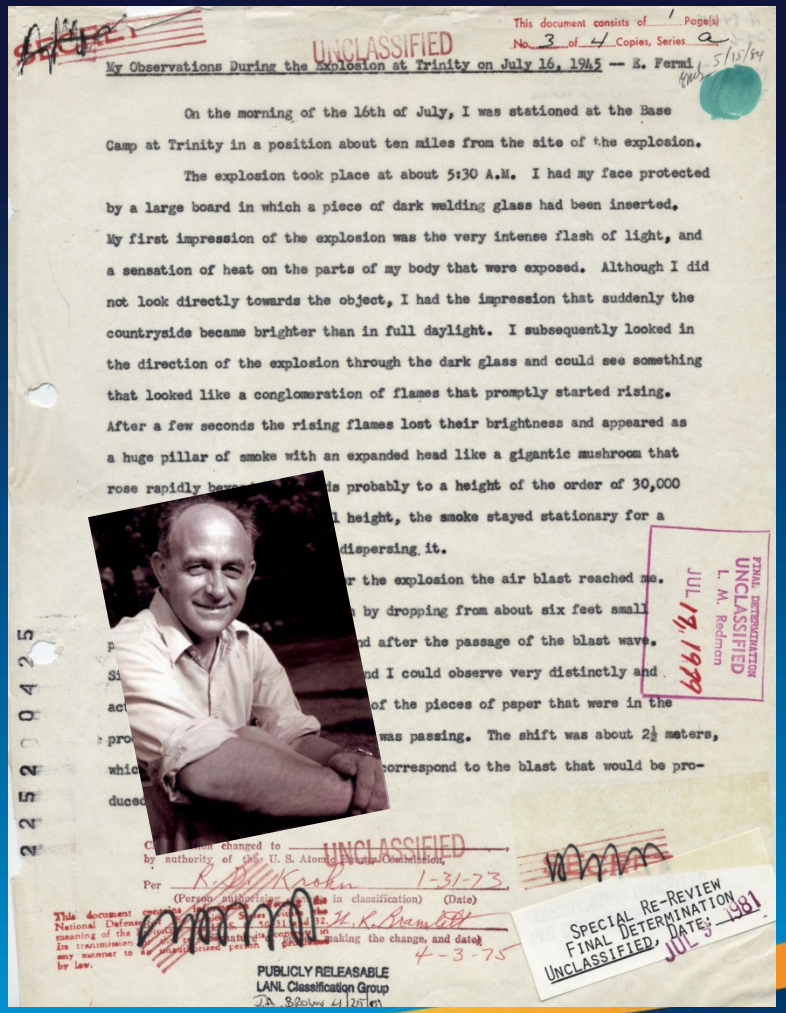
Aero Cameras

Mitchell Cameras

A Sampling of Trinity Footage

Eyewitness Descriptions

- “It blasted; it pounced; it bored its way right through you.” – Isidor Rabi
- “We saw the whole sky flash with unbelievable brightness in spite of the very dark glasses we wore.” – Emilio Segre
- “The thing that got me was not the flash but the blinding heat of a bright day on your face in the cold desert morning.” – Phillip Morrison (from ten miles away at base camp!)
- “It turned yellow, then red, and then beautiful purple.” – Ralph Carlisle Smith
- “It was as though the earth had opened and the skies had split.” – New York Times reporter William L. Laurence



SECRET

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This document consists of 1 Page(s) No. 3 of 4 Copies, Series A

My Observations During the Explosion at Trinity on July 16, 1945 — E. Fermi

On the morning of the 16th of July, I was stationed at the Base Camp at Trinity in a position about ten miles from the site of the explosion.

The explosion took place at about 5:30 A.M. I had my face protected by a large board in which a piece of dark welding glass had been inserted. My first impression of the explosion was the very intense flash of light, and a sensation of heat on the parts of my body that were exposed. Although I did not look directly towards the object, I had the impression that suddenly the countryside became brighter than in full daylight. I subsequently looked in the direction of the explosion through the dark glass and could see something that looked like a conglomeration of flames that promptly started rising. After a few seconds the rising flames lost their brightness and appeared as a huge pillar of smoke with an expanded head like a gigantic mushroom that rose rapidly here[illegible]s probably to a height of the order of 30,000 [illegible] height, the smoke stayed stationary for a [illegible] dispersing it.

[illegible] the explosion the air blast reached me. [illegible] by dropping from about six feet small [illegible] after the passage of the blast wave. [illegible] and I could observe very distinctly and [illegible] of the pieces of paper that were in the [illegible] was passing. The shift was about 2½ meters, [illegible] correspond to the blast that would be pro-duced [illegible]

FINAL DETERMINATION UNCLASSIFIED L. M. Redman JUL 17 1979

changed to UNCLASSIFIED by authority of the U. S. Atomic Energy Commission, Per R. P. Krohn 1-31-73 (Person authorized to make the change in classification) (Date)

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H. K. Brown 4-3-75

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SPECIAL RE-REVIEW FINAL DETERMINATION UNCLASSIFIED, DATE: JUL 3 1981

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The Emotional Aftermath

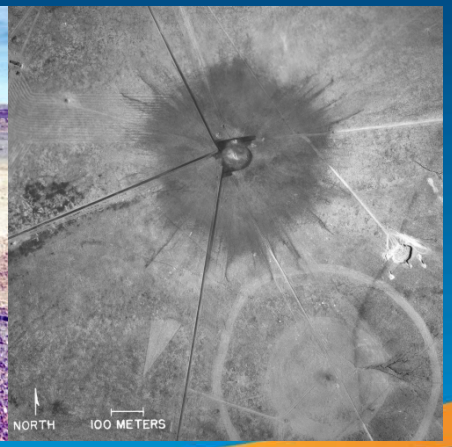
- “Some people claim to have wondered at the time about the future of mankind. I didn’t. We were at war and the damned thing worked.” – Norris Bradbury
- “Well, now we’re all sons of bitches.” – Kenneth Bainbridge
- “Our first feeling was one of elation, then we realized we were tired, and then we were worried.” – Victor Weisskopf
- “The spectacle was tremendous, beautiful, magnificent, terrifying, exciting, humbling, scary.” – Marge Bradner
- “You could see it on their faces. I saw that something very grave and strong had happened to their whole outlook on the future.” – Stan Ulam

“You owe me ten dollars.”
Kistiakowsky to Oppenheimer

The Physical Aftermath

- The blast ejected earth into the atmosphere where it was irradiated, melted, fell back to the ground, and solidified
- This glassy new material was dubbed Trinitite
- An area ~600m wide centered on Ground Zero was coated with Trinitite
- The force of the explosion created a shallow crater Bainbridge estimated to be ~5’ deep and ~30’ in diameter (some estimate it is up to ~10’ deep by ~1200’ wide)
- Only a small portion of the tower’s reinforced concrete footings survived the test



A New Danger: Fallout

- The blast produced a significant amount of radioactive fallout
- On July 14th, Hempelmann and Stafford Warren had set the upper dose limit over a two week period at 75 roentgens
- To put that in perspective, today the permissible dose for a DOE worker is roughly 75r over the course of a lifetime!
- The most significant dose was received by a nearby family: they received as much as 47r over a two-week period
- Cattle in the area fared worse
- The Army purchased 75 of the most injured animals: a herd of Trinity cows and their descendants resided at Oak Ridge for decades

The End of World War II

- On August 6, 1945 Hiroshima was attacked
- 80,000 were killed immediately by the 15 kiloton blast
- On August 8th the Soviet Union declared war on Japan
- On August 9th Nagasaki was bombed
- 45,000 were killed immediately by the 21 kiloton blast
- An armistice was declared on August 14
- Los Alamos received the Army-Navy “E” Award on October 16th

The Legacy of Trinity

- Symbolically, Trinity marked the beginning of the final chapter of Imperial Japan's existence
- Trinity opened a new era in human history; an era in which mankind could destroy itself…
- …but Trinity has also, apparently, helped render global wars obsolete
- Trinity was, arguably, the greatest scientific experiment ever conducted
- It helped usher-in the age of super-science: massive, national, federally-directed research programs
- In that sense Trinity helped set a precedent for the Apollo Program, the Human Genome Project, etc.

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The Trinity Site 70 Years Later

Suggested Reading

- Kenneth Bainbridge, Trinity (LA-6300-H)
- Jim Eckles, Trinity
- Leslie R. Groves, Now it can be Told
- Barton Hacker, The Dragon's Tail
- Lillian Hoddeson et. al, Critical Assembly
- Peter Kuran, Trinity and Beyond (DVD)
- Richard Rhodes, The Making of the Atomic Bomb
- Ferenc Szasz, The Day the Sun Rose Twice

Credits

I would like to thank the following individuals

Howard Coe, LANL Videographer

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Peter “Pete” Kuran, Academy Award-Winning Cinematographer

Glen McDuff, LANL Retiree/Consultant

Ellen McGehee, LANL Historian

Charles McMillan, LANL Director

Steve Obrey, LANL Chemical Diagnostics and Engineering Group

Roger Rasmussen, Trinity Witness

Cary Skidmore, LANL Detonator Technology Group

D. Ray Smith, Y12 Historian