The Manhattan Project.

G B S M U N.

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Letters from Chairs

Welcome to Los Alamos: You are now all part of the most secret and important government project in all of US history. This is a committee in which you will be dealing with the most dangerous and overpowered weapon humankind has ever made. You will be making plans with this bomb, manipulating the bomb, and planning history with the bomb. Are you all ready to be the masters of this new nuclear age?

Hello, I'm Mikaela Streicher and I will be your Chair for the Manhattan Project Committee for GBSMUN 2022. I am very excited to be chairing this committee as this was the turning point for science, military, and political history. Most of the history in the 20th Century and even a little in the 21st Century was commanded by this weapon. And seeing the beginnings being replayed will be invigorating.

This will be my first time chairing a committee. I am currently a Junior and have been in MUN since the inception of my high school career. However, in addition to Model UN, I am also a part of Academic Bowl, Women in STEM, STAND for Peace, Science Olympiad, and Pencils for Promise. Outside of school I also am part of an science educational outreach program at Argonne National Laboratory, which actually came about because of the Manhattan Project.

Thus to finish, I cannot wait until we can see the intersection of science and politics! In the meantime however, if there is anything you ever need, feel free to contact me at 236491@glenbrook225.org.

Let Us Protect Our Homeland!

Hello, my name is Nikhil Ruia and I am your vice chair for GBSMUN 2022. I am a Junior and have been in MUN at GBS for 3 years. I also play on the Junior Varsity Tennis team. In addition to MUN, I am a part of Academic Bowl, Computer Science Club, Interact Club, and Game Design Club. However, Model UN has probably been one of my favorite parts of high school. I am excited to have the opportunity to be a chair in one of the committees. In addition to the Manhattan project, I am very interested in cars and how to build my own. My email is 236442@glenbrook225.org, feel free to contact me for any questions.

Hello, my name is Andrea Lutai and I will be your moderator for GBSMUN 2022 in the Manhattan Project committee. I am a Sophomore and have been part of MUN at GBS for 2 years where my experiences have been most memorable. A little more about me is that I'm on the Track and Field team as well as part of some clubs at GBS such as Key Club, Hellenic Club, and UNICEF. I am very excited to see this committee in action as we have some great topics in store. Also, if you have any questions regarding the committee or topics in general, don't hesitate to ask any questions. My email is 246419@glenbrook225.org.

Content Warning

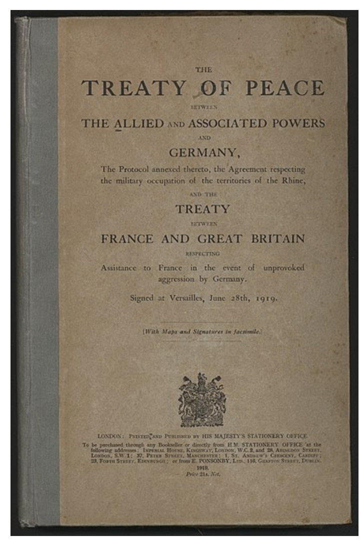
Though historical topics are being discussed and are part of a time in which the country was in turmoil, it is necessary that the committee remains in debate with a 21st Century Mindset.

Therefore, it is imperative that racism, sexism, homophobia, religious intolerance and all forms of discrimination are not tolerated in committee. Any speech, directive and/or crisis arc that uses discriminatory and/or opressive language will not be tolerated and are prohibited, and will result in removal from the conference without warning.

Important to Remember

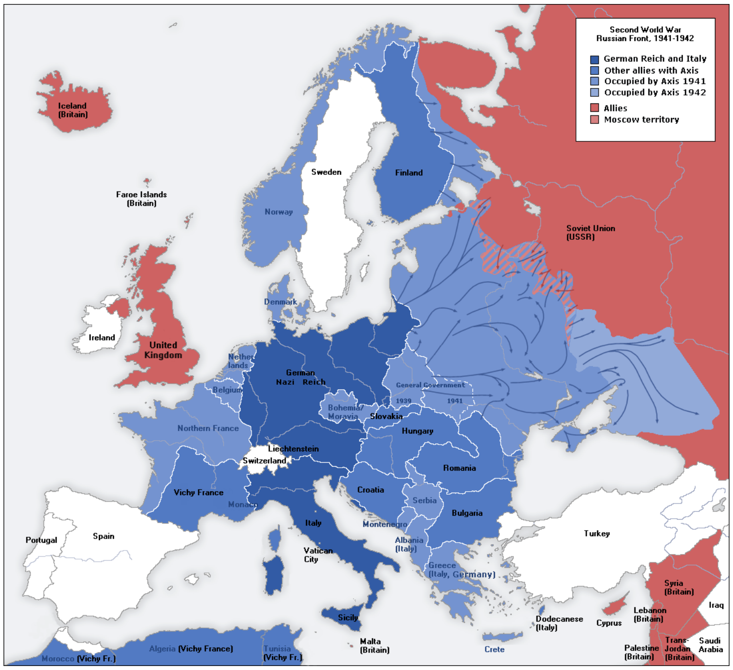
- We will go over basic crisis information in the beginning of the committee for those who are new tpo Model UN.
- This Committee will take place right after the bomb has been essentially fully designed, however it has not yet been tested.
- You are tasked with many different missions, however, you as the delegates will determine exactly where you want this committee to go.
- Partly contradictory to the previous statement, keep conversations of the bomb very much to non-boosted, fission only nuclear weapons. Nonetheless, discussion of thermonuclear weapons will not deduct points for awards, unless it is egregiously out of 1940's knowledge of the atomic bomb.
- There will be information, in committee, about further research that can occur in committee.

World War II History



In 1919, the Treaty of Versailles was signed in the Palace of Versailles in France. The treaty has been criticized by many historians for its "war-guilt" clause. This clause reprimanded Germany as the leading cause for the war and the evils done by the Central Powers. Germany was forced to give up land and more to the Allies, including Alsace and Lorraine to France, overseas colonies to Allied Nations, and the occupation of the Rhine River. In addition, Germany was forced to demilitarize. The treaty put a cap of 100,000 men on Germany's army, axisa cap of 6 battleships, and banned the use of conscription. Finally, Germany was forced to pay billions in reparation to the Allies. Germany was put solely at fault for inciting the war, and this angered them.

In 1933, Adolf Hitler came to power under the Nazi party in Germany. He was a sick but decisive leader who wanted revenge for the wrongdoings imposed on Germany. He began to strengthen the army and navy of Germany, in direct violation of the terms of the Treaty of Versailles. Foreign countries, however, did not act on this, fearing that enforcing the Treaty would trigger more violence from the German state. In fact, America, the United Kingdom, or Russia did not do anything about Germany's malicious actions until 1939. On September 1,

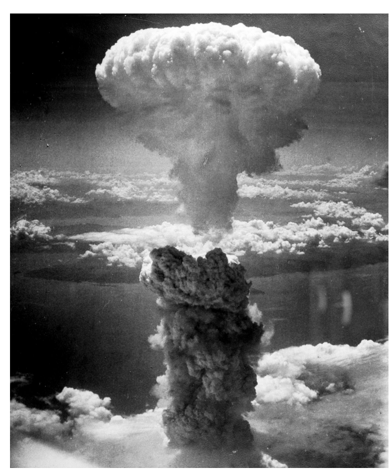


1939, Nazis started an invasion of Poland, a direct act of war. Poland fell to the Nazis in only two months, but the war had already started.

America, Great Britain, France, and the Soviet Union formed the Allied powers to stop the power grabbing of Germany. Germany allied with Italy and Japan to form the Axis powers, who tried to gain land and power.

The Allies were well equipped to fight a war. While in the midst of a depression, the war provided an opportunity to create jobs and get out of the Great Depression. Additionally, the Allies were not harmed by forced reparation like Germany. Financially, the Allies had the upper hand. Militarily, the Allies also had the upper hand. Without the limits on military manpower, America and Britain had a decently sized army who could handle a war from the weak German state. However, the Germans proved that discipline beat out numbers in a war. Germans were highly motivated by the use of propaganda, and were very quick to mobilize. Germans were more prepared for the war, after all, they were the ones who planned it. Germans had better strategies as well, *blitzkrieg*, was a very fast method of destruction utilized effectively by the German army. The doctrines behind the Panzer divisions (tank divisions) were much more effective in punching holes in an enemy's lines than the tanks of the Allies, even though the Allies had more tanks. Germans also used bomber planes, a relatively newer technology, effectively to destroy armies. It was so effective that the Germans forced the entirety of France to surrender in only 6 weeks.

In addition, the Japanese caused problems for the United States. On December 7, 1941, the Japanese attacked Pearl Harbor. This brought the United States into the war, which could have been enough to defeat the Germans. However, the United States' main priority was to bring down the Japanese and their threats against America. Because of this division of power, America was considering the prospect of losing the war. Therefore, in 1939, the Manhattan project started to ensure an Ally victory. This evolved into over 130,000 people working on the atomic bomb. In July of 1945, the atomic bomb was finally created and tested. In August of 1945, Little Boy, the name of the atomic Bomb, was dropped on Hiroshima. A second bomb, Fat Man, was dropped in Nagasaki 3 days later. Japan surrendered a week later. However, our committee takes place months before this, about February of 1945, when the bomb is not fully developed or tested. WB



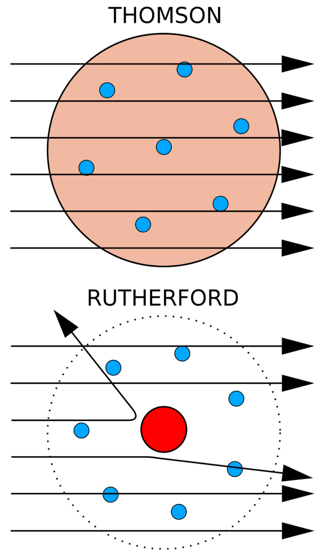
Definitions

Key Terms:

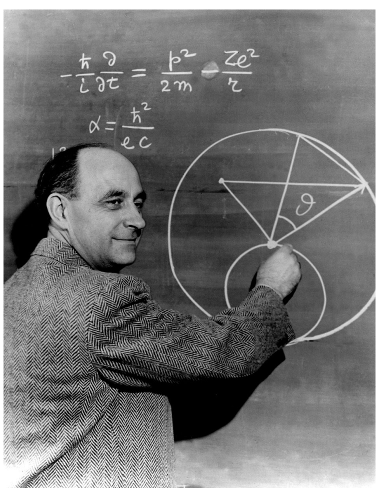
- Atom – The smallest form of an element. This is the level at which the nuclear process with certain Elements takes place (at the atomic level, generally with regards to the atom's nucleus).
- Isotope – Two or more forms of the same element that contain equal numbers of protons, but different numbers of neutrons in the nucleus. The same element, but with a different weight.
- Uranium 235 – The Element Uranium, containing 92 protons and 143 neutrons in it's nucleus. It is radioactive and highly fissionable. It occurs in nature much less than Uranium 238.
- Uranium 238 – The Element Uranium, containing 92 protons and 146 neutrons in it's nucleus. It is radioactive but not as fissionable as Uranium 235. It is the most common form of Uranium in nature.
- Radioactivity – When an atom Element spontaneously gives up energy. This process is described in detail in the section "Science of the Manhattan Project".
- Fission – The process by which a larger element absorbs a neutron, which causes that isotope of the element to become unstable, and in turn split into two (or more) smaller, but stable element isotopes.
- Fissile Material – Are materials that can undergo a Fission reaction. Some elements are too stable for this to occur, and others such as Uranium 235 are very unstable and will Fission easily.
- Chain Reaction – A self sustaining Fission reaction, meaning that the Fission of one atom will result in the Fission of nearby atoms of the same Element, and continue in a chain, until all available atoms have Fissioned.
- Critical Mass – This is the amount of an Element needed to sustain the Chain Reaction noted above. Without a certain amount, what could be a chain reaction will fade out very quickly.
- Separation – The separation of isotopes of a particular Element. Most commonly discussed with regards to the Manhattan Project is separating Uranium 235 from Uranium 238, as a certain amount of Uranium 235 only is needed to have a Critical Mass of Uranium that will sustain a Chain Reaction.
- Enrichment – Is the process of increasing the content of Uranium 235 within a certain amount of Uranium, generally by means of Separation, noted above.
- Electromagnetic Separation – Separation of (Uranium 235) isotopes using magnetic and electric forces.
- Gaseous Diffusion – Separation of (Uranium 235) isotopes (after converting to gas) based on the weight of the isotopes.

Manhattan Project History

Preceding Discoveries:



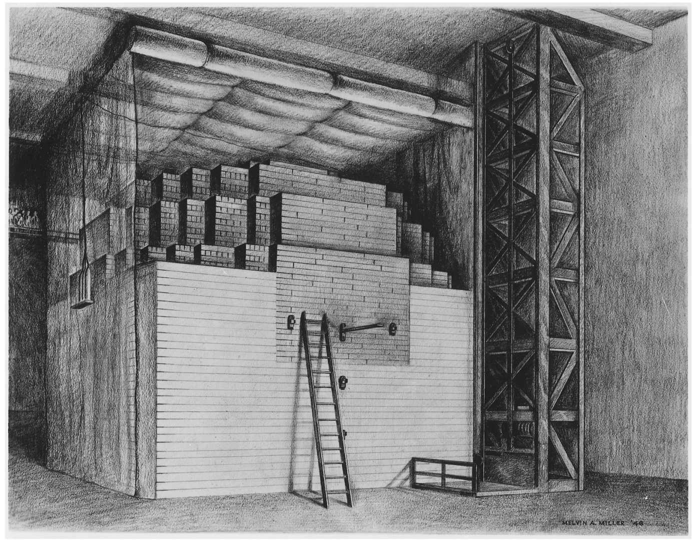
The dawn of the industrial age brought a scientific revolution to our understanding of what makes-up our world. With this, came the understanding of the atom, and eventually some instabilities within certain atoms. For example, in the late 1800's x-rays were discovered in Germany by Wilhelm Roentgen, and radioactivity was discovered in France by Henri Becquerel, both showing that some atoms are not stable, and that high energy particles can come from an atom. Another principal achievement was the description of an atom in 1911 by Ernest Rutherford describing a center to an atom (a nucleus) which contains most of the atom's mass and all of its positive charge (protons). However, Rutherford did not know yet about the existence of the neutron (also contained in the nucleus), which James Chadwick discovered in 1932. With the discovery of neutron, new scientific theories about the nucleus (comprising multiple protons and neutrons) led to theories about potential instabilities within an atom based on previous discoveries of radioactivity. Leo Szilard in 1933 conceived that it may be possible to split an atom with a neutron, and even conceived that it may be possible to cause a chain reaction of atoms splitting that could release a lot of energy. That release of energy, Leo Szilard theorized, could be utilized in a military fashion to create an uncontrolled detonation, a.k.a. a bomb. A year later, Szilard filed patents regarding chain reactions through neutrons and a critical mass of a substance necessary for an uncontrolled explosion. The interesting fact about Szilard's theories are that they were proposed long before the actual discovery of nuclear fission.



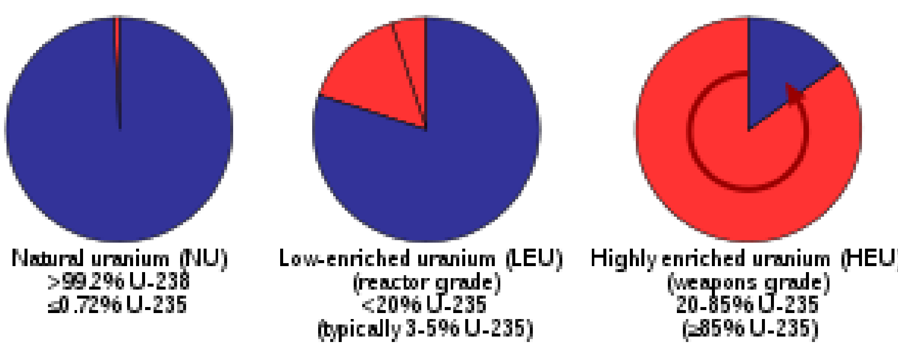
Meanwhile in Italy in 1934, Enrico Fermi and a group of scientists, unbeknownst to them, split Uranium through bombarding it with neutrons. Thought they found it odd that the Uranium had different than expected radioactivity after the neutron bombardment. They had thought possibly they created an element heavier than Uranium, but they had not realized they had split the Uranium atom into other smaller atoms of different elements. The same year, following examination of Fermi's hypotheses, Ida Noddack indicated in a published paper that the unexpected radioactivity may be the Uranium splitting into smaller pieces (atoms of other smaller elements). Though she had correctly theorized 'nuclear fission', it was not fully accepted until it was confirmed by other scientists about 4 years later.

Fission and Weaponization:

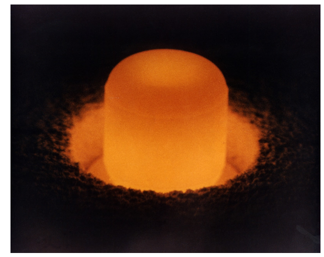
After Ida Noddack's publication, Fermi did more research (e.g. experimenting on the speed of neutron bombardment to heed different results), as did a few other scientists such as Arthur Dempster who figured out that Uranium had different isotopes, in particular U-235 (with 92 protons and 143 neutrons) vs. the more naturally occurring U-238 (with 92 protons and 146 neutrons). Other scientists working off this theory of the atom splitting, such Otto Hahn, Lise Meitner, Otto Frisch and Niels Bohr, had successfully figured out the Uranium atom had indeed split into atoms of lighter elements and were able to provide the theoretical model and mathematical proofs of what was then termed as nuclear fission. [The actual mechanics of nuclear fission will be described in the section of the background guide titled "The science of the M.P.".] In 1939, upon hearing about this additional research and confirmation of the theory of nuclear fission, independently of each other both Robert Oppenheimer and Leo Szilard come to the conclusion, that during the process of the Uranium atom splitting into smaller atoms of lighter elements, this nuclear fission will produce excess neutrons not needed in the smaller atoms. This provides additional support for Szilard's chain reaction theory, in which the excess neutrons could, in turn, split additional Uranium atoms creating even more additional neutrons which again could split more atoms. Oppenheimer, utilizing Szilard's theory of a critical mass (of Uranium) conceived that a certain amount of Uranium could possibly produce an uncontrolled chain reaction of atoms splitting, that would happen extremely quickly and with incredible energy, such that if properly prepared, could be turned into a bomb.



Additional tests and discoveries began to solidify the thought that an atomic chain reaction could be used as a weapon. For example, Niels Bohr demonstrated that the different isotopes of Uranium (U-235 and U-238) had different properties of nuclear fission. Most importantly, he determined that U-235 was less stable, and would undergo fission more readily than U-238. Along with that, other scientists did various experiments, some independently, some in collaboration, to test different theories and analyzed different variations of nuclear fission, as well as testing multiples methods to sustain a nuclear chain reaction.

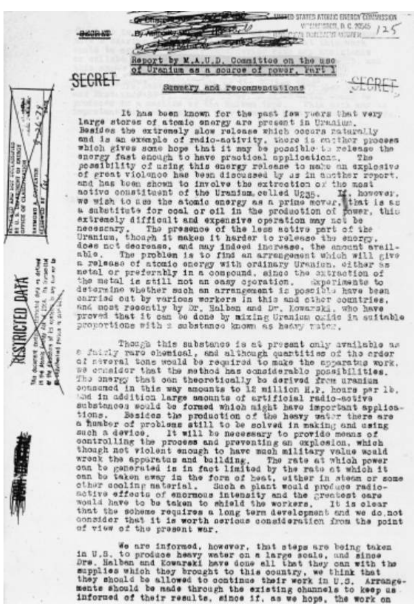


After the onset of World War II near the end of 1939, an advisory committee on Uranium is created by President Roosevelt to explore the possibility of a military weapon based on a nuclear chain reaction, in part from the behest of the US Physics community, including Albert Einstein, in order to develop such a weapon before the Germans.



Theoretical estimates and testing were concentrated in determining what type of fission would be most effective and how much Uranium would be required as a critical mass to sustain such a reaction with the desired explosive capability. Throughout 1940, experiments confirm that U-235 is best suited, and British scientists estimate two pounds of Uranium would be required, while US scientists estimate only one pound. [In the end, the first Uranium bomb contained about 120 pounds of Uranium, though it is believed that only 1-2 pounds underwent the actual explosive nuclear fission.] While the fissionable aspects of U-235 were known and actively experimented, it was actually theorized that a yet non-existent (or at least not yet discovered) element, Element 94 (with 94 protons and 145 neutrons) would be highly fissionable like U-235.

During 1941, scientists (such as Glenn Seaborg) aggressively tried to create this element by adding neutrons to Uranium-238. They created Element 93, which almost instantaneously radioactively decayed into Element 94 with 145 neutrons), and it was shortly confirmed this



[redacted] UNITED STATES ATOMIC ENERGY COMMISSION 125

SECRET

Report by M.A.U.D. Committee on the use of Uranium as a source of power, Part I

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Summary and recommendations

It has been known for the past few years that very large stores of atomic energy are present in Uranium. Besides the extremely slow release which occurs naturally and is an example of radio-activity, there is another process which gives some hope that it may be possible to release the energy fast enough to have practical applications. The possibility of using this energy release to make an explosive of great violence has been discussed by us in another report, and has been shown to involve the extraction of the most active constituent of the Uranium, called U_{235}. If, however, we wish to use the atomic energy as a prime mover, that is as a substitute for coal or oil in the production of power, this extremely difficult and expensive operation may not be necessary. The presence of the less active part of the Uranium, though it makes it harder to release the energy, does not decrease, and may indeed increase, the amount available. The problem is to find an arrangement which will give a release of atomic energy with ordinary Uranium, either as metal or preferably in a compound, since the extraction of the metal is still not an easy operation. Experiments to determine whether such an arrangement is possible have been carried out by various workers in this and other countries, and most recently by Dr. Halban and Dr. Kowarski, who have proved that it can be done by mixing Uranium oxide in suitable proportions with a substance known as heavy water.

Though this substance is at present only available as a fairly rare chemical, and although quantities of the order of several tons would be required to make the apparatus work, we consider that the method has considerable possibilities. The energy that can theoretically be derived from uranium consumed in this way amounts to 12 million H.P. hours per lb. and in addition large amounts of artificial radio-active substances would be formed which might have important applications. Besides the production of the heavy water there are a number of problems still to be solved in making and using such a device. It will be necessary to provide means of controlling the process and preventing an explosion, which though not violent enough to have much military value would wreck the apparatus and building. The rate at which power can be generated is in fact limited by the rate at which it can be taken away in the form of heat, either in steam or some other cooling material. Such a plant would produce radio-active effects of enormous intensity and the greatest care would have to be taken to shield the workers. It is clear that the scheme requires a long term development and we do not consider that it is worth serious consideration from the point of view of the present war.

We are informed, however, that steps are being taken in U.S. to produce heavy water on a large scale, and since Drs. Halban and Kowarski have done all that they can with the supplies which they brought to this country, we think that they should be allowed to continue their work in U.S. Arrangements should be made through the existing channels to keep us informed of their results, since if, as we hope, the work on

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Element had an even higher explosive capacity than Uranium. Despite the usefulness of Uranium-235 and the new Element 94 (now called Plutonium and its particular isotope Plutonium-239), the Uranium that mostly occurs naturally is U-238, and in addition to that, is not just pure Uranium. So it must first be separated from other materials, and then 'enriched' converted from U-238 to U-235 to be useful. The methods and cost to do this in any useful quantities is extremely expensive and fairly difficult. Different processes were developed in 1941. Several additional committees were formed during these times to help the scientific community and military engage in these tasks; The National Defense Research Committee (NDRC) and The Office of Scientific Research and Development (OSRD), as well as sister committee in Britain known as the code-name MAUD Committee (not an abbreviation). As the US entered the war, things really picked up, and the foundations of the official project were laid. Strategies and locations and were chosen for various separation and enrichment activities in December 1941. In January 1942, Roosevelt officially approved production of a nuclear bomb. Manhattan, NY and Berkeley, CA were selected separation and enrichment areas. Chicago, IL is selected as a location for the enriched Uranium stockpile and reactor testing, and for possible Plutonium production. In addition to different methods for separation and enrichment of Uranium, and production of Plutonium, different designs for the bomb itself, in particular, how the critical mass would be put together, and how it would be triggered, had to be considered.

Because organization of all these projects was so disparate, Brig. Gen. Wilhelm Styer ordered Col. James Marshall to organize a U.S. Army Corps of Engineers District to head up the development. On 13 AUG 1942 the Manhattan District Corp was established (the official start of the Project). In September 1942, Col. Leslie Groves based on his previous success with large projects is appointed head of the Manhattan Project. The following day he purchases 1250 of top Uranium, and the day after selects another Uranium separation location in Oakridge TN. The day after that he is given the Army's highest procurement authority, and within a week is promoted to Brigadier General. In October 1942 Gen. Groves orders long debated Plutonium production decisions be made within a week.

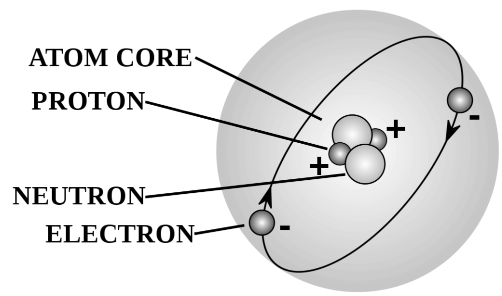
Shortly afterward in November 1942 he selects Los Alamos NM for the location the laboratory for physics research and weapon design, also known as Project Y. Robert Oppenheimer is selected to lead this location scientifically as the lab director. By December 1942, gaseous diffusion, is chosen as the primary enrichment method, even though some design theory was lost due to secrecy with the British, as another method, centrifuge separation, had too many technical problems. But in 1943, Oak Ridge is equipped for electromagnetic separation and Plutonium separation. Meanwhile Hanford WA is also selected as a site for Plutonium production. For the next two year separation and enrichment of Uranium accelerate at each of the designated sites (though each type encountering it's own problems, with reprioritization of the methods happening throughout that time), while the potential for the sufficient production of Plutonium also begins to become a realistic possibility. In addition to that, airplane bombers were being reconfigured to carry what was to be a very heavy payload. And aerodynamic testing was conducted on bomb delivery. Likewise the two main ideas for assembling and exploding a critical mass for the bomb were actively pursued; a gun type assembly (shooting one piece of fissile material to another to achieve critical mass) and an implosion method (compressing a 'loosely' packed fissile material into a tightly packed critical mass). It is now spring of 1945, and your task will now be to select the best method for assembling and exploding a critical mass for the bomb, choosing how the components will be selected, assembled, and to decide on which additional components may be necessary. You will also need to test your selections and decide upon a delivery. Good luck. Your hard work, amazing scientific knowledge, and perseverance will help us succeed. With greatest regards, Gen. Leslie Groves.

Science of the Manhattan Project (MP)

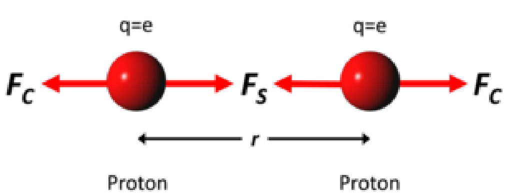
General Nuclear Science:

To understand the bomb and how the science discoveries of the 20th Century played a role in developing the bomb, we must have a basic understanding of the science behind it. Additionally, the physics package of the bomb needs to be made in such a way that allows itself to be useful militarily. Thus, the bomb needs to be able to detonate when the US Army would want it to detonate, be small enough to be carried in a plane, and be able to detonate in such a way that it doesn't harm any of the soldiers when released. Essentially, the bomb needs to be weaponized.

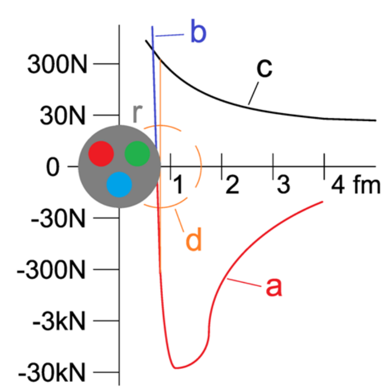
Disclaimer: What will be written is what was known about the specific Mk 1, Mk 2, and Mk 3 bombs during the Manhattan Project. Though Edward Teller was devising a hydrogen-bomb at this time, this will not really be described in detail in any capacity in this background guide. Thus, First Generation Nuclear Weapons will be what the committee's primary focus will be.



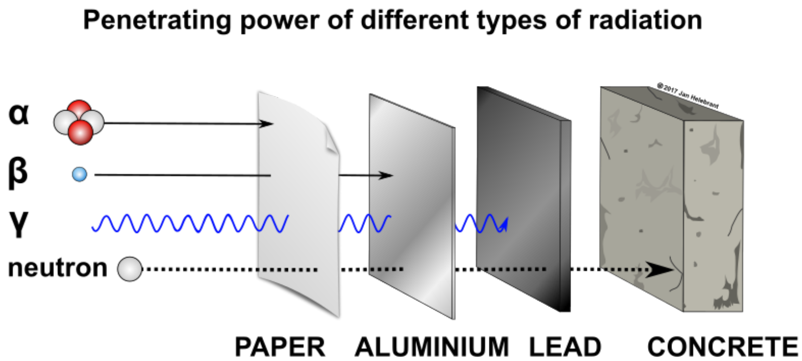
The atom is where our story starts. The structure of the atom consists of a nucleus that holds protons (which are positively charged) and neutrons (which have no charge), surrounded by empty space and electrons (which are negatively charged) buzzing around. The electrons having no specific use in the creation of the atomic bomb, we will focus our attention on the nucleus. Within the nucleus, as mentioned, there are both protons and neutrons. The protons, influenced by the electromagnetic force, naturally repel against each other, because they have like charges. However, the atom's nucleus does not break apart because of a greater force holding them together, called the 'strong nuclear force', which binds the nucleus together through gluons (which are essentially particles holding the protons and neutrons like glue). This phenomenon is somewhat analogous to holding two magnets of the same end charge next to each other. The electromagnetic repulsion is noticeable, but a person with the force of their hands can push the two magnets together regardless, which can be likened to the strong nuclear force.



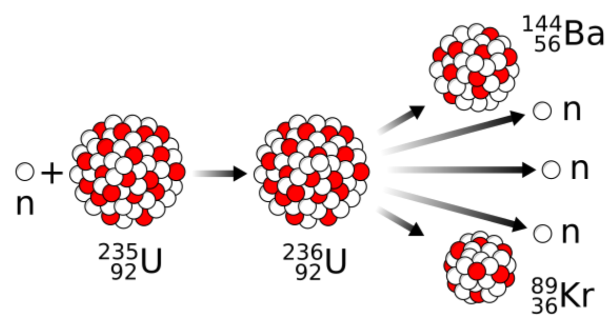
Nonetheless, even though the strong nuclear force can overcome the electromagnetic repulsion in an atom's nucleus, it is only strong in extremely small distances, so eventually, as a nucleus grows in size with the addition of more protons, it is difficult for an atom to stay together. The addition of more neutrons will help the strong nuclear force bind the nucleus, which is why heavier elements often have many more neutrons than protons. But at a certain point the nucleus becomes unstable, and thus it must release energy, and sometimes a part of itself, as a way to gain stability. That is called radioactivity and it can happen in multiple ways.



For example, in an unstable atom Alpha decay occurs when a helium nucleus is ejected from the unstable atom (e.g. the atom changes to a lighter element when it loses two protons while creating a new helium nucleus). Beta decay occurs when a nucleus contains too many protons and neutrons, and to stabilize itself, will (through a complicated process not described here) either convert a neutron to a proton or convert a proton to a neutron (changing to an element higher or lower than the original element itself). Or Gamma decay occurs as simple release of an electromagnetic high-frequency wave (as a gamma ray) in order to release excess energy, but in this case the nucleus is the same and does not change elements.

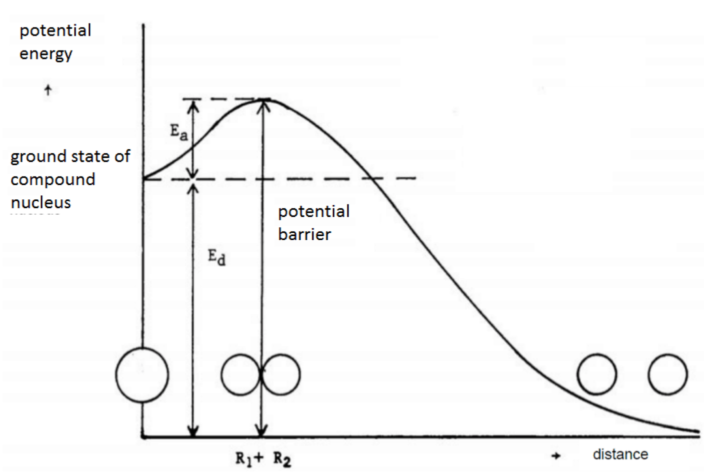


However, there are a few additional things to note. First, these radioactive decays can occur naturally, or can be brought out artificially through the bombardment of an atom with a neutron or some other particle, but generally with a neutron. Additionally, the neutrons, depending on the speed at which they come toward the nucleus, can change the outcome of what type of decay occurs. Another thing to note is that there are times in which the basic radioactive decays mentioned above are not enough for the atom to gain stability. Instead the atom may split itself in half (or close to half) which is nuclear fission. For example, an atom of Uranium-235 that gets hit with a neutron of any speed, will for a millisecond absorb the neutron and become Uranium-236, but then, because of the new unstable energy that it cannot hold, it will break into Barium with 56 protons and Krypton with 36 protons and release three free neutrons not associated with any atom.



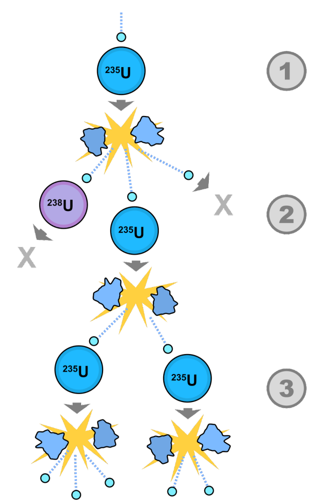
This is not the only way uranium can split, but it does demonstrate that neutrons are released in the process, which is what makes a nuclear bomb possible. Because of these other neutrons, if there are other atoms of a fissile (able to undergo fission) material nearby, they can also absorb a neutron and undergo the same fission process just described. That in turn will also release more neutrons and those neutrons could continue to be absorbed by other atoms that again fission, and so on. And so, if enough fissile material is close together, a release of neutrons that bombard into additional fissile atoms can exponentially create a fission of atoms into a chain reaction. And the amount of energy that is released from one fission can be up to a million times greater than the amount of energy from breaking chemical bonds, such that the release of energy from a chain reaction could be so great that it could obliterate a city.

But the issue is that an element needs to be able to undergo fission with low neutron bombardment energy, and there are only a few atoms capable of doing so. Also, one needs to have enough material for the nuclear chain reaction, to not burn out so quickly as to not be a bomb at all.

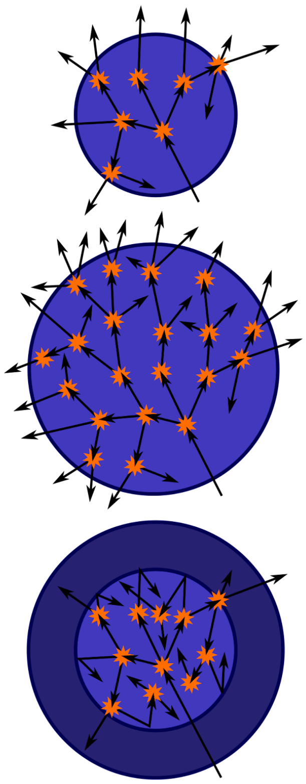


Only a few elements are inherently radioactive, meaning there are no known stable isotopes of that element. And out of those, there are even less that are fissile and have enough of an ability to overcome the nuclear fission energy barrier. Plutonium-239 and Uranium-235 are two of these such elements. They have an even number of protons but an odd number of neutrons which helps the isotope, when bombarded with a neutron, even a slow one, to have enough energy to undergo fission. That's because there is an increase in the energy through the neutron, but also because the pairing of the odd neutron helps to increase its energy level.

On the other hand, for example, Uranium-238 has both an even number of protons and neutrons and thus when bombarded with a neutron it now has an unpaired neutron, and now wishes to do something with that extra neutron. Typically, U-238 when bombarded with neutrons becomes U-239 and will undergo beta minus decay and turn into Neptunium-239 because that stray neutron was turned into a proton. Again, after a few days, because Ne-239 is unstable, that will undergo beta minus decay and transmute into Pu-239. This process was used in the Hanford Breeder Reactor site in Hanford, WA and was to used help make the Plutonium that could be utilized in an atomic bomb. So the solution to the problem of which elements would be utilized for a chain reaction was solved by enriching U-238 into U- 235, and also by producing Pu-239 from U-238 through neutron bombardment.



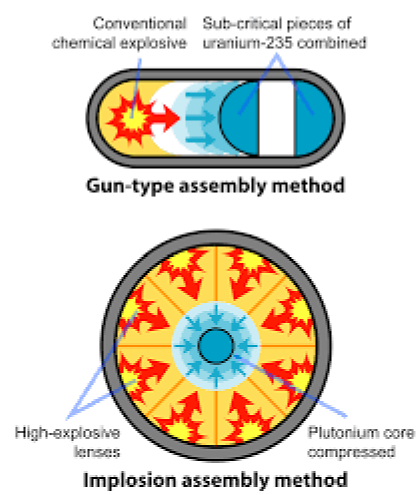
Nonetheless, there is still another factor to be considered, and that is the amount of fissile material needed to detonate an atomic bomb. This amount required is called a 'critical mass'. It is determined by the mass in which the neutrons are in equilibrium with the desired detonation of the material, meaning the number of free neutrons created through the fission process is equal to the amount of neutrons that are needed to keep a fission chain reaction going. However, because we want an uncontrolled explosion, we will need a supercritical mass in which the newly free neutrons continually bombard other atoms causing those atoms undergo fission. Essentially, the rate of neutron loss by absorption is not as great as the rate of creation of free neutrons made through fission ($k > 1$).



Yet, we need to delay creating a critical mass in the bomb until the moment it is desired to have it explode, otherwise the chain reaction and explosion would happen too early. There needs to be some way to keep the fissile material in subcritical form, and then turn it into a supercritical mass that can be used to make a bomb, at just the precise moment. There are two main methods of achieving this. A gun type method and an implosion method, with either uranium-235 or plutonium-239.

A gun type method would have two cylinders of fissile materials that would be mated together at the desired time of explosion to allow for supercritical mass, while an implosion device would have a sphere, possibly hollow (though not necessarily) and use chemical explosives to push in the sphere from all directions (like squeezing a ball) making it dense enough to reach critical mass. Though with either of these methods, other factors such as the size, shape, density, the elemental composition of the pit (the core of fissionable material in the bomb), or even if a reflector is present (which reflects free electrons back into the pit to increase bombardment) will all need to be considered in order to determine the needed critical mass to reach a sustained uncontrolled chain reaction.

Some methods of getting to this critical mass are more efficient than others. For example, neither of the gun implosion bombs (the Mk 1 code-named Little Boy for the uranium gun or Thin Man for the plutonium gun) are very effective, however the Thin Man was drastically more in-effective because of the length needed to keep the two components separate before the desired explosion. Thus, in this committee, you will need to make sure you have an efficient enough bomb design to make sure that you use as little fissile material as possible. This is because there is a limited supply of raw Uranium ore than can be obtained, and within that limited raw Uranium, only a very small amount of U-235 (the isotope of Uranium needed to build a bomb) occurs naturally within the ore (the ore contains only 0.7% of U-235, because U-238 is the most naturally occurring isotope).



And while processes were developed separate and extract U-235 from U-238 (known as enrichment), they are expensive and not particularly efficient, so only a limited supply of U-235 can be obtained through enrichment. Also, Uranium is needed to create the Plutonium bomb, because it is depleted Uranium (the U-238 that is left over from the enrichment process) that is bombarded with neutrons in a breeder reactor to make Plutonium. In addition to the fact that Uranium is needed to make either bomb, to achieve supercritical mass, there needs to be enough of the correct isotope as to not let the reaction die out. This means trying to get as much pure Uranium-235 or Plutonium-239 as possible, while making sure U-238 and Pu-240 is as limited as possible.

So, you will need to ensure there will be enough Uranium ore extracted and Plutonium-Uranium fuel made to ensure there is enough of the correct isotopes required. However, the amounts of Plutonium and Uranium needed for critical mass differ, and so depending on the element you will need different masses. Which you can consider playing out as a decision to be made in committee, because not as much Uranium ore is needed to make Plutonium, per se, as needs to be made as Uranium-235, so you might need less Uranium ore, though it may take longer to make, and there is no guarantee that the Plutonium bombs would work.

<u>Weaponization Science:</u>

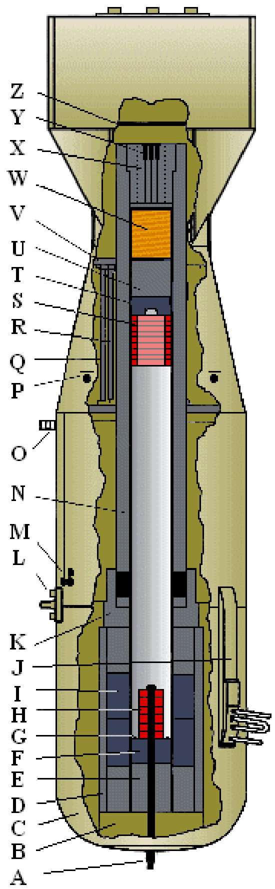
Most of what is written above are the basic nuclear physics needed to understand the workings of an atomic bomb, but the Uranium by itself is just a physic package, and to create a weapon from that is actually a lot more complex than just that piece of it. One cannot just place to pieces of Uranium together to make a critical mass. The most obvious question being, how do I put the two pieces together, to make the critical mass, without blowing up myself. Two methods were proposed. A gun barrel type system, where one piece is shot quickly towards another to reach critical mass, and an implosion type device where loosely pack material is compressed together by some means to reach critical mass through increased density.

In addition to putting the two pieces together, one had to consider how much material is put together, in what manner it is put together, how fast it is put together, and when it is put together. Therefore, one then had to answer all of these questions and more, which was essentially answering how to arm and when detonate the bomb. And even beyond that, other questions, such as enhancing the likelihood of a chain reaction by means of additional 'starter' neutrons to ensure initiation of a chain reaction need to be considered. Yet on top of that, other components, such as a timer or an altimeter (or method of gauging the distance of the bomb to the ground as it falls) needed to be taken into account in order for the explosion to happen at the desired altitude.

Planes had to be redesigned to be able to deliver the bombs. They had to be redesigned to fly at high altitudes, long distances, and carry heavy payloads. Bay doors had to be redesigned, and the plane had to be able to maneuver easily and get away quickly after delivering the bomb. Numerous test runs had to be made in order to test the weight, size, shape, ballistics, and arming of the bomb before the first one could be successfully dropped.

Mk. 1: [enunciated as Mark 1]

Code named Little Boy, the 'mk one' bomb was designed as the gun-type assembly with Uranium used as the fissile material. At the time of it's use, the Little Boy used nearly the entire stock of U-235 produced up to that time. It had to take many considerations into account regarding its specific design. For example, the shape of the Uranium pieces had to be able to be brought quickly together in a 'gun-barrel' without damage. A hollow cylinder was chosen as one half with another smaller cylinder to fit inside chosen as the other half. The design also had to take into account stopping the fast moving piece to fit with the other in order to create the critical mass. It



Cross-section drawing of Y-1852 Little Boy showing major mechanical component placement. Drawing is shown to scale. Numbers in ( ) indicate quantity of identical components. Not shown are the APS-13 radar units, clock box with pullout wires, baro switches and tubing, batteries, and electrical wiring. (John Coster-Mullen)

Z) Armor Plate
Y) Mark XV electric gun primers (3)
X) Gun breech with removable inner plug
W) Cordite powder bags (4)
V) Gun tube reinforcing sleeve
U) Projectile steel back
T) Projectile Tungsten-Carbide disk
S) U-235 projectile rings (9)
R) Alignment rod (3)
Q) Armored tube containing primer wiring (3)
P) Baro ports (8)
O) Electrical plugs (3)
N) 6.5" bore gun tube
M) Safing/arming plugs (3)
L) Lift lug
K) Target case gun tube adapter
J) Yagi antenna assembly (4)
I) Four-section 13" diameter Tungsten-Carbide tamper cylinder sleeve
H) U-235 target rings (6)
G) Polonium-Beryllium initiators (4)
F) Tungsten-Carbide tamper plug
E) Impact absorbing anvil
D) K-46 steel target liner sleeve
C) Target case forging
B) 15" diameter steel nose plug forging
A) Front nose locknut attached to 1" diameter main steel rod holding target components

"Atom Bombs: The Top Secret Inside Story of Little Boy and Fat Man," 2003, p 112.
John Coster-Mullen drawing used with permission

also had to take into account, first a material around the outside of the Uranium that would help hold the pieces together before the chain reaction blew it apart, but also to help reflect neutrons back into the Uranium to bolster the chain reaction.

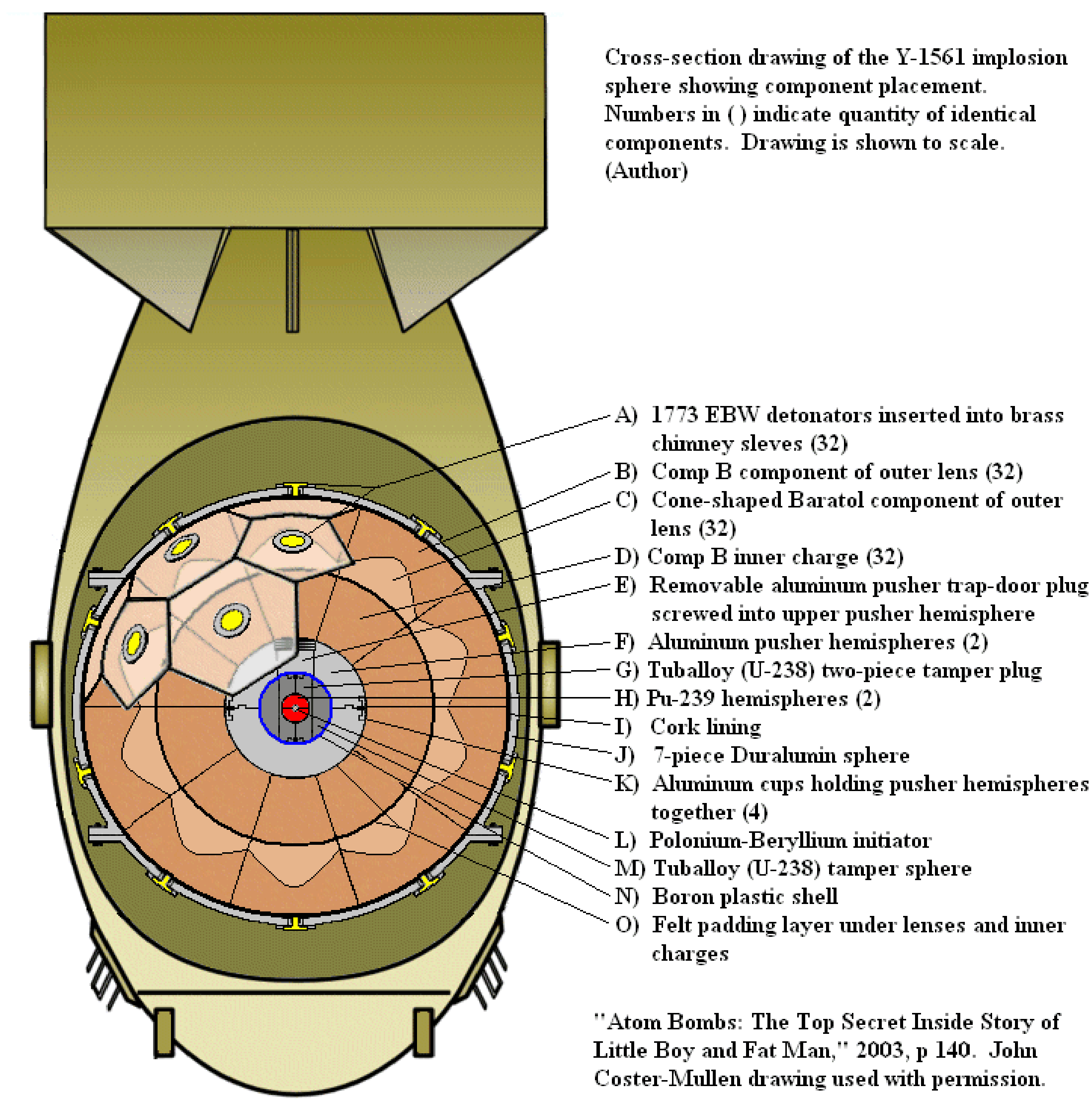
But it also had to have a mechanism to start the gun at the precise time after dropping from the plane. This was achieved through several, purposefully redundant mechanisms. One was a set of timers, carefully calibrated after high numbers of practice runs, another was a set of altimeters, and another was 4 sets of radar (but these did not activate until the bomb had fallen to a certain height determined by the timers and altimeters, to avoid enemy radar detection); 1 radar to establish the altitude more accurately than altimeters, and another to confirm it before activating the system, with 2 additional as back ups in case either of the other 2 did not work.

Little boy was also of its own particular shape. As a gun barrel design, the part containing the Uranium was long and skinny, and the rest was a tail added on to help recreate know bomb shape ballistics, so that it would drop in a certain formation once released from the plane. And the pilots also had to practice maneuvering quickly away from the oncoming explosion, considering how they expected the size and velocity of the explosion to be.

Additionally the bomb contained ‘safing’ plugs. The plugs prevented premature detonation of the bomb (in flight on the way to the destination). These were plugs that blocked the internal circuitry from arming. A green plug was used to block the circuit, and only replaced with a red plug which activated the circuit, just before the bomb itself was dropped. So you see, there are far more things to consider than just making the Uranium explosive, and this still does not cover all the necessary aspects.

Mk. 3: [enunciated as Mark 3]

Code named Little Boy, the ‘mk three’ bomb was designed as the implosion-type assembly with Plutonium used as the fissile material. The Fat Man had most of the same mechanisms and



Cross-section drawing of the Y-1561 implosion sphere showing component placement. Numbers in ( ) indicate quantity of identical components. Drawing is shown to scale. (Author)

"Atom Bombs: The Top Secret Inside Story of Little Boy and Fat Man," 2003, p 140. John Coster-Mullen drawing used with permission.

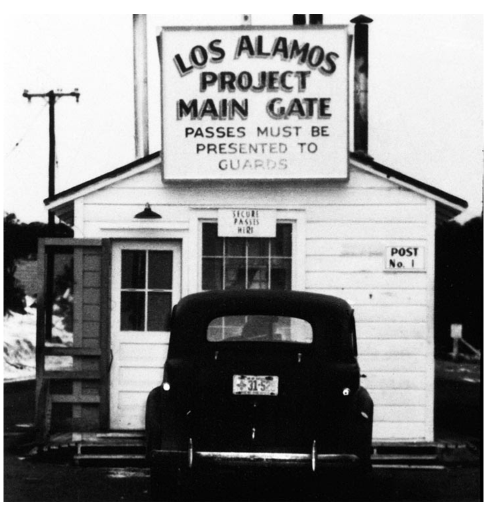
redundancies as Little Boy, but the implosion-type assembly itself used in Fat Man was far more complex than the gun-type used in Little Boy, though if created properly, it was far more efficient than the gun type, in that much less material was needed for a certain size explosion to occur.

The implosion method relied on compressing the Plutonium into itself, so that once it reached a certain density it would become a critical mass and start a chain reaction. This was accomplished by means of an explosion, but the complexity involved comes from the fact that the Plutonium had to be surrounded by a series of shells, 7 in fact, made with various materials for various functions. Some to hold things in place, with others (such as a U-238 shell) to enhance the reaction, and others to keep neutrons in check before detonation, and others to reflect neutrons back to the sphere during detonation. On top of all that, were shells containing explosives to compress the Plutonium. The best arrangement of these explosives turned out to be something like a soccer ball, with each panel containing an explosive, with the panel being nicknamed 'lenses'. It was crucial that the explosives were simultaneous, so that the compression would happen evenly from all sides.

To add complication, Plutonium can come in varying densities to start with, so the proper density of Plutonium selected had to be compatible with the compression of the implosion device. Similar to Little Boy, the aspects of the Fat Man's ballistics had to be dealt with. Because the internal explosive portion of Fat Man was essentially a ball, the design of the bomb was almost round in the front portion, but a more aerodynamic nose was put on the 'front' of the bomb, while the typical 'wings' were added to the tail portion of the bomb. So again you see, there are far more things to consider than just making the Plutonium explosive, and again this still does not cover all the necessary aspects.

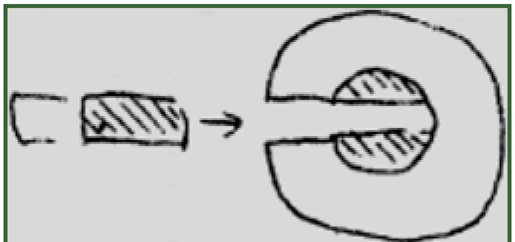
History of Los Alamos National Laboratories

Los Alamos laboratory in New Mexico was one site, out of a number of sites, around the United States selected as part of the Manhattan Project for a particular, and secretive, process in the development of the Atomic (Nuclear) Bomb. Originally code-named "Project 'Y'", the Los Alamos site was dedicated to the design and manufacturing of the Bomb itself. Whereas some sites, for example, were for research on the feasibility of the fission of Uranium and Plutonium, some sites for the m separation of Uranium from other materials, some sites for the production of Uranium and Plutonium, and other sites for the enrichment of Uranium from U-238 into U235 (into weapon/bomb grade Uranium).



Robert Oppenheimer was selected by General Leslie Groves to be the lab director and lead scientist at Project Y / Los Alamos, because he was very convincing to General Groves on the need for strong scientific principles and coordination, but secrecy, of the Manhattan project, despite his relative inexperience as both an administrator and scientist in comparison to those he would lead (some were already Nobel Prize winning scientists). But he was found to be an extremely effective leader in helping the other scientist to excel and exchange ideas.

While the properties of Uranium and Plutonium were fairly well understood by the time Los Alamos began to work as a highly functioning laboratory, full of world-renowned scientists, the principles of fission were still only theoretical and had never been tested. The mandate of Los Alamos was to design a bomb based on these fission principles for both Uranium and Plutonium. Designs to create a theoretical ‘critical mass’ necessary to sustain a fission ‘chain reaction’, how to create the critical mass without detonating before the desired time (pre-detonation), and to determine how long the chain reaction would be sustained were the major tasks at hand for the group of scientists. Below are early designs created for what would be the Little Boy gun-type design for a Uranium bomb on the left and the Fat Man implosion-type design for a Plutonium bomb on the right.



Early diagram of a possible gun-type design. This is a sketch from Robert Serber's “Los Alamos Primer,” April 1943.

Early diagram of a possible implosion design. This is a sketch from Robert Serber's “Los Alamos Primer,” April 1943.

While the gun-type assembly originally seemed to be the simplest and easiest design, it actually turned out that the gun-type assembly had a higher risk of pre-detonation with Plutonium, while an implosion-type assembly (imploded at high speeds) required less material, did not require as much highly enriched material, and was more efficient in the explosion. Thus, it made sense to give good consideration to an implosion-type device, because as a weapon they could be manufactured more quickly and less expensively than what was needed for a gun-type assembly.

Though neither type of assembly would be meaningful without the sufficient production of (enriched) Uranium or Plutonium. This is how the other sites of the Manhattan Project (in particular Oak Ridge, Tennessee and Hanford, Washington) played an important role in the development of the bomb. The site at Oak Ridge was able to successfully enrich enough Uranium for a bomb, while the site at Hanford was able to produce enough Plutonium for a bomb.

With the war in Europe essentially concluded, the war in the Pacific was still ongoing, and plans were being made to possibly make use of these bombs against the Japanese. But still no actual bomb had been built or tested. Through the direction of Robert Oppenheimer (with the authority bestowed upon him through the President and General Groves), your assignment for this MUN Committee is to consider designs (for example, a gun-type or implosion-type), choose as a group of scientists what you believe to be the design, and a create test (with either Uranium or Plutonium) for the most effective (e.g. in terms of ease of construction, cost of construction, reliability, and avoiding predetonation).

Topic A - Secrecy

Recent Updates

Every member of the Manhattan project has been sworn to secrecy. However, only a few days ago, we got dubious information that the Japanese government has been made aware of our plans. However, we don't know much. What we do know is that they have mysteriously started mining Uranium. It could be for some other purpose, as its metallic elements if depleted of radioactive material can be good as ballasts for ships. Or, it could simply be for profit. Whatever it is, we must find out the true cause behind this sudden uptake in mining. Additionally, Japanese planes have been seen on reconnaissance missions much closer to land than ever before. It is completely possible that the Japanese have received word of our plan to build the best weapon known to man. As of now, we still have not completed the bomb or started testing it.

If they have the resources and brainpower needed to build an Atomic bomb, then this war might not turn out as we expect. The problem is, we simply don't know if they have what is necessary or not.

Possible Solutions

One important step to a solution is to find out more about what the Japanese know. There are several ways to learn more. Firstly, reconnaissance missions are a great way to see up close what is happening in the country. However, we would need to overcome the obstacle of sending such a mission out without alerting anyone of its true intentions. Secondly, we know that if they know anything about the Manhattan project it is through someone from within the team. If we can find out who the mole is, he can tell us how much he told the Japanese military.

Everyone knows that the best offense is a good defense. Another solution to focus our attention on defense against a nuclear attack. Systems that can track an incoming nuke and ways to disarm the nuke before they reach their target will save a lot of lives in America. However, this would mean spending less time building our own Atomic weapons.

Finally, one possible solution is to ignore these speculations altogether. We have one job here and that is to build a very large bomb. Wasting time trying to figure out what the Japanese are doing and how to stop them is only distracting to the main goal at hand. This may be a risky bet, but it will make sure that we are able to complete the bomb as fast as possible.

Questions to consider

1. Should the public be aware of the developments in Japan or here in America?
2. What is your role to play in this event?

Topic B - Lack of Fissile Material

Recent Updates

Uranium is very much needed for the creation of the atomic bomb. The entirety of its existence and the project fulfilling what it is supposed to fulfill, rests on having enough Uranium and fissile material in general (which is usually always stemming from Uranium). However, the United States main source of Uranium from the Shinkolobwe Mine in the Belgian Congo has stopped. There is very little uranium production happening there as the miners are striking and revolting because of the slavery and dangerous mining conditions that they are enduring. This may be grassroots or may be through Soviet leadership, but regardless of the reasons behind the strike and revolt, there is now a Uranium shortage, and it doesn't seem like it will end soon. It seems that there will be very little uranium to the point of making even one bomb quite difficult.. Especially since the highest grade uranium ore comes from the Belgian-Congo. However, even though the Belgian-Congo is high in both uranium and the specific uranium isotope needed, the amount of uranium and the extent of the shortage may still need to be confirmed.

Nonetheless, if we cannot find a new source of uranium, or find a new method to need less uranium, there is a possibility that the Manhattan Project will come to a halt and fail its utmost mission.

Possible Solutions

The solutions can either be done through a personal directive or a committee directive.

Yet, first, it is important to get the exact information of where the strike is originating from and if there is a possibility to resume mining operations. Additionally, it may also be wise to see if this strike is really hurting Manhattan Project operations to begin with. Thus, the first possible solution would be dealing directly with the Shinkolobwe mine.

Another possible solution is starting a new mining operation elsewhere, however, the prospects of the economy might need to be taken into account. There are issues with making sure that the mine is economically stable enough to continue any operation and/or even start an operation. Additionally, where would this possible mine be located? What will the steps be to put this mine into effective use to make the Manhattan Project worthwhile to begin with?

A third possible solution would be making a more effective bomb design that requires less uranium and/or plutonium to undergo supercritical mass. Though this may be the most technically challenging, it may also be the most effective and strategic in the long run, especially militarily.

These are obviously not the only solutions, but are meant to be provocative to get thinking about possibly unconventional solutions.

Questions to consider

1. What solution do you believe would be the most effective in obtaining enough fissile materials?
2. What is needed to effectively prospect for Uranium if a new mine or continuing operation is to be decided upon?
3. Which organizations would be effective to work with that could help you accomplish any of the solutions listed above or your own solutions?
4. What are some other solutions you can come up with?

Position Paper and Character Information

*Position papers need to be printed out and will be collected the day of the conference.

**Note: Not all positions listed will be characters playing in committee. Some may be used if assassinations are in play, but the positions are mostly so you can do some reaserch.

Character List:

Luis Alverez – Critical in designing the timing and technique of the implosion-type device.

Hans Bethe – Appointed director of the Theoretical division at Los Alamos, Bethe's work included calculating the critical mass, the efficiency of Uranium-235, and the duration of a potential explosion.

Norris Bradbury – Was the head of E-5 at Los Alamos, the Implosion Experimentation Group. After the war, he succeeded Robert Oppenheimer as director of the Los Alamos Laboratory.

Enrico Fermi – Developed the first sustainable (non-explosive) chain reaction of Uranium at the University of Chicago, which towards the end of the war, was the origin of the Argonne Laboratory, outside Chicago.

Richard Feynman – Originally worked on a method to separate U235 from U238, he later at Los Alamos, worked with Hans Bethe calculating the critical mass, the efficiency of Uranium-235, and the duration of an potential explosion.

Eric Jette – A Metallurgist, who was instrumental in determining properties of Plutonium.

George Ksitiakowsky – He was in charge of the division that developed the explosive lenses used in the implosion-type device.

Seth Neddermeyer – He was one of three con-inventors of the implosion-type device.

John von Neumann – A mathematician, he was one of the theoretical scientist working on both the nuclear physics properties, as well as the properties of the bomb's mechanics.

Emilio Segre – He determined that Plutonium would not be suited for a gun-type device, and also measure the effects of radiation from the Trinity test site.

Cyril Smith – (Another) Metallurgist, who was instrumental in determining properties of Plutonium.

Edward Teller – A theoretical physicist, he we one of the scientists to convince President Roosevelt to develop an atomic bomb, which led to the creation of the Manhattan Project.

Victor Weisskopf – He was a group leader in the Theoretical division at Los Alamos under Hans Bethe.

Robert Wilson – Worked on electro-magnetic separation of U-235 from U-238, and was a group head in the Experimental division at Los Alamos.

Ernest Lawrence – Invented the Cyclotron, used to separate radioactive isotopes, such as U-235 from U-238.

Robert Bacher – Convinced Oppenheimer to have Los Alamos be a civilian, rather than a military, laboratory. He was also head of the Physics division, and later head of the Gadget division at Los Alamos.

Isador Rabi – Recruited by Oppenheimer to be a director at Los Alamos, but he declined, though he did serve as a consultant to the Manhattan Project. Along with Bacher convinced Oppenheimer to make Los Alamos civilian.

Glenn Seaborg – Co-discoverer of Plutonium, he was in charge of the separation process for removing plutonium from irradiated uranium slugs at the University of Chicago during the Manhattan Project.

Joseph Kennedy – Recruited to be the head of the Chemistry and Metallurgy division at Los Alamos, he was temporarily positioned as 'acting' head because he was 26 years old, but soon became the official head of that division.
William "Deke" Parsons – He was responsible for the ordinance (bomb handling) and the non-nuclear aspects of the bomb. He was also responsible for the delivery program (Project Alberta) on Tinian Island, and served aboard the Enola Gay as the weaponeer during the bombing of Hiroshima.
Vannevar Bush – Chairman of the National Defense Research Committee (NDRC), he was instrumental in advocating to the President the need for a bomb program, which led to the Manhattan Project.
James Conant – The next Chairman of the NDRC after V. Bush, the NDRC was a significant source of research for the Manhattan Project, supplementing the activities of the Army and Navy.
Samuel Allison – He was director of the Manhattan Projects Metallurgical Laboratory in Chicago.
Kenneth Bainbridge – He was director of the Trinity Test, the first nuclear bomb.
Leo Szilard – He was the chief physicist of the Manhattan Projects Metallurgical Laboratory in Chicago, and with Albert Enstein penned a letter to the President noting the possibility that Germany could develop a nuclear bomb.
Klaus Fuchs – He worked in the Theoretical Physics Division at the Los Alamos Laboratory, under Hans Bethe, and allegedly provided some information to the Soviet Union.
Albert Einstein – Although he did not work on the Manhattan Project (he was denied Security Clearance), he along with Leo Szilard penned a letter to the President noting the possibility that Germany could develop a nuclear bomb.
Lise Meitner – Although invited to work on the Manhattan Project at Los Alamos, she actually refused to work on it, saying that she 'will have nothing to do with the Bomb."

Sources to Consider

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