

WARTIME AMMUNITION PRODUCTION

16 December 1946

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GENERAL MCKINLEY:

Gentlemen, this morning we are fortunate in having General Hardy with us, from the Ordnance Department, to talk on a subject that is near and dear to him, I think, by virtue of the gray hairs he accumulated during the war.

General Hardy is a graduate of the Rensselaer Polytechnic Institute and also Harvard University, where he received his M.B.A. in 1934. He has had a great deal of Army schooling, having gone through Ordnance Technical School, Ordnance School of Application. He graduated from the Command and General Staff School in the Class of 1939.

Just prior to the outbreak of war, General Hardy was on duty at Charlestown, Indiana, where he supervised the construction of the Charlestown Ordnance Works, one of the largest smokeless-powder plants in the world. From there, he went to St. Louis, where he was the Chief of the St. Louis Ordnance District.

His next assignment, and a very important assignment, was in the Office of the Chief of Ordnance as Chief of the Ammunition Branch, where he spent most of the war. He is now the Chief of Military Service in the Office of Chief of Ordnance.

His subject this morning is "Wartime Ammunition Production." I take great pleasure in introducing General Hardy to you.

GENERAL HARDY:

General McKinley said I had received considerable schooling during my Army Service; that is true. As most of you know, during peacetime we went to school a lot. Consequently, I am particularly interested in schools; what you try to accomplish at schools; how many officers should go to the various schools; what training they should get, and whether they are used after their course is completed on duty appropriate to the training they have had.

Some of the schooling I had came after I had the experience. I claim it is wrong for an officer to go through life backwards. He should get a lot of training and then go to duty rather than take the duty and then get the training.

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I seldom know enough to keep my mouth shut, so I have been criticizing personnel policies and the way they send people to school. After the war, I wound up having the Military Service which, in Ordnance, includes all the military personnel, civilian personnel, and training. So at the present time I am not on duty pertaining to ammunition, but am selecting officers for various assignments; trying to get instructors for the schools where they are in demand, and assigning students to schools.

I tell you these things because I accepted the invitation to come down here not with the idea of just talking about what might be considered a favorite subject, because I spent most of my service on ammunition, but in order to add my little bit to what you gentlemen are doing, to see what the school is like, and to talk with General McKinley.

When we talk about ammunition, we usually start off by telling how little we had upon the outbreak of war and then explain what they did during the war. That, I believe, applies to many products. I would like to do it a little differently this morning. I would like to talk about ammunition procurement first; why it is different; why so many people talk about it; and why there was so much criticism of the Ammunition Program in the early stages of the war.

Normally, when the Staff considers ammunition, they figure the requirements to meet whatever operations they have in mind, and they talk complete rounds. They want a million 105-HE rounds or five hundred hand-grenades or three million anti-tank mines, or what have you.

It seems very simple when you are talking about complete rounds of ammunition. You have got something that goes in a gun or that is hung on a plane, or put into a man's hand, and it functions--or it should!

When it comes to the procurement of ammunition, we do not talk complete rounds. They are the end product only. The real problem in ammunition is the procurement of an endless number of components--explosives, chemicals, and various types of loadings, such as shell-loading, bomb-loading, bag-loading, and so on. Each one of these operations is so large that it constitutes practically a separate industry in itself. For example, we procured TNT in such quantities we built separate plants just to make the TNT. We built several of them. In connection with TNT we had to get toluene. So we went into the oil industry. We got additions to oil refineries. We even built a whole new refinery.

Back of that is acid and back of that is ammonia. We constructed seven ammonia plants which, you will find, collectively equalled the total previous capacity for producing ammonia in the United States. So each component was a material within itself.

When we talk about shells, we are talking about a machining industry; not a few isolated items procured in thousands but procured in millions.

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So that as far as ammunition procurement is concerned, we can break the problem down into production of metal components, that is, fuses, boosters, shells, and what not; procurement of explosives, related chemicals, and acids; various types of loading and assembly into complete rounds, which is done after your various components have been loaded, usually in the same loading plant where the principal type of loading is performed.

Then we get to the heart of the problem, which is scheduling. In the Army, we talk about scheduling, we talk about requirements, and we talk about programmed procurement in a large and heavy way. The requirements, as I said before, are handed to the procuring services. They are dependent upon the operations the Staff has in mind. When those quantities are handed to us, we have to produce within the time limit specified, if possible.

Our trouble is not turning around and saying to the Staff, "You want a million 105-HE. We will give you five hundred thousand this month and five hundred thousand next month and there you are." Or if they want five hundred thousand a month, saying, "We'll get up to that capacity within three months." Our main difficulty comes in scheduling all of the parts and materials necessary to make those rounds so that when we get the final product out of a loading plant it amounts to what our requirements call for.

Most of you, I believe, are familiar with the Army Supply Program we had during the war, the so-called MPR-20, which specified the amounts and types of ammunition required. Under the second line we had the programmed procurement, sometimes referred to as the Schedule of Production. Those schedules, as far as ammunition was concerned, were made in my office--the ones which were programmed procurement--and most of them were by guess.

I brought a book down here this morning, which I do not intend to pass around, but I want to hold it up as an example. When we had war-time expansion in our mortar ammunition, this book was used with all its pages--I don't know how many there are. Each page is filled with lists of contractors' estimates, quantities of labor, materials, and machine tools required. That was the summary of our first estimate.

That is what we call scheduling. We did it to control the parts and materials that went into loading plants. We stress that point because with the quantities involved as to material, labor, and facilities, we had constant relationships with, and had to get approval from, the War Production Board regarding materials, sites, construction, and what not; also from the War Manpower Commission as to the labor involved. Frequently, those gentlemen were experienced in their own particular fields and many of the officers brought in were unusually capable.

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We would go over a program such as this and we would spend a couple of hours on shells. They would say to us, "Do you have the answer to the 60 or 81-mm. mortar program?" When they would ask us that, we would say, "No; we have twelve more items to go over." When we did get through we would still have to talk about the complete round story. That is the difficulty with ammunition.

When I first came to Washington, a very good friend of mine was leaving--I know he was not relieved on account of his not having done his job well because he went to a bigger job--but he asked me why the Ammunition Program was criticized so much. My answer was that it was so difficult to portray in simple language, or through simple graphs, to those over you. The only real solution is to have the procuring agency meet the schedules set by the Staff and then they will leave you alone. In other words, if the Staff wants a million rounds, and gets a million rounds, you hear nothing further from them. But if they want a million and you give them five hundred, why all hell breaks loose.

Perhaps you think I have stretched that phase of the program. Some of you, some day, are going to be on War Department Staffs. I ask you to remember, when you are talking complete rounds, that somebody is spending a good many hours on a lot of miscellaneous items which, singly, should never be referred to the top staff. They cannot get bogged down in the details of fuses and primers and things like that.

We have been asked, "Why don't you buy complete rounds? You buy complete tanks or you buy main assemblies; you buy a complete gun; you buy a complete recoilless mechanism. Why don't you buy a complete round?" We tried that years ago, in the early stages of industrial mobilization. We went to some of the larger corporations in the country and asked them in time of war would they take on contracts to produce complete rounds. They said they would not. In the first place, if we went to someone who was machining steel, he usually had no facilities and knew little about machining brass, copper, or aluminum.

On top of all that we had these everlasting explosives, which are stuck in everything. The risk involved is so great that private corporations do not feel they can assume the risk. Incidentally, that was one reason for the cost-plus-a-fixed-fee contract: the entire risk was on the Government. The large corporations provided the management and were good on learning the know-how, but the entire risk was on your Uncle Sam.

Along with that, as I said, these various items have to be produced in such large quantities that it requires a separate plant for even one product like TNT. Due to the hazards involved, those plants must be in the country and not in the center of a populated area. Lines must be spread out within the plants so that if one part goes up the rest of it is still useable. Consequently, we have never found any way to just sign a fixed-price contract with a private manufacturer to produce a

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finished round of anything except a practice bomb, or something like that, that has no explosive in it.

I would like, briefly, to run over just how we handled the mechanics of the program. It is rather dull, but it will give you an idea of what was involved.

Let us assume that the Staff has said they want a million rounds of 105-HE per month. When we get that requirement, it has to be broken down into percentage of each type. On each type we have to determine the percentage of various fuses. At one time we had something like fifteen different types of ammunition for the 105 howitzer. I remember General Barnes, who was head of our Research Division, saying it would not be long until we had a projectile that would do everything in the world to the enemy except kill him. We had lavender smoke, pink smoke, green smoke. We had shells that fired pamphlets, circulars, and I don't know what all. As far as we were concerned, we could make anything that did not get up to as large a quantity that it caused a shortage of material or labor; but how the fellows out in the field, up at the gun, could carry all of those types of ammunition, and have them available when needed, we never found out. Maybe some of you gentlemen did.

So, when this program for a million 105's was broken down into the various types, we had the people in charge of metal components, explosives and loading, gather in a room. We asked each one what schedule he could meet on his respective parts and materials. We listed all of those in pencil. We took the components or the loading or the material that came up with the longest time period and, depending on whether the officer or civilian was optimistic or pessimistic, I changed his schedule. That became the official Estimate of Production. It might have shown, for instance, that at the end of five months we would produce 100,000 105 rounds, and the next month 200,000, the next month 500,000 and the next month one million.

The next thing was to make sure everybody performed so that that schedule would be met. In order to do that, that schedule was sent out to what we call the Field Director of Ammunition Plants, which was really an extension of my office in Washington, but located in St. Louis, where it was practically in the geographical center of the sixty powder explosives and loading plants that the Government had built. That office broke it down further into the required powder, explosives and loading and assigned the job to the various plants because, in that office, they followed nothing but that part of the work and were familiar with the details of each plant. So, when the plant itself got a schedule, it was not a guess. It was an order from our office that they must produce on that schedule.

In a similar manner we took the schedule month by month and broke it down into the number of fuses, boosters, shells, and so forth. In doing

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that, we had not only to take this 105 round but we had to take every other round in the whole program. In order to determine the number of boosters, fuses, and primers we would need, we would have to take at least thirty rounds and compute all requirements broken down into the various components. That is because ammunition is composed of a series of components put together on various combinations.

I might point out this fact: they are never in a permanent combination. So there wasn't any way on earth we could take one single round of ammunition, break it down, and come up with an answer. Hence, the personnel who got the requirements for fuses and boosters did not know whether they were for the 105 or any other round. All they knew was they had to produce that many boosters, for instance, and someone else was responsible for seeing that the number of boosters produced were properly distributed in the assembly plants.

When these requirements for metal parts had been determined, that became an order for those procuring officers to get those parts on time. They, in turn, sent them out to the procurement districts, who already had received ample funds and ample authority to negotiate the contracts, sign the contracts, do the inspecting, and follow the shipping schedule (furnished by our office here in Washington) to whichever plant the part should have gone.

In the early stages of the war, there was a tendency to count up the number of rounds of ammunition and add up the total requirements of various components. Then they would tell a procuring officer that he should buy a million boosters for example, he went out and bought boosters until Hell wouldn't hold them. He got them from the place he could get them quickest, with the least investment of machine tools, and what not. He did an excellent job.

But perhaps a booster was an item that could be procured quickly. The fellow next to him had an order to produce a corresponding number of cartridge cases. The cartridge cases were being made of brass. The Small Arms Program was taking nearly all of the brass in the United States. The fellow could not get the necessary brass. He could not make the cartridge cases. As a consequence, we wound up with a warehouse full of boosters and no cartridge cases. We had warehouses filled with shells, powder, TNT, and what have you, that we did not know what to do with.

The program became very much out of balance. As you gentlemen know, the first shortage of material caused a lot of difficulty until C.M.P., the Controlled Materials Plan, was put into effect and had operated long enough to be really effective. There were shortages in many lines without relation to the importance of the program.

Now the W.P.B. was not very bashful about telling the War Department about its mistakes. At one time, in late 1942, as an example of

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what I have just been explaining we had 955,000-155 shell-forgings. Now we couldn't hide those. You know how big a 155 is (indicating), about six inches around. When you get nearly a million of those, you can't simply stick them under your desk. Well I heard about that every fifteen minutes. We had no capacity set up to machine them. We were asking for steel for other shells in the program. All I would ever get out of W.P.B. was, "why did you hog all of the steel in the million shells?" When you added up the tonnage of those shells, it was a big factor.

So our biggest problem was to get this program in balance and find a way to solve the scheduling which I spoke about. We did that, as I described, by breaking it down into bits and pieces and setting a monthly schedule for everyone to shoot for. For instance, if we had a hundred thousand components to be produced in the third month, we did not want a hundred thousand on our hands in the second month. We wanted them in the third month. There wasn't any point in getting ahead because it was only going to throw the whole program out of whack.

People say to us, "How did you control it?" Well, if some procuring officer placed a contract for delivering a hundred thousand rounds in the third month and some manufacturer produced them in the second month--we didn't give him any kind of shipping instructions--that left a rather difficult storage problem on the contractor's part. Then we cut his contract back. We had that much authority in the war, to cancel contracts, reduce the extent of them. We just cut them off, when necessary. We had very little trouble after industry and our procuring officers all over the United States realized that we had to stick to a monthly schedule and everybody was shooting for the one rate, not a half-dozen rates.

In the districts covering the United States we had to give every American manufacturer an equal part. We had the smaller war plants with us. A great many ammunition manufacturers are very small; so the smaller war plants could not see why they could not get business. But when you had forty-two people making the same fuse and you were trying to distribute their product to all of the different loading plants, you had a tremendous problem on your hands. One fellow would give you a carload once a month, the next fellow once a week and a big manufacturer would turn out a carload every twenty minutes.

Now, as you can imagine, all of that had to be controlled. We did it by a regulating system. We were successful in that by getting people who knew railroading thoroughly, in our office, so that they could tell the ammunition people how to work with the railroads.

Along that same line, when you take so many people, so many manufacturers--the forty-two, for instance, that I mentioned--making one fuse, you cannot get them all to make anything alike, no matter how

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you specify or prepare your drawings. There is always a variation and always a difference between the inspectors.

We solved some of these difficulties by using what we called Industry Integrating Committees, which you must have heard about before. That consisted of taking every manufacturer of the same item, forming them into a committee, asking one of the better manufacturers to act as an assistant chairman, and he controlled the group. We told him the over-all schedule we wanted. We gave him a key inspector, the best Government inspector of that particular item, we had. We assigned an officer to him. The assistant chairman furnished the clerical help from around his own plant. He had no authority to issue an order to any other contractor, but he could tell the officer with him what he wanted, provided he did not violate any laws or rules. That officer, in turn, issued the necessary orders in the name of the Chief of Ordnance. The key inspector was sent from plant to plant and refereed these various ammunition programs. He had the final say in the acceptance or rejection of material.

We found also that one manufacturer might not be meeting his schedule because he was out of material while, at the same time, another one had a whole yard full. We got the fellow with the full yard to give some to the fellow without any material and in that way we built up production.

General Campbell found out he got more fuses than the Army required without the necessity for building those plants which had been originally scheduled for construction. We had to get proper clearance from the Department of Justice because, under the law, if manufacturers speak to each other, exchange material, or show any inference that they are fixing a price, they will be subject to fine under the provisions of various laws. That clearance was obtained and the minute the war was over, we withdrew it.

Those committees, I might say, came in very handy also in making adjustments in the program. The armies in the field never wanted the same amount or the same types of ammunition for any extended period of time. We actually, in one instance, sent out a telegram on a Saturday afternoon and cancelled every contract for a certain item and the following Monday morning we reinstated the same thing because the Southwest Pacific had sent in a requisition for that material.

We did not make much heavy-artillery ammunition during the early part of the war. It was thought that bombing would solve the situation. When the Armies got in Italy, around Cassino, the heavy artillery came into prominence. We expanded that program tremendously. Just as soon as the expansion was underway I received a letter to explain by endorsement why we were procuring a certain heavy type shell when the stock on hand as of the first of January was greater than the previous twelve

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months' expenditure. During the time that paper floated around the Staff, wherever it went, the stock had dropped down to zero. We were signing contracts for new plants.

So there was a constant change in the program. We cut down one item while we were building up another. We were trying to get the program in balance. We found, in order to do that, we could take these committees with every manufacturer making a certain item and ask them to meet in some central place, say, Chicago or Cincinnati or St. Louis. I would go there with the change in the program that was wanted. We would have, sometimes, one hundred or a hundred and fifty contractors at that meeting. We would let each one come up and tell me any reason why his contract should not be cut or changed. Before we left the meeting, I set a new rate for each manufacturer and, collectively, the total was the rate which the War Department desired.

We found that worked out very well. It made it easy for someone like myself to do it quickly. We found out one very important fact: American manufacturers do not like to have any of their contracts cancelled. They all hate to lose any business--naturally. If you got them all together in one room and explained the whole program and told them the truth, they would all take the cut and say nothing about it. But if you told one contractor you were going to cut his contract in half, or cancel it, he would be down your throats next week. He would go talk to his Congressmen and everybody else whenever he thought somebody was being favored. If you will get them all in one room and explain your whole program to them, they will do anything you ask, take any cut or make any change, and you will never have any trouble with any of them.

I think that is particularly important, to tell the manufacturers what we are trying to do. That even applied when we were trying to get them interested in industrial mobilization. You see, we have so many programs that are so secret that when we talk to manufacturers we don't tell them anything. Now if they don't know what we are trying to do, naturally they cannot help us.

To go back to the old stock way of looking at it, what did we have prior to the war as far as equipment was concerned? We did not have enough to talk about, so we might as well drop that. However, we did have a few things which turned out to be very important. The Ordnance Department had kept an office in Wilmington and an officer and a couple of civilians. That officer worked along with Dupont and Hercules drawing up plans and designs for explosive plants and chemical plants, so that when the war came the Chief of Ordnance did not have to run and jump off the end of the plank. He had a rather comprehensive plan of expansion for various types of powder and explosives. That involved raw materials, types of plants, size of lines, safety distances, types of construction, and so on. That saved

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a tremendous amount of time.

In addition to that, occasionally a little money was available and Picatinny Arsenal actually purchased some ammonia-oxidation towers and other types of equipment which take a long time to build. These were stored at the arsenal. When this expansion came along, those pieces of equipment, which were the most difficult to get, were pulled out of Picatinny and sent to the new plants. It permitted those plants to start much more rapidly than originally contemplated.

To my mind, it was not the fact that we did not have the ammunition that was so important, but it was the fact industry had no experience in making any type in any quantity. As an example, we had at Picatinny Arsenal a series of buildings built as we got a few dollars now and then. They were not a production line by any stretch of the imagination. We built only four bag-loading plants during the war. I, personally, happened to be at the first one. It was operated by Goodyear Tire. It was based on their ideas of straight-line production to get quantities--based on the processes used at Picatinny. The first line to go into operation making the 105 charges gradually crept up to some three thousand charges per eight hours, per line. I think the Picatinny rate, according to the original design, for a day's work would have been twenty-seven hundred.

The plant engineer came to me, with a broad grin on his face, and said, "Say, we're up to three thousand. We're over what Picatinny said a line would do." I would not admit it to him, but I only kidded him because we really wanted more. I said, "When you get up to four thousand, come back and we'll talk it over." Before the war ended, they produced eleven thousand charges on that same line in eight hours' time.

We did not have anything like that. We never considered that as a part of preparedness. We developed a new thing once in awhile and we made a half-dozen of them. We made them by hand methods. We made enough rounds or guns, or what have you, for the field service tests. After all, industry does the quantity production in this country. They can set up a small line in peacetime and get as many as they can on one shift, working a certain number of days a week.

Another example is that we had always made TNT in a certain way. We had built a lot of TNT plants. There had been an experiment about making TNT under a process called reverse nitration. After one of these plants was operating pretty well, the operator thought he would try this reverse nitration on a broad scale. He tried it out on one line and then went on to his whole plant. Well, we finally trebled the output of TNT per line, per day; cut the cost more than in half; and we shut down some of the TNT plants. We actually tore down one plant right in the middle of the war. It had been built up at Lake

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Ontario, just outside of Niagara Falls.

To my way of thinking--this is my personal idea--a little money spent in making TNT, even if you took it out and threw it into the ocean, might have developed a process like that and we would not have built so many plants. We would have saved endless time.

We have had a lot of ammunition since time began. We never made any drastic improvements. In this expansion program we went out and asked the leading manufacturers in the United States to help us. We had Coca-Cola help us. That seems far-fetched perhaps, but they make enough Coca-Cola and spread it around the country. We also called on Proctor & Gamble to help out. They said, "Did you ever stop to realize that at Picatinny Arsenal your officers spend twenty-five years and maybe for ten or fifteen years out of that time they work on something like ammunition. They get a broad experience and learn an awful lot. We couldn't hope to compete with them. But on a particular round we are making, we make more in a week than any of your fellows saw in the preceding twenty years." That, gentlemen, was literally true. When we made fifty thousand rounds of something, we thought we had a lot. They made something like five million a month. On that particular round, after a month or two, you couldn't tell them much.

Take our loading program. We had always poured TNT through a series of buckets. It was indeed quite hazardous. They devised a bucket with sixteen down-spouts, heated with steam to keep the TNT molten. They would draw it up through a vacuum, let it flow over and fill all sixteen buckets up to a prescribed level. When it finally hit the prescribed level, the excess would gravitate into an overflow.

The electrical industry devised X-ray equipment that permitted us to look into shells. You could tell whether they were pretty solid or had a hole in them. If they had a hole in them, they might pop out and away would go you and the gun.

Those kinds of things, I think, are important. It is not so important that you have warehouses filled with things, which may become obsolete next week.

General McKinley spoke of my being with the powder plant which was the biggest in the world. That is true. We had sixty plants--which was almost inconceivable--that cost about three billion dollars. They ran from five thousand acres to twenty thousand acres, most of them with a thousand buildings, or more, on them. It is hard to explain, so you can conceive how big that program was.

The thing that brought it to my attention first was we had hardly gotten underway when a sample of the powder made at Indiana was sent to Aberdeen for test. In those days we were not allowed to say "yes"

or "no." The Proving Ground sent the results on to Washington and Washington said whether the powder was good or not. Eventually they told us. Some fellow would call me up on the telephone and say, "A lot of the powder you sent to Aberdeen has been tested. We think it is all right, but it is just on the edge of the specifications." So we held a debate about it. Maybe we could have a retest. He said, "What I want to know is, how much of that powder did you make? How much have you made since you sent that test in?" I said, "This is a big plant. While you fellows have been fiddling around, we've made three million more pounds. So if you don't want a few more warehouses filled up with powder you'd better say 'yes' or 'no'." The plant produced a million pounds a day, besides some other things. A million pounds of smokeless powder a day is quite a lot of powder. That was only one of seven plants.

(Referring to Charts)

These red lines (indicating) show the actual production in 1942, 1943, 1944, and 1945; also what was projected for the balance of 1945-46. Of course the war ended, so they quit. But you can see there was a steady increase. I want to bring out that fact because that shows there was a steady increase everywhere. That steady increase affected the amount of material we used; the amount of steel, brass; and other materials. So we were having trouble continuously by imposing a tremendous load on American industry. That went up in 1945. You can see we were going pretty nearly to five billion dollars' worth of ammunition.

These (indicating) show the monthly rates, how they went up at various times. They only started to come down following V-E Day.

Now the important point to bring out is that in between we had monthly deliveries of 90-mm. ammunition, as an example, up here in January 1944. In April 1945 we were on our way up again and in June 1945 we went back down again. So that when you cut back on the components I told you about, that would show up something like this (indicating). The people over us and the Staff would say, "We have given you relief on your materials, and what not, because we have cut your requirements down on an important item like heavy ammunition." But the 60 and 81-mm. mortar ammunition went through the roof at approximately the same time. Your total bombs upped and stayed up. So that, over all, the impact was tremendous.

Now back in 1942-43 it was not so bad. When it came to the Fall of 1944 and General Glay was flown back from Europe and the General Staff and all the top group of people got together on account of the stringent shortage of artillery ammunition and we went out at that stage, at the beginning of 1945, and started to build plants and spent three hundred and some million dollars on additional facilities, machine tools, and employed eighty thousand more men, that was getting pretty near the squeeze. That was the hard part.

Another thing I would like to bring out is that, on paper, talking complete rounds, this is easy: you want that many; you don't want so many; you tell the people to stop. But every time you say you do not want so many rounds of 90-mm. ammunition, you cannot cut back to that point (indicating) from here (indicating) in less than several months. You have got steel and brass coming out of the mills. You have forgings coming; you have machinings coming. You have your whole pipeline filled. Now if you should stop like that (snapping the fingers), the whole thing collapses and you lose your men; the contractors, in turn, lose their contracts. If the services do not want them, they will go out and seek commercial business. After all, they have got to live. It is their business to live and not just sit down and do nothing.

After V-E Day the general thought was that we would cut our requirements to this (indicating), as an example; but not knowing what would happen to Japan we would keep our capacity out to here (indicating). That was almost an impossibility. That is not twenty percent of your capacity. That does not allow a big manufacturer with ten thousand people to run one shift. He could not run five days in times like that because every laboring man in the country was getting double time or time and a half. Consequently, he might end up with an idle shop. You cannot shut a shop down and let the machine tools stay idle. You can't start it up again unless you have someone who knows how to operate it. When they tried to do that, the stocks of shells and forgings, and what not, on hand would meet these requirements without operating the shop at all. So, keeping that retained capacity was a very difficult thing at that time.

In order to keep peacetime capacity out of these sixty plants, we have about forty-five of them still left. We plan to keep about twenty-five. They can be kept in standby condition; but you might as well face the fact that when war comes you have got to partially re-equip them, get them back in operating order. We figure it will take us anywhere from three to four months to start and six months to get into operation. So there is no sense in kidding ourselves on that.

This chart (indicating) will give you some idea of the magnitude of the program starting at the beginning of 1945. We were actually producing at that time 400 million dollars' worth of ammunition per month. We crept up to that point which, if I remember correctly, was 434 million dollars in April 1945. Then, of course, V-E Day came along and we came down in a big and heavy way. We were planning to taper off at around three hundred million when V-J Day came along and we quit.

However, it had been planned to go up to 600 million dollars' worth of ammunition a month by the end of 1945. That is the program we were working on until shortly before V-E Day. It is along in here (indicating).

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This drop, you see, after the first of the year, was caused by the people who were computing their requirements always figuring their requirements to the end of the year. If they had not used all they thought they would, they put it over here (indicating). I might point out that this line (indicating) did go back up again.

The first cut was a nine percent out; the next was fifteen to eighteen percent. Then, following V-E Day, we went down to this line (indicating); that was our current schedule. When we got down there we were asked to keep the capacity along that gray line (indicating)-- I don't think most of you can see that; it was in about that area. We were supposed to keep the capacity at four hundred fifty million dollars a month, which actually was at three hundred million until the Japanese war went up or down.

This hump (indicating) certainly cost a lot of money. We were on our way up. We had to start back in November 1944 and sign contracts and order machine tools. I think it was in November 1944 that we ordered something like three thousand additional machine tools and I don't know how many--perhaps a hundred million dollars' worth of new facilities.

There were a lot of cancellations of contracts but, of course, it was a lot cheaper than continuing something you did not need. If we had ever gotten to that point, we would have had ammunition enough to shoot everybody in the world. I mean that is a fabulous quantity. I do not know, in tons, what that is, but at this point it amounted to 800 thousand tons of ammunition. Eight hundred thousand tons of ammunition is a lot.

Referring to this chart you will notice I use "Dollars or Tons". When you start talking rounds, as I indicated in the first part of this talk, you get confused.

I would like to spend a few minutes to tell you what we have now and, if time permits, what we had prior to the First World War.

We have in storage at the present time six and three-quarters million tons of ammunition. That is a fair-sized amount. If there were to be an emergency, we have enough stuff on hand to supply a sizeable army over a sizeable period of time, while we are starting up these various plants and things we have in reserve. So, you see, we are not back where we were.

People say, "You won't get any money to maintain it." Remember, you cannot simply walk away and leave it. You have got to have some protection. It has to be maintained. I, personally, do not believe, until some of it is demilitarized, we will ever lack money for some kind of protection because it is a dangerous thing just to leave around. It will require maintenance and renovation. As it deteriorates and

becomes obsolete, of course, we will demilitarize it and sell the scrap.

In addition to that, we have 375 million pounds of smokeless powder in storage and approximately 150 million pounds of high explosives. So, we are not so bad off; that is, as far as your basic materials go.

Those seem like large amounts but that amount of high explosive and powder amounted to anywhere from thirty to sixty days' consumption during the war. In other words, we had to keep, on explosives, about thirty days ahead of the loading plant. On smokeless powder we kept sixty days ahead because it takes longer to make. So the amounts we had left are not excessive from a manufacturing point of view. The six and three-quarters million tons does seem quite large, but remember the 800 thousand tons a month.

There was bound to be a lot in the plants on V-J Day, a lot in transit in this country, a lot in boats and a lot in the depots overseas that had never been used and was returned to this country. So I do not think the costs are too excessive for what happened.

I would just like to leave a couple of thoughts with you. One is you should plan for ammunition on an over-all tonnage basis and by industries. We have industrial mobilization plans gradually being worked up. We make requirements on some basis. We figure out the number of 105's and the number of 90-mm.'s we will want. But, in my opinion, in time of peace you add requirements and subtract stocks and come out with arithmetical balances that mean nothing.

We do need to know how big the Army is going to be that you are planning for; we do need to know the type of equipment you are going to need. You can break it down into classes: your 240 eight-inch in one bracket, your 105's in another, your brass items in another. In that way you can plan on material and labor. But you won't be able to know everything.

We haven't the slightest idea, and I don't believe anybody can tell you honestly, who is going to make any particular round in any particular war. In the first place, we are not going to remain static. We hope to have a lot of new items and not make all the obsolete ones.

In the second place, American industry is changing so rapidly that what they do today is obsolete next week. At the end of the war we were actually putting up a plant in north Chicago--I've forgotten the name--where they made 155-mm. shells, using girls. You had to hunt to try to locate a man in the place. Now that was my idea of push-button production. They made the 155 shell forgings, which is, as you know, no toy. It is rough work even in an ordinary forging plant. Here was a girl, surrounded by a piece of plastic and a few buttons. She did the whole job. Something like that would take up one-third the space and one-half the people used in the average 155 shell plant.

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Then I think we should maintain our present stocks in good condition. As they become obsolete or too bad, throw them away. Don't spend your money on something that doesn't amount to anything. We are faced with two situations: we either get a lot of money and maintain everything, or else we get little or no money and toss away everything. We do not want to lose our nerve.

Then, in addition to developing new items, it seems to me that in running a manufacturing line on new items, as I referred to before, you must work out your techniques of production; how you can make the shift, using women, using automatic machine tools. That is just as important as developing a new item. If we do that, we are ready to go.

Speaking from the point of view where I sat during the war, it would be a God-send if all commanders and high-ranking Staff officers would look at the ammunition requirements months before they got tight. It does take time to break them down, I know. It cannot be done in two minutes. The requirements take quite a long time to compute. So frequently we got these panic demands--I say "panic", but they weren't really panic, but urgent demands--that they had to have a certain item. Now I do not say the top officers could have cleared that situation, but if their understudies would compute these requirements, and if Top Commanders would apply their personal judgment, sometimes we might start a lot faster, because there is a time factor in everything you do.

Are there any questions?

GENERAL MCKINLEY:

Any questions?

A STUDENT OFFICER:

How did the size of the Navy's ammunition procurement program compare with the Army's?

GENERAL HARDY:

It was much smaller in over-all extent, except on the five-inch rocket. The Navy's five-inch rocket was a Navy item. They made them all for themselves. During the war, the Navy ordnance ammunition part of it, and our part were thicker than thieves. We made all the powder, of all types, for them. They had some capacity but we made most of it. We made most of the TNT.

Now on that five-inch rocket, they made the complete rocket. We furnished the powder only. They sent them to our Proving Ground for test and the Navy issued them. We never built a new facility without

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consulting the Navy's requirements for similar material.

A STUDENT OFFICER:

You mentioned seven ammonia plants which were equal to the previous prewar capacity in the United States. I wonder if you would comment on those additional ammonia plants that were built during the war for commercial facilities and authorized by W.P.B. without the concurrence of the Ordnance Department. Will you tell us why those were built when the Ordnance Department had already closed down some of their ammonia facilities.

GENERAL HARDY:

In my opinion--

A STUDENT OFFICER (.interposing):

That's what I want.

GENERAL HARDY:

They were entirely uncalled for at that particular time. I know Ordnance objected, but they were built any way.

A STUDENT OFFICER:

May I ask if you know why W.P.B. wanted them built? Was it purely a political question, or what was it?

GENERAL HARDY:

That would be my suggestion, but I would not say.

A STUDENT OFFICER:

Based on the plants existing, we will say, on V-E Day minus one, would you care to explain the present stockpile, or the stockpile of ammunition now available in days or months. I mean is it in weeks or months?

GENERAL HARDY:

I would say it was in months. At that time it was scattered all all over the world. Now it is concentrated in our depots. You can get this whole business out now wherever you want it; send it on to any area you want.

I would say it would last, as I remember the reports we got on rates of expenditure, probably five months.

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A STUDENT OFFICER:

Looking over this whole picture of the inventories we have, also the plant facilities, particularly the end reserve plants--being futuristic about the thing--we still get back to the old point of money. Now it is admitted, I think, that all of this, on paper, looks good. There isn't any sense in building plants until technological advances prove they are necessary.

Now do you think the money is going to flow any freer? Do the current appropriations indicate we have enough money to enable us to go ahead better than we did previously? I meant, what are the prospects of having more money? Are they better than heretofore?

GENERAL HARDY:

Oh, yes.

A STUDENT OFFICER:

Do you think we will have a fairly free hand in it?

GENERAL HARDY:

We will never have a so-called free hand. The Army never has the upper-hand. But, you see, so many of us tend to forget what we had before. We got used to billions of dollars; so when we got down to our current appropriations, for instance, we received only 363 million dollars this past year. But compared to the amount we used to get prior to the war, this was quite generous. Where we used to put down, for example, six and nine ciphers now you put down the six and five ciphers. If you put the other four ciphers on the other side, the number looks just as big and you are where you were to start off with.

Now I am not as pessimistic as lots of people. We ask for--I've forgotten what it is--twelve million dollars to maintain some standby plants. Well, they cut us down to nine million. You see, your costs should be very low. Now you take an acid plant. If it is not actually operated it is going to go to hell any way; you cannot keep it for long. The acid will eat out part of the stuff so you have to replace it in the end.

A STUDENT OFFICER:

You stated that if a manufacturer produced an item in two months' time, when he was supposed to produce it in three months, under your program you actually asked your inspectors and contracting officers to see that it was produced in that time. Now do you mean to say you actually curtailed production in order to do that?

GENERAL HARDY:

Yes; we had to. You see, for one thing, we did not have the necessary storehouses to put them in.

A STUDENT OFFICER:

You started off and divided your material into two parts, namely, metal components and chemical components. I wonder if you would care to comment on the so-called commodity procurement plans that have been advocated and which were, to some extent, partially used in this war by some people.

GENERAL HARDY:

What do you mean?

A STUDENT OFFICER:

The procurement of one commodity by one organization. For instance, within your organization you would have a section or branch that did nothing but procure chemicals; another branch would do nothing but procure your nonferrous metals; another ferrous metals, and so forth.

GENERAL HARDY:

I think you really have to do that when your program gets so big. You see, that is where your central control comes in.

Now I thought, at first, you meant what we call procurement assignment. You can certainly avoid a lot of duplication by having a very definite assignment of procurement.

One of you gentlemen asked about our relationships with the Navy (referring to the first question of the discussion period). When it came to the new rockets, and so forth, which involved a new type of powder and which was a new development, we had a big plant out in Kansas which made most of that. The Navy got all of their powder from that plant. They gave us the job of making the powder. They put specialists on things that were not of general knowledge.

A STUDENT OFFICER:

During this war I tried to solve our problem of facilities expansion. You made one statement during the course of your lecture this morning which seems to indicate I can put my hopes away because you said we can build plants in no time at all; that it was the least of all the problems we had. Now is that likely to be the case in any future emergency? Can you expand that a little further?

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GENERAL HARDY:

Building a shell is not much of a trick. We have a remarkable construction industry in this country and we have a very efficient engineering corps. When it comes to actual construction--other than the shortage of materials and a little labor trouble--I really never thought it was very difficult.

Our main trouble on that score was that somebody would devise a building and they would come along and say, "We'll put transite on the outside, or clapboard, or something else." It so happened that in the particular area where you were trying to build it they never heard of either one of them; but they had millions of bricks available. If we wanted them to use bricks in the construction, they would put it up immediately.

A STUDENT OFFICER:

How does the time factor enter into it?

GENERAL HARDY:

If you are going to put in a plant to make--well, just take nitrate acid as an example. You would want one of these towers they have there. You could build twelve ordinary plants while you are waiting for that one tower.

GENERAL MCKINLEY:

When you say "plant" you just mean the masonry.

GENERAL HARDY:

The type of equipment. When I talk about running a manufacturing line, I mean we set up a certain process like I mentioned in connection with TNT. If, in peacetime, we had been anywhere near successful in this reverse nitration process I spoke of, and had applied that to our design of new equipment we would have avoided building about one-third, at least--probably half--of our TNT plants. Yet, in that TNT plant the actual construction, so-called construction, is much more simple than making the various types of equipment which are made out of special irons, stainless steel, and so forth.

Now I do not mean to say you can build a big building, fill it with machine tools in fifteen minutes. That is ridiculous. But usually you will find your automatic machinery (if you are cutting metal) or your complicated chemical equipment, will take much longer than your construction people will take to put it in when they get it.

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There is one thing I would like to add: In connection with building these plants, the sites were the difficult thing. They needed tremendous amounts of water, power, and so forth. You don't find those on every street-corner.

A STUDENT OFFICER:

You mentioned that the Small-Arms Ammunition Program took most of the cartridge brass, at one stage or the other, and that that affected seriously the ammunition production.

GENERAL HARDY:

We had a tremendous shortage of brass. We never really ran out of toluene. When ever we had an excess, that went into the high-octane program. Fortunately, most of the time, when we had a shortage, we took from them without any undue trouble.

Sheet steel was terrifically short for awhile, but brass was the most drastic shortage we had.

When the Small-Arms Program was so high--I have forgotten the percentage--they practically cleaned out the whole country as far as brass was concerned.

We tried to make cartridge cases out of steel. It is perfectly possible to make a cartridge case out of steel and have it function. We were quite successful on certain rounds; on other rounds, it was just a holy mess. It was not successful and did not function well. Besides, they were difficult to make. We did not make them in the quantities desired. That was all because we had a new item. We were trying to throw it into quantity production before the process had been developed. Consequently when they made a million, if the heat treatment did not hit on the nose, that million was no good. But we had to do something. It can be done and in peacetime you can work it out.

A STUDENT OFFICER:

Would you comment just a little further on the facilities and equipment situation in regard to its present status; whether you think there are sufficient, we'll say, standby facilities; and what do you think are the future prospects?

GENERAL HARDY:

I think at the present time there is sufficient capacity as far as ammunition itself is concerned.

Let me put it in this way: In 1943 there was a big change in this program. There was great reduction in certain types of things

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and an increase in others. It just so happened that some of the loading lines, TNT lines, and what not, could be shut down. Improvements in processes like I mentioned on TNT permitted plants to be eliminated entirely.

The Production Executive Committee of the War Production Board and certain sections of the ASF Staff set up certain rules which we had to follow in order to determine which plants and what contracts would be cancelled, and so forth. In applying those rules, it was very difficult to apply them all when you had a large number. When we finally decided on shutting down the Lake Ontario TNT plant, they said, "Why don't you shut down the one in Pennsylvania or Illinois?" So we would proceed to give them all of the facts: labor, transportation, consumption, yields and all that business.

It got to the point where they were influenced to a larger extent by the dollar. In other words, if you could make TNT for seven cents in one plant and six and a half cents in another, we would shut down the one where it cost us seven cents. Now from the short-term view, that was fine. But we said, "What are you going to do when the program is changed?" So we made up a postwar plan for our facilities. We drew those plans up in 1945. We finished them about three days before V-J Day. It shows every powder, explosive and loading facility we have. They are arranged in relative order of merit--what we consider merit, such as their ability and their economy and their location, water supply, and what not. The Under Secretary's Office has tentatively approved this balanced program, which is about forty per cent of our maximum. Actually War Assets hasn't gotten a lot of them and we are probably going to keep a lot more unless someone finds an "out" for them.

So we are pretty well fixed at the present time on that kind of stuff.

GENERAL McKinley:

Thank you very much, General Hardy. This has been very interesting. We want to thank you for giving this fine talk to us.

(Applause)

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