NONFERROUS METALS RESOURCES

5 October 1954

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NONFERROUS METALS RESOURCES

5 October 1954

COLONEL BARRETT: Admiral Hague, General Niblo, ladies, and gentlemen: This morning we have the second in our series of lectures on natural resources. The subject is "Nonferrous Metals Resources." It includes a wide catalog of materials, beginning with copper, lead, zinc, and tin, and there are many other strategic metals.

Our speaker's present duties bring him in very close contact with the national defense aspects of these materials. Also, his background admirably suits him to talk to us on this project. Not the least of his qualifications is the fact that he is a graduate of the Correspondence Study Branch of this institution.

It is a pleasure to welcome to this platform this morning Dr. John D. Morgan 1/, Special Assistant to the Assistant Director for Materials, Office of Defense Mobilization, and to introduce him to you. Dr. Morgan.

DR. MORGAN: Thank you, Colonel Barrett. Admiral Hague, members of the faculty, students, and guests.

The nonferrous metals are one of a group that should be of particular interest to the military people, because, looking back through history, they are the materials with which the military, over the longest period of years, probably had the most to do.

In considering the uses of the nonferrous metals today, we find several other materials, such as ferroalloys, light metals, plastics, and other chemicals and synthetics, taking their places in many applications. However, looking back several thousand years, you may recall the bronze age as a period in history where man's use of bronze, an alloy of copper and tin, was particularly important, and where its use in military applications, such as shields, spears, chariots, and rams on vessels, and so forth, spurred the search for additional sources of raw materials. Probably, most of the early advances in metallurgy were

1/ Opinions are those of the author and do not necessarily reflect official views.

made because of man's desire to use nonferrous metals for military purposes. This is clearly revealed in the names of some of our common alloys as for example "admiralty metal," an alloy sponsored by the British for naval usage. We also have "gun metal" for the casting of cannons; "gilding metal," "cartridge brass," and other names will no doubt come to minds of this group.

In the eighteen hundreds, and extending probably through the early nineteen hundreds in this country, the service metallurgists--particularly in Army Ordnance, Naval Ordnance, and the Bureau of Ships--included some of the outstanding metallurgists in the country. Under present conditions, with specialization in science, there are probably few men in uniform who are actually skilled specialists in this field. Instead the military men have become administrators and rely on large staffs of civilian scientists in the arsenals and in private industry.

The nonferrous metals are relatively rare in the surface of the earth, even though they have had wide application. Listed are a few of the most common elements that comprise the earth's crust, to illustrate this point. Geologists have estimated--and these are all round figures--that the earth's crust is composed of about 47 percent oxygen, 28 percent silicon--silicon being the most abundant metal in the earth's crust. Yet we see very little of it in metallic form. It is a rarity only coming into use today. Eight percent of the earth's crust is aluminum--one metal the uses of which have greatly expanded in the last 30 years. Iron comprises only 5 percent of the earth's crust. We will not consider iron and aluminum herein except for purposes of comparing them with some of the nonferrous metals. Iron has been in use for many years by man, but aluminum is a relatively newcomer. Calcium comprises nearly 4 percent of the earth's crust; sodium and potassium, about 3 percent; magnesium, 2 percent. Yet calcium, sodium, and potassium are not actually used as metals. Magnesium, however, in the past 15 years, particularly as a result of World War II and the Korean War, is coming into widespread use.

Going further down the scale of abundance in the earth's crust, we come to titanium, accounting for 0.6 percent, just coming into use on a tonnage basis in the last year or two. Running further down the line, to pick up the nonferrous metals, it has been estimated that copper, which has been used for thousands of years, comprises only 0.01 percent of the earth's crust. Zinc comprises about 0.006 percent of the earth's crust; lead, 0.0008 percent.

Then we come to the very small fractions. Tin comprises about 0.0005 percent of the earth's crust, while the mercury in the earth's crust is about 0.0000025 percent.

Finally, when we come to platinum, eight zeros preceed the number which gives its estimated percent of the earth's crust.

Thus it may be seen that the nonferrous metals are very scarce in the earth's crust. However, at the present time we use vast quantities of some of them. I will not quote precise figures, but will cite the relative orders of magnitude, and will compare them with a few other common materials.

Naturally, the most abundant of all the metals we use in this country is steel. United States steel productive capacity right now is about 124 million tons. Aluminum comes next, and United States primary aluminum capacity is around 1.5 million tons. We are using somewhat in excess of that by importing some from Canada. We use about 1.5 million tons of primary copper a year. We use about 1.2 million tons of lead and about 1 million tons of zinc a year.

Then there is quite a drop off from the three big nonferrous metals--copper, lead, and zinc. The annual use of tin is only about 85,000 tons. Of antimony, we use about 40,000 tons; arsenic, about 23,000 tons. Of cadmium we use around 3,000 tons; silver, around 3,000 tons; mercury, around 2,000 tons. Then there are several where we use quantities of less than 1,000 tons, like bismuth, selenium, gold, tellurium.

Finally we come down to platinum, rubidium, osmium, and so forth, where the annual United States use is measured in ounces rather than in pounds or tons.

The above data give a picture of the overall tonnage requirements in the United States for these materials. You might be interested in the use data for the USSR. Rather than quote any secret figures here, I will quote the "London Metal Bulletin," which estimates that USSR steel production is now around 42 million short tons. USSR copper production is estimated at about 410,000 tons in 1953; USSR aluminum production, about 330,000 tons; lead, about 320,000 tons; zinc, about 300,000 tons; and tin, about 12,000 tons. Naturally, this is not a complete measure of USSR consumption, because the Russians undoubtedly import some also.

USSR copper production of about 410,000 tons is about half of the United States domestic mine production. USSR production of lead, about 320,000 tons, is pretty close to our domestic mine production of about 350,000 tons. USSR zinc productions of about 300,000 tons is about two-thirds of our present production, which is running somewhat under 500,000 tons at the present time. Their tin production at 12,000 tons is larger than ours, since we have almost no domestic tin mine production in the United States.

Another important characteristic of the metals is price. Metals are used in particular applications because of their different characteristics. Each individual element has its own certain characteristics. But over a period of years few are used as elements, but instead the metals are mixed with others to form alloys. Alloys are solid solutions of two or more metals and, by proper scientific study, metallurgists have determined which crystal structures and atomic lattices fit together to give the most desirable qualities of strength, lightness, resistance to corrosion, electrical conductivity or nonconductivity, and so forth, as required.

In all uses price is important, and we would not wish to use something that costs too much if we can employ a cheaper metal, because cost, particularly in wartime, is a measure of the use of manpower and electric power and all the other resources that are likely to be scarce.

To compare the costs of metals, we find that the cost of iron and steel is around four cents a pound. That is probably our cheapest metal. However, it is not a nonferrous metal since iron is the ferrous metal. About the cheapest of the nonferrous metals is arsenic, which sells at about 5.5 cents a pound. Zinc is now selling at 11.5 cents a pound. Lead is about 15 cents a pound. Aluminum costs around 22 cents a pound. I mention aluminum, though it is not a nonferrous metal, becuase of the great interchangeability that exists now, or that could take place in the future, between aluminum and zinc. The domestic zinc miners are a bit happier about the price of zinc which recently went up a few cents a pound and they wish it would go up further. If the price of zinc should exceed 15 cents a pound for very long, with aluminum at 22 cents a pound, there is real danger that the zinc people can lose to aluminum their market for many diecastings even though there are certain advantages in the ease of handling zinc.

Questions of substitution are important to the military because many of the items that are bought are purchased under performance specifications. In a diecasting you may not specify whether it has to be made

out of zinc or aluminum; so price conditions will govern what that is to be made out of. But the Office of Defense Mobilization (ODM) and other civilian agencies of the Government must make provision now for an adequate supply of these materials to meet military requirements. Thus requirements data must be frequently reviewed.

Going up in the price scale a bit, we find antimony at 30 cents a pound, and copper at 30 cents a pound. The copper mines have been very pleased that, through a succession of circumstances, the price of copper has stayed up around 30 cents a pound, quite consistently, for the past year or so. With aluminum at 22 cents a pound and copper at 30 cents a pound, that is probably one of the biggest favors the copper industry is doing for the aluminum producers. Naturally, the copper miners are happy today. However, if that thirty-cent price continues over a long period of time, my guess is the use of copper may drop off in several applications and aluminum will move in.

Tin is now around 93 cents a pound. Here we have a somewhat artificial price in that it is being kept up by U. S. Government operation of the Texas City Tin Smelter with the output of that smelter being held in Government stocks.

Cadmium is around $1.70 a pound; bismuth, $2.25 a pound; and mercury, which has skyrocketed in recent months, is now around $4.35 a pound. Titanium sponge is selling somewhat under $5 a pound. Silver, which has many industrial uses, sells for about $12 a pound. Metallic zirconium is $70 a pound. Beryllium metal is $71 a pound. Germanium, with very new and interesting electronic properties, is $295 a pound. Palladium, which is used in high temperature applications and for plating is $350 a pound.

Finally, we come to platinum, which is $1,350 a pound. And of course the most expensive nonferrous metal, if you want to consider it one, is radium, where, at $20 a milligram, the price works out to be about 9 million dollars a pound.

Thus it can be seen that the price range for the nonferrous metals covers quite a scale. The prices I have given you are roughly those prevailing today. Naturally, price will depend on the quantity one wishes to buy under a particular specification, shape, or form, and that sort of thing. If you want the exact figure for a certain purpose, you will have to look it up or get quotations from sellers.

Another interesting property of metals is their melting point. I will pick out a few of the nonferrous metals to show why that is of interest. On the high side rhenium, osmium, and ruthenium have melting points of around or in excess of 2500 degrees centigrade. So for very high temperature applications these metals have uses. Coming down the scale, we find that copper melts at slightly above 1000 degrees centigrade. Silver melts at about 960 degrees C. Aluminum, which is not a nonferrous metal, but mentioned for comparison as we go along, melts at about 660 degrees C. Zinc melts at about 420 degrees C. Tin melts at about 232 degrees C.

Coming down the scale further, we find mercury, which is actually a liquid at room temperature.

The low melting points of copper and tin should indicate why the ancient people used so much bronze and why for so many hundreds of years military use of the nonferrous metals expanded. The low melting point metals could be handled by the relatively primitive metallurgical techniques that prevailed until a few decades ago. Almost anyone could build a good, hot fire and melt tin at 232 degrees centigrade, and copper at 1083° C and come up with an alloy. As we get into the new metals having melting points of several thousand degrees, new techniques are required to handle them.

Another property of the nonferrous metals that is of interest is their specific gravities. Here again we have a wide range. The heaviest ones are the platinum group--osmium, iridium, platinum, and rhenium--with specific gravities of 20 to 22. That is 20 to 22 times heavier than water. Coming down the scale we find mercury, which is 13.5 times heavier than water; lead, 11.4 times heavier than water; tin, 7.3 times heavier than water; zinc, 7.1 times heavier than water.

I would like to compare zinc, with a specific gravity of 7.1 to aluminum, which has a specific gravity of 2.7. While one buys metal by the pound, in many cases one wants to use it on a volume basis--for example, to fill up a casting or conduct an electrical current. So, therefore, aluminum at 2.7 specific gravity, compared to zinc at 7.1, has about a 2.5-fold advantage on a volume basis over zinc. That shows why, even though aluminum sells at a higher price, it can still compete with zinc. One can't compare metals merely on a cents-per-pound basis.

Coming now to the lightweight metals, zirconium has a specific gravity of 6.4. That's a metal that is just coming into use at the present

time. Titanium, at 4.5 specific gravity, shows why it is particularly interesting. It is heavier than aluminum but much stronger, thus its strength-weight ratio gives it an advantage over aluminum.

Silicon metal has a specific gravity of 2.4. You will recall that I pointed out earlier that silicon is among the most abundant elements in the earth's crust, comprising about one-fourth of the earth's crust. If they can ever find a satisfactory way to use silicon metal, which is very abundant, with a low specific gravity, we will have a really interesting metal.

A still lighter metal, beryllium, has a specific gravity of 1.8. Then we come down to the very lightest of the nonferrous metals, lithium, which has a specific gravity of only one-half. A given volume would be only half as heavy as water.

As I pointed out before, however, we use but few of these metals in their native state. Instead, they are used as alloys. There are numberless alloys which I will not attempt to catalog, but I will simply list a few to provide examples.

The admiralty metal I referred to consists of 70 percent copper, 1 percent tin, and 29 percent zinc. There are alloys of the nonferrous metals with the light metals. Duralumin, for example, consists of 3 to 4.5 percent of copper, 1 percent of magnesium, a small amount of manganese, and the rest aluminum. Aluminum brass, used in certain applications, consists of about 60 percent copper, 40 percent zinc, and 1 percent aluminum. Just that 1 percent of aluminum, added to the other metals, gives an increase in strength.

Great quantities of antimonial lead are used, it being a mixture of antimony and lead. Antimony strengthens lead and that is the form usually used in storage batteries (as in the wet-cell storage batteries), and in type metal. Machine bearings are often made of babbitt metal which consist of about 89 percent tin, 7 percent antimony, and 4 percent copper.

The exact figures are unimportant. There is no point noting them. These are just cited to give you illustrations of the various types of uses.

There's a whole group of brasses which run from 88 to 64 percent copper, and from 6 to 34 percent zinc, with various amounts of other metals. They can be poured; they can take the shape of a casting; they

can be brittle; they can have a high yellow color or a high red color, depending on the constituents.

There are alloys of the nonferrous metals with the ferroalloys, such as cupronickel, containing 15 percent nickel and the remainder copper, used for bullet jackets.

Certain metals expand upon solidifying, in contrast to most metals, which shrink a bit. Therefore, there are expansive alloys, which contain fairly large percentages of bismuth and antimony. You are no doubt familiar with the plug that will let go, when the temperature reaches a certain point, to set off the water spray system. These plugs are made of an alloy that melts at 160 degrees F. They are composed of about 53 percent bismuth, 27 percent lead, 13 percent tin, and 7 percent cadmium. An interesting point is that the mixture of those four metals has a lower melting point than any one of the metals by itself.

There are many other alloys that cannot be mentioned in this limited lecture.

We should now review some of the problems in the nonferrous metals area that the Government, in general--the ODM, in particular--is concerned with. What we try to do for all the nonferrous metals (and for all the other metals, as well) is to see where we stand in meeting possible military requirements. We try to get, at least every year, from the military and the atomic energy people an up-to-date estimate of their requirements for a war of several years' duration.

Chart 1, page 9.--This is a symbolic chart showing requirements and supplies for a nonferrous metal during a war period of several years. For example, if this were the chart for copper, the military requirements would include those for cartridge cases. If this were the chart for lead, the military requirement would include lead for storage batteries and lead for bullets. If this were the chart for tin, probably there would be few direct military requirements for tin, although the military would use tin cans for food.

Where AEC has special requirements, these also would be included.

This chart also indicates that the essential industrial requirements are computed. If this were the chart for copper, the essential industrial requirements include copper for wire for high-voltage transmission lines. If the chart were for lead, the essential requirement would include

CHART 1

DETERMINATION OF MINIMUM STOCKPILE OBJECTIVES

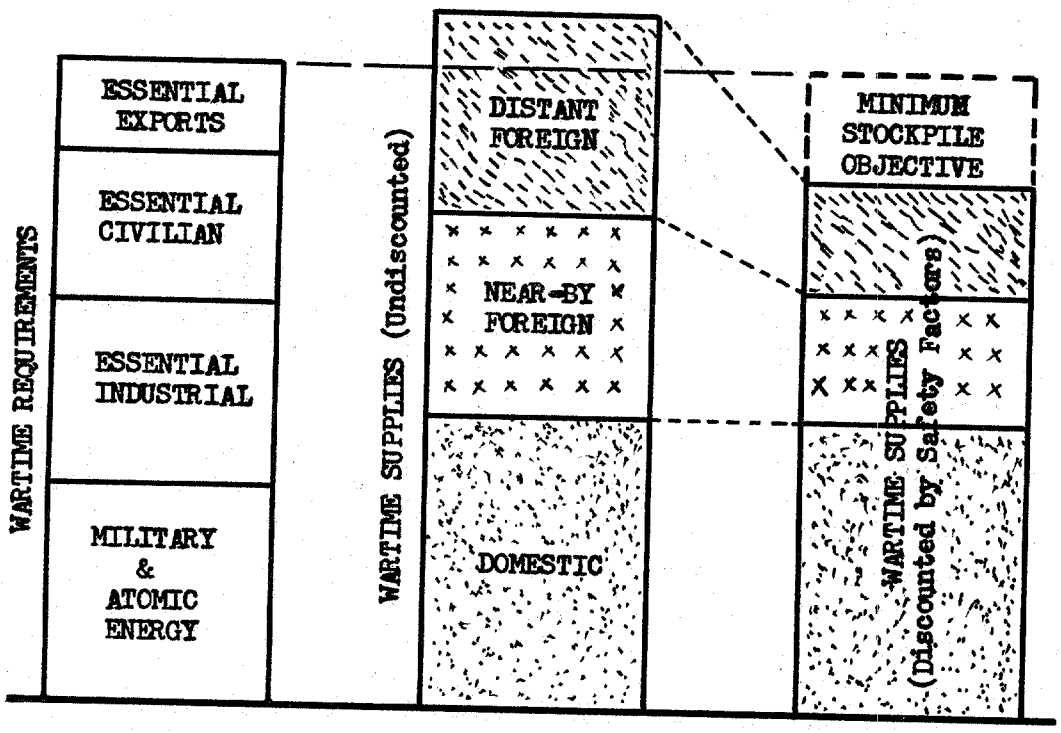
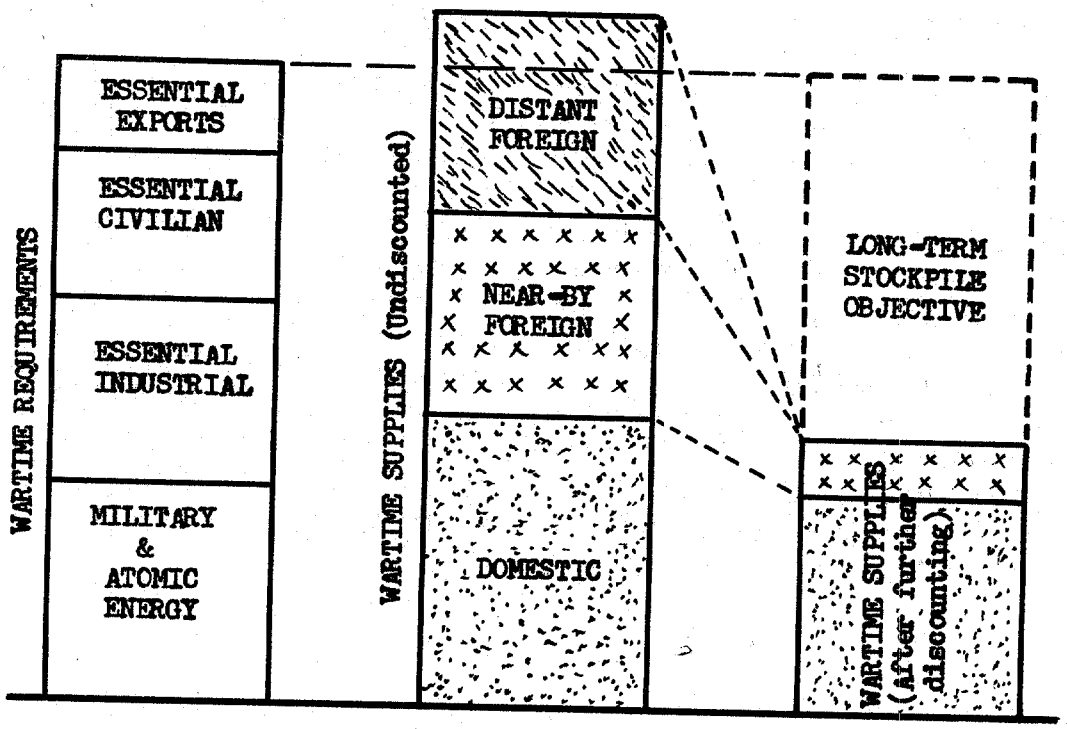


CHART 2

DETERMINATION OF LONG-TERM STOCKPILE OBJECTIVES



lead for tetraethyl lead for gasoline. If the chart were for tin, the needs for tin cans would be included. In addition the essential civilian requirements are included where they can be identified, as are essential exports.

On this chart estimates are set off against the requirements. In the case of copper, this would include the United States domestic mind production.

Then the supplies that would come from nearby, foreign sources would be estimated. For example, in the case of lead, this would be the lead from Mexico.

Also estimated would be the supplies that could come from distant sources which the Joint Chiefs of Staff (JCS) have told us are likely to be accessible from a military viewpoint, but where it might be difficult to get materials out. For example, in late 1944 we had military accessibility to the Philippine Islands; but it was several years later before we could rehabilitate the mines and get out chrome or manganese. The center column of chart 1 would indicate that the supply is greater than the requirement. But we don't stop at that point.

We next make a calculation in which we reduce supply estimates from the foreign sources by certain safety factors, called discounts. The largest discounts are applied to the most distant and dangerous sources and we would count on only a much smaller percentage of their supply actually being available to the United States.

Even in the case of nearby accessible countries we would not count on their full output in time of war because of the possibility of internal unrest or disruption of transportation, and so forth.

The actual discounts are reviewed every year, in consultation with the JCS, the State Department, and other agencies. The discounted supplies are plotted on column 3 of chart 1 which shows a deficit--the difference between the total requirement and the factored supply--and this deficit is generally the same as the minimum stockpile objective. Later you will have a further detailed lecture on stockpiling and I will just cover this briefly to point out certain problems in the case of the nonferrous metals. There are 13 nonferrous metals being stockpiled: antimony, beryl, bismuth, cadmium, celestite, copper, lead, mercury, platinum and iridium, selenium, tin, and zinc.

Recently, the President announced (and I understand that his Industrial College experience is a factor in his familiarity with and interest in materials problems) a new stockpile policy--the long-term stockpile policy--intended further to reduce wartime dependence on foreign sources of metals and minerals. The nonferrous metals have been particularly affected by the new policy.

Chart 2, page 9.--This chart illustrates schematically the application of the new policy. In column 3 supplies from distant foreign countries are discounted completely. Supplies coming from the nearby countries are further discounted to the point that all that we really count on are our relatively close neighbors, and we even discount the domestic production to a certain extent, where there is strategic vulnerability in the case of critical facilities.

Then, comparing that further discounted supply to the requirements results in a long-term stockpile objective. The Government will move as quickly as possible to meet the minimum stockpile objective, because that is the quantity absolutely essential to have on hand to fight a war. In the case of the nonferrous metals, nine are in the 100 percent complete class, insofar as the minimum objective is concerned.

However, in making acquisitions in proceeding from the level of the minimum objective to the new long-term objective, we are moving more deliberately so that we can also assist in maintaining the domestic mobilization base. The domestic minerals industry is one of the main sinews of modern war.

In August 1954 the President directed our agency, the ODM, to buy domestic lead and zinc toward the long-term stockpile objectives, to assist in maintaining the domestic mobilization base for lead and zinc. Accordingly, we are limiting our procurement to newly mined domestic lead and zinc. This has the effect of maintaining in operation a number of United States mines so that, if war comes this year, next year, or in a couple of years from then, that output will be available and can be counted on.

At the start of the Korean War, the stockpile was only about one-third complete on an overall basis. The situation in the case of several nonferrous metals was particularly bad. Accordingly, it was necessary for the Government to make a variety of contractual arrangements to expand supply, some of which we have not seen the end of yet, nor will we for a long time.

Let me give you an illustration of what was involved.

Chart 3, page 13.--This is a schematic illustration of the problem. Let us assume that, at the start of the Korean War, there was a normal domestic production of a certain nonferrous metal--10 units a year.

The question that then arose was: How much should we expand the supply? This was a difficult question to answer, because this question was also involved: By what date do we need the additional supply?

In 1950, when the Korean War started, no one knew whether there would be an all-out war a short time later. Therefore, to complete the stockpile expeditiously, it was necessary to expand the supplies of raw materials. However, the more the domestic supply is expanded, as illustrated by chart, page 9, the less need there is for a stockpile. There is a point where one meets oneself coming around the corner.

If the stockpile objective for a certain nonferrous metal were 100 units and we had none on hand, and war was not expected for about 10 or 11 years, it would be necessary to expand the annual supply of that nonferrous metal only about 10 units. Then, over a period of 10 years, the stockpile could be completed, since it would take about one year to bring the mines into production. By expanding the industry 100 percent, considerable disruption would ensue.

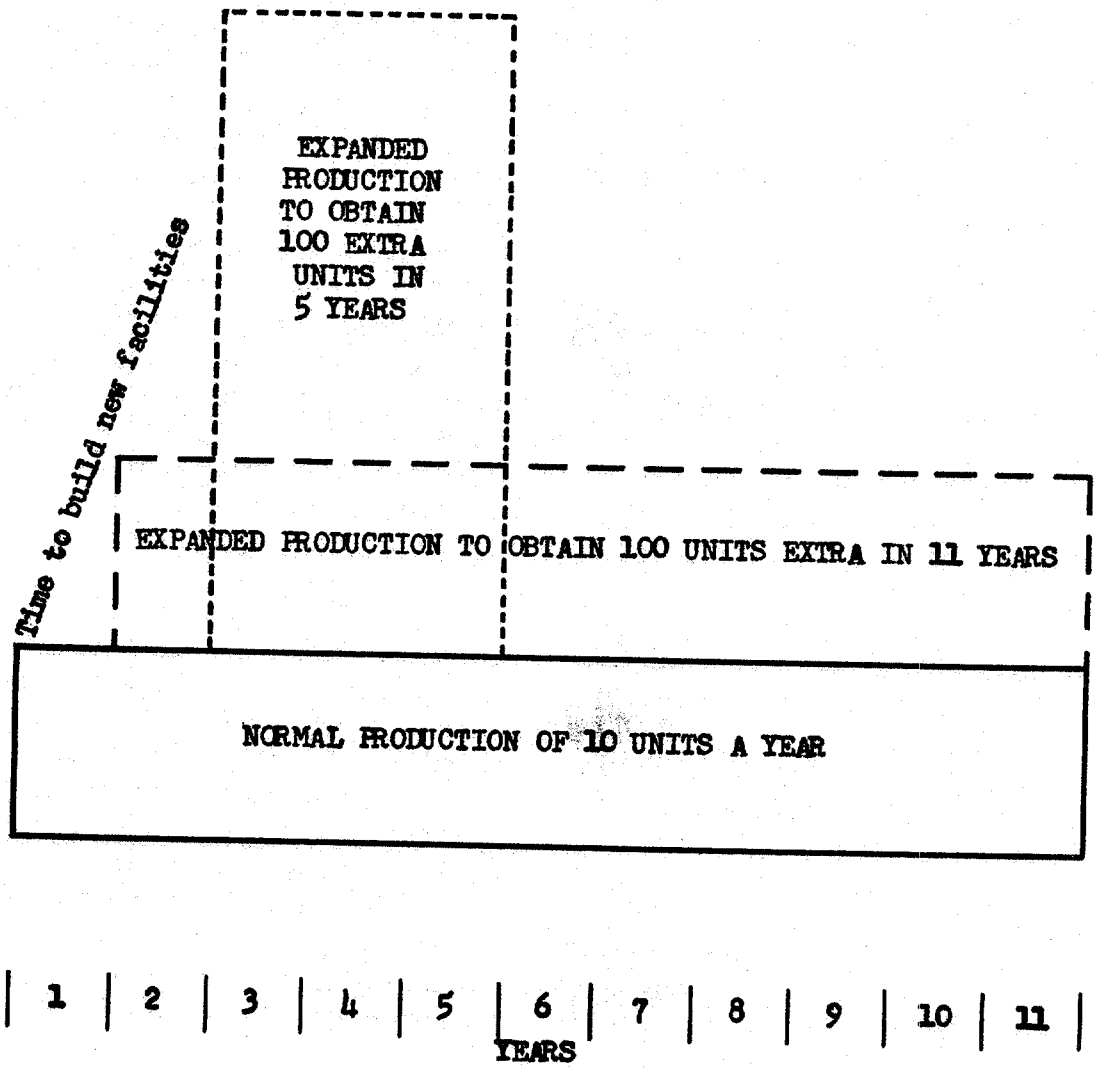
However, if it were necessary to complete the stockpile in five years, it might take at least two years to get into production, because a much bigger mine plant would be required. Consequently an additional annual capacity of about 33 units would be needed. Assuming that two years would be required to get into production, if 33-1/3 units were purchased each year for three years, the stockpile would be complete at the end of five years.

The problems involved in a rapid and large expansion of mine capacity are very great. In the first place most operators would not be interested in a three-year contract since they could not amortize the cost of the facilities in a three-year period. In addition the tax rate might be such that there is little incentive to mine out a deposit in a period of three or four years and sell it all to the Government. With excess-profits taxes, personal taxes, and so forth, the owner would realize little of the value of his ore deposit.

CHART 3

EXPANSION OF PRODUCTION MUST BE RELATED TO REQUIREMENTS

BOTH QUANTITY-WISE AND TIME-WISE



In several cases it was necessary to have the Government contract for quantities in excess of the minimum quantities needed, and some of these contracts are still in effect. In addition it should be noted that in general metal and mineral contracts are exempt from the normal renegotiation statutes.

Let me give you one example of what was involved in expanding nonferrous metals production. In Arizona in World War II, a deposit was discovered by geological and geophysical means. It is known as the San Manuel deposit. It was found too late to be developed during World War II. Then when the Korean War came along, the San Manuel owners came to the Government and reported that they had one of the biggest undeveloped copper properties in the United States. The Government was particularly desirous of expanding the supply of copper within the United States so that we would have it right here at home where we need it.

Under the Defense Production Act, the Government has the authority to make contracts running through 1963. The San Manuel people got a contract that will run for several years after they get into production and it is estimated that about four and a half years would be required to build the facilities. The contract was signed in 1952 and the Government agreed to give them 75 percent accelerated tax amortization. They also required a loan of about 94 million dollars from the Reconstruction Finance Corporation, and the Government contracted to purchase 365,000 tons of copper and 16,000 tons of molybdenum, which latter was a byproduct.

That mine is not yet in production. At present they are sinking the shafts, of which two have been put down and three more are needed. The ore body is about 1,800 feet underground, and they expect to hoist 35,000 tons of ore a day. The mine is expected to come into production about a year from now. They have a floor price on the copper around 24 cents a pound, plus escalation for various contingencies. If the price of copper stays above the floor price in the next several years, the Government will not take title to any of that copper, although it has a first call on any copper, if it needs it. If, on the other hand, the price of copper drops below the floor price in the contract, the Government will take title to the copper. Then ODM will have to determine whether to put it into the stockpile. We will if there is room for it.

However, we can't sit around today and leave the copper stockpile incomplete, wondering whether the price may drop several cents a pound several years from now. Accordingly, we are going ahead and buying additional copper for the stockpile now.

Copper involves the largest amount of Government obligations among the nonferrous metals. Under the Defense Production Act, commitments have been made of about 6.8 billion dollars for all expansion since the start of the Korean War. Machine tools took about 1.2 billion. Aluminum came next with 1.1 billion dollars (that provided for the expansion of the aluminum industry from 750,000 tons a year to 1.5 million tons). Copper required 881 million dollars, largely for guaranteeing the expansion of domestic copper production. The other nonferrous metals involved smaller amounts of money than that. But I have given you the copper case as an illustrative example of one of the biggest programs.

The activity of all the different copper companies will result in a United States domestic copper production of about 250,000 tons a year more than would have existed without the Government guaranteed expansion.

I have one final remark that should be of interest. We think of the steel industry, producing its hundred-odd million tons of steel, using its hundred-odd million tons of iron ore, as the biggest metal industry in the country. That it probably is. I would like to point out, however, that we produce about 800,000 tons of domestic copper a year. A few years ago the average grade of the copper ores mined in this country was around 2 percent. At the present time the average grade of the copper ores mined is slightly above one-half of 1 percent. That means that in the nonferrous metals industry a ton of copper ore is being mined today and is crushed to a size finer than sugar in order to extract 10 pounds of copper, which will be sold at about 30 cents a pound. In order to produce 800,000 tons a year of copper, the copper mining industry has to mine nearly 100 million tons of copper ore, almost as much as the iron ore that the steel industry uses.

Other ores are experiencing the same decline in grade in this country. The metal content of lead and zinc ores is dropping.

Therefore, there is increasing pressure from the domestic mining industry for more protection, such as higher tariffs, more Government contracts, and so forth, as foreign metals take over portions of the United States market--the domestic mining people allege some are being dumped. Therefore, as our defense needs for these metals taper off and as the stockpile is completed, we are running into many serious problems which may involve the Government with the metals industry.

You will read a lot more about these problems in the papers and hear a lot more about them as time goes on.

Thank you very much.

COLONEL BARRETT: Dr. Morgan is ready for your questions.

QUESTION: Dr. Morgan, I believe you said you are stockpiling for a war of several years duration. Who calls the signals on this? Is this thought of as a normal war, a conventional type war?

DR. MORGAN: I wish to point out that you will have a lecture on stockpiling a couple of weeks from now--accordingly, I will cover your stockpile questions only very briefly. The length of the war was originally set out by the Munitions Board when it was responsible for the stockpile program after the passage of the Stockpile Act. ODM has reviewed that and we are continuing the original basis.

QUESTION: What are the sources of your funds for stockpiling, and is any foreign-aid money available to you in this program?

DR. MORGAN: The stockpile purchases materials mainly from appropriations made by Congress to the General Services Administration under the Stockpile Act. Materials are also acquired in exchange for counterpart funds derived from foreign aid under the old ECA-MSA, now the FOA. Materials are also derived from contracts made under the Defense Production Act of 1950. Materials are also derived from surplus transfers by other Government agencies under the Federal Property Act.

QUESTION: I noticed in your talk, as well as in the Paley Report, that silicon is referred to as a metal. I made a check a few moments ago and it is listed there as a nonmetallic element. Does that indicate there has been a difference in classification over the years?

DR. MORGAN: Normally, silicon occurs combined with oxygen as silicon dioxide or in plain language, sand. It is a major nonmetallic mineral when used wherever sand is used. Just recently scientists have been working on silicon by itself and it appears to have some interesting metallic properties. There are many metals that are on the borders of the metallic or nonmetallic categories and they can be called one or the other, depending on the purpose.

QUESTION: Dr. Morgan, you mentioned essential civilian requirements as making up part of the total requirement picture in determining your stockpile objective. What is normally included in essential civilian requirements and what is excluded, generally speaking?

DR. MORGAN: Generally, the essential civilian requirements are what would be necessary to maintain the civilian population at a standard of living of about that of World War II. It has to be determined material by material. For example, rubber for tires on civilian automobiles to get the workers to work could be as important as rubber on military vehicles. Another example, in the nonferrous metals area, a certain number of civilian telephones will have to be manufactured, which in turn will require copper, nickel, tin, and other metals that go into telephones.

QUESTION: Can you state, being close to this problem, if there is exploratory activity going on in the territory of Alaska for nonferrous metals?

DR. MORGAN: I will be glad to answer that question for it will give me an opportunity to describe a program that I had not touched upon at all. To aid in expanding the supply of materials, there is a relatively modest program administered by the Defense Minerals Exploration Administration in the Department of the Interior, operating under funds available under the Defense Production Act. They have 28 million dollars which they use to put up from 50 to 75 percent of the cost of a number of exploration projects.

Let us say, for example, that a copper deposit is suspected to exist. They will send out a couple of geologists and mining engineers from the Geological Survey and the Bureau of Mines to make a tentative examination of the property. If it looks like there is a possibility of mineral occurrence, that could qualify for 50 percent assistance. If the owner finds copper, all he has to do is repay the Government its share on a royalty basis. If nothing is found, which is also important in this field, the results of the project are filed and the debt is canceled.

In answer to your specific question, under this program there are a couple of projects going on in Alaska right now. One in particular comes to mind which was recently investigated by the Joint Committee on Defense Production, headed by Senator Capehart. It involved exploration for tin and tungsten, which four years ago were in pretty short supply. Today, however, little has been found at that site.

QUESTION: In computing the materials required to back up the military requirement, are you using the World War II consumption rates, or are your rates of material use based on some current operating plan. The second part of the question is: Are you allowing anything in there for the disruption of any segment of the economy if this goes into effect?

DR. MORGAN: I don't say this in criticism of the military, because you are all military people here, and I spent several years in the Regular Army myself--but when we get accurate and up-to-date military requirements for materials it will be a wonderful thing. Apparently they must have a strategic plan; then convert it into end items; then further convert it into requirements for materials. The process may take 18 months or two years. It is a pretty hard thing to get done. However, as fast as the military people can give us something that they will stand by, we use it in developing our supply programs.

For example, in calculating the copper requirements, a substantial substitution of steel cases in the larger artillery shells is contemplated, whereas in World War II brass was used. We are now using electrolytic tin plating that requires much less tin and that is reflected. Should there be an increased requirement for lead for nuclear shielding, that would be included.

On the question of disruption in this country, we are trying to eliminate disruption in calculating the size of our long-term objectives. I had indicated before that we actually discount some of the domestic raw materials production and quite a bit of the production in nearby accessible areas just for that hazard, so that, if, for example, much of the copper is processed in one or two major refineries, or if all of the beryllium metal is produced in one facility, we will discount that facility for a period of time and stockpile accordingly, so if the facility is knocked out we still would have the material on hand.

QUESTION: Doctor, from your description of the San Manuel mine project, it would seem that a nice way for a company to have a sure income is to engage in such a project. Why then was the requirement for statutory renegotiation of contracts of that type eliminated? If the aim was incentive to get a company into such a business, I should think the relativity of a sure dollar return would be enough of itself.

DR. MORGAN: The mining industry has a long history of being encouraged to develop the resources in the United States. Going back to

the basic mining laws of the 19th century, which gave prospectors the right to locate on the public lands, and after making a valid discovery of a mineral, to own outright that particular piece of land from the surface of the earth to the middle of the globe, up to the present time, Congress has passed various forms of legislation to encourage domestic mining.

Recently, in the new tax act, higher percentages of depletion were allowed for the strategic metals and minerals. Exemption from the Renegotiation Act was one example of congressional acts intended to encourage the domestic production of strategic metals and minerals. Naturally there is some control--because in negotiating the contracts for expansion, the Government can negotiate carefully; so the possibility of someone making an unholy profit from the negotiated contracts should be small.

QUESTION: In my mind uranium is a nonferrous metal, yet your presentation said little about it. Is it proper to infer that there is no problem with respect to this or is my presumption incorrect?

DR. MORGAN: I deliberately eliminated uranium from my discussion; it is primarily in the province of the Atomic Energy Commission (AEC). Uranium and thorium are the two fissionable materials, which by the Atomic Energy Act, are the exclusive responsibility of the AEC. Under the Defense Production Act, we set aside a little money for uranium exploration, and we have negotiated a few contracts in which uranium was involved on a tie-in basis, but we have no primary responsibility for it. If you have any questions on uranium I think it would be better to ask them when you have a lecture on atomic energy.

COLONEL BARRETT: There will be separate coverage on that.

QUESTION: On your long-range plans or objectives there on that particular chart you show a decrease in domestic production. Do any of your long-range objective charts show an increase in domestic production over the long-range view?

DR. MORGAN: In calculating the domestic supply for the minimum objective, we would count on any readily feasible expansion that would not require premium prices, and so forth; but one of the basic ideas underlying the stockpile is to have the material on hand before the war begins and to thus eliminate the need for uneconomic expansion that requires diversion of men, materials, facilities, and time, once the war

has started. So that in calculating the long-term objectives we would discount the normal United States supply, if there is anything in it that would require premium prices or anything that is particularly vulnerable.

QUESTION: Has your office done anything about encouraging or subsidizing the plastics industry so as to substitute those materials for some of the metals in certain places?

DR. MORGAN: Yes, the use of plastics was encouraged first by asking the services and the civilian industries to use less metal--such as copper. Also, at the time when the metals were under allocation and copper was under the Controlled Materials Plan, if they wanted metal for nonessential uses, they didn't get it.

In addition certain portions of the plastics expansion has received accelerated tax amortization assistance under the authority of the Internal Revenue Act of 1950, but there have been no major procurement contracts for plastics.

QUESTION: Would you say something about the schedule of the San Manuel production? Is it a matter of convenience?

DR. MORGAN: The intent was to get them into operation as fast as possible. With the deposit, as I indicated--1,800 or 2,000 feet underground--they are sinking shafts down to the ore body and putting in the development workings underneath the ore body before starting to mine the ore. In mining a big, low-grade underground mineral deposit, a lot of work has to take place in what is called "development," that is, driving the drifts underneath the ore body, and blocking it out so that the ore, when it is properly blasted, will fall down of its own weight, and the force of gravity will crush it. Working underground, driving entries into the ore body is slow work.

QUESTION: Dr. Morgan, you spoke of maintaining a base with reference to lead and zinc. How do you determine the size of this base or its production level in subsidizing its operation?

DR. MORGAN: I didn't indicate that we have subsidized the mobilization base. I very carefully tried to say, and I will repeat again, that, when we are purchasing materials for the stockpile, we will buy them from domestic producers where such producers are also part of the mobilization base. I didn't say we pay subsidies or premium prices for lead and zinc. We are buying at the market price.

To answer the other half of your question--how do we determine the mobilization base--it is not easy. In the case of metals and minerals production, the Department of the Interior is the delegate agency which is in touch with the industry. They make a complete study of each one of the metals and minerals producing industries to show roughly what level of production could stand on its own feet in fairly normal times.

QUESTION: On two or three occasions now, we have heard previous speakers tell how important the requirement is for titanium. In reading about titanium it seems that we have a very definitive requirement for it in the future; but, it seems to be coming along very slowly. Would you tell us specifically what we are doing to speed it up?

DR. MORGAN: I could give you quite a bit on that, but I believe you are to have a lecture on the light metals. Is that so?

COLONEL BARRETT: That is correct.

DR. MORGAN: Do you expect titanium to be covered?

COLONEL BARRETT: Yes; aluminum, magnesium, and titanium.

DR. MORGAN: Briefly, the situation is that titanium now costs about $5 a pound in sponge form, and it costs $15 to $20 a pound in the forms in which it is ultimately used. Before the Government makes extensive commitments for something that costs $15 or $20 a pound, compared to aluminum, which costs 22 cents a pound, it has to be pretty sure what it is doing. Firm military requirements from the Department of Defense are required.

QUESTION: How and where do you store these tremendous stockpiles?

DR. MORGAN: The stockpiles are stored all over the country, preferably as close as possible to the point of ultimate consumption, and yet outside the danger area that might surround any particular metropolitan location or concentration of industry. They are stored to take advantage of in-transit freight rates, and where possible, they are stored on old military depots and Government warehouses. Most of the nonferrous metals--such as copper, lead, and zinc--can be stored out in the open in the rain on hard stands for convenience of handling, so storage costs are small. Some other stockpile materials require covered storage and special handling. For example, platinum, at $93 an ounce, has to be put in vaults.

COLONEL BARRETT: Dr. Morgan, on behalf of the Commandant, the faculty, and the student body, I thank you for a fine presentation on nonferrous metals resources. Thank you very much.

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