

ATOMIC ENERGY

HEARINGS

BEFORE THE

SPECIAL COMMITTEE ON ATOMIC ENERGY

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PURSUANT TO

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A RESOLUTION CREATING A SPECIAL COMMITTEE
TO INVESTIGATE PROBLEMS RELATING TO
THE DEVELOPMENT, USE, AND CON-
TROL OF ATOMIC ENERGY

PART 1

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WEDNESDAY, NOVEMBER 28, 1945

UNITED STATES SENATE,
SPECIAL COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The special committee met, pursuant to notice, at 10 a. m., in room 312, Senate Office Building, Senator Brien McMahon (chairman) presiding.

Present: Senators McMahon (chairman), Russell, Johnson, Connally, Byrd, Tydings, Vandenberg, Austin, Millikin, and Hickenlooper.

Also present: Edward U. Condon, scientific adviser, and James R. Newman, special assistant to the special committee.

The CHAIRMAN. We have with us today Major General Groves, who took such a prominent and leading part in this project.

We are pleased to have you with us, General. Will you go right ahead.

STATEMENT OF MAJ. GEN. L. R. GROVES, UNITED STATES ARMY

General GROVES. I have a short opening statement which I would like to read to the committee.

It is essential, in the highest national interest, that further development in the field of atomic energy be pursued under controls which will preclude the utilization of atomic energy in a way which would imperil the national safety or endanger world peace. Future activity in this field is so important to the national welfare, and potentially to the enrichment of our living, that control should be exercised by a special commission independent of any existing Government agency with the sole duty of supervising and controlling the development of atomic energy. The commission should have complete authority over all activities in the field, subject only to the approval of Congress and the President. The commission should be composed of persons of recognized ability whose actions would be unquestionably in the public interest. Broad discretionary powers and adequate funds are essential to its success.

The War Department will always have a vital interest in the use of atomic energy for military purposes. In the field of practical administration and operation, the Army can furnish invaluable assistance. Civilian and military personnel who have acquired knowledge and experience on the project should continue to serve to the extent that their services are useful. The commission should be in complete control of policy and should exercise general direction and supervision of all activities.

Because of the current uncertainty, we are daily losing key people whose services should be retained. Until that uncertainty is resolved by the establishment of a national policy, we are not in a position to offer acceptable commitments to these key people. Prolonged delay will result in appreciable loss of the present efficiency of the vast combination of plants, scientific talent, and engineering skill.

We must recognize the clear distinction between domestic control and international control. The two can and should logically be separated. Domestic control is necessary no matter what international policy may be eventually worked out for the United States and the world. It is necessary to protect America's tremendous investment in atomic research and development and to insure that this development will go steadily forward.

I would like to discuss for a few minutes what happened when these bombs were dropped over Japan. I don't know how much repetition there is in this, but I do not believe there is very much.

The atomic bomb mission which went overseas, headed by Major General Farrell, made no attempt at Nagasaki and Hiroshima to secure or estimate exact casualties. This was not possible because the mission did not survey the cities until over a month after the dropping of the bombs.

The best over-all estimates—and these come from the Japanese as they were given to General Farrell—of the dead and missing at Hiroshima are somewhere between 70,000 and 120,000; injured, between 75,000 and 200,000.

At Nagasaki, the dead and missing were between 40,000 and 45,000, and the injured about 40,000.

The figures at Nagasaki are much better than they are at Hiroshima because the authorities were able to act after Nagasaki because it hit one section of the city, the industrial section, and did not destroy all of the city and military governments. At Hiroshima there were a number of military targets, including army divisional headquarters, an army ordnance depot, an army transport base, an army clothing depot, all the public utilities, an oil storage depot, various textile and rayon plants, and Japanese Army headquarters, the commander of which was charged with the defense of that section of Japan against American attack.

Practically everything at Hiroshima for a radius of about a mile and a quarter from the point of detonation was burned as well as blasted. Up to a radius of 2 miles from the point of detonation everything was blasted, with some damage from burning. Between a radius of 2 and 3 miles, everything was about half destroyed. Beyond a radius of 3 miles, damage was fairly slight, with roof damage up to 5 miles. Glass was broken up to a radius of 12 miles.

There were about 20 masonry and steel structures left standing in the central portion of the city. However, the interiors of all buildings were gutted and all windows were out. Few bridges were destroyed; most were left intact except for handrails and sidewalks.

In the pier area—Hiroshima was a great military port—individual warehouses were collapsed. Intervening hills protected some nearby areas from the blast. Automobiles had roofs caved in, shelters were caved, and street cars were derailed and burned. About 4 miles away a fire was started in a forest on the mountainsides.

There were approximately 20,000 army personnel in Hiroshima at the time of the bombing, of which 80 percent were casualties. The Army headquarters, which I spoke about, had 9,000 men in the headquarters; of those, 7,000 were casualties.

At Nagasaki the blow was struck in a largely industrial area, which left a large part of the residential area more or less standing. The effects of the explosion in the industrial area were probably more spectacular and startling than Hiroshima; for example, the complete destruction of the huge steel works by blast and fire, and the destruction of the torpedo works by blast alone. Within a radius of 2,000 feet from the point of detonation, heavy industrial buildings, gas storage tanks, and many reinforced concrete structures were destroyed. The steel frames in all buildings in all cases were pushed away from the point of detonation. For a radius of 8,000 feet, Japanese workers' homes were completely demolished. Up to a radius of 2 miles, workers' homes had collapsed; roofs and walls were smashed, but were left partly standing except in isolated cases where exceptional shielding was given by local topography. Up to a radius of 3 miles there was some roof damage to tiles of heavy type. Glass and plaster damage was evident up to much greater distances.

Up to 2,000 feet, 9-inch concrete walls were destroyed. Up to a radius of 4,000 feet, brick smokestacks with 8-inch walls were displaced, cracked, and overturned.

The northern ordnance plant, at a distance of 4,000 feet from the point of detonation, had corrugated iron stripped from walls and roofs, window sash pushed out and framework overturned and destroyed. These were of light-steel-frame construction.

Fire damage was heavy throughout the area. The length of the burning area was 3 miles, with a 6,000-foot width in the northern part of the city.

The Japanese listed no destruction to shipping in the harbor, which was a considerable distance away, except minor damage to superstructures, which included broken glass. There were about 100 ships and small boats in the harbor, of which about a third were 100 tons in size.

Senator AUSTIN. May I ask a question at this time, Mr. Chairman?

The CHAIRMAN. Of course, Senator.

Senator AUSTIN. Have you any record of the examination of these two areas made since the time that you are now testifying about that would indicate whether there is a residue there of radioactivity in those areas?

General GROVES. Yes, sir; and there is none. That is a very positive "none."

I would like to read a statement from an eyewitness, which goes into that phase of it.

The CHAIRMAN. General, was that because of the way that the bomb was exploded?

General GROVES. Yes. The bomb was exploded at considerable height, and for that reason there were no after-effects from radiation. There were some radiation effects at the time of the explosion; they were instantaneous. No one suffered who was not exposed at that moment, and the casualties, as far as we can determine, resulting from that were relatively small.

The CHAIRMAN. If it is a permissible question, at Alamogordo, where you exploded from the top of a steel column, there was some radioactivity, was there not?

General GROVES. At Alamogordo we exploded it at a height of 100 feet on top of a tower, and there was residual radioactivity on the ground right below the point of explosion. That was of such a nature that you could walk through it, you could spend hours in there, but I would not have wanted to sit down and make my home in that area.

The CHAIRMAN. Would you want to own some of those cows, General, that they say changed their color?

General GROVES. They changed their color, but an examination of the animals shows they were not injured in any way other than having temporary gray hairs. They were streaked with gray.

This account was written at our request by a Jesuit Father, who was on a mission to Japan. He had formerly been in Tokyo, and his school was moved from Tokyo to Hiroshima.

As you know, the Jesuit Fathers, for a number of years—and I should say centuries—have been some of our most accurate reporters of world events. He prepared this at our request. I imagine he would have prepared it anyway and sent it back to the headquarters of the society.

He is a German named Father Siemes. This is his eyewitness account:

Thousands of wounded who died later could doubtless have been rescued had they received proper treatment and care, but rescue work in a catastrophe of this magnitude had not been envisaged. Since the whole city had been knocked out at a blow, everything prepared for emergency work was lost, and no preparation had been made for rescue work in the outlying districts.

Many of the wounded also died because they had been weakened by undernourishment, and consequently lacked the strength to recover. Those who had their normal strength and who received good care slowly healed the burns which had been occasioned by the bomb.

It was also noised about that the ruins of the city emitted deadly rays and that many workers who went there to aid in the clearing died, and that the central district would be uninhabitable for some time to come. I have my doubts as to whether such talk is true, and myself and others who worked in the ruined areas for some hours shortly after the explosion suffered no such ill effects.

He and a number of his fellow priests went from this outlying novitiate where they were living down into the center of the city to rescue their Father Superior who had been injured. I think they were in the ruins for about 12 hours, and from that time on they devoted most of their attention in assisting in the alleviation of the suffering, and certainly were exposed to anything anyone would be exposed to.

Senator RUSSELL. That was immediately after the explosion?

General GROVES. Within a few hours they got the word. It took about 12 hours going in and out of the city.

There has been something said of relief workers who were injured in the relief work. Those relief workers were in the city before the bomb went off, and they were just like any other inhabitants. They were in there because the Japanese had decided to evacuate all unnecessary population from Hiroshima. I think they felt that the city had been spared from bombing up to then. They did not know why, but they expected it to be bombed. They did not know it was being reserved, as it were, for this.

Senator MILLIKIN. May I ask, General, was Hiroshima on the list of cities to be bombed that were scattered over Japan?

General GROVES. No, sir; it was not on that list. That list was put out by General LeMay, and did not include Hiroshima. I don't recall whether it included any other cities that we were interested in or not.

This is again from Father Siemes' account, and is his concluding paragraph.

Senator AUSTIN. May I ask a question before you pass forward?

General GROVES. Yes, sir.

Senator AUSTIN. There was one phrase in your testimony that causes this question, and that was "as soon as he heard about it," or words to that effect. Is it true that this priest did not know of the explosion until someone told him?

General GROVES. Oh, no, sir. He was, as I recall, about 4 to 5 miles from the explosion—or maybe 3—well into the suburbs. He was standing in front of the window when this bomb went off, apparently just looking out and seeing what a beautiful day it was. It was good weather, and there had been an air-raid alert, because of these three planes that had come over, but the Japanese had decided the three planes were photographic planes, and had apparently recalled the alert.

He was standing there looking out the window when the bomb went off and he saw this terrific light effect, and was scratched around his face and hands, I suppose by flying pieces of glass.

He did not realize at the time—for he thought it went off right over his head, and to him it was just a single bomb—he did not realize what had happened to the city until the refugees started streaming by. He did not know even then, and couldn't imagine that his Father Superior who was so far removed from him could possibly have been injured.

This is the final conclusion by Father Siemes:

We have discussed among ourselves the effects of the use of the bomb. Some consider it in the same category as poison gas and were against its use on the civilian population. Others were of the view that in total war as carried on in Japan there was no difference between civilians and soldiers, and that the bomb itself was an effective force tending to end the bloodshed, warning Japan to surrender, and thousands to avoid total destruction.

It seems logical to me that he who supports total war in principle cannot complain of a war against civilians. The crux of the matter is whether total war in its present form is justifiable even when it serves a just purpose. Does it not have material and spiritual evil as its consequences which far exceed whatever good might result? When will our moralists give us a clear answer to this question?

Senator RUSSELL. Before we get away from the question Senator Austin asked, do you intend to touch any further on the radioactivity?

General GROVES. I would be glad to right now.

Senator RUSSELL. I suppose the War Department has conducted an independent investigation other than that statement submitted by the priest?

General GROVES. Oh, yes, sir.

Senator RUSSELL. The first reports coming out of Japan were naturally highly colored and stated, as you have just related, that there were thousands of people who sickened and died several days after the explosion, and went so far as to say it killed all the fish in the rivers and created havoc generally.

What did the commission find?

General GROVES. I would like to explain first what the mission consisted of.

I have forgotten now whether it was after the Nagasaki bomb or after the Hiroshima bomb that I realized that this war was not going to last very much longer. I had always thought such would be the case once we dropped one. So I assembled in this country a special group to go over to investigate what had happened in Hiroshima and Nagasaki. Some of the group came from the Marianas where General Farrell was, and the whole group went over under his personal guidance. We sent essential medical scientists of the highest repute in the United States, headed primarily by Col. Stafford Warren, who is, in normal times, one of the leading authorities, a professor at the University of Rochester.

We had the full support of General MacArthur's headquarters over there and assistance in going into these cities once we were landed in Japan.

They made very careful studies. They talked to the Japanese doctors and the military, all of whom had order and who faithfully carried out those orders to cooperate in giving us all possible information.

We are still studying those facts and figures, and I think I can make some positive statements. First, there was no radioactivity damage done to any human being excepting at the time that the bomb actually went off, and that is an instantaneous damage.

The CHAIRMAN. General, you don't make any point of congratulation on that result, the fact that that didn't happen, do you? If there was radioactivity, there wouldn't be anything morally wrong with that?

General GROVES. No; we hoped to avoid that, and we did avoid that; but I think that is something that if it was a choice between radioactivity on a few Japanese or even a number of thousands of Japanese or a case of saving 10 times as many American lives, I would go the American way on that question without any hesitation.

The CHAIRMAN. It seemed to me that the War Department had made a great deal of the fact and sought to emphasize it time after time, that there was no harm from radioactivity.

Of course, if you are simply telling the fact, that is one thing, but its very reiteration seemed to me to indicate that there was some feeling on the part of the War Department that there was something morally wrong if it had. I just wanted to get your view on that.

General GROVES. There would be no feeling, as I say, on my part, on anything that would have shortened this war by a single day.

Senator RUSSELL. My question was not intended to indicate that I thought there was anything morally wrong if the radioactivity had been very disastrous; but thousands of people all over this country are living in tremendous fear of this atomic energy and its use. I thought it would be well to develop just how far the effect of the radioactivity would go.

General GROVES. I would like to go into that, if it is agreeable to you gentlemen, now.

As I say, our facts disclosed that nothing happened of that character excepting at the time the bomb went off, and that the number of casualties from that were relatively small. Nobody knows what the casualties were or how they were made up; but all the investigations by men who were in there to investigate and get the facts, not

to come out with an answer, indicated very clearly that that was the case.

Now, at the time the bomb went off, a person who was within a certain range could be affected by radioactivity; but in the normal case, he would already have been killed by the effects of the explosion or by the tremendous heat, and that is the real thing to think of. If he was right on top of the bomb, he could be killed in a dozen ways, all of them equally fatal; and as he removes himself from that exact point, certain of these possibilities are removed.

It really would take an accident for a man, the average person, within the range of the bomb to be killed by radioactive effects.

Senator MILLIKIN. Mr. Chairman, may I ask a question, please?

The CHAIRMAN. Yes, Senator.

Senator MILLIKIN. General, is there any medical antidote to excessive radiation?

General GROVES. I am not a doctor, but I will answer it anyway. The radioactive casualty can be of several classes. He can have enough so that he will be killed instantly. He can have a smaller amount which will cause him to die rather soon, and as I understand it from the doctors, without undue suffering. In fact, they say it is a very pleasant way to die. Then, we get down below that to the man who is injured slightly, and he may take some time to be healed, but he can be healed.

Senator MILLIKIN. Does that come about through treatment or through time?

General GROVES. Through time. Radioactive effects are like X-rays. They depend upon the intensity and the time. Anyone who is working with such materials, who accidentally becomes overexposed, just takes a vacation away from the material and in due course of time he is perfectly all right again.

Senator MILLIKIN. Let me ask you, would the effect be different had the bomb exploded in the ground?

General GROVES. If the bomb had exploded on or near the ground, that is, within a hundred feet or so, the effect would have been the same as at New Mexico, I believe; there you would have had lasting effects for a considerable period of months. You would have had a considerable number of radioactive casualties, and I think that you would have had an area which should have been banned from traffic.

The first mission given to our organization that went over there was to determine that the cities of Hiroshima and Nagasaki were 100 percent safe for American troops, and to know absolutely that that was a fact so that the men themselves would know that everything was all right.

Senator MILLIKIN. General, can you tell me the largest size regular bomb that was used in the Pacific area at the time of Hiroshima and Nagasaki?

General GROVES. No; I really do not know, Senator.

Senator MILLIKIN. Can you give us a reference point, some sort of bomb that was in use, and tell us how many of those bombs it would have taken to produce the same result in those cities?

General GROVES. I am sorry, I cannot tell you exactly. I believe that at that time they were using against Japan a bomb which must have had about 1,000 pounds of explosives in it; against Okinawa,

possibly up to 10,000 or 15,000 pounds of explosives. I may be in error on these figures, but I can tell you that taking the heaviest type of bomb they had that a rail of a thousand planes would not have been as effective as this one bomb in actual damage done to the cities—no comparison.

Senator MILLIKIN. One thousand bombs of the type they were using would not have produced a similar effect?

General GROVES. That is correct. At Tokyo, which had been bombed repeatedly, and I don't know how many times or how many bombs were dropped there, there were a great many burned-out sections, but it also had a great many usable sections. The casualties at Tokyo I understand are greater than they were at Hiroshima or probably as great as in both of these bombings, but the effect was not the same.

Senator MILLIKIN. Are the cities comparable, so that you could draw a comparison?

General GROVES. In physical damage, I would say that it would take maybe as many as 2,000 planes to equal the effect of 1 of the bombs; but in the effect on the people, there is a much greater effect. I think the Japanese officer who was assigned to aid General Farrell at Hiroshima presented that thought in the best possible way. He stated that when it comes to the fire bombing of Tokyo and the high-explosive bombing, there was something you could do about it—that the bomb fell and you took your chances; a small number of people were killed with each bomb, and you could get out and save some of your property. In general, it was something that you could stand up against. But he said when it came to the Hiroshima bomb it was unendurable, and I think that is the real statement; that it is an unendurable bomb to anyone, and particularly to someone who did not know it was coming. How much the surprise element had to do with our success I don't know, but I am a great believer in military surprise, as is everyone; and this was the greatest surprise since the Trojan horse, and it ended a war just as suddenly.

Senator MILLIKIN. May I ask you, what was the percentage of loss on our plane flights in that area?

General GROVES. I do not know, Senator. Due to the cooperation of various services, such as the Navy Special Rescue Service, and the supreme care that was exercised, I think that our loss rates were getting better all the time. After all, these planes were flying a tremendous distance, and just in the normal time of flight they were bound to have accidents. How many men were lost there, I do not know.

Senator MILLIKIN. Passing the question of time in shortening the war, I was trying to determine the lives that we saved just in point of the air missions that would be required to produce the same amount of damage.

General GROVES. In that, I don't know that you could get a real figure, but I think we could get that from the War Department for the record if you would like to have it. I think that the real saving in life came in regard to the attack on the beaches. The Japanese, from all that we can find out, had no intention of quitting this war even if we had bombed by normal means and destroyed every city in Japan. The people on the beaches of Kyushu, in the caves there, were perfectly prepared and expected to stand there and die—men, women, and children—and take as many Americans with them as they could.

Senator MILLIKIN. Your point is that the psychological effect created by this bomb served to pull them out of the war, whereas the same amount of damage, the same number of casualties produced in other ways might not have pulled them out of the war?

General GROVES. That is absolutely correct.

Officers I have talked to, who have toured Japan under the conditions as they are now, state that this bomb created a fear throughout all of Japan that was just indescribable, and that that was the first real propaganda that they could understand; maybe they had gotten a lot of leaflets, but this was something they could understand, and it went all over the Japanese press, and they knew that it was the end. Of course, it was a tremendous point for the Japanese Government and the ruling classes to lean on as a face saver to get out of the war.

Senator MILLIKIN. Thank you very much.

The CHAIRMAN. You and I have talked about Churchill's estimate of what he thinks was saved this country and England.

Do you agree with his estimate, and will you state it for the record?

General GROVES. As I recall, it was 1,000,000 Americans and 250,000 British. I don't know what the basis of his estimate is. I think probably that it is a little high.

All that I can say definitely is that probably, if you figure on the number of divisions that had been announced as making that landing, and think of the number that were on Okinawa and that this was the homeland, you can estimate quite properly that the casualties that would have been suffered—and I am speaking of the serious casualties, not the ones that are just for a day or two and not the ones who are disabled for life due to illness of various kinds—could well have numbered into the hundreds of thousands, possibly up to Churchill's figures, and certainly enough so that everyone who had a boy over in that theater, or expected to have one, was dreading the day of that landing on Japan. I don't think that that dread was unjustified at all.

Certainly, the military authorities in their plans and in their estimate of the situation never felt that the landing on Japan would be a push-over in any sense of the word. They felt that they were going to fight to the last cave.

Senator VANDENBERG. What was the Hiroshima date, General?

General GROVES. August 5.

Senator VANDENBERG. And what was the date of the test in New Mexico?

General GROVES. July 16.

Senator VANDENBERG. So that as soon as this bomb had been developed to your satisfaction as a success, there was no delay in its use in the war itself?

General GROVES. There was no delay. I would be glad to tell you of the delays that we had from the time that we could have done it. The whole bomb depended on when we could get the material. The mission that I gave to the scientific laboratory at Los Alamos, N. Mex., under Dr. Oppenheimer, was that I wanted a test of that bomb as soon after we got sufficient material to them for the test and it could be processed and put into the bomb. My recollection is that they were 3 days late. In other words, they had a few things that they had not solved ahead of time. That mission had been given

to them over 2 years before. I felt it was a master performance on their part.

Part of the bomb for Japan was sent over there, as you know on the *Indianapolis*, and part of it followed by air. The bomb was ready to be dropped, or could have been ready to be dropped on the 31st of July. It had to be assembled overseas in part. We had to wait for weather, so that it was really from the 16th of July until the 31st, and in that time we had to assemble enough material and ship it.

Our production of material was going up on a very sharp curve, and we had enough for the first time. The delay in the use of this bomb was 5 days, and that was due to weather.

Senator VANDENBERG. Up to July 16, you had not been prepared to proceed?

General GROVES. Oh, no, sir. We did not have enough. We couldn't. In other words, we could have fired our first bomb on July 16, and the second on July 31 in the Marianas. If we had had a second test in this country, which we would not have had under any circumstances, that could have saved the time of travel from the United States over there of about a week. So that the second test could have been on July 24.

Senator VANDENBERG. So that completely dissipates the stories that were general in this country, that there was a long and substantial delay in the use of the bomb for international political reasons?

General GROVES. Those stories are completely without basis in fact.

Senator HICKENLOOPER. General, coming out of the Los Alamos test were the stories of the effect of the flash and the light on the eyes of the observers at great distances.

Did the priest who wrote this report make any statement as to any effect on his eyes at that comparatively close distance?

General GROVES. He did mention that eye effect and talked about a girl who was much closer than he was, and how she was blinded temporarily from the flash just as you are if you happen to look at a welder on a street-car track as you drive down the road. You are temporarily blinded, but your eyes soon recover, and you are all right.

We have had no results that I know of that indicated any real eye effect. There would possibly be some, but if they were minor, just a few, I would not know it. There were certainly not any great number or I would have known it.

Senator HICKENLOOPER. It seems to me I recall from reading some of the stories that have appeared in articles and in the newspapers that the observers at Los Alamos were unable to view the first flash even through darkened glasses.

General GROVES. That is correct. I think the best example of that were the observers who, I believe, were 27 miles away. Those were the observers who had worked with it and were not necessary to the test, and they had a vantage point out there. They were provided with the equivalent of welders' helmets with the glass that is in them, and they could view the explosion through those.

The ones who were looking directly at it at the time of the explosion, which were approximately 90 percent, were just sort of temporarily blinded just as you are when a flashlight bulb goes off, just that same feeling, and the result was that they could follow right along and see what happened. Some of the men in their excitement,

having had 3 years to get ready for it, at the last minute forgot those welders' helmets and stumbled out of the cars where they were sitting, and did not have the helmets in front of their eyes. They were distinctly blinded for maybe 2 or 3 seconds, and in that time they lost the view of what they had been waiting over 3 years to see.

Senator HICKENLOOPER. How far away were they?

General GROVES. About 27 miles, as I recall. It may have been 20, but I think 27.

I was at 10 miles and looked at it as soon as I could turn around after it went off. I looked at it through dark glasses. That was probably a fraction of a second, or maybe a little bit more. At that time I could look at it, and it was perfectly all right through a piece of smoked glass.

Senator RUSSELL. What equipment did you give the crew of the plane that carried the bomb?

General GROVES. They had special glasses of the polaroid variety that they could twist to change from almost full light down to no light at all, and they were supposed to be screwed down to the complete no-light basis.

Senator HICKENLOOPER. It seems curious that this priest could be 4 or 5 miles away from the center of this explosion without anticipating it and suffer no particular ill effects from his eyes.

General GROVES. I think the answer to that is that when we saw the thing go off in New Mexico, although we had figured out and told ourselves that we were going to have this tremendous light and should watch our eyes and all of that, we did not really believe it; it was so far beyond the human experience, seeing this tremendous light in the sky, that it just gave you a strength of light many times that of daylight, so we over-emphasized that effect and thought it was more dangerous than it was. In the same way, it was so overpowering that I was not particularly interested in the blast or the noise effects of this explosion. In other words, most of us lost the keenness of observation that we should have had for such a thing because we were so dumbfounded by this light effect, although we had expected it and said, "That is what is going to happen."

Senator MILLIKIN. Can you tell us of the heat reactions, if any, felt by the observers in New Mexico?

General GROVES. The only heat reaction that I recall was just a sort of warm glow. Some people claimed they felt it on the backs of their necks. We were all lying on the ground faced away from the explosion, and they claimed they felt some; but I did not feel any.

Of course, for a considerable distance around all the vegetation was seared off. There wasn't any left.

Senator MILLIKIN. What is the heat generated at the moment of explosion?

General GROVES. I would prefer not to answer that in open hearings, sir.

Senator MILLIKIN. Let me ask you one more question.

In your opinion, had Japan lost the war strategically at the time of the bomb?

General GROVES. I think Japan lost the war—and of course I am not speaking for the War Department here—at the Battle of Midway, but they didn't know it and would not admit it, and their people did

not know it. It took something to knock them out of the war. They were still fighting, and they had no expectation of quitting even if they had lost the war.

The CHAIRMAN. General, it occurs to me that some foreign agent might spread this radioactive material around a city, and you would not know it was being spread because you could not see it, and it might kill a whole population.

General GROVES. You would know it, because everybody who used X-ray film would know it was all fogged, and you would have almost immediate warning because they are using X-ray film constantly. Every person with a camera would find it out as soon as he tried to develop a picture. The photographic film would tell you immediately.

The CHAIRMAN. Suppose some enemy were to drop an atomic bomb or atomic rocket on you. Would there be any danger of radioactivity?

General GROVES. If they dropped one on a city and exploded it close to the ground, there would be radioactivity there that would have an effect.

The CHAIRMAN. Do those rockets that the Germans used over London explode near the ground?

General GROVES. I don't know just where, but some exploded, I believe, on landing. I don't know where most of those exploded, but I believe the world knows today that the way to get maximum explosive effects is to get up in the air, depending on the size of the explosion. For that reason, if they want explosive effect, they will certainly set it off up in the air.

If we had set that bomb at Hiroshima off when it hit the ground, the damage would not have been nearly so great. It was designed to be set off so as to give us the maximum possible explosive force.

The CHAIRMAN. I think those rockets that went over London exploded on contact. If they were loaded with atomic material and it spread out, there would have been considerable danger then from radioactivity?

General GROVES. There would have been considerable danger, but the total damage done to London would have been much less than if the rockets had been exploded in the air; so the real fear would have been in the case of a fuse that did not work and did not go off when it should have up in the air, but then would have been a much less favorable result from the explosion. I say "less favorable" from the standpoint of the enemy dropping it.

The CHAIRMAN. General, relating the bomb to approximately the same size that was sent over Hiroshima, suppose one dropped upon Washington. Could you estimate the amount of damage and relate it to Washington?

General GROVES. Related to Washington, if that bomb had been dropped, say, in the center of the Pentagon, there wouldn't be any Pentagon left.

The CHAIRMAN. That is a big result.

General GROVES. That would have far-reaching consequences.

If it were dropped in what would probably be the goal of any enemy dropping it in Washington, so that it hit on the Federal triangle and destroyed the offices of the Government, it would have destroyed an area maybe 2 miles in diameter so there wouldn't be much left there.

Of these big Federal buildings that are well built, many would have their walls standing. All of the limestone and marble on the facing would have been blown off. There is not much question of that, but the concrete and steel structure might still be standing.

All interior partitions would be gone; all the windows and window frames would be gone, and in general you would have a number of buildings standing just as you see them in the picture of Hiroshima, everything flat in between, and maybe 2 feet deep in rubble of all varieties, with these walls standing there but absolutely unusable.

The normal house that most Washingtonians live in would be completely destroyed in that area. It wouldn't be findable.

The area of real damage, where there wouldn't be much left, would have extended from the Capitol to the National Cathedral at Massachusetts and Wisconsin, or something of that general order.

It would have gone over across the river into the Pentagon area, and have blown out all the windows and window frames of the Pentagon, and probably blown out most of the interior partitions. It would not have destroyed the Pentagon, but it would probably have done a tremendous amount of damage.

Senator VANDENBERG. It wouldn't have wiped out our deficits, would it?

General GROVES. I think it would have taken the Treasury out, excepting the lower vaults; but, in general, there just wouldn't be anything left.

You would have found all of your headquarters in municipal government would be gone. At Hiroshima, as a rule there were about 400 firemen in the town, or 450, and about 25 were left fit for duty immediately after the explosion. That is typical of what happens to all your municipal affairs.

In the United States, it would have taken probably about 30 minutes to start organizing relief, and every man that could walk would be helping someone else. The Japanese did not handle it that way, and that built up their casualty lists.

The better disciplined our people are—that is, the fact that they know such a thing might come now automatically gives them a defense against it—and anything that is in the nature of an organized body gives still more power to resist and to lighten the losses that occur in such a catastrophe.

Senator VANDENBERG. General, if you had to start from zero today, with nothing except your experience and knowledge, how long would it take you to produce a bomb?

General GROVES. You mean with the same full authority I have had in the past?

Senator VANDENBERG. Yes.

Senator CONNALLY. Do you mean with the installations?

Senator VANDENBERG. No; I mean all installations are out; he has got to start at zero.

General GROVES. But knowing what we do today?

Senator VANDENBERG. That is right.

General GROVES. I would say if we had complete authority and freedom from interference by suggestions from lots of people, we could do it in probably 2 years' time as compared to the almost 3 that it took us.

If we had that interference I think it might take anywhere from 5 to 10 years, because it is so easy to say, "We have got a better process; you should build the better process and get more efficiency, or you can do it faster," or something else, and by the time you get through settling those matters, the time has gone.

Senator VANDENBERG. Would you be willing to state what our total investment in atomic energy is up to this time?

General GROVES. I would be willing to state, but unfortunately I do not know the figure. I should say, offhand, the figure of \$2,000,000,000 that was given in August was very close. I think by this time it is probably about, I should say, a little over \$2,000,000,000, maybe \$2,100,000,000, something of that order. I would be very glad to supply that figure.

Senator VANDENBERG. Would you state the total employment in the United States on this enterprise?

General GROVES. The maximum direct employment either by us or our contractors who were working directly for us was 120,000 peak.

There were, in addition to that, all the suppliers of goods who were furnishing on a unit-cost basis. These are not included in that; it might make up a total of 200,000 people, maybe 225,000.

With respect to the operational forces, operating our establishment, the peak of those was somewhere in the order of about 55,000—between 50,000 and 55,000.

Senator VANDENBERG. Now, in dealing with the problem we have to consider, among other things, that we have some Federal cities on our hands, have we not?

General GROVES. Yes, sir.

Senator VANDENBERG. Will you state for the record what they are and, very briefly, what has been done there?

General GROVES. At Oak Ridge, Tenn., we have a town, or a city I think would be a better way to put it, which had a maximum population of 78,000. We have discontinued certain work down there, trying to economize where we can, remembering that money is now controlling where time was before. So that I should say that it would compare in size with the normal city, residential city of, maybe, approximately 50,000. That is 100 percent a Government city.

Senator VANDENBERG. That is the city you built right up from the ground?

General GROVES. Yes; right up from the ground in every way, including every facility considered to make up a city—amusements, stores, and everything else.

Senator VANDENBERG. And the Federal Government owns the whole thing?

General GROVES. The whole thing is owned by the Federal Government; yes.

Senator VANDENBERG. What else?

General GROVES. Hanford, Wash., at Hanford Engineering Works, at what was the site of Richland, Wash., a small town.

There we have a city which is designed to house, I believe, about 5,000 workers and their families. Just what the total population is, I cannot say. I imagine it would be about 15,000 to 18,000. The houses there are different from the ones which you saw in Tennessee. They are probably of better construction but they were also cheaper to build because of the locality.

Senator VANDENBERG. Now, is that a Federal city?

General GROVES. That is a Federal city, the same way, on Government property, everything owned by the Government.

At Los Alamos, N. Mex., the town there is more like the normal military reservation. It has housing for married people and it has quarters for bachelors and the unmarried. It has a large military population, mostly enlisted men who were young scientists who came into the Army and whom we picked out by reason of their records and brought into the work. They were people without whom we could not have done this job. We had a total of about 3,500 of these men out there at Los Alamos.

Our problem there is much more serious than at the other two places. We can house the people we need at the other points but we cannot house them at Los Alamos,, the people we should have there right today.

They were brought in there during the war but they will not come in time of peace without some provision for their families and we are faced now with what we are going to do with that establishment.

Due to the uncertainty we are losing the people; we are faced with a very desperate situation.

That laboratory was designed to develop the bomb, all the theory connected with the bomb, the designing and the engineering of it, and to take the pieces that were made elsewhere, as well as some that were made right there, and assemble them into the final bomb; to do some of the final processing of the material as it came from these two plants.

Generally, that laboratory was to develop all the technical details that went into our operations overseas. They furnished the men who were our technical detachment overseas, which was a combination, like everything else in this project, of the American people, made up of Army officers, enlisted men, Navy officers, and civilians, both scientific and highly skilled mechanics of a type that is far beyond what you would normally refer to as a skilled mechanic.

Senator VANDENBERG. Now, is it your contention, General, that in the adequate continuity of developing atomic energy, it is going to be necessary to maintain all these enormous installations?

General GROVES. It is going to be necessary from the standpoint of—but before I answer that, I would like to add that, in addition to those things that you have generally been made aware of, we have certain laboratories that are Government-owned. We have one in Tennessee, which you went into that afternoon. That is a very important laboratory. We have one near Chicago, in the outlying districts of Chicago.

The CHAIRMAN. That is the Argonne?

General GROVES. The Argonne; that, also, is a Government laboratory, although it has been operated for us by the University of Chicago.

Then, we have these various laboratories in universities where, while they are university laboratories, we have been supporting them. We will have to continue to support them if we are going to stay in the lead in this field, because the universities cannot afford to support them, in the first place. In the second place, the universities will

not wish to work on certain problems we are vitally interested in, because they are not of particularly scientific interest as a whole.

The CHAIRMAN. Is that not the reason, General, that you have lost some of your personnel?

General GROVES. Oh, yes.

The CHAIRMAN. Some of these scientists who have done a wartime job of making an explosive will want to get back to something that they consider a little more constructive, will they not?

General GROVES. They wish to get back to the type of life which they chose as young men. They chose to be academic scientists because they like the life. When a man chooses his profession considering all the financial rewards and considering how hard he is going to have to work, and considering the surroundings, and he chooses an academic profession, he would like, in the main, to get back to it. They still feel that the academic profession is more attractive.

The CHAIRMAN. General, going back—

Senator VANDENBERG. Excuse me. Can we have an answer to the question, General?

General GROVES. Did I dodge it? I am sorry.

Senator VANDENBERG. No; you wanted a little more prefix to it. You remember what my question is?

General GROVES. Yes. I would like to amplify a little the situation I am faced with at Los Alamos.

There we are trying to establish this scientific laboratory which will be of a highly secret order. It will have there the heart of the weapon and everything else, as it has in the past.

In order to have scientists of the caliber we are getting—we are getting good men there despite all the handicaps that we have in getting men—we are not getting some of them, we are losing some we would like to keep, but we are getting good men and we hope that we will have an operating laboratory.

To get those men, we are having to encourage them to come and we are encouraging them in two ways.

The first way is that, in addition to working directly on this weapon for us, they are going to be given the equipment and they are going to be given the time to engage in certain fundamental research that they would be doing if they were back in their home universities. That is part, as far as I am concerned, of their salary. We are merely giving them that much time to do the work that will enable them to keep on doing our job with the fullest of interest.

These men have very active minds, they border on the genius type and unless we do that, we just cannot keep these men, we cannot keep them doing it willingly and with pleasure and, I think, with efficiency. In other words, we cannot keep them working toward one goal all the time without ever taking their noses off that particular grindstone. They should have that opportunity of doing their own work, and we are going to furnish that.

We are also going to furnish them with housing that will enable them to have their families there and to have the proper housing for the supporting cast, which is enormous.

These scientists will need the technicians; they will need the technicians to do the wiring for them, so that they can devote their time to.

what they are being paid for, which is scientific endeavor and not the rigging up of their own experimental equipment. This is the custom in most university laboratories. You see these very high-grade men having to spend time worrying about wiring up things that they could buy if the budget permitted them to buy.

Now, what we have to keep operating, in my opinion, at the present time is this:

We have to keep operating everything from the standpoint of having a sufficient supply of bombs on hand until somebody makes up his mind as to what is to be the future of this work.

If we shut down a plant, there is no telling what the cost of that shutdown will be. It is possible it can be restored in 6 months' time, that the cost there would be five million or ten million dollars.

How long it will take us to get the personnel back even in time of war is a question. We, of course, have our lists of everybody who worked or is working for us and, naturally, we would send out and call them and get them back.

But we do not know about the equipment. We have never shut down a plant like this. We are shutting down certain sections in our plant in Tennessee and we are shutting down the sections that we feel aid the least and the shutting down of which would enable the greatest saving in money.

In other words, if we can save 35 percent of our money, maybe we will only lose 10 percent in production.

However, when it comes to shutting down the remaining works at Tennessee or the Hanford Engineering Works, we are making a decision that cannot be easily corrected—in fact, a decision which may not be possible of correction. I do not know whether certain of these buildings and equipment could be shut down without having to replace certain parts. I know that we would have to replace certain parts; just how many, nobody knows and nobody will know until we shut down and try to start again.

It is not like some other weapons, like a gun which we can cosmoline and put away and say that we can always clean it up in 30 days and we would have that gun in shape. We cannot do that.

We cannot shut down the Los Alamos laboratory and ever assemble a laboratory like it again, except in time of war. We cannot stop our work at the Clinton laboratories and start up again because we would have lost the personnel—there is not much in equipment there.

With regard to the work at the Argonne, we would lose the momentum we now have and it would cost a tremendous lot of money if we had to get that momentum back.

Senator VANDENBERG. How are you operating? Are you still operating under war appropriations?

General GROVES. We are still operating under war appropriations and those appropriations, of course, run out next July 1.

Senator VANDENBERG. Have you made a budget estimate for the next fiscal year?

General GROVES. No, sir; I have not, because I had hoped that that would be done by some other agency.

We are preparing now, in view of the fact that legislation has not been passed, we are starting in now to get together a general idea of what it will cost.

I cannot possibly give you any figures today, because we are still trying to decide what is going to be done on the major decisions, the ones that will affect us for 5 and 10 years. We cannot do that until we have somebody who will make up his mind about it.

Senator VANDENBERG. So, if I understand you, speaking generally, you would anticipate not only the desirability but the basic necessity of substantially maintaining your present establishment in peacetime?

General GROVES. Yes, sir; as it now stands. That is, with the reduction we have already made in Tennessee and with a distinct saving in personnel as time goes on, because we are getting savings. Naturally, we are watching and seeing where we could do with less personnel. As we learn more about the process we are able to do that and as the time factor becomes of less importance, we are also able to do a great deal more.

For instance, we no longer have to rush materials through; we can take our time about it and it does not cost us anything to have material in process, whereas before it was costing us days of war.

Now it merely means we can get it any time; but the pressure of time is gone.

Senator VANDENBERG. Speaking generally, is this going to be a billion dollars a year, half a billion, or do you have some figure in mind?

General GROVES. I would hate to speak because you might remember the figures [laughter] but I should say that it will be less than a half billion.

Senator HICKENLOOPER. I was just wondering, General, with regard to this matter of safety. How long would it be safe for a fellow to walk around with a radioactive dime in his pocket?

General GROVES. I don't know, Senator.

Senator HICKENLOOPER. Do you think it would be safe?

General GROVES. I wouldn't carry it. [Laughter.]

Senator MILLIKIN. General, am I correct in interpreting your remarks to the effect that you favor the maintenance of the essential parts of your set-up until Congress decides upon its policy?

General GROVES. Yes, sir.

Senator MILLIKIN. You are not advocating a permanent maintenance?

General GROVES. No, sir; I am not advocating its permanent maintenance; the permanent maintenance of the essentials of our present organization.

I am advocating it until such time as Congress passes some legislation. I am advocating it beyond that point to the time when the body that is given the responsibility over this thing has a chance to really understand what problems it is going to be faced with.

Senator VANDENBERG. Regardless of what kind of action Congress takes, is it your view that it is necessary to maintain it? If I understand you, if we are to maintain our momentum in the field of atomic energy, regardless of what Congress does, you say it is going to be necessary substantially to maintain an institution approximately of the present magnitude?

General GROVES. No; I think that it is possible that that can be cut considerably in magnitude, within a period of, say, 2 years.

In other words, our first problem is to get adequate supplies on hand and then we will be in a position where we can say that now we can start cutting down on that establishment.

Senator AUSTIN. May I ask a question?

The CHAIRMAN. Certainly, Senator.

Senator AUSTIN. In your view, does it make any difference, with respect to this minimum amount of facilities, whether the ultimate control of this production is in the hands, you might say, of an institute that is operating as a private enterprise, with its own horde of trustees that are self-perpetuating and thus released from Government; or whether it is to be continued to be operated by Government through some agency set up for that purpose and always under the control of the Government?

Whichever role we should decide to take, whether public ownership or private ownership, there is a minimum below which we cannot afford to drop, in your view. Is that right?

General GROVES. That is correct; but I cannot imagine the Government failing to continue to have a controlling voice in this problem because it involves the whole existence of the Government and of the people that make up that Government.

Senator CONNALLY. General, at that point, I assume that your theory is that it is no more necessary to keep an Army and Navy than it is to keep other essential war or aggressive agencies and weapons in a distant part of our national defense. Would you not say that it is just like maintaining—spending hundreds of millions of dollars—maintaining the Army and the Navy?

I assume that your idea is that so long as this thing has all its potentialities it is pretty well demonstrated to be in the interest of the Government to maintain these plants and control this instrumentality until some new policy is adopted; is that right?

General GROVES. I think that this is an integral part of our national defense.

Senator CONNALLY. That is right.

General GROVES. And it is not only an integral part but it is absolutely essential to our avoiding national suicide.

To me it is not a substitute for the Army and Navy, but it is certainly part of the integrated force—I hope a well-balanced force—of whatever is needed to protect the interests of the United States.

Senator CONNALLY. I would like to ask you this question. Furthermore, would it not be wholly impracticable to turn this over to any private corporation? Do you not think that the Government itself ought to keep the whole of it?

General GROVES. I feel that this is so important that it must be retained under complete governmental control and that private industry should have no rights whatsoever with respect to this, excepting those rights that can be given without interfering with the welfare of the United States.

Senator CONNALLY. Thank you.

Senator TYDINGS. Have you any estimation offhand as to the number of employees that you think would be required to operate permanently the establishment that you describe, beginning 2 years from today?

General GROVES. I should say offhand that it would get down below 35,000.

Senator TYDINGS. For all these plants?

General GROVES. For everything.

Senator TYDINGS. How many do you have now, roughly?

General GROVES. Roughly, we have now, I believe, about 45,000.

Senator TYDINGS. So all you see in the picture is the possible reduction of about 10,000 employees when you reach the 2-year level which you have described?

General GROVES. Yes; but I also see a great reduction in the subsidiary employees who are furnishing materials of one kind or another, so that the impact on the country will be less.

Senator TYDINGS. Are they Government employees or private?

General GROVES. You mean on furnishing those materials?

Senator TYDINGS. Yes.

General GROVES. Private.

Senator TYDINGS. So that the governmental picture as of today is 45,000; and you see it 2 years ahead from now as being about 35,000?

General GROVES. The governmental picture is a lot more than that at the present time. I was speaking of operating only. We are still trying to finish certain things which are almost finished so that we will have a well-planned process.

Senator TYDINGS. What I am trying to get at is: What is the over-all governmental picture—governmental employees as of today and what you think it will be in 2 years?

General GROVES. I should say the over-all governmental employee situation is that we will cut it almost in half within 2 years. It is about 70,000.

Senator TYDINGS. And you think that 2 years from now, if the plan you have in mind is carried out, it will be 35,000?

General GROVES. I think under 35,000. As I said to Senator Vandenberg, I hate to submit my successors to something that will be worrisome in the future.

Senator VANDENBERG. Well, is this figure you are making a figure that would include the operation of the Federal cities?

General GROVES. Yes, sir.

Senator VANDENBERG. And it includes the necessary employees for that purpose?

General GROVES. Yes, sir.

Senator TYDINGS. May I ask you one other question? The expense of operating that plant today, the over-all governmental expense of operation today on the 70,000-employee basis, plus the cost of acquiring materials, and so forth, the operating of all the plants you now have, how will that figure compare with your figure for 2 years from now? Will it be the same cost, will it be half, one-third, or two-thirds, in your opinion, of what it is today?

General GROVES. I think it will go down to probably half or two-thirds.

Senator TYDINGS. You mean it will go down two-thirds?

General GROVES. No, sir; it will be, at the end of that time, between 50 and 60 percent of what it is today.

Senator VANDENBERG. That is, without inflation? [Laughter.]

General GROVES. Of course, if you are going to raise all the civilian salaries we had better make it all military, so that the pay rates won't go up. [Laughter.]

Senator VANDENBERG. General, I would like to ask you one more question—if I may, Mr. Chairman?

The CHAIRMAN. Yes, sir.

Senator VANDENBERG. Assuming an international decision to outlaw the use of atomic energy for military purposes, in your opinion could the world be successfully policed in respect to that objective?

General GROVES. I don't know. It all depends on what the attitude of governments is. I don't think it could be policed as of today unless the United States is ready, on the drop of a hat, to start an offensive, aggressive war against somebody who has taken the first step toward preventing the inspection that will be necessary.

I don't think—you are really getting me out of my field—but personally speaking, as an individual—I don't believe that the people of the United States would ever be willing to enter on an aggressive war to destroy another nation because some agent of the United States Government said that he was not allowed to go and look at a certain city because they said, for example, that the roads were bad or they had an epidemic of smallpox in that area.

Now, that is what we are faced with. We have got to have inspectors who can go everywhere, who can go into every man's house—not quite into every man's house but, in general, nose into everyone's business throughout the world.

Now, we can do a lot and be reasonably certain that things are going on as they should be by other means, maybe, by watching certain trade movements and the like. But it is impossible, unless you have complete and free access to every nation in the world, a willing access of the type that we give any foreign national in traveling in this country in general. It will be necessary also to have that access include every one of our industrial plants. It will be necessary for them to poke into all the rooms where we are developing a new piece of commercial equipment and it will be necessary to have the shrewdest and sharpest people to do that job.

It is awfully hard to think of anyone who is of that caliber who could ever forget his national loyalty. I certainly would not be willing to recommend any man that I thought was capable to be one of these international inspectors who would forget for one minute that he was a United States citizen with all the loyalty that means.

Now, of course, I have been educated and brought up on the United States' first principle.

The CHAIRMAN. Just a minute, General. That implies that the inspector you would recommend, if he found in the making of a joint inspection in this country that, we will say, in the laboratories of one of our big corporations that there were some secret works going on—is it your thought that you would reprimand that man if he reported to an international inspection service what was going on in that laboratory?

General GROVES. You mean—no; I would not reprimand him. I just say that if I were that inspector I would always be thinking about the United States, as well as the international organization.

The CHAIRMAN. You would also think about the obligations that the United States undertook, to open up to an inspection service, under a solemn agreement that they would? You would reprimand this United States inspector who was a member of an inspection panel of, we will say, six members who joined in a report, we will say, to the United Nations Organization that there was some secret atomic-energy work going on, we will say, in Princeton, N. J.?

General GROVES. No; but I would hope not to have anything to do with it, Senator, myself, personally.

If there were secret work going on in the laboratory of one of our big commercial organizations and that secret work involved, say, a new design of an automobile that was being kept secret for trade purposes, I would hate to be a party to encouraging some foreign commercial spy in getting information about that. It is so hard to draw the line as to what is atomic energy and what is something else.

The CHAIRMAN. We are talking about atomic energy, weapons of war, and not automobiles.

General GROVES. But, to me, it means this: As I say, any inspection service has got to be free to go into every crook and nook and cranny of the United States, to be certain that any work being done is not work on atomic energy.

That means that we are all going to have them; if they decide that I am working on atomic energy and they say that I must have some notes at home, it means that they can come up and search my house.

That is the degree to which you have got to go if you are going to depend on that service. That is so because when the scientists developed this thing, the theories on which this was done, practically all of them, were based on theoretical blackboard work and you would have to be able to inspect those blackboards.

I think you have got, maybe, to change the world from feeling loyalty to nations. We had a civil war in this country and it was based on loyalties, and you do not drive those loyalties out of a man's head overnight. You cannot just say that everybody in this country now is going to owe allegiance to some international organization.

Now, we may do it. We may come to it. It may be the solution. But, at the same time, we have to have the feeling—we may be misguided in that feeling—but we have to feel that the other nations of the world will come into this with just the same desires as we have.

Senator VANDENBERG. Now, assuming that we do try to discriminate between the development of atomic energy for war purposes as distinguished from peaceful purposes and suppose we allow a general world-wide development of atomic energy for peace purposes, is it possible to develop atomic energy for peace purposes and stick to that with complete fidelity—

General GROVES. No, sir.

Senator VANDENBERG. And yet be just as ready, the day after tomorrow, to turn it into a war weapon?

General GROVES. We can. The real secret of this development does not lie in the work that was done at Los Alamos, which was the development of the bomb itself; it was in the preparation of the material, that was the hard job.

Now, I am not taking away anything from Los Alamos. They did a magnificent job but it is something that if we had to do over again—supposing I was an outsider and was in some other country and I was told to duplicate that job. My real worry would not be the work at Los Alamos, but the work that led to the development and to the successful operation of the separation plants.

There was involved not only the development. We had to learn how to operate and that took us a long, long time.

We were on the brink of failure; in fact, we were over the edge on the failure side many times and for long periods of time.

It is that that is the real thing which I would like to see kept. Now, in other words, that means that you cannot separate the peace and the war. They are just so closely interlinked that you just cannot separate them.

While you may say that we can use it for peace and if we start out for war we will do something, I say that you have got to be prepared to go into an aggressive war at the drop of a hat, at somebody's say so, and without even waiting to assemble Congress in special session because it would take too long. We would have to change from peace to war pretty fast and get to making enough bombs before they could put our bomb-making capacity out of business.

Senator HICKENLOOPER. In other words, there is no difference between the material and its use for peace and industry and public health and fields of that kind and its use as a weapon? The same material is used for both purposes?

General GROVES. It is the same. It is in a different form, as you know. I think I have shown you all those various steps in these processes, where they take the material and change it from one salt to another and do that all the time and that does not take very long with modern chemistry.

Those things can be studied and they are being studied and these processes can be discerned, they can be learned from very small amounts of the material. It can be done by sneaking out some of the material and they can develop all of our processes and be all ready to go when the time came.

Senator TYDINGS. Right along that same line, suppose that the leading nations started on the production of atomic energy for peacetime purposes and that they had plants which produced it and it was beginning to be utilized to run ships or automobiles or electrical plants or whatever it might be.

They would then have plants that were making the elements that go into a bomb. I imagine that it would not be a very difficult procedure, after assembling all the elements, to build the apparatus that would make the bombs. As I understand it, the problem is to get the elements.

General GROVES. That is right.

Senator TYDINGS. So, if we do have an atomic-energy-operated world, all the inspections will be pretty much dissipated—the value, rather—because once the development of atomic energy is assured to different nations and the means for producing it is set up, it is a very short step from there, both in time and in mechanics and intellect and everything else that enters into it to change that into making a bomb with it?

General GROVES. That is correct. If that came to pass and I had anything to say about the inspections, I would want an inspector of my own in every plant that this material was being used in for the production of energy and I would also want somebody in there watching that man to make certain that he was still my man.

Senator TYDINGS. You would still want another man watching him?

Senator VANDENBERG. In view of all these complications, have you thought this thing through as to a recommendation?

General GROVES. You mean, as to what to do?

Senator VANDENBERG. Yes.

General GROVES. I feel that the step proposed by the President, as announced in the agreement or announcement signed by himself and Mr. Attlee and Mr. King was the correct step to take.

In other words, we have now got a weapon which can destroy an enemy very suddenly and punish him to the point where it would be a long, hard pull if he is going to win out. I don't believe, necessarily, that we will have a push-button war in which somebody will press a line of buttons and then the war will be over. But I do think that whoever is hit by what comes from that line of buttons is going to be at a terrific disadvantage. He is going to have the equivalent of 5 or 10 Bull Runs on the first day of the war.

Senator TYDINGS. With three Pearl Harbors thrown in.

General GROVES. I was not mentioning Pearl Harbors.

Senator VANDENBERG. That is around the corner down there [indicating corridor]. [Laughter.]

General GROVES. That is what is going to happen. I think that the discipline of the people is going to tell whether they quit like various nations quit in this war or whether they are going to go on fighting no matter how dark that day looks to them.

The CHAIRMAN. In that event, maybe there will not be enough people left to compose a coroner's jury if we had that kind of devastation.

General GROVES. I think the thing we are faced with is that this can be a terrific blow in the early stages of a war. It is a terrible temptation to anyone who wishes to start a war, as Japan did with us. It could give them a tremendous advantage in the way of a sudden surprise attack which would come without all the diplomatic palaver that went on in this case.

For example, using Japan as an instance, they would have come in 1935, or something like that time, when supposedly everything was lovely between us, but they would have made up their minds that we were an obstacle to a Greater Asia and therefore they were going to put us out of business.

Senator TYDINGS. General, coming back to this question of inspection, I take it from your remarks that inspection might be feasible and beneficial in the early development of this energy and before atomic energy gets into what might be called civilian use.

I take it that after that point was reached and atomic energy was being used on a wide scale, let us assume, it seems to me that the value of the inspection decreases correspondingly as civilian use of the atomic energy increases, because it would be so widespread, so much of it here, there, and every place. Is that correct?

General GROVES. I would say that perhaps the value would not decrease but the possibility of doing it would become just hopeless.

Senator TYDINGS. Yes.

Senator BYRD. General, the answer you gave to Senator Tydings' question was that you said it was hopeless. I presume you have been doing considerable thinking on the feasibility of inspection?

General GROVES. Yes, sir; I have.

Senator BYRD. Have you called upon the officers for a report on that subject?

General GROVES. Not for a report, but I have discussed it individually with a great many of them.

The CHAIRMAN. It is my information that a great many of them, officers and generals, will discuss that phase and we hope that we will have the best of their thinking on that proposition within a short time. I just wondered as to how deeply the War Department had considered the subject.

General GROVES. We have discussed the subject. On all such matters we have discussed them very closely with a number of scientists. As you know, we have a great many hundreds and even thousands of them and we do not discuss everything with all of them. After all, we still have work to do and so have they.

However, we try to get a cross section of their views and opinions as to how just such a thing can be operated. We also try to get their opinions on a great many other things—when we get into something that involves science as a whole we try to get the views of their representatives.

There is one thing I would like to take this opportunity to correct and that is this: I do not feel that there is any real difference between the War Department and the scientists.

I say that because the War Department does not want to put the scientists in a strait-jacket, they want every possible advance in the country scientifically, as well as in all other fields of knowledge.

The scientists, on the other hand, do not wish to disclose things that should not be disclosed to foreign governments.

I think that that is really their standpoint on that. I had hoped today to be able to read to you an extract from a letter written by one scientist to another of which he sent us a copy.

The CHAIRMAN. Before you go into that, General, I would like to go back to your estimate of 2 years that you made in answer to Senator Vandenberg's question.

Assuming that we were starting from scratch with what we now know about it today and suppose that we wanted to get into production, I want to ask you this.

Have you taken into account the following factors:

First, on the assumption that the safety of operating personnel is to be disregarded, would that period of time be considerably shortened? It would, would it not?

General GROVES. I think, if safety of operating personnel is to be disregarded, it may be.

I would also like to add that when I said 2 years I assumed that we knew what had happened but that we did not have the experimental work done and that we had to repeat that. In other words, that we threw away our notebooks, as it were. If we did not do that, that time, maybe, would be shortened. Well, it would still remain almost 2 years, but it would be a lot easier.

The CHAIRMAN. I would like to go into that because that seems to me to be a very pertinent subject for further inquiry.

I think one of the things you have to determine is the possibility of other nations getting going on this project.

That leads me into another subject I want to inquire into, namely, if certain countries were to announce, tomorrow, that they had it, I wonder if it would change your views any.

Now, you have the assumption that if safety of personnel were disregarded entirely it would cut down the period somewhat?

General GROVES. It would cut it down in this country, if we could do that.

The CHAIRMAN. In other words, if we built those buildings without any regard for safety factors or if we just took an empty factory building, any empty factory building, or put up a great big shed or a great big tent just to cover you from the weather and without any regard to the cities you built around this project which took, of course, a good deal of time, you could then really bring it down to the basic factor of building some complicated machinery, could you not?

General GROVES. No; because you would have a cleanliness affair. Now, if you take the work that you saw at Tennessee, the two big plants, there were no unusual safety factors built into those plants. They were built that way because they had to be in order to start operating.

The CHAIRMAN. But we developed four processes in 3 years, did we not?

General GROVES. Yes, sir.

The CHAIRMAN. Now, assuming that we took the best process and proceeded from scratch on that—that is, when I say “scratch,” I mean with the knowledge of how to go about it—without regard to safety and using flimsy buildings without building any city and using one process that will work, that has been found to work before, does that change your 2-year estimate?

General GROVES. Yes; if we built one, the 2 years would probably become 3 years because you could not accomplish what we did if you built one process. It might become 4 years.

The CHAIRMAN. But today you know the best process, do you not?

General GROVES. Yes, I know.

The CHAIRMAN. Knowing the best process and concentrating on that, would it shorten the time?

General GROVES. No, sir; it would increase the time.

The CHAIRMAN. In other words, you have got to use all four processes?

General GROVES. Not all four, but it would increase the time because of the whole over-all picture. I am taking it from the time we started until we have a bomb that would work. I would rather not explain the details of that in an open hearing.

Senator HICKENLOOPER. General, if we disregarded the safety factor of the personnel, would not the morale of the personnel have something to do with the efficiency?

General GROVES. I do not think—knowing what I do know of American citizens—I do not think that we could operate this thing, even with the most highly disciplined troops, without regard to safety.

Senator BYRD. You have had no operating accidents?

General GROVES. We had no operating accidents throughout this project that were directly attributable to the unusual nature of the material that was a fatal accident. We had one after the bomb was exploded. We then had one which we should not have had; there was no reason for having it.

It was like all accidents, industrial or home accidents. If you do not turn on the light when you go down to the cellar, you are going to start having accidents; that is something that's too bad, but that is the way most industrial accidents happen.

Senator HICKENLOOPER. But even in the case—General, let us assume, in order that we may have an extreme assumption—let us assume that we had slave labor or impressed labor of one sort or another. Would not the morale factor of the impressed labor, knowing that their safety was not being taken into consideration, reduce their efficiency almost to the point of zero?

General GROVES. I would say that the best example of that is to read what the American prisoners did in that machine shop in the Japanese prison camp. There the Japs found out that impressed labor ceases to be of value when it is for anything but plain physical labor, like shoveling dirt. Where you get into highly complicated technical processes, where one man can turn a valve and turn it back again and nobody can tell that he did it unless he has a terrific amount of equipment such as we have for registration, it is just too bad.

Senator HICKENLOOPER. And you cannot stand for sabotage in this business.

General GROVES. That is right. Sabotage is a very serious problem. We have had some cases where a man made a mistake and that mistake was extremely costly. I think it would be very difficult to operate without the highest morale on the part of the workers and without the highest degree of intelligence and capacity.

Senator TYDINGS. Going back to the question of inspection again because, after all, sooner or later we have got to determine what to do to protect ourselves and the world, I take it that you are looking ahead 15 or 20 years, to what we might say would be the normal evolution of atomic energy.

With that viewpoint, according to your statement as I understand it, you consider that as of doubtful final value; and that your opinion is that some approach to it, similar to President Truman's statement, is the best thing we have been able to conceive for the future protection of our own country and of the world?

General GROVES. I think so. That will lead to inspection of a certain type. That approach, in my opinion, leads toward the opening of international frontiers and a free interchange of people and essential ideas.

With that free interchange I think that it is impossible for a dictator to exist, except in a very small place, like a city. For example, you may have a city dictator but he cannot become a national dictator with a capacity of waging war and drawing the whole world into it.

To me the important thing is the opening up of all nations to freedom of travel and that, you might say, would be an inspection service, but you would not say that if we had inspection we would be safe.

You would be expanding that. You would have not only scientists, but you would have engineers, you would have nationals of all types traveling back and forth and spreading the doctrine of how the rest of the world lives.

I think that would do more toward obviating wars than anything else because then a man would say, "Why should I starve over here when I can go to another country and be treated decently?" The better men would tend to migrate and the thought of war would be less and less in their minds.

Senator TYDINGS. So that the real hope cannot be pinned too strongly on inspection alone?

General GROVES. No, sir.

Senator TYDING. Inspection simply implements a plan for the control of atomic energy?

General GROVES. I believe depending on inspection alone would be like depending on having most of these bombs alone and saying, "Here, we have got 10 times as many bombs as anyone else has, so we are absolutely safe." We are not absolutely safe. It may have a very strong influencing effect.

I think, in the same way, an inspection service would be a great influence and, as far as we are concerned in our own country, would be quite effective, but I do feel that we cannot depend on it unless we are willing to have every house subject to inspection without warning or without warrant.

Senator MILLIKIN. May I ask a question?

The CHAIRMAN. Yes.

Senator MILLIKIN. General, assuming that there is inspection and assuming that it is reciprocal and assuming that to make it efficient involves a large number of inspectors who would be privileged to go through all our industrial processes and laboratories and that the same privilege would exist in all other countries, what would be the effect on the private enterprise economy of the world?

General GROVES. I don't think there would be anything private anymore because if, for instance, you have got a new type of automobile brake, you would have to explain it to every other nation.

You might say that that possibility might not be included; but as soon as they can pry around and they start finding out things it will be so.

I think the history of the General Motors proving ground, for example, showed that. They had, they found out, to bar the public to keep their competitors from finding out what they were doing.

Senator HICKENLOOPER. As soon as somebody locks a door to an inspector, that places the building immediately under suspicion?

General GROVES. Yes. If I were running that inspection service, I would want to know what was going on in that building.

Senator HICKENLOOPER. Whether it was work on industrial power or atomic power, the inspection would have to be held to find out?

General GROVES. Oh, yes. It may be something that somebody is making; for instance a better microphone. I would say: "I wonder how it fits into this bomb. I want to use it. Maybe they are making a special type of fusing for that bomb."

Senator HICKENLOOPER. May I ask another question?

The CHAIRMAN. Yes.

Senator HICKENLOOPER. General Groves, I would like to ask you, is there any encouragement at this time—

Senator VANDENBERG. I don't think so.

Senator HICKENLOOPER [continuing]. For the development of a reasonably adequate defense against the atomic bomb within the reasonably near future?

General GROVES. I know of none. I think the only defense is to stop the carrying vehicle before it can launch the bomb.

The CHAIRMAN. How about its being planted by sabotage around our cities?

General GROVES. As to its being planted by sabotage, I think that that means that you have to know enough about what is going on if you want to have complete protection.

There again you have got to have a corps of inspectors that will go into every room, you might say, of everybody's house and see if they have got the ingredients for the bomb.

Senator HICKENLOOPER. My point is this: There is no encouraging answer when it comes to defense now to detect a bomb in the air and explode it, for instance, or destroy it before it reaches its target once it is launched?

General GROVES. No way. I see no hope of that and none in the future. You must figure, in this instance, that you have got to stop them 100 percent. It is not sufficient to stop half of them. You have got to stop them all and no one, I think, has yet been ever able to devise a perfect defense line.

Senator HICKENLOOPER. You can detect it with radar, the approach of it if it is coming, just as a metal object; but there is no way of detonating them or reaching them?

General GROVES. You could detonate them with high-powered artillery, but some of them would get through. As you know, the attack by the German buzz bombs—a great many of those were shot down but some of them got through; not enough of them to do enough damage when they got through, so they could stand that. But these bombs, you have to stop them.

Senator VANDENBERG. I would say your answer is, "There is no encouragement—period."

General GROVES. There is no encouragement—period.

The CHAIRMAN. Assuming that 40 of these were planted around 40 of our centers of population and were detonated in some mechanical way, of what value would 10,000 of these bombs be to us, distributed around the country ready to launch at an aggressor?

General GROVES. I would say the value would be that although we had suffered a loss through the damage of 40 such bombs—

The CHAIRMAN. Which might mean 40,000,000 people?

General GROVES. Which might mean 40,000,000 people; but the rest of the people would still win the war.

The CHAIRMAN. How would they know where to launch the 10,000 we had?

General GROVES. It is a little hard for me to conceive of someone just exploding such bombs without at least letting us know who it was.

The CHAIRMAN. Well, let us assume that country A takes over country B, a small country. This small country, for all you can find out, these 40 bombs come from this small country. On that suspicion, are you going to launch the 10,000 bombs at country A?

General GROVES. If I were running the Government I certainly would not hesitate very long on that, because you are faced then with the need of an instant decision which would mean the life or death of the United States and you could not sit down and have a jury trial to determine whether that country did it or not.

The CHAIRMAN. But they might be innocent.

General GROVE. Well, if they are innocent—

Senator RUSSELL. They are out of luck.

The CHAIRMAN. In other words, it is too bad for us or too bad for them, the innocent country?

General GROVES. Yes, sir. But it is just like anything else. If you are driving an automobile across the street and a child runs across

the street and you instinctively turn the wheel and run into another car and kill somebody in that car, it is too bad for that person in the other car.

The CHAIRMAN. I don't think any system of morality I know of would work.

General GROVES. In other words, I feel that it is very difficult when you take a hypothetical question, to know just what all the background is going to be. That is what would determine it, the background. I cannot imagine not knowing who was responsible. I personally feel that if that was done the nation responsible would tell us.

The CHAIRMAN. If we had an inspection force, the feasibility of such an event as I have described would be, you might say, considerably lessened, would it not?

General GROVES. Considerably lessened; yes, sir.

The CHAIRMAN. From that point of view inspection would be zero plus, some factor; anyway?

General GROVES. Yes, sir. That is what I said to Senator Tydings. I hope I made it clear that I do not oppose inspection because I feel that the steps the President is taking will lead eventually to some type of inspection. But I would say that you cannot make inspection 100 percent perfect.

The CHAIRMAN. Don't you think that it would be easier for us to act before other nations got it?

General GROVES. I am very much in favor of rapid action on this and that has been the policy of the War Department straight through, that everything should be done to get this thing settled and on the way as soon as possible.

The CHAIRMAN. Rapid international action as well as domestic?

General GROVES. Oh, yes, sir.

The CHAIRMAN. One more question, General, and then we have got to adjourn.

This stuff we are making now, as you know, has a peacetime use for experimentation, making it serve a use for good instead of for destruction?

General GROVES. Yes; we hope it has. We think it has. We do not know yet, but we think that we will find the way through that problem.

There is no question in my mind that it is going to come.

The CHAIRMAN. So, to consider our production day by day as simply for bomb-making purposes is to throw it a little out of focus, is it not?

General GROVES. Yes, sir; although we do not know yet. In the end, I think that the atomic bomb will be considered as a byproduct of the atomic age.

The CHAIRMAN. Thank you, General Groves.

We will adjourn until 10 o'clock tomorrow morning.

(Whereupon, at 12:05 p. m., the committee adjourned until 10 a. m., Thursday, November 29, 1945.)

ATOMIC ENERGY

THURSDAY, NOVEMBER 29, 1945

UNITED STATES SENATE,
SPECIAL COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The special committee met, pursuant to adjournment, at 10 a. m., in room 312, Senate Office Building, Senator Brien McMahon (chairman) presiding.

Present: Senators McMahon (chairman), Russell, Johnson, Connally, Byrd, Tydings, Vandenberg, Austin, Millikin, Hickenlooper, and Hart.

Also present: Edward U. Condon, scientific adviser; and James R. Newman, special assistant to the special committee.

The CHAIRMAN. General, I believe you had finished your formal statement.

General GROVES. Yes, sir.

The CHAIRMAN. Are there any questions which you want to ask, Senator Hart?

Senator HART. No; I was not here during all of his testimony.

The CHAIRMAN. Of course; you had to attend a meeting of the finance subcommittee.

Senator Hickenlooper?

Senator HICKENLOOPER. I would like to ask the general a question or two, if he cares to give an opinion on this matter. If this is a matter that you feel you prefer not to answer, it will be perfectly all right. If you can, I would like to have it answered.

Assuming our present state of advancement in the atomic science, assuming that we kept on within reasonable degrees of scientific progress vigorously advanced, what in your opinion would be our opportunity of keeping reasonably ahead of any other nation for a period of time?

In other words, could other nations catch up to us in spite of all the time and scientific effort that we might put into this thing, based on our accomplishment?

STATEMENT OF MAJ. GEN. L. R. GROVES—Resumed

General GROVES. Other nations can catch up to us on fundamental science within a reasonably short period. They can catch up with us eventually on our present state of technological advance, engineering, and operation, assuming that we remain stationary.

The CHAIRMAN. Pardon me; I did not get that last answer.

General GROVES. I will be glad to repeat it. On the basic fundamental scientific knowledge, other nations can catch up with us with-

in a comparatively short period, say 2 years, and that assumes that other nations will make a really serious effort. They cannot do it by just sitting there with a handful of men and spending a few dollars. They have to spend a lot of money and put their best people on it. There has to be a lot of people, and they have to be supported. They cannot take the time to build their own apparatus. They will have to have it made by mechanics instead of professors.

On the development of that basic information into the information that is necessary to produce a bomb, including the separation of the material, the making of plutonium, and the development of the bomb, they can catch up to where we are at the present time within a period of years.

I testified before the House committee, in response to a direct question on that point, that one nation could catch up and produce a bomb, if they did it in complete secrecy, probably within from 15 to 20 years—more likely the latter. If they did it without secrecy and with a great deal of help from the United States and from England and Switzerland—and I say Switzerland because she is a manufacturer of precision machinery—it could be done in 5 to 7 years, probably seven.

Now, that would be catching up with us to where we stand today.

Senator HICKENLOOPER. Assuming that we go forward from where we are today on advanced research and intensive research into this fission field and the whole field of atomic energy, is it reasonable to assume that we could keep several steps ahead for a long period of time, ahead of the accomplishment of any other nation, if we devoted time to it?

General GROVES. I believe that we can keep ahead of any other nation in the world for all time to come, provided that the rules are the same for the two nations.

Senator HICKENLOOPER. That does not mean, of course, that they cannot build a bomb that would blow up?

General GROVES. That is right, and it also means this: When I say that the rules are the same, if we have secrecy and they have secrecy, we will be ahead. If we have free and open distribution of every bit of knowledge we have, and they have secrecy, they eventually are going ahead because they will finally find out something that we don't know and we won't find it out.

Senator HICKENLOOPER. I have one other question, if you would care to comment.

Do you consider the development of the atomic bomb or the atomic fission in this country, eventually resulting in the making of the bomb, to be entirely a question of scientific calculation plus mechanical development, or are there some other elements that went into that besides those scientific and mechanical things?

General GROVES. There were the scientific developments and there were the decisions as to which route to take to get those developments. Those decisions are probably not so important now as they were at that time, because people know that we were successful.

Then there is the other factor, and that is the operation. These plants do not operate themselves. It took many months before we could make one of our processes work in operation. You could take one element of it and it would work. That was the electromagnetic plant, but it did not work satisfactorily as a complete process until the

best management and the best advisers we could get on the problem had worked and worked at that problem for many months.

Senator HICKENLOOPER. Is it a fact that it requires an unusually high degree of fidelity in personnel as well as scientific and mechanical development?

General GROVES. It requires all the qualities that any employer wants in his personnel up to the utmost. It requires skill, ingenuity, faithfulness, and carefulness that is hard to equal elsewhere in the world.

Senator HICKENLOOPER. Thank you.

The CHAIRMAN. General, you say that they can catch up on fundamental science involved within a comparatively short period. I believe you said that period was 2 years. It has been my understanding that the fundamental science has been encompassed in the Smyth Report.¹

General GROVES. No; I don't believe that is correct, sir. The Smyth Report gives the fundamental science that was known or could be easily deduced. It did not give all the fundamental science.

There is always the question of what is fundamental. Here you have something that stretches over a tremendous field, and the question is: What is fundamental?

It is just like the framework or the bone structure of the body. What is the fundamental framework?

The CHAIRMAN. But the Smyth Report received world-wide distribution, did it not?

General GROVES. Yes, sir.

The CHAIRMAN. That would be my conception of fundamental principle.

General GROVES. If that is your conception of fundamental, if that is the definition you apply to fundamental, then it is already known and was known back in 1939.

The CHAIRMAN. In other words, the problem now is to take the theoretical principles which are known and put them into application?

General GROVES. Yes.

The CHAIRMAN. That is, we have the "know-how" of doing that.

Now, do you think it would take 2 years for them to get to the point where they would start to develop the "know-how"?

General GROVES. I believe it would take them 2 years to get to the point where it would be feasible to get into the actual development of plants, start that phase of it, and to me that is the fundamental knowledge.

The CHAIRMAN. You have two other estimates. You say that if we gave help it would take them 5 to 7 years. What do you mean by giving help, which would reduce it from the estimate of 15 to 20 years?

General GROVES. I mean this: We would give them various engineering developments, how to make certain things, how certain machinery was made, the exact design and exact specifications, the metallurgical processes, as well as the analyses—everything that a man has to know in order to do the job.

¹ A General Account of the Development of Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Government, 1940-45, by H. D. Smyth, chairman of the Department of Physics of Princeton University and consultant to Manhattan District, U. S. Corps of Engineers: published by the U. S. Government Printing Office, August 1945.

The CHAIRMAN. Well, it seems to me if we gave that, they would be able to go ahead and do it in a very much shorter time.

General GROVES. No; the only way they could do that would be to have us send over American labor to do the job for them.

The CHAIRMAN. This 15 to 20 years, 5 to 7 years, and 2 years—just so that we will have the record straight—are estimates by you?

General GROVES. Yes, sir.

The CHAIRMAN. That estimate would seem to me to encompass a pretty detailed knowledge about the industrial manufacturing, engineering, and scientific fields in the various nations to which you applied the estimate. What I am getting at, General, is that it is a guess, isn't it?

General GROVES. Yes, sir, it is a guess.

The CHAIRMAN. A pure guess?

General GROVES. It is my guess, based on my knowledge of what it took us, and I certainly had the opportunity to have a better basis for the guess as to what it took us than any other individual.

With respect to other nations, some of them we know something about; others have had a wall around them and it has not been possible to know what is necessary in order to make the guess. But we do know, we have looked into the problem, we have consulted and I have personally discussed the problem in its various phases with everyone with whom I could come in contact who had any basis of knowledge.

The CHAIRMAN. I have some more questions on that, because I think this is a very important point.

As to the countries on which you have not had such full information, the guess would be worth a good deal less than it would in others, would it not?

General GROVES. I think that follows naturally.

The CHAIRMAN. Of course, you know that the scientists who worked on this have a different estimate of the factors involved?

General GROVES. I know that some of them do, and I know that some do not. I believe that the answer to that really falls within how closely they were acquainted with the industrial problems with which we were faced in this country as opposed to how much of their time was devoted to the purely scientific phases.

I would also like to point out that when you say my guess may be in error—which I admit fully, naturally—it may be in error in the other direction. It may be that instead of this being 20 years it should be 40 to 50. A good many people who know and have been in some of these countries tell me they don't think they could ever build it, because they could never get, under their present system, men with courage enough to go in and make the mistakes that are necessary to produce such a thing as this.

The CHAIRMAN. I presume you would agree that no country of any size is holding back on this problem, and, for purposes of prestige and purposes of equalization, if you please, they are not sparing any efforts from here on. You don't think they will go about this lackadaisically, do you?

General GROVES. I have no information which would lead me to believe that they are pursuing it with the vigor that the United States pursued it, or anything approaching that vigor. They are still ap-

proaching it from the standpoint, you might say, of the attitude that was taken in Germany from 1939 until the end of the war. It has not reached, as far as I know, the point where anyone has started really to do anything. They are still talking and still working in their laboratories; they are still collecting scientists; they are not putting behind those scientists, or over them, or in front of them, the management and the engineering and the drive that are going to accomplish anything in a hurry. They are going to build up their stocks of fundamental knowledge, their basic science, and the things that build onto that science, so that later they will save some time; but they are not yet, as far as I know, making the determined effort that is necessary in this work to make it a success in a short time.

The CHAIRMAN. Haven't I read something in the papers about England starting a plant?

General GROVES. You have read a good deal of discussion, and it depends on which paper you read; but as far as I can tell and as far as I know, and I think my information is accurate, England has not yet made any step comparable to what we did.

The CHAIRMAN. You stated that we could keep several steps ahead, and I think we ought to make it clear for the record.

As Senator Hickenlooper said, they don't have to go ahead of where we are now to make it somewhat uncomfortable.

General GROVES. I am glad you brought that up, because I meant to comment on that, and that is that in this affair it certainly will not do us any good to be a few steps ahead if they are right up behind us and they have enough; so it is not sufficient just to say, "Well, we can always be ahead of them."

The CHAIRMAN. When you say, "Keep a few steps ahead," I presume you mean a bigger explosive and a bigger detonation?

General GROVES. Yes, one that may be cheaper and may be in greater quantity, particularly cheaper in production.

The CHAIRMAN. Of course, cost has never been a factor in the making of warfare. Isn't that true?

General GROVES. I think costs sometimes have a good deal to do with it. Our country has so much economic power, they have to decide what we will do with that power. In our case, during this last war, despite all of the economic power of the United States there had to be a military decision made by the President on the advice of his military advisers that the effort that would go into this project should be devoted to that rather than to something else. No country is rich enough to embark on such a project as this without realizing that it affects its economic structure.

The CHAIRMAN. Of course that theory does not hold water. There was Hitler. I remember that Mr. Miller, who was the financial attaché at the Embassy, made a speech in this country before the war that there wouldn't be any war because Hitler could not afford it.

The Kaiser was supposed not to have been able to afford it, either.

I don't follow your theory that cost or money has anything to do with the making of war.

General GROVES. Money does not as such, but the economic power does; and when I speak of that, I speak of the factories, the raw materials, and the labor.

The CHAIRMAN. Wherever they are found in abundance, plus a determination to proceed, you have a situation on your hands in which

there are unknown factors, of course, but nevertheless you can come to the conclusion they are going through as far as they can.

General GROVES. I have no doubt but that they will go through if they decide that they want to, and then it is just a question of how soon they can. I also understand that most of these nations state that they are unable even to subsist without money from the United States, so it is a little difficult for me to see how they can embark on something of this scale so blithely.

I think they have to consider how they are going to handle this, how much they are going to reduce the rations of their people, and possibly how much money they are going to have to borrow from the United States to build these plants with which to attack us.

Senator HICKENLOOPER. Have you finished, Mr. Chairman?

The CHAIRMAN. For the present, yes.

Senator HICKENLOOPER. May I ask the General a question?

Let's assume that some other nation or other nations, no particular nation, could build pilot models and experimental models in which they could produce small quantities of this fissionable material.

Does it necessarily follow that because they can produce these small models in fairly sizable laboratories, for instance, that they can thereafter easily go on and build quantity production models with any great speed?

General GROVES. Not unless they are a lot smarter than we were.

Senator HICKENLOOPER. In other words, there is a difference between the experimental models that produce very small quantities and the quantity production plants that produce this material in sufficient quantities to be usable as an explosive?

General GROVES. There is a great difference, and I think you saw at Clinton the preliminary pilot model for the Hanford Engineering Works.

Senator HICKENLOOPER. Yes.

General GROVES. Now, the difficulties in the problems that we were faced with there in the Hanford Engineering Works are just not comparable. They merely sort of gave us a little guide as to what might be done.

Senator HICKENLOOPER. In other words, when you built the pilot model you certainly did not know how to advance to production?

General GROVES. It was like having a headline to a newspaper story that was going to run three columns and you had the headline only.

Senator HICKENLOOPER. Reverting to the question of our keeping ahead of other nations, I assume that if they reached a point of production of this material that we have reached today they would be producing bombs that could blow our cities to pieces.

If we went forward from today, on the basis of knowledge that we have, it is reasonable to assume that the main advantage we might get from the scientific development would be, perhaps, an exploration of the field of new and different materials that would be fissionable and possibly, although it may be remote, the discovery of some more adequate defense against the atomic bomb. Is there experimentation and development along those lines?

General GROVES. I think that at the present time we have merely scratched the surface of knowledge, and we are in the same position

as some other sciences were a few hundred years ago. For example, in the lifetime of all of us we have seen the tremendous advances in the equipment for medical services. If you go to a doctor's office now, he has everything that is necessary to make a good guess, at least, as to what is wrong with you, whereas formerly, a hundred years ago, he did not have those facilities.

We are now in the same position in this field that medicine and medical treatments were in several hundred years ago. We don't know, but maybe we have gone a lot beyond that point. Maybe we have learned everything, but we have no reason to suspect so, because the more we work the more we learn things. We have not reached any slowing down on learning.

Senator HICKENLOOPER. It is interesting to note that we have not developed any defense, figuratively speaking, against the slingshot except to go farther away or put up a wall; but they can still throw the missile over it.

General GROVES. We can always, of course, if the world should ever get into such a horrible position, disperse. It would be a terrible thing economically to have to live in an armed camp. What we hope, at least I personally hope, will come within a reasonable length of time is a freedom which such wars; but I don't believe that freedom will come by ignoring the tremendous impact of this as a military weapon.

Senator MILLIKIN. Mr. Chairman, may I ask a question, please?

The CHAIRMAN. Senator Millikin.

Senator MILLIKIN. General, roughly how many separate items go into the making of one of these plants? Is it in the order of thousands?

General GROVES. Well, many, many thousands. I think the best answer to that, that really gives you what you want, is that at the Hanford Engineering Works, the Dupont Co. had over 10,000 subcontractors, each of them supplying a different material and not raw materials or basic materials. They were supplying subassemblies, you might say, as if they were in the automobile business.

Senator MILLIKIN. Each one of those items involves a technique that is the result of long experience and oftentimes of exclusive "know how." Is that not true.

General GROVES. I would say not each item, but a great many of them. In fact, of the 10,000 probably 50 percent at least required special "know how." Some of them required "know how" which with all of the power and knowledge of American industry, took us more than 18 months to learn.

Senator MILLIKIN. In many cases you took advanced technology that made them advance still further.

General GROVES. Advance much further, and far beyond what they thought was practicable. I think a good answer to that, in clearing up that point, was a statement made to me by a gentleman I met some months ago who manufactured a certain type of material which is in common use, but in the normal plant you use, say, 100 pounds of it a year, which would seem a large consumption. This gentleman told me he received an order from the Hanford plant which instead of being 100 pounds per year might be said to be 10,000 pounds per year. He replied and said, "You don't need this; you are throwing away,

Government money; why do you need it," and the answer came back: "Supply that material."

Without the 10,000 pounds it would not have worked, because you cannot, in this complicated affair, use certain materials when you need a higher grade. They just will not work.

Senator MILLIKIN. Would it be correct to say that thousands of these items represent a reflection of technological skills that have been built up in this country for many, many years, in many cases for many generations back, not only as to the particular firm that is making the item but the workmen and the craft traditions that have been passed on?

General GROVES. I think the answer there would be not only thousands, but probably tens of thousands of items.

Senator MILLIKIN. Leading now to the end point toward which I am driving, anyone that wants to do the same thing has either got to duplicate that same technology in that same way, or possibly in an expedited way as much as it can be expedited, or borrow it or assemble it from around the world. Is that correct?

General GROVES. That is correct.

Senator MILLIKIN. Either way of doing it would be a difficult way of doing it, would it not?

General GROVES. Yes, sir; unless they had world support for doing it.

Senator MILLIKIN. And it would require a long, long time?

General GROVES. I believe so; yes.

Senator MILLIKIN. With a rather technical and highly skilled overall direction which in itself, you suggest, may be lacking?

General GROVES. There is nothing that is harder to get than competent management, I think, as everyone who has tried to operate knows, and not only top management, but down below in what would normally be termed the subsidiary positions.

Senator MILLIKIN. If a country that figured on making this bomb commenced to reach out and pull in scientists that specialized in atomic energy, and if they started buying specialized machinery here, there, and in other places over the world, we would find out about that in the normal course of events, would we not?

General GROVES. We would. That comes back to the point I stated, that if they went out and told the whole world, it would be 5 to 7 years; but if they tried to do it all themselves, it would probably be 20.

I think there is another point there which will clarify it. I have discussed just how a nation would proceed on such a thing. I believe the first thing they would do would be to start educating their workmen and their management so that they could operate such an affair. Now, you cannot pass on the ability and the skill of management, or of scientists, or of any other highly skilled workmen, in, say, 5 years, and then liquidate the men—because you never know what problem is going to come up. You cannot pump a man dry unless it is something that is simple, like a formula.

I believe that certain formulas, for example the one for bitters, have been kept in the family as a trade secret, and no one has achieved the knowledge of that secret. That could probably be told in half an hour, but you cannot tell the secrets and the knowledge that are necessary to operate a thing like this in half an hour or in half a cen-

tury. You have got to build up your men and build them up so that they have the capacity to do the job.

Senator TYDINGS. General, assuming that in any one of the big nations the funds were available, the material was available under reasonably conceivable conditions, and with a degree of good fortune in discovery, we will say, how long would it take any of the leading nations in your judgment to reach the point that we have reached in this country with reference to the atomic bomb?

General GROVES. Depending upon which country you take, because there is a wide variation between them—

Senator TYDINGS. I didn't want to take one particularly, for obvious reasons, but say any of the three or four leading countries.

General GROVES. It would depend on what knowledge they had and what their industry was. In a country in which people were interested in it, if they did it in complete secrecy, it is my opinion it would take from 15 to 20 years; if they did it with the help and assistance of ourselves, England, and Switzerland, they could do it some 5 to 7.

Senator TYDINGS. Your guess would be, as between those two propositions that it looks as if you have a margin of safety in some cases of, say, 12 to 15 years?

General GROVES. Yes; I think that in any case we have a period of at least 5 to 7 years in which the problems of the world can be settled to such an extent that we won't immediately start dropping these bombs on each other.

The CHAIRMAN. Senator Tydings, before you came in, the general testified that was a guess.

Senator TYDINGS. I understand.

General GROVES. There is a more complete discussion, Senator, in the record.

Senator MILLIKIN. Mr. Chairman, I would like to pursue that just a step further.

Aside from Switzerland, Sweden, Belgium, France, what other nations could help a nation?

General GROVES. England.

Senator MILLIKIN. England, I assume, is with us.

General GROVES. Those are the principal nations, and I believe that you can almost limit it to the United States, England, and Switzerland, with possibly Sweden. It is the machine industry that is necessary. Certain things could be done in Switzerland or in the United States that cannot be done easily elsewhere.

Senator MILLIKIN. France used to make a lot of small items of various kinds.

General GROVES. Yes; and Switzerland has also been a center of high-grade machine tools of special design. You find a great many of them in this country, particularly in any plant that has been in operation for a number of years and has accumulated a number of special Swiss machines.

Senator MILLIKIN. Do you think of any other countries? I think we ought to have that pretty clear on the record.

General GROVES. I don't know what was taken out of Belgium and France by the Germans. Those two countries could supply certain assistance, no doubt, and I believe they would if they were paid for the assistance.

Senator MILLIKIN. Did you say France and Germany?

General GROVES. France and Belgium. Germany, of course, could supply technicians, management, engineers, and scientists.

Senator HICKENLOOPER. Doesn't Czechoslovakia have a highly developed machine industry?

General GROVES. It has certain things.

Senator CONNALLY. Mr. Chairman, I want to ask a question.

General, it is not your fault, because you have been prodded into it by members. I think it unwise to take up each one of these countries and particularize and estimate how long it would take. It might indicate an intention to have a contest with them, or cause some unfavorable reaction.

I submit that to the chairman as worthy of consideration, at least.

The CHAIRMAN. It might be better, I think, Senator, if we generalize.

General, we have no compact with any country mentioned whereby the country has agreed not to proceed either to do it themselves or help anybody else, have we?

General GROVES. I think anything of that kind I would prefer to discuss in closed session, sir.

Senator HART. May I ask a question, Mr. Chairman?

The CHAIRMAN. Certainly.

Senator HART. Following that same subject of your estimate, you did not mention supplies of raw materials as being in the picture. Is there anything that is not already in the record that you would like to say on that point?

General GROVES. Not in an open hearing, sir; and I would like to make it clear, Mr. Chairman, particularly in view of the presence of newspaper people behind me, that the fact that I would prefer not to discuss certain things in open session does not mean there is anything there, because either affirmation or denial is something that I would prefer to avoid. The fact that I have said I prefer not to answer does not really mean I know the answer. That is important for the benefit of the press, sir.

The CHAIRMAN. We have gotten to this point, General. I think it is safe to say that we have no such agreement with Switzerland, for instance, not to engage in it or experiment. I think it is well for people to know that.

Senator MILLIKIN. I would like to say, for the benefit of Senator Connally, that I opened this subject of nations that might be in a position to contribute material for the making of the bomb without reference to any particular nation, without having as an end purpose an alinement against any nation, and it seemed to me it was very important that we know in our consideration of this problem just who is in a position to give effective help in the construction of an atomic bomb.

There was no reflection on any country; there was no insinuation or implication on my part that it might be used by or against any country.

Senator CONNALLY. My attention was attracted to the fact that you mentioned a whole lot of countries and left out some. I submit that it doesn't require a hand pointing to a sign that this is the so and so country, because by elimination anyone could determine what country you are talking about, and that is what I am objecting to.

Senator MILLIKIN. Senator, I am objecting to the proposition of smothering simple, open facts of what nations are in a position to contribute to the making of an atomic bomb.

Senator CONNALLY. We don't expect them to contribute to us to make an atomic bomb. We are going to have to make them ourselves.

Senator MILLIKIN. I think it is agreed that if anyone else makes them, we will lend the money to make them.

Senator HART. I would like to observe for Senator Connally's benefit that the questions were altogether founded on the state of industry in these various countries.

Senator CONNALLY. The state of industry in manufacturing automobiles or bombs? We are talking about bombs.

Senator HART. No; the general industry.

Senator CONNALLY. Bombs are what we are supposed to be investigating.

Senator HICKENLOOPER. I have a great deal of faith in General Groves' discretion, which I think he has proved, and I don't think General Groves would answer anything he thinks is detrimental to the public interest. Therefore, I felt perfectly free to ask him such questions as he would care to answer, and he has answered them.

Secondly, I believe that the answers elicited about these various countries are probably as well known to every other country in the world as they are to any of our people, and I could see nothing dangerous or inimical to our interests in either the questions asked General Groves or his answers given.

The CHAIRMAN. General, this weapon is not just a new weapon of war, is it?

General GROVES. I don't follow the question, Senator; I am sorry.

The CHAIRMAN. Well, there has been some statement made that this is just a new weapon of war. I know you don't agree with that.

General GROVES. Oh, I think the term usually used is that this is "just another weapon."

The CHAIRMAN. My mistake.

General GROVES. Anyone who says that, with all due respect to whoever he may be, is just ignorant of the power of this weapon; and I think the more people think about it the more they realize the importance of this and that it is not just another weapon. I think they realize that it ended the war with Japan, and sooner than it would have been ended otherwise, and that if we had been able to drop it sooner it would have ended the war just as promptly.

The CHAIRMAN. In other words, it can be a decisive weapon of war.

General GROVES. I don't know that any weapon is decisive, excepting the will of the country to continue to fight, when that is broken. But as a weapon, it is very important.

The CHAIRMAN. In view of that statement, do you not think that your former statement that you can see no desire upon the part of other nations to go ahead with this is perhaps open to some question?

General GROVES. I didn't say that I didn't see any desire, I believe. At least, that was not my intention.

I said, or wanted to say, that I did not know of any nation that was now really going after it hard, but that they were still proceeding along the lines of laboratory research on a limited scale and had not done what we had done, which was to attack this problem with real

vigor as if they really meant to get somewhere. They are still wandering around, discussing and arguing as to what is the best method.

They have given wild estimates, such as an estimate that appeared recently from a very distinguished gentleman of one foreign country, to the effect that any nation could have this bomb within 6 months.

Well, I just say that that is an absolute impossibility. It is that kind of discussion that is going on.

The CHAIRMAN. That was Professor Oliphant of England.

General GROVES. That was the press report that came over.

The CHAIRMAN. Well, he wrote an article of recent date in *Nature*, which is a British scientific magazine.

He is the fellow who discovered the basic tube that made radar possible, is he not?

General GROVES. I don't know much about his career at that time. He is a distinguished physicist and a man of tremendous scientific ability.

The CHAIRMAN. He did; he discovered the basic principle of the radar tube. It was his statement that you referred to.

General, I understand we killed about 500,000 people in areas in Germany, and of course pretty well wrecked her desire to fight, with the air attack.

Reverting to your testimony of yesterday that if we killed 40,000,000 people here you thought the war could still go on, do you think we would be able to wage effective war with 40 of our cities laid waste and 40,000,000 people killed?

General GROVES. I think we would wage war for quite a while on that basis if we still had the will to win, and I think anyone who travels over the United States and knows the strength of American industry and the ability of Americans feels that we would continue to fight for a long time.

I think the war years of 1861 to 1865 show that the American people do not stop fighting, no matter how hard they are pressed or what the conditions or the odds are. I don't think the Americans have changed much since that time.

The CHAIRMAN. Of course the 40 cities would contain the bulk of our industrial industry. Wouldn't that have some effect on the ability of the Nation to wage war?

General GROVES. It would have a tremendous effect, and I did not want to say yesterday that it would not make conditions very hard for us; but I did wish to make the point that we could still go on fighting and that we wouldn't necessarily quit. I don't know just particularly when we would know what we were faced with. If our people have courage we are not going to stop just because of somebody destroying a great deal of our potentialities. We would always be faced with the problem, "Is it worth while to go on?"; but England was faced with that problem and they decided to go on. It was the courage and determination of a few people in England that carried that balance over. Maybe if they had all been willing to quit they could have quit very easily.

The CHAIRMAN. General, do you want to give us some cost figures for the record on these various projects?

General GROVES. I can give you general cost figures, I think. I do not remember those figures exactly, because they are rather large. If you want to give me a little time to hunt, I will try to hunt fast.

The CHAIRMAN. Perhaps you can furnish those for the record. We would like to have those inserted in the record.

General GROVES. All right, sir.

(The following statement was subsequently submitted by General Groves and made part of the record:)

MANHATTAN ENGINEER DISTRICT GENERAL OVER-ALL COSTS

1. Diffusion plant

(a) The cost of research and construction of the diffusion plant was approximately \$545,000,000, of which about \$45,000,000 was spent on research by various plants and universities. The one major university working on research was Columbia, and the amount expended there was approximately \$11,500,000.

(b) The monthly bare costs of operating this plant under the initial conditions have been approximately \$6,000,000. These costs should increase appreciably as the plant continues in operation. (These costs do not include the cost of Government-supplied materials or the indirect costs of housing and transporting employees.)

2. Electromagnetic plant

(a) The cost of research and construction of the electromagnetic plant was approximately \$350,000,000, of which about \$33,000,000 was spent on research with various plants and universities. The one major university working on research was California, and the amount expended there was about \$14,000,000.

(b) The monthly bare costs of operating the entire plant have been approximately \$12,000,000. These costs should decrease appreciably in the future. (These costs do not include the cost of materials supplied by the Government or the indirect costs of housing and transporting employees.)

3. Metallurgical, Argonne and Clinton Laboratories, and other institutions

(a) The total expenditures on the activities at the Metallurgical and the Argonne Laboratories through June 30, 1945, were about \$17,000,000, of which about \$550,000 was spent on construction at Argonne. (These costs do not include the costs of materials furnished by the Government.)

(b) The total expenditures on the activities at the Clinton Laboratories through June 30, 1945, were about \$25,000,000, of which approximately \$12,000,000 was spent on construction. (These costs do not include the cost of materials supplied by the Government or the indirect costs of housing and transporting employees.)

(c) The total expenditures on related and closely coordinated activities at other institutions to June 30, 1945, were approximately \$4,000,000.

(d) The cost of production of metallic uranium at Iowa State College (where production of uranium ingots continued until the spring of 1945) amounted to about \$2,000,000, not including the cost of raw materials furnished by the Government.

4. Hanford engineer works

(a) The total cost of the Hanford engineer works, including housing facilities, is approximately \$350,000,000.

(b) The present operating costs are about \$3,500,000 per month. (These costs do not include the costs of certain materials furnished by the Government.)

5. Los Alamos laboratory

The total expenditures on the activities centering on Los Alamos laboratory have amounted to about \$60,000,000, of which about \$26,000,000 was spent on construction. Military pay is not included in these figures.

6. Housing

(a) Oak Ridge: Expenditures on housing facilities, including necessary roads, utilities, schools, and shops, at Oak Ridge total approximately \$110,000,000.

(b) Hanford: The total construction cost of all housing facilities at Hanford was approximately \$48,000,000.

(c) Los Alamos: The total cost of housing of all types at Los Alamos was approximately \$4,500,000.

7. Industrial accidents

(a) The cost to the project of industrial accidents to workers and their subsequent care was about \$4,441,000 up to August 31, 1945. This cost included com-

compensation benefits, medical payments by insurance companies, and that portion of plant medical operating expense assignable to industrial accidents; it is broken down as follows:

- (1) Total cost in connection with construction:
 - (a) Compensation benefits, \$1,577,000.
 - (b) Medical payments, \$757,000.
- (2) Total cost in connection with operation:
 - (a) Compensation benefits, \$938,000.
 - (b) Medical payments, \$1,169,000.

(b) The total accident experience of the Manhattan Engineer District is 62 percent lower than comparable experience of private industry. The National Safety Council's "Award of honor for distinguished service to safety" was presented to the Manhattan Engineer District on December 9, 1945, in recognition of the record made "in achieving and maintaining low accident rates at the Manhattan District facilities throughout the country under the urgent demands for speed in the unique processes attending the development of the atomic bomb."

The CHAIRMAN. General, what are the prospects for the development of bombs of considerably greater destructive power than those produced so far?

General GROVES. I think I can answer that one. It is a little hard to answer in open hearings, but I think it is of sufficient importance so that it should be in the open.

The CHAIRMAN. I asked the question, General, on the basis of the preliminary conference we had in which you said you thought you could answer that question.

General GROVES. I think—and I am speaking now primarily on the basis of the normal course of development, and not on any basis that there is something we know and have not disclosed or anything like that—we have built and fired three bombs. We have done this in a hurry. Our mission was to get a bomb that would go off with power. When we first started, various people talked about enormous sizes. In order to get the thing done, I stated that our goal was to have a bomb that would be the equivalent of at least a thousand tons. That was not the goal; that was the bare minimum.

Senator JOHNSON. Was that a thousand tons of TNT?

General GROVES. The equivalent; yes, sir. As announced by the President, the bombs were of the order of 20,000 tons of TNT.

Initially we all thought we could get something in the order of 10,000 tons of TNT, and I believe that I stated that the various scientists, as they started to work on this and started to wonder about how sure they were of their figures, kept putting in factors of safety, so when we came out at the end some of them even thought it would be below a thousand tons; but it actually had about 20,000, or in that order.

Senator TYDINGS. 20,000 tons equivalent?

General GROVES. Yes, sir; they are always equivalent.

Now, as to the prospects of developing bombs of considerably greater destructive power, I think they are promising; but I would also like to point out that when you go beyond this size of bomb you start to wonder where you are going to get a target that will require the full effect of this bomb. At Hiroshima we had such a target. In other words, it landed and there was space enough so that all of its destructive energy could be used. At Nagasaki we did not have that opportunity. We had a long, narrow target, and the bomb was bigger than it had to be. There was a lot of wasted energy that went off to the sides. If you remember how that river looked, the width of the

target varied. I think there were some points where there was actually no development at all.

Senator BYRD. Were the two bombs of the same power?

General GROVES. They were of the same order; yes, sir.

Senator BYRD. You would say the same amount equivalent of TNT.

General GROVES. Yes, sir. No one knows what the exact amount is. We made an attempt to determine it, but you couldn't prove it. We have not discussed, Senator, the bombs in detail, and I would prefer not to discuss them in open hearings.

Senator CONNALLY. General, does the power of the bomb increase in proportion to the size or amount of material in the bomb?

General GROVES. I don't mind answering that one here.

Senator CONNALLY. Leave it to secret session, if you like.

General GROVES. I would like to leave most of it in secret session, but there is one thing that I think should be made known, and that is what happens in an explosion anyway.

What really happens is that you develop an explosive force, and then that blows apart.

Now, the question is if you put too much material in there it doesn't all explode because it is blown apart before it has an opportunity to explode, and there is a definite limitation on just saying, "Well, you made one bomb of this size; let's put two of them together and have twice as much material and we will have twice as big a bomb."

Senator CONNALLY. If you have any hesitation, don't answer any of these questions; but there was an old theory of chemistry or physics of which I have a very hazy recollection, that you don't get any more power out of something than you put in it. Is there in these atoms a latent power that is just there that needs touching off? I am speaking industrially now, more than about this theory of ruining everything with bombs; automobiles, and everything. Do you get any more force out of the bomb than you have to put in it through all these manufacturing processes and expenditures of fuel and energy and so on? If that is a secret, don't tell it.

General GROVES. I don't know the exact answer because I have never figured out how much energy we put into it; but I think it can best be expressed by this illustration: If you dig coal you get a certain amount of heat out of that coal. Whether you used up more or less energy in digging that coal, what you would get out of it would remain the same. In other words, there is something in here which if we start to explain would be getting us into some of Einstein's theories and a few other things which I would find trouble in explaining, and I am sure you would not be able to understand my explanation. Essentially there is something that is already there which we take advantage of. We don't compress this energy and put it all in one package as it were; it is there.

Senator CONNALLY. Well, it is the old idea of the indestructibility of matter, on which I was basing my question.

General GROVES. This might be based on the theory of the equivalence of mass and energy.

Senator CONNALLY. That explains the whole thing to me. General.

Senator RUSSELL. General, the papers tell us that some of the scientists are of the opinion that if a large number of these were exploded over the world that it would reach out into the elements in the atmos-

phere, and any other elements, and start splitting atoms there which would set the entire world on fire, and instead of being a world we would just be a new star and all life on the planet would be extinguished almost automatically.

Do you have any theory on that to give us?

General GROVES. My only theory is that I don't worry about it, because if it happens it will be all over and we won't have that to worry about. We won't have to explain that one, but the theory is not concerned with getting a number of these bombs but with getting one that is big enough to do that. No one knows what that size is. It is all highly theoretical.

The CHAIRMAN. That is where this thing was 3 years ago?

General GROVES. That is correct, but 3 years ago there was an agreement among the better nuclear physicists that these theories were correct. I don't believe there is that agreement now. It is more or less the kind of thing that they will discuss as a possibility when they are just sitting around talking; theoretically they may be able to prove that such a thing is possible, but the best advice I have, and I certainly don't hold any personal views or knowledge on the subject, but the best advisers tell me that they are not a bit worried, and I, personally, am not worried. I feel it will be beyond my lifetime, and then I will let the next generation worry as to whether they are going to blow themselves up or not.

I think there are many other things that a crazy man who had power behind him, and who got enough crazy people with him who all wanted to commit suicide, could do to destroy life on this earth as well as by this means.

Senator RUSSELL. There is one other question. Yesterday you implied that you had some doubt as to the practicability of a thorough world-wide inspection or checking on the production methods or use of atomic energy. Is that due to the difficulty in exploring all the places where this energy might be developed, or just on your opinion that the people would object so strenuously to the measures that would be necessary that it would be impossible?

General GROVES. I believe it is both. In other words, if the people object too strenuously they can stop thorough inspection. This country has never been able to have thorough inspection on certain things.

Senator TYDINGS. Prohibition is a good illustration of that.

General GROVES. So are the moonshiners in certain sections of the country where you might say the people were not so solidly against the Government as they were with prohibition, but you have that problem and also it takes such an awful lot of people.

I didn't say yesterday that inspection wasn't something that should not be done. I pointed out the difficulties of it because I did not like the idea of anyone feeling that it was something that with a wave of the hand you could accomplish and have effective inspection.

I do not believe that it is safe to say that inspection gives us a 100 percent guarantee. It is just like all inspection of all kinds. It is the reason that an airplane on reconnaissance can tell you if they see something, but they can't tell you something isn't there if they don't see it. That is true of everyone who is out looking for things.

Even in the days when cavalry was of real importance in this world of ours, we had to have infantry go behind the cavalry to make certain

the cavalry had not missed some of the military information that we wanted to have. You have got to look at every foot.

In this case you have got to look much closer than is generally spoken of. You just cannot go to the big industrial plants and say, "What is going on here," and then walk out.

Senator RUSSELL. You have shown us various little gadgets where if you would hold some piece of some radioactive element you would have certain reactions. You don't think it is possible to have any machine or development expose the place where any work of this nature might be done?

General GROVES. No, I don't think that is possible at this time. You could get certain things, there is no question; but other things you could not get.

The CHAIRMAN. Those certain things would be necessary in order to make an atomic explosive, would they not?

General GROVES. No; I don't believe so, Senator. I believe that it could be fixed up. In other words, you could put shielding on certain things.

Senator RUSSELL. You don't think you could fly over in an airplane with one of these machines and tell?

General GROVES. No, sir. Just how much you can do with that no one knows. After all, we were faced with the practical problem a few years ago in trying to find out what was going on in Germany, and we had many theories presented as to how we could find that all out; some of the theories were good, but you could not do it. After all, you have got to have the men who are going to make the inspection come back. Certain things can be done by a general, broad inspection; but I believe also that there is one thing you could do to defeat broad inspection if you intended to. Certainly if you are going to conceal or try to get away with something, the first thing you would do would be to start fighting on the inspection method that was used.

Remember that all nations would probably find out what type of inspection methods were used, and then they would go out to beat those methods.

Senator RUSSELL. We have heretofore, I believe, used only uranium in developing this energy. Has any extensive research been made with other elements to determine whether or not it would be practicable to use them?

General GROVES. I think the answer to that is that our goal was to get a bomb, and we went after that goal and have done a considerable amount of research in trying to build up knowledge. We built this bomb with inadequate knowledge, particularly inadequate scientific knowledge. Every time we could guess at the answer, we guessed at it without knowing why that was the answer, and we have consistently tried to fill in those gaps in knowledge.

We are working on that today with the purpose of trying to know all that we can about fission.

There is a great deal of talk in various places about how ultimately you can split other atoms, and ones of more common material. They have talked about how fine it would be if you could split hydrogen and oxygen, and then nobody would have a monopoly on the air.

We don't know how to do that yet, and I don't think anybody even has a real glimmer of an idea. It may come in fifty or a hundred

years. I don't see it coming within a few years; if it does come, then that will be something to be faced by the people who are then responsible.

But we are not neglecting the advancement of science. We are doing everything we can to encourage it and to encourage it in our own laboratories and at our own expense.

The CHAIRMAN. General, is this material uranium radioactive in the ground?

General GROVES. Yes, it is to some extent.

The CHAIRMAN. Airplane surveys with a suitable detecting apparatus would register the presence of uranium on contact in low flight?

General GROVES. That would all depend on the shielding of the uranium on the ground. You see, when it is down in a mine or down several hundred feet, it is shielded by the earth in between. But it would also depend on the equipment.

No one that I know of has yet been able to locate uranium deposits by flying over them in low airplane flights.

If you put a piece of uranium in a room, you could probably find it if you could get up close enough. It is the same thing with some of your detecting equipment which is such that, when you hold a luminous dial in front of it, it registers, and the man who designed the equipment says, "That is a fine piece of equipment; look what it registers." Then I held my hand in front of it and it registered the same way. That is the size of it.

If you get apparatus that is too delicate then you find it goes out of order. It is one thing to have delicate apparatus in a laboratory where it can be very carefully protected from shock, and it is another to mount it in an airplane and send it through the air and really know what you are getting. You could get suspicions, but you would get a great many false suspicions.

I think eventually something may be possible on that, and certainly if I had any responsibility for inspection, it would be one of the methods of attack that I would take to try to get that knowledge. I think that eventually something can be worked out.

The CHAIRMAN. General, I have just one more question. If, perchance, by intense work it were possible to develop this process for central heating within the next 2 years, assuming that hypothesis, it would be impossible to use it until the international control problems were settled, would it not?

General GROVES. You mean to use it in the United States?

The CHAIRMAN. Yes.

General GROVES. No; I don't know of any reason.

The CHAIRMAN. You would have to put guards around it?

General GROVES. Yes, and I don't care whether it is under international control or not. I think you would want guards around it, for you have got too much money in there alone not to have guards, and real guards, too.

The CHAIRMAN. Thank you, General.

Senator CONNALLY. Mr. Chairman, I just want to say this: I think the general has made a very fine and splendid exposition of this matter and I want to congratulate him on the great work he has done in connection with the whole program and its development.

General GROVES. Thank you, sir.

The CHAIRMAN. I might say that the general has done a splendid management job in the last 3 years and has accredited himself most favorably.

Senator JOHNSON. Before the witness leaves, Mr. Chairman, I desire to say this: I concur in what the Senator from Texas has said.

But going back to the question of detection, this committee saw the finest instruments that science can devise within 12 feet of tremendous radioactivity, and the instruments were in no way affected. A dime was borrowed from the Senator from Iowa and inserted in that machine, and when it became radioactive and was placed near that machine, it went completely crazy.

Senator TYDINGS. The machine or the dime?

Senator JOHNSON. The machine. That indicates to me, at least, that it is going to be pretty hard to detect radio-activity with any kind of device, because there you had a perfect example of the difficulties of it. Just a concrete wall shut it off.

General GROVES. I think I said earlier, particularly if I knew what the rules of inspection were, that I could hide the material so that the inspectors would not find it; I think that any nation would have enough representation on that body of inspectors so that they would know.

Senator JOHNSON. That is particularly true with respect to the material when it is reduced to a chemical compound, where there is very little or no radioactivity present?

General GROVES. I think in various portions of the process it would require less shielding, but the shielding is not an impossible task; I would rather undertake the shielding than I would undertake the separation, or, particularly, undertake the detection.

Senator JOHNSON. That is all, Mr. Chairman.

The CHAIRMAN. Thank you, General.

General GROVES. Thank you, sir.

The CHAIRMAN. Professor Urey.

STATEMENT OF DR. HAROLD C. UREY, PROFESSOR OF CHEMISTRY, UNIVERSITY OF CHICAGO

Dr. UREY. My name is Harold C. Urey. I am professor of chemistry at the University of Chicago. During the war I was at Columbia University in the city of New York and was director of the SAM Laboratory. SAM was code for "Special alloyed materials," which in turn was code for the laboratory doing the research on the diffusion process for the separation of the uranium isotopes and for the production of heavy water and other materials. I did not work directly on the production of the atomic bomb but on materials used in its production. Altogether I have worked about 5 years on this problem.

The CHAIRMAN. I notice, Doctor, that you would not state it, but, for the record, I believe you are a Nobel prize winner.

Dr. UREY. That is right.

The CHAIRMAN. And that award was made upon the basis of your successful experiments on heavy water?

Dr. UREY. That is right.

The CHAIRMAN. In 1932?

Dr. UREY. Yes; in the fall of 1931, reported in 1932.

The CHAIRMAN. Thank you.